

The Epidemiology of Hip/Groin Injuries in National Collegiate Athletic Association Men's and Women's Ice Hockey

2009-2010 Through 2014-2015 Academic Years

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Background: There is limited research regarding the epidemiology of hip/groin injuries in ice hockey, the majority of which is restricted to time-loss injuries only.

Purpose: To describe the epidemiology of hip/groin injuries in collegiate men's and women's ice hockey from 2009-2010 through 2014-2015.

Study Design: Descriptive epidemiology study.

Methods: Hip/groin injury data from the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP) during the 2009-2010 through 2014-2015 seasons were analyzed. Injury rates, rate ratios (RRs), and injury proportion ratios (IPRs) were reported with 95% confidence intervals (CIs).

Results: During the 2009-2010 through 2014-2015 seasons, 421 and 114 hip/groin injuries were reported in men's and women's ice hockey, respectively, leading to injury rates of 1.03 and 0.78 per 1000 athlete-exposures (AEs), respectively. The hip/groin injury rate was greater in men than in women (RR, 1.32; 95% CI, 1.08-1.63). In addition, 55.6% and 71.1% of hip/groin injuries in men's and women's ice hockey, respectively, were non-time loss (NTL) injuries (ie, resulted in participation restriction time <24 hours); 7.6% and 0.9%, respectively, were severe (ie, resulted in participation restriction time >3 weeks). The proportion of hip/groin injuries that were NTL injuries was greater in women than in men (IPR, 1.28; 95% CI, 1.11-1.48). Conversely, the proportion of hip/groin injuries that were severe was greater in men than in women (IPR, 8.67; 95% CI, 1.20-62.73). The most common hip/groin injury diagnosis was strain (men, 67.2%; women, 76.3%). Also, 12 (2.9%) and 3 (2.6%) cases of hip impingement were noted in men's and women's ice hockey, respectively.

Conclusion: Hip/groin injury rates were greater in men's than in women's ice hockey. Time loss varied between sexes, with men sustaining more injuries with time loss over 3 weeks. Despite increasing concerns of femoroacetabular impingement in ice hockey players, few cases of hip impingement were reported in this dataset.

Keywords: epidemiology; athlete-exposure; non-time loss injury; recurrent; femoroacetabular impingement

Ice hockey is fast paced and unpredictable, with an inherently high risk of injuries.^{9,18} Relative to other sports, ice hockey practice injury rates are low and competition injury rates are high for both men and women.^{9,13,14} Compared with women, men sustain ice hockey injuries at a higher rate at all levels of competition.¹⁴ The hip/groin region is a complex region of anatomy that poses difficulties for prevention, management, and rehabilitation.³ Housing the

body's center of gravity, nearly every athletic movement requires force generation through the hip/groin region, including loads up to 8 times one's body weight while jogging.³ Therefore, even greater loads are placed on the hip joints during vigorous athletic activity.³

There is limited research on hip/groin injuries in ice hockey. Previous research has noted that the hip/groin region comprises approximately 9% of all ice hockey injuries,⁹ hip injury rates are higher in competition versus practice,¹ and that hip/groin strains have high recurrent rates, likely due to the biomechanical forces involved in skating, inadequate rehabilitation, or time to recovery.²⁶

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However, the understanding of functional anatomy surrounding the hip/groin and advancements in hip arthroscopy have improved, which may have led to more athletes presenting with general hip pain and injury.²³ Notably, between 1991 and 1999, the National Hockey League (NHL) exhibited a significant increase in groin-related injuries, with more than 20 athletes on the NHL's injury list due to groin-related issues in 1999.³

Improved diagnostics have allowed for more accurate diagnosis of hip/groin injuries. However, little research has examined hip/groin injuries, and the studies that have been done have been limited to examining time-loss (TL) injuries only (ie, injuries resulting in participation restriction of at least 24 hours)¹ or intra-articular hip injuries among elite athletes.⁸ At the beginning of the 2009-2010 academic year, the National Collegiate Athletic Association (NCAA) Injury Surveillance Program (ISP) began to track non-time loss (NTL) injuries (ie, injuries resulting in participation restriction <24 hours).¹² Thus, injuries that may cause pain and are reported to sport medicine clinicians but do not inhibit gameplay are reported within the NCAA-ISP. The purpose of this study was to describe the epidemiology of hip/groin injuries reported by athletic trainers (ATs) in collegiate men's and women's ice hockey during the 2009-2010 through 2014-2015 academic years.

METHODS

The NCAA-ISP is a prospective surveillance program that has been ongoing since the early 1980s and is currently managed by the Datalys Center for Sports Injury Research and Prevention (hereafter known as the Datalys Center), an independent, nonprofit research organization.¹² Data included originates from 6 years of men's and women's ice hockey data collected during the 2009-2010 through 2014-2015 academic years. This study was approved by the Research Review Board of the NCAA. The methodology of the NCAA-ISP has been previously described,¹² but is briefly summarized below.

Data Collection

The NCAA-ISP utilized a convenience sample of NCAA varsity teams across all divisions that sponsor ice hockey (Divisions 1 and 3) from 25 sports with participating teams' ATs reporting injury and exposure data. The number of programs providing data varied by sport and year.¹² During the 2009-2010 through 2014-2015 academic years, 66 men's ice hockey programs provided 148 team-seasons of data; 30 women's ice hockey programs provided 68 team-seasons of data.

The ATs attended school-sanctioned practices and competitions and logged the number of student-athletes participating in each practice and competition. Injuries were reported in real time through the electronic health record application used by the team medical staff throughout the academic year. In addition to injuries, the surveillance system also captured other sports-related adverse health events, including illness, heat-related conditions, general medical conditions, and skin infections. Data included varsity level practices and competitions and team conditioning sessions but excluded individual weight-lifting and conditioning sessions.

The AT completed a detailed event report on the injury or condition, selecting preset values for variables such as body site, diagnosis, and injury mechanism. Body sites that could be selected included abdomen, ankle, arm (upper), cervical spine/neck, chest/ribs, ear, elbow, eye, foot/toes, forearm, hands/fingers, head/face, hip/groin, knee, lower leg/Achilles, lumbar spine/lower back, mouth, nose, sacrum/pelvis, shoulder/clavicle, thigh, thoracic spine/upper back, and wrist. ATs also selected 1 of approximately 50 diagnosis categories, including cartilage injury, contusion, fracture, impingement, spasm, and strain. Injury mechanism included player contact, surface contact, non-contact, overuse, as well as contact related to specific equipment such as boards, puck, skates, and stick. This study included only those injuries where the body site injured was identified as "hip/groin."

After initially inputting injury data, the ATs could return to view and update the data as needed over the course of a season. For example, if additional follow-up care provided evidence of initial misclassification of the diagnosis, then the AT could modify the diagnosis selected, or when the student-athlete returned to sports participation, the return date could be added. In addition, the ATs were able to flag those hip/groin injuries that were recurrent.

Deidentified common data elements (CDEs) were extracted from certified electronic health record applications.¹² The CDEs included injury and exposure information, were stripped of any identifiers, and encrypted prior to export to the central aggregate research database. The frequency of export or submission of data varied slightly among health record application vendors. This CDE standard allowed ATs to document injuries normally as part of their daily clinical practice as opposed to having them separately report injuries for injury surveillance program purposes. All certified electronic health record applications had to successfully complete a data validation process to be certified.

Exported data passed through an automated verification process that conducted a series of range and consistency checks. Data were reviewed and flagged for invalid values.

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TABLE 1
Hip/Groin Injury Rates by Division and Type of Athlete Exposure
in NCAA Men's and Women's Ice Hockey, 2009-2010 Through 2014-2015^a

	Men's Ice Hockey		Women's Ice Hockey	
	Injuries in Sample, n	Rate per 1000 AEs (95% CI)	Injuries in Sample, n	Rate per 1000 AEs (95% CI)
Competition	210	2.12 (1.83-2.41)	28	0.72 (0.45, 0.99)
Practice	211	0.68 (0.59-0.78)	86	0.80 (0.63, 0.97)
Overall	421	1.03 (0.93, 1.13)	114	0.78 (0.64, 0.92)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2009-2010 through 2014-2015. AE, athlete-exposure; NCAA, National Collegiate Athletic Association.

The ATs and data quality assurance staff were notified and worked together to resolve the issue. Data that passed the verification process were then placed into the aggregate research dataset.

Definitions

A reportable injury occurred as a result of participation in an organized intercollegiate practice or competition and required the attention from an AT or a physician. Multiple injuries could be included as the result of 1 injury event. A reportable athlete-exposure (AE) was defined as 1 student-athlete participating in 1 NCAA-sanctioned practice or competition in which he or she was exposed to the possibility of athletic injury regardless of the time associated with that participation. Only athletes with actual playing time in a competition were included in competition exposures. We relied on the expertise and training of the ATs providing data to accurately define the body part and diagnosis of injuries.

Hip/groin injuries were also categorized by the number of days in which athletes were restricted from participation. In addition to classifying injuries as NTL and TL, we also considered severe injuries,⁶ or TL injuries resulting in participation restriction over 3 weeks or student-athletes prematurely ending their season (ie, season-ending injury).

Statistical Analysis

Data were analyzed to assess rates and patterns of hip/groin injury sustained during collegiate ice hockey. We calculated hip/groin injury rates overall and by event type. We then examined injury rates by diagnosis, injury mechanism, and injury activity and injury distributions by participation restriction time (ie, percentage of NTL injuries, percentage of severe injuries), surgery needs, and recurrence. Rate ratios (RRs) compared rates by event type (ie, competition and practice). The RRs also compared rates between men's and women's ice hockey. Injury proportion ratios (IPRs) compared injury proportions by participation restriction time, surgery needs, and recurrence. All 95% CIs without 1.00 were considered statistically significant. Data were analyzed using SAS-Enterprise Guide software (version 4.3; SAS Institute Inc).

RESULTS

Overall Rates and Frequencies

Men's Ice Hockey. During the 2009-2010 through 2014-2015 academic years, 421 hip/groin injuries were sustained by 320 student-athletes in men's ice hockey (range, 1-5 injuries per student-athlete) (Table 1). These injuries were sustained during 407,918 AEs, leading to an injury rate of 1.03 per 1000 AEs. Although approximately half of all hip/groin injuries occurred during practice (50.1%, n = 211), the competition rate (2.12/1000 AEs) was greater than the practice rate (0.68/1000 AEs; RR, 3.10; 95% CI, 2.56-3.76). Of all hip/groin injuries, 19.5% (n = 82) were recurrent and 3.1% (n = 13) required surgery. In addition, 55.6% (n = 234) were NTL injuries and 7.6% (n = 32) were severe. The most common severe injuries were diagnosed as strains (n = 16) followed by cartilage injuries (n = 6).

Women's Ice Hockey. During the 2009-2010 through 2014-2015 academic years, 114 hip/groin injuries were sustained by 90 student-athletes in women's ice hockey (range, 1-3 injuries per student-athlete) (Table 1). These injuries were sustained during 146,057 AEs, leading to an injury rate of 0.78 per 1000 AEs (Table 1). Although approximately three-fourths of all hip/groin injuries occurred during practice (75.4%, n = 86), the practice rate (0.72/1000 AE) did not differ from the competition rate (0.80/1000 AEs; RR, 0.90; 95% CI, 0.59-1.37). Of all hip/groin injuries, 24.6% (n = 28) were recurrent and 1.8% (n = 2) required surgery. In addition, 71.1% (n = 81) were NTL injuries and 0.9% (n = 1) were severe. The 1 severe injury was diagnosed as a strain.

Sex-Based Differences. Overall, the hip/groin injury rate in men's ice hockey was greater than that of women's ice hockey (RR, 1.32; 95% CI, 1.08-1.63). This difference was retained in competitions (RR, 2.94; 95% CI, 1.98-4.37) but not in practices (RR, 0.85; 95% CI, 0.66-1.09). In addition, there were no differences in the proportions of hip/groin injuries that were recurrent (IPR, 0.79; 95% CI, 0.54-1.15) or required surgery (IPR, 1.76; 95% CI, 0.40-7.69). However, the percentage of hip/groin injuries that were NTL injuries was greater in women compared with men (IPR, 1.28; 95% CI, 1.11-1.48). The proportion of hip/groin injuries that were severe was greater in men compared with women (IPR, 8.67; 95% CI, 1.20-62.73).

TABLE 2
Hip/Groin Injury Rates by Diagnosis in NCAA Men's and Women's Ice Hockey, 2009-2010 Through 2014-2015^a

Diagnosis	Injuries in Sample, n	Rate per 1000 AEs (95% CI)	NTL, % ^{b,c}	Severe, % ^{c,d}	Recurrent, % ^c	Requiring Surgery, % ^c
Men's ice hockey						
Cartilage injury	15	0.04 (0.02-0.06)	60.0	40.0	46.7	60.0
Contusion	71	0.17 (0.13-0.21)	71.8	4.2	7.0	0.0
Fracture	1	<0.01 (0.00-0.01)	—	—	—	—
Impingement	12	0.03 (0.01-0.05)	58.3	8.3	16.7	0.0
Spasm	8	0.02 (0.01-0.03)	87.5	0.0	0.0	0.0
Strain	283	0.69 (0.61-0.77)	49.8	5.7	22.6	0.4
Other/unknown	31	0.08 (0.05-0.10)	61.3	16.1	12.9	9.7
Total	421	1.03 (0.93-1.13)	55.6	7.6	19.5	3.1
Women's ice hockey						
Cartilage injury	4	0.03 (0.00-0.05)	—	—	—	—
Contusion	10	0.07 (0.03-0.11)	80.0	0.0	10.0	0.0
Fracture	0	0.00	—	—	—	—
Impingement	3	0.02 (0.00-0.04)	—	—	—	—
Spasm	0	0.00	—	—	—	—
Strain	87	0.60 (0.47-0.72)	70.1	1.2	24.1	0.0
Other/unknown	10	0.07 (0.03-0.11)	70.0	0.0	30.0	0.0
Total	114	0.78 (0.64-0.92)	71.1	0.9	24.6	1.8

^aData originate from the Datalyx Center for Sports Injury Research and Prevention Injury Surveillance Program, 2009-2010 through 2014-2015. AE, athlete-exposure; NCAA, National Collegiate Athletic Association; NTL, non-time loss.

^bIncludes injuries that resulted in time loss <24 hours.

^cPercentages not calculated when injury count is <5.

^dIncludes injuries that resulted in time loss >3 weeks or the student-athlete prematurely ending their season.

Hip/Groin Injury Distributions

By Diagnosis and Injury Mechanism. The most common hip/groin injury diagnoses were strains (men, 67.2%, n = 283; women, 76.3%, n = 87) and contusions (men, 16.9%, n = 71; women, 8.7%, n = 10) (Table 2). In particular, 12 (2.9%) and 3 (2.6%) cases of hip impingement were noted in men's and women's ice hockey, respectively. The most common injury mechanisms in men's and women's ice hockey hip/groin injuries were noncontact (49.4%, n = 208 and 58.8%, n = 67, respectively) and overuse (17.6%, n = 74 and 18.4%, n = 21, respectively) (Table 3). In addition, 27.1% (n = 114) and 13.2% (n = 15) of men's and women's ice hockey hip/groin injuries, respectively, were due to contact. Most men's ice hockey contact-related hip/groin injuries were from player contact (13.1%, n = 55), whereas most women's ice hockey contact-related hip/groin injuries were from surface contact (6.1%, n = 7). The only injury mechanism-specific sex difference found was that the rate of hip/groin contusions in men was larger than that of women (RR, 2.54; 95% CI, 1.31-4.93). The player contact hip/groin injury rate in men (0.13/1000 AEs) was greater than that in women (0.03/1000 AEs; RR, 4.92; 95% CI, 1.78-13.59). Also, the board contact hip/groin injury rate in men (0.07/1000 AEs) was greater than that in women (0.01/1000 AEs; RR, 5.37; 95% CI, 1.28-22.47).

By Position. Position was not available for 26 (6.2%) men's and 6 (5.3%) women's ice hockey hip/groin injuries. Of the remaining hip/groin injuries with known position, the forward was the most common position injured (men, 50.6%, n = 200; women, 50.9%, n = 55). Compared with all other positions, goaltenders were more likely to have

noncontact injuries in men's ice hockey (66.0% vs 48.3%; IPR, 1.37; 95% CI, 1.08-1.72) but not in women's ice hockey (66.1% vs 57.8%; IPR, 1.06; 95% CI, 0.70-1.59).

DISCUSSION

This study examined the descriptive epidemiology of hip/groin injuries in NCAA men's and women's ice hockey. Our study includes the largest sample of men's and women's ice hockey hip/groin injuries to date to our knowledge. In addition, our sample includes TL and NTL injuries, which allows for a better estimate of the spectrum of injuries presented to ATs in the collegiate ice hockey setting. Previous research has shown that NTL injuries account for 78% and 84% of the injuries reported in men's and women's collegiate sports, respectively,²⁰ although ice hockey was not included in the sample. In the current study, the overall rate of hip/groin injuries was greater in men than women. Our inclusion of NTL injuries as opposed to previous research that only included TL injuries may have resulted in contrasting findings.² Our findings, however, support previous research that the men's competition injury rate is greater than the practice rate, and that hip/groin strains comprised the largest proportion of diagnoses for both men's and women's ice hockey. Awareness regarding these injuries may have increased alongside better detection of related pain.

Limitations

Our sample is a convenience sample and, therefore, may not be generalizable to the entire collegiate ice hockey

TABLE 3
Hip/Groin Injury by Injury Mechanism in NCAA Men's and Women's Ice Hockey, 2009-2010 Through 2014-2015^a

Injury Mechanism	Injuries in Sample, n	Rate per 1000 AEs (95% CI)	NTL, % ^{b,c}	Severe, % ^{c,d}	Recurrent, % ^c	Requiring Surgery, % ^c
Men's ice hockey						
Player contact	55	0.13 (0.10-0.17)	36.4	9.1	12.7	0.0
Surface contact	12	0.03 (0.01-0.05)	75.0	0.0	0.0	0.0
Boards contact	30	0.07 (0.05-0.10)	80.0	6.7	10.0	0.0
Puck contact	3	0.01 (0.00-0.02)	—	—	—	—
Skates contact	1	<0.01 (0.00-0.01)	—	—	—	—
Stick contact	8	0.02 (0.01-0.03)	75.0	0.0	0.0	0.0
Other contact ^e	5	0.01 (0.00-0.02)	—	—	—	—
Noncontact	208	0.51 (0.44-0.58)	56.3	5.8	22.1	1.9
Overuse	74	0.18 (0.14-0.22)	46.0	14.9	32.4	10.8
Other/unknown	25	0.06 (0.04-0.09)	64.0	8.0	8.0	4.0
Total	421	1.03 (0.93-1.13)	55.6	7.6	19.5	3.1
Women's ice hockey						
Player contact	4	0.03 (0.00-0.05)	—	—	—	—
Surface contact	7	0.05 (0.01-0.08)	57.1	0.0	14.3	0.0
Boards contact	2	0.01 (0.00-0.03)	—	—	—	—
Puck contact	0	0.00	—	—	—	—
Skates contact	0	0.00	—	—	—	—
Stick contact	1	0.01 (0.00-0.02)	—	—	—	—
Other contact ^e	1	0.01 (0.01-0.02)	—	—	—	—
Noncontact	67	0.46 (0.35-0.57)	74.6	1.5	23.9	1.5
Overuse	21	0.14 (0.08-0.21)	71.4	0.0	42.9	0.0
Other/unknown	11	0.08 (0.03-0.12)	54.6	0.0	0.0	9.1
Total	114	0.78 (0.64-0.92)	71.1	0.9	24.6	1.8

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2009-2010 through 2014-2015. AE, athlete-exposure; NCAA, National Collegiate Athletic Association; NTL, non-time loss.

^bIncludes injuries that resulted in time loss <24 hours.

^cPercentages not calculated when injury count is <5.

^dIncludes injuries that resulted in time loss >3 weeks or the student-athlete prematurely ending their season.

^eIncludes contact with out-of-bounds objects and other unspecified equipment.

student-athlete population or other levels of ice hockey competition. In addition, our study utilized surveillance data; individual risk factors that may predispose student-athletes to hip/groin injuries and further specifics about the use and types of imaging, treatment, and surgery utilized could not be examined. It is possible that some diagnoses may have been based on clinical findings alone and did not have confirmatory studies performed. ATs' clinical approach to and knowledge of the rapidly expanding field of athletic hip injuries cannot be accounted for regarding their effect on injury rates. We also cannot account for variations in the composition of the team medical staff with which participating ATs work to identify, diagnose, and manage injuries; these variations may occur between divisions (eg, Division 1 vs Division 3) as well as within divisions (eg, large vs small university). Certainly with an increasing awareness of femoroacetabular impingement (FAI) and cartilage lesions, ATs may be diagnosing the condition more frequently and perhaps taking a more conservative approach to athletes' rehabilitation, leading to an increase in time-loss associated with these injuries. Historically, there are few cases of hip impingement and no registered cases of FAI in the NCAA-ISP, although they are common in the research; in addition, older studies may not have even included FAI as a potential diagnosis code. Thus, collection versus actual incidence of these pathologies

warrants future research. Finally, with regard to the discussion of hip injuries in goaltenders, it is important to note that the style of goaltending was not recorded in the data. However, personal communications with former collegiate and professional hockey players have noted that modern goaltenders employ a hybrid of butterfly and traditional standup styles; thus, it is reasonable to assume that our population reflects a similar style.

Event Type and Participation Restriction Time

In men's ice hockey, although approximately the same number of hip/groin injuries occurred in competitions and practices, the competition rate was greater than the practice rate. This is similar to previous research utilizing NCAA-ISP data from 1989-1990 through 2003-2004.¹ In contrast, in women's ice hockey, competition and practice rates did not differ. The high competition rates in men may be due to the nature of ice hockey, in which aggressive, fast-paced play alongside "subbing on-the-fly" and checking may place athletes at greater risk for injury during competition.¹³ In addition, players likely do not check as aggressively or illegally in practice, thus decreasing the risk of checking-related injuries in practice. Checking not being allowed in women's ice hockey may further emphasize why men's ice hockey had a greater competition injury rate than

practice while there was no difference between event types in women's ice hockey; men may sustain hip-/groin-related injuries while avoiding contact from opponents as well.

The similarities in rates by event type in women's ice hockey may be partially attributable to rules that prohibit checking. This is further supported by findings that the rates of hip/groin injuries due to player contact and board contact in men was greater than in women. The proportion of NTL injuries was greater among women, and the proportion of severe injuries was greater among men, which may further suggest differences in the playing styles and rules of men's and women's ice hockey. Future research should continue to observe how rule and style differences between men's and women's ice hockey are associated with injury risk. Few hip/groin injuries required surgical treatment. Future research is warranted with larger samples of ice hockey hip/groin injuries requiring surgery.

Injury Mechanism

In both men's and women's ice hockey, the most common injury mechanism was noncontact, which can be attributed to factors such as the biomechanics of the ice hockey skating gait and the complexity of the hip/groin region. The biomechanics of ice skating require great balance, precision, and control of technical skills^{17,27} while withstanding excessive tensile and compressive forces during acceleration and deceleration.⁴ Additionally, approximately 24 muscles act on the hip joint, many of which have several actions dependent on joint positioning.¹¹ There are often strength imbalances among ice hockey athletes, whether between contralateral hip musculature or between agonist and antagonist muscles, and these imbalances predispose athletes to injury.^{24,25} Ice hockey athletes are 17 times more likely to injure their groin region when adductor strength is less than 80% of his or her abductor strength.^{11,24}

Early childhood specialization may also contribute to the high rate of noncontact/general play injuries in our sample. Early specialization leads to compromised growth and maturation where adolescents do not diversify their skills and muscle development, leading to increased accumulation of movement-specific overuse injuries.^{15,16} It has been suggested that muscle weakness is a risk factor for adductor/groin strains, whereas decreased flexibility is not.²⁴ Additionally, previous research reported 14 of 39 and 25 of 39 asymptomatic ice hockey players had positive magnetic resonance imaging findings for adductor–abdominal rectus dysfunction and hip pathologic changes, respectively.²² It is possible that these asymptomatic anatomical abnormalities may predict future disabilities. Further research is needed to determine the significance of these imaging findings, however.

Position

All positions for both sexes most commonly sustained noncontact and strain injuries. However, our AEs were not collected by position; therefore, we were unable to calculate position-specific injury rates. Previous research at the elite level has collected position-specific exposure data, finding a

greater rate of intra-articular hip injuries per game appearance in goaltenders than other positions.⁸ Future research that calculates position-specific exposures is necessary to examine whether injury rate discrepancies seen at the elite level occur within the collegiate level.

Examining position more in depth is important, especially for the goaltenders who utilize “butterfly” positioning^{10,19,29} and have limited time involved in player-to-player contact. As goaltenders drop into the butterfly position, their hips may exceed their active internal rotation range of motion¹⁰ with concurrent hip flexion.^{28,29} It was estimated that goaltenders drop to the butterfly position an average of 34 times per game and 300 times per practice.^{5,7} Extreme joint positions in the hip/groin region also occur during both deceleration, which mostly affects forwards and defense, and recovery from the butterfly position to a ready position.^{28,29} These vulnerable positions must be considered when treating FAI, which has become an increasingly common diagnosis in ice hockey players, especially goaltenders.^{21,23,28,29} However, FAI is also difficult to diagnose apart from strains, particularly since the pathophysiology of FAI is still poorly understood. Thus, as suggested in previous research,^{4,18} our sample may include misdiagnosed FAI and strain cases. Future research needs to continue examining how the onset of FAI occurs while considering methods that better document FAI cases.

Prevention

Although injuries may be inherent with ice hockey participation, sports medicine clinicians must adopt strategies to reduce hip/groin injuries. In a study observing the effectiveness of a preseason preventative exercise program, 33 of 58 professional ice hockey athletes were deemed “at risk” for adductor strains based on preseason hip adductor strength testing. After the strength-focused intervention was implemented, only 3 adductor strains were sustained in the 2 subsequent seasons; 11 adductor strains were sustained in the 2 seasons prior to the intervention.²⁴ In addition, ice hockey policy makers should investigate possible rule changes and equipment modifications that would reduce hip/groin injury rates. Furthermore, adolescents should consider remaining diversified in sport, especially those sports that may not place as much stress on the hip/groin region. Future research is needed to further examine the efficacy of such interventions.

Strength/conditioning programs are particularly important because of the large proportion of recurrent hip/groin injuries in our sample as well as for the injury prevention mechanism noted above. Nearly one-fifth and one-fourth of all hip/groin injuries were recurrent in men's and women's ice hockey, respectively. In addition to the approximate 24 muscles acting on the hip/groin region, the hip joint has 6 degrees of freedom, contains the body's center of gravity, and has multiple biarticulate muscles.¹¹ Given the complexity of the hip/groin region and its involvement in force generation for nearly every athletic movement, ATs are posed with very difficult rehabilitation processes. Skating requires the recruitment of the entire kinetic chain, so rehabilitation must have a holistic approach involving all

joints of the lower extremity as well as core.^{17,27} Thus, strength/conditioning programs must also account for initial and recurrent injury risk factors such as premature return to play with inadequate rehabilitation, poor skating technique/skills, and anatomic abnormalities. Future research is needed to determine the efficacy of holistic rehabilitation and strength/conditioning programs in decreasing overall and recurrent injury rates.

CONCLUSION

Our sample reported on both TL and NTL injuries, with NTL comprising the majority of both men's and women's ice hockey hip/groin injuries. Strains were also the most commonly reported injury. Contact-related injuries were more common in men than women, and men's hip/groin injury rates were greater in competitions than during practices, although no differences were found in women. Such findings may be the result of rule differences, particularly as checking is not allowed in women's ice hockey. FAI was an uncommon diagnosis in the population. Future surveillance is required to better estimate hip/groin injury rates, particularly as improved diagnostics are introduced.

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