

Epidemiology of Injuries in National Collegiate Athletic Association Men's Ice Hockey: 2014–2015 Through 2018–2019

Adrian J. Boltz, MSH*[†]; Aliza K. Nedimyer, MA, LAT, ATC†‡; Avinash Chandran, PhD, MS*[†]; Hannah J. Robison, MS, LAT, ATC*[†]; Christy L. Collins, PhD*[†]; Sarah N. Morris, PhD*

*Datalys Center for Sports Injury Research and Prevention, Indianapolis, IN; †Human Movement Science Curriculum and Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, Department of Exercise and Sport Science, University of North Carolina at Chapel Hill; ‡Curriculum in Human Movement Science, Department of Allied Health Sciences, School of Medicine, The University of North Carolina at Chapel Hill

Context: The National Collegiate Athletic Association has supported men's ice hockey, a distinct sport that mandates high-velocity gamesmanship, since 1974.

Background: Injury surveillance systems are designed to identify evolving injury trends and their temporal qualities. Continual monitoring of collegiate men's ice hockey athletes remains essential.

Methods: Exposure and injury data collected in the National Collegiate Athletic Association Injury Surveillance Program from 2014–2015 through 2018–2019 were analyzed. Injury counts, rates, and proportions were used to describe injury characteristics, and injury rate ratios (IRR) were used to examine differential injury rates.

Results: The overall injury rate was 7.65 per 1000 athlete-exposures. Injuries from competition occurred at a rate nearly 7 times that from practice injuries (IRR = 6.54, 95% CI = 6.08, 7.04). The most common specific injury diagnoses were concussions (9.6%), acromioclavicular sprains (7.3%), and medial collateral ligament tears (3.7%).

Summary: Injury rates by event type and season segment were higher than previously reported. Contusions accounted for nearly a quarter of all injuries, and acromioclavicular sprain rates increased notably across the study period.

Key Words: college, sport-related, injury surveillance

Key Points

- Competition-related injury rates, regardless of season segment, were higher than practice-related injury rates.
- The most commonly injured body parts were shoulder, and head/face; a greater proportion of shoulder and head/face injuries were reported in competitions than in practices.
- The most commonly reported specific injuries during the study period were concussions, acromioclavicular joint sprains, and medial collateral ligament tears; rates of acromioclavicular joint sprains, and medial collateral ligament tears steadily increased between 2015/16 and 2017/18 before slightly decreasing during the final year of the study.

The sport of ice hockey is played by athletes of all ages across the globe. Thus, ice hockey has a large presence in the United States, with nearly 400 000 youth athletes and over 150 000 adult athletes¹ participating in USA Hockey–sponsored programs in 2018–2019. It follows that collegiate ice hockey in the United States is also popular, with over 4000 athletes participating in men's ice hockey programs as part of the National Collegiate Athletic Association (NCAA) during the 2018–2019 academic year.² The NCAA first sponsored men's ice hockey championships³ in 1974, and the number of NCAA membership programs has continually increased since then. By 2018–2019, a total of 150 men's ice hockey programs competed across 3 divisions as part of the NCAA.²

Knowing that there is, and will continue to be, a substantial population of collegiate men's ice hockey players in the United States, it is important to continuously obtain information about injuries sustained by such athletes.

Sports injury surveillance has been consistently used to describe injury patterns among large populations of athletes.⁴ Data captured within surveillance systems are often instrumental in developing etiological hypotheses that can be examined further in subsequent small-scale studies.^{4,5} Beginning in 1982, the NCAA developed an injury surveillance system, which has advanced over time in data collection methodology to its current form known as the Injury Surveillance Program (ISP).^{6,7} The NCAA ISP has captured data on men's ice hockey–related injuries since its inception and has been integral in appraising the nature and frequency of injuries sustained by these collegiate athletes.^{3,8,9} Previous ice hockey studies have

The articles in this issue are published as accepted and have not been edited.

identified an overall injury rate of approximately 5 injuries per 1000 athlete-exposures (AEs).⁹ Studies have also reported higher competition injury rates (16.3/1000–18.7/1000 AEs) than practice injury rates (2.0/1000–2.2/1000 AEs) in this population.^{3,8} Furthermore, it has also been noted that the most commonly injured body parts in this group are the hip/thigh/upper leg, shoulder/clavicle, and head/face, with most injuries classified as muscle/tendon strains and sprains.⁹ Previous studies have also found that concussion rates are higher in competitions than in practices.^{3,9} However, since those examinations, notable rule changes have been implemented that may have affected the incidence of injuries in NCAA men's ice hockey; in particular, amendments have been made to position-specific (attacking player and goaltender) rights inside or outside the crease and to the definition of the “slashing” penalty. Therefore, recurrent and periodic evaluations of the burden of ice hockey-related injuries in this population are needed to identify emerging patterns and inform effective injury prevention practices.^{10–12} Thus, the purpose of this study was to describe the epidemiology of men's ice hockey-related injuries captured among NCAA men's ice hockey players between 2014–2015 and 2018–2019.

METHODS

Study Data

Men's ice hockey exposure and injury data collected in the NCAA ISP during the 2014–2015 through 2018–2019 athletic seasons were analyzed in this study. The methods of the NCAA ISP have been reviewed and approved as an exempt study by the NCAA Research Review Board. In brief, athletic trainers (ATs) at participating institutions contributed exposure and injury data using their clinical electronic medical record systems. A *reportable injury* was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified AT or physician, regardless of time lost. Scheduled team practices and competitions were considered reportable exposures for this analysis. Data from 41 (30% of membership with sponsored programs) participating programs in 2014–2015; from 23 (16% of membership with sponsored programs) in 2015–2016; from 26 (18% of membership with sponsored programs) in 2016–2017; from 23 (16% of membership with sponsored programs) in 2017–2018; and from 35 (23% of membership with sponsored programs) in 2018–2019 qualified for inclusion in analyses. Qualification criteria are detailed further in the methods article in this issue.¹³

Statistical Analysis

Injury counts and rates per 1000 AEs were examined by event type (practice, competition), season segment (pre-season, regular season, postseason), and time loss (time loss [TL], non-time loss [NTL]). An AE was defined as 1 athlete participating in 1 exposure event. Weighted and unweighted rates were estimated; however, results are presented in terms of unweighted rates (unless otherwise specified) due to low frequencies of injury observations across levels of certain covariates. Temporal trends in injury rates across the study period were evaluated using

rate profile plots stratified by levels of explanatory variables. Similarly, temporal trends in rates of most commonly reported injuries were also examined across the study period. Injury counts and proportions were examined by TL, body part injured, mechanism of injury, injury diagnosis, player position, and activity at the time of injury. Injury rate ratios (IRR) were used to examine differential injury rates across event types and season segments. The IRRs with associated 95% confidence intervals (CIs) excluding 1.00 were considered statistically significant. All analyses were conducted using SAS (version 9.4; SAS Institute).

RESULTS

Overall, a total of 3330 men's ice hockey injuries (national estimate: 18 109) from 435 120 AEs were reported to the NCAA ISP between 2014–2015 to 2018–2019; this equated to an injury rate of 7.65 injuries per 1000 AEs (Table 1). A total of 1014 injuries from practice events and 2316 injuries from competition events were reported. The competition injury rate was significantly higher than the practice injury rate (IRR = 6.54, 95% CI = 6.08, 7.04). Competition and practice injury rates by year were relatively stable across the study period (Figure A).

Injuries by Season Segment

During the study period, 260 preseason injuries (national estimate: 1759), 2872 regular season injuries (national estimate: 15 213), and 198 postseason injuries (national estimate: 1138) were reported to the NCAA ISP (Table 1). The preseason (IRR = 1.35; 95% CI = 1.12, 1.62) and regular season (IRR = 1.48; 95% CI = 1.28, 1.71) injury rates were higher than the postseason injury rate. Trajectories of preseason, regular, and postseason injury rates were comparable across the study period (Figure B), though preseason and postseason injury rates appeared to consistently increase between 2016–2017 and 2018–2019.

Time Loss

Among all reported injuries, 43.1% resulted in TL greater than or equal to 1 day (9% of all injuries were missing TL information). The prevalence of TL injuries was similar between practice- (44.1%) and competition-related (42.7%) injuries. The practice TL injury rate was stable across the study period. Conversely, the competition TL injury rate appeared to fluctuate across the study period (Figure C). Across the study period, the competition-related TL injury rate (rate = 8.78) was significantly higher than the practice-related TL injury rate (rate = 1.39; IRR = 6.34, 95% CI = 5.67, 7.09).

Injury Characteristics

Overall, the most commonly injured body parts were the shoulder (16.1%), head or face (15.2%), and hip or groin (12.1%; Table 2). Hip and groin (19.7%), trunk (11.5%), shoulder (10.4%), and hand and wrist (10.4%) were among the most prevalently reported practice-related injuries. Shoulder (18.7%), head and face (17.4%), and hand and wrist (12.1%) were among the most prevalently reported competition-related injuries. In general, most injuries were

Table 1. Reported and National Estimates of Injuries, Athlete-Exposures (AEs), and Rates per 1000 AEs by Event Type and Season Segment^a

	Number AEs Rate per 1000 AEs (95% CI)					
	Overall		Practices		Competitions	
	Reported	National Estimate	Reported	National Estimate	Reported	National Estimate
Preseason	260	1759	217	1550	43	209
	36 030	232 424	34 681	226 042	1350	6382
Regular Season	7.22 (6.34, 8.09)	7.57 (6.69, 8.45)	6.26 (5.42, 7.09)	6.86 (6.02, 7.69)	31.85 (22.33, 41.37)	32.75 (23.23, 42.27)
	2872	15 213	759	4196	2113	11 016
Post Season	362 113	1 832 305	259 790	1 296 410	102 323	535 895
	7.93 (7.64, 8.22)	8.30 (8.01, 8.59)	2.92 (2.71, 3.13)	3.24 (3.03, 3.44)	20.65 (19.77, 21.53)	20.56 (19.68, 21.44)
Overall	198	1138	38	222	160	916
	36 976	193 808	28 062	148 629	8914	45 179
Overall	5.35 (4.61, 6.10)	5.87 (5.13, 6.62)	1.35 (0.92, 1.78)	1.49 (1.06, 1.92)	17.95 (15.17, 20.73)	20.27 (17.49, 23.06)
	3330	18 109	1014	5967	2316	12 142
Overall	435 120	2 258 537	322 533	1 671 082	112 587	587 455
	7.65 (7.39, 7.91)	8.02 (7.76, 8.28)	3.14 (2.95, 3.34)	3.57 (3.38, 3.76)	20.57 (19.73, 21.41)	20.67 (19.83, 21.51)

^a Data presented in the order of reported number, followed by athlete exposures (AEs), estimated injury rates, and associated 95% Confidence Intervals (CIs) for each cross-tabulation of event types and season segment. Data pooled association-wide are presented overall, and separately for practices and competitions. National estimates were produced using sampling weights estimated on the basis of sport, division, and year. All CIs were constructed using variance estimates calculated on the basis of reported data. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition, and required medical attention by a team Certified Athletic Trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

attributed to player contact (38.6%) and apparatus contact (30.2%). Most competition-related injuries were attributed to player contact (46.8%) and apparatus contact (30.5%); whereas most practice-related injuries were attributed to apparatus (29.6%) and noncontact (24.7%) mechanisms. Most reported injuries were classified as contusions (25.9%), sprains (19.1%), or strains (16.1%).

Whereas competition-related injuries were classified more prevalently as contusions or sprains, practice-related injuries were classified more prevalently as strains than competition-related injuries (Table 2). The most commonly reported specific injuries during the study period were concussions (9.6%), partial or complete acromioclavicular (AC)-joint sprain (7.3%), and partial or complete medial collateral ligament (MCL) tear (3.7%). Concussion rates varied across the study period (Figure D). The incidence trajectories of both AC-joint sprains and MCL tears mirrored each other across the study period, steadily increasing between 2015–2016 and 2017–2018 before decreasing during the final year of the study period (Figure D).

Injuries by Ice Hockey-Specific Activities and Playing Positions

Most reported injuries in men’s ice hockey between 2014–2015 and 2018–2019 occurred during general play (28.6%), checking (22.2%), and shot blocking (11.1%; Table 3). Most reported injuries were among forwards (61.7%), followed by defensemen (29.8%) and goaltenders (6.3%).

SUMMARY

In this study we described the epidemiology of NCAA men’s ice hockey-related injuries reported to the NCAA

ISP between 2014–2015 and 2018–2019. Injuries occurred at a significantly higher rate during competitions than practices, which is consistent with previous epidemiological studies of this population.^{3,9} The overall competition injury rate observed between 2014–2015 to 2018–2019 (20.57 per 1000 AEs) was higher than those observed between 2004–2005 to 2013–2014 (13.5 per 1000 AEs)⁹ and from 2000–2001 to 2003–2004 (16.3 per 1000 AEs)³ within the same population (although previous analyses have only included TL injuries). Across all 3 study periods, preseason and regular season injury rates were comparable, although consistently higher than postseason injury rates.^{3,9} Injury rates across all season segments in the present study were markedly greater in magnitude than those reported in previous studies.^{3,9} The observed differences are likely attributable to a multitude of factors; nonetheless, improvements in surveillance methods, greater numbers of participating institutions,¹⁴ and changing culture of injury-reporting behaviors and disclosure among athletes may have contributed to the aforementioned observation.¹⁵ Whereas injury surveillance is an effective tool for identifying temporal patterns, surveillance systems are not well positioned to capture factors such as athlete reporting behaviors. Targeted studies should focus on juxtaposing observed injury rates with the dynamic nature of sport culture. Also, continued surveillance during periods of healthy participation in injury surveillance is needed to better appraise the stability of observed temporal patterns in injury incidence. Continued surveillance may also further elucidate underlying mechanisms and relationships contributing to varying injury manifestations. This, coupled with more nuanced ascertainment of unique sport-specific injury-risk exposures (during competition and practice), such as total ice time, distance skated, number of rotational

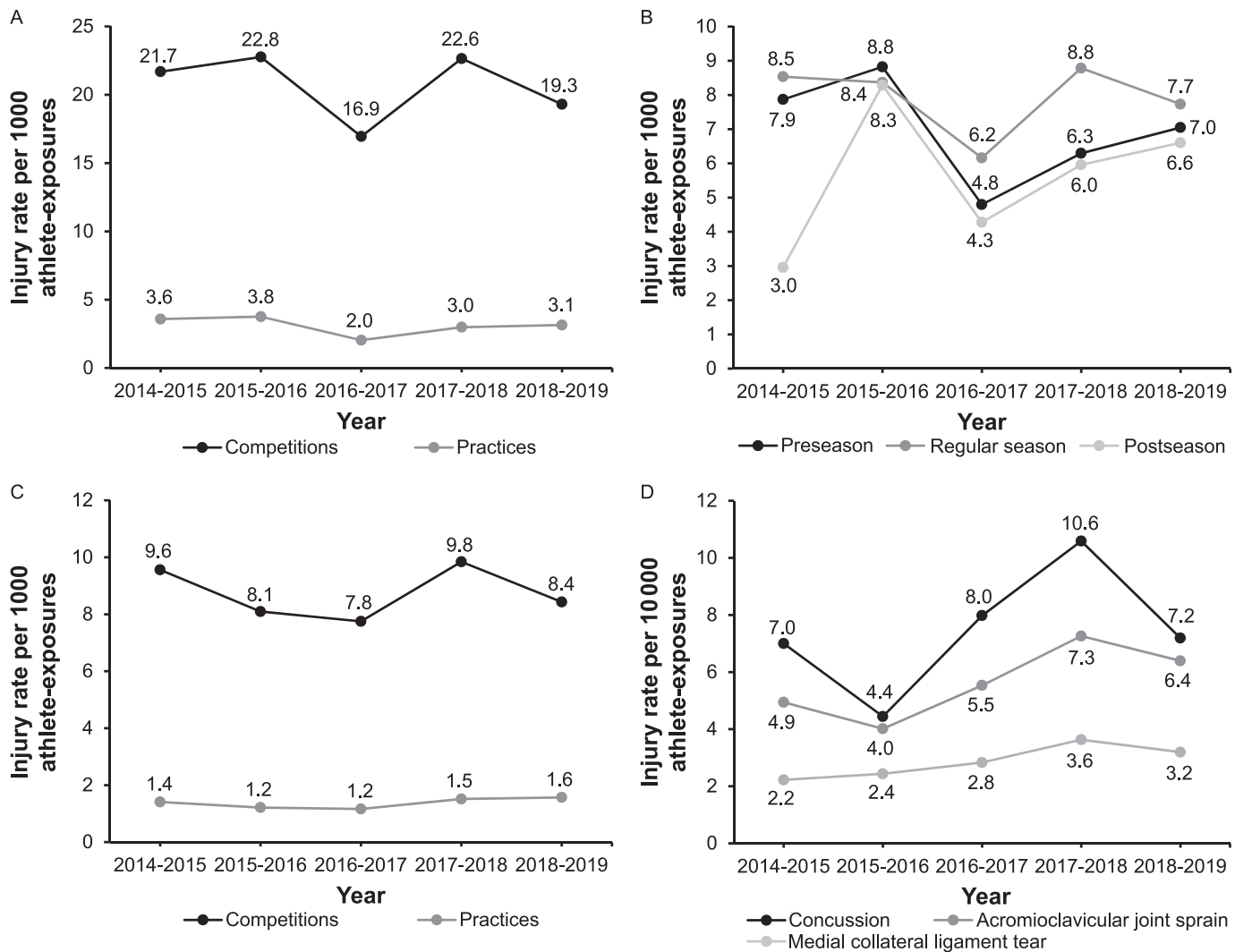


Figure. Temporal patterns in injury rates between 2014–2015 and 2018–2019. **A,** Depicts overall injury rates (per 1000 AEs) stratified by event type (practices, competitions). **B,** Depicts injury rates (per 1000 AEs) stratified by season segment. **C,** Depicts rates (per 1000 AEs) of time loss injuries stratified by event type (practices, competitions). **D,** Depicts rates (per 1000 AEs) of most commonly reported injuries: concussion, partial or complete acromioclavicular-joint sprain, and partial or complete medial collateral ligament tear. Rates presented in all figures are unweighted and based on reported data. Abbreviation: AEs, athlete-exposures.

and linear force impacts or collisions, and workload monitoring should be prioritized in future studies.

Most competition-related injuries were to the shoulder, head or face, and hand or wrist and were classified as contusions, sprains, and strains. This is unsurprising for a collision sport in which players move at a fast pace, particularly considering that most competition-related injuries were the result of player and apparatus (ie, sticks, boards, puck) contact. Flexible boards with qualities to absorb forceful impact have been used to reduce the incidence of injury attributed to contact with the boards.¹⁶ It has been suggested that they are more effective in decreasing the risk of concussion and shoulder injuries than traditional inelastic boards.¹⁶ It is important to note the NCAA ISP does not capture contextual information on setting such as board type, and future researchers may aim to collect such information with small-scale studies to better appraise their effectiveness in reducing injury risk. In contrast with competition injuries, most practice injuries were to the hip or groin, trunk, hand or wrist, and shoulder;

and a large proportion of practice-related injuries were attributed to noncontact mechanisms, as observed in previous studies.^{3,17} This may be expected given the greater amount of time athletes spend performing limited contact maneuvers (drills) on the ice during practices than during competitions. However, researchers have conducted few investigations into the etiology of practice-related noncontact injuries. Targeted analyses in this population may help researchers gain a better understanding of the etiology of noncontact practice-related injuries and may direct ATs, coaches, and players to assess notable risk factors that can be addressed to decrease the incidence of these injuries.

Between 2014–2015 and 2018–2019, concussions were among the 3 most commonly reported injuries in NCAA men’s ice hockey. Aside from men’s football, men’s ice hockey has one of the highest concussion incidence rates across NCAA sports.¹⁸ It has been previously noted that these deleterious injuries largely occur as a result of player contact during gameplay.^{18,19} Moreover, the results of the present study suggest that the incidence of concussion has

Table 2. Distribution of Injuries by Body Part, Mechanism, and Injury Diagnosis; Stratified by Event Type^a

	Overall, (%)		Competitions, (%)		Practices, (%)	
	Injuries Reported	National Estimate	Injuries Reported	National Estimate	Injuries Reported	National Estimate
Body part						
Head/face	506 (15.20)	2667 (14.73)	402 (17.36)	2109 (17.37)	104 (10.26)	558 (9.35)
Neck	80 (2.40)	507 (2.80)	60 (2.59)	390 (3.21)	20 (1.97)	116 (1.94)
Shoulder	537 (16.13)	2665 (14.72)	432 (18.65)	2157 (17.76)	105 (10.36)	508 (8.51)
Arm/elbow	183 (5.50)	1141 (6.30)	130 (5.61)	812 (6.69)	53 (5.23)	329 (5.51)
Hand/wrist	384 (11.53)	2031 (11.22)	279 (12.05)	1414 (11.65)	105 (10.36)	618 (10.36)
Trunk	301 (9.04)	1689 (9.33)	184 (7.94)	974 (8.02)	117 (11.54)	715 (11.98)
Hip/groin	403 (12.10)	2423 (13.38)	203 (8.77)	1100 (9.06)	200 (19.72)	1323 (22.17)
Thigh	181 (5.44)	1041 (5.75)	141 (6.09)	793 (6.53)	40 (3.94)	247 (4.14)
Knee	305 (9.16)	1599 (8.83)	231 (9.97)	1189 (9.79)	74 (7.30)	411 (6.89)
Lower leg	77 (2.31)	414 (2.29)	52 (2.25)	246 (2.03)	25 (2.47)	168 (2.82)
Ankle	226 (6.79)	1215 (6.71)	137 (5.92)	662 (5.45)	89 (8.78)	553 (9.27)
Foot	92 (2.76)	478 (2.64)	52 (2.25)	250 (2.06)	40 (3.94)	228 (3.82)
Other	55 (1.65)	238 (1.31)	13 (0.56)	46 (0.38)	42 (4.14)	192 (3.22)
Mechanism						
Player contact	1286 (38.62)	6671 (36.84)	1083 (46.76)	5594 (46.07)	203 (20.02)	1077 (18.05)
Surface contact	247 (7.42)	1252 (6.91)	195 (8.42)	978 (8.05)	52 (5.13)	274 (4.59)
Apparatus contact	1006 (30.21)	5372 (29.66)	706 (30.48)	3699 (30.46)	300 (29.59)	1674 (28.05)
Out of bounds contact	27 (0.81)	236 (1.30)	23 (0.99)	196 (1.61)	4 (0.39)	40 (0.67)
Noncontact	424 (12.73)	2346 (12.95)	174 (7.51)	835 (6.88)	250 (24.65)	1511 (25.32)
Overuse	155 (4.65)	1103 (6.09)	50 (2.16)	295 (2.43)	105 (10.36)	808 (13.54)
Other or unknown	185 (5.56)	1129 (6.23)	85 (3.67)	547 (4.51)	100 (9.86)	582 (9.75)
Diagnosis						
Abrasion/laceration	189 (5.68)	1086 (6.00)	136 (5.87)	750 (6.18)	53 (5.23)	336 (5.63)
Concussion	320 (9.61)	1641 (9.06)	263 (11.36)	1345 (11.08)	57 (5.62)	296 (4.96)
Contusion	862 (25.89)	4669 (25.78)	658 (28.41)	3517 (28.97)	204 (20.12)	1152 (19.31)
Dislocation/subluxation	111 (3.33)	585 (3.23)	78 (3.37)	416 (3.43)	33 (3.25)	169 (2.83)
Fracture	145 (4.35)	730 (4.03)	115 (4.97)	597 (4.92)	30 (2.96)	133 (2.23)
Illness/infection	13 (0.39)	92 (0.51)	4 (0.17)	22 (0.18)	9 (0.89)	69 (1.16)
Inflammatory condition	116 (3.48)	743 (4.10)	52 (2.25)	297 (2.45)	64 (6.31)	446 (7.47)
Spasm	87 (2.61)	522 (2.88)	41 (1.77)	207 (1.70)	46 (4.54)	315 (5.28)
Sprain	635 (19.07)	3240 (17.89)	515 (22.24)	2612 (21.51)	120 (11.83)	628 (10.52)
Strain	536 (16.10)	3016 (16.65)	294 (12.69)	1551 (12.77)	242 (23.87)	1465 (24.55)
Other	316 (9.49)	1787 (9.87)	160 (6.91)	828 (6.82)	156 (15.38)	958 (16.05)

^a Data presented in the order of reported number, followed by the proportion of all injuries attributable to a given category. Data pooled across event types are presented overall, and separately for practices and competitions. National estimates were produced using sampling weights estimated on the basis of sport, division, and year. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition, and required medical attention by a team Certified Athletic Trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

increased in recent years.^{3,9} We acknowledge that the determinants of concussion incidence, especially in this high-velocity sport, are multifactorial. In particular, widespread concussion education has been critical in improving attitudes towards concussion and concussion-reporting behaviors among athletes.^{20,21} Moreover, recently initiated large, multisite studies of sport-related concussions may have also heightened awareness with regards to this injury and may have consequently influenced diagnostic sensitivity as well as reporting behaviors.^{22,23} Nonetheless, using strategies aimed to reduce the incidence of concussions including the implementation of educational programs to alert stakeholders (coaches, players, parents) of signs and symptoms, specific rule changes to further inhibit illegal player contact, and advancements in protective equipment, as well as appropriate management after diagnosis, are likely to reduce the prevalence and burden of this injury.²⁴⁻²⁷

Another commonly reported injury in men's ice hockey players is an AC-joint sprain.²⁷ It has been previously

reported that AC-joint sprains in men's ice hockey were largely caused by legal player contact, specifically body-checking, and contact with the boards.^{12,29} Frequency of player-to-player collisions is a known risk factor among sports that predispose athletes to this injury, as observed among men's football.^{29,30} Despite gameplay of football comprising a higher incidence of player-to-player collisions, AC-joint sprain injury rates were higher among men's ice hockey athletes. We postulate that this increased incidence may be partially attributed to greater flexibility of ice hockey shoulder pads, juxtaposed with football shoulder pads. There has been evidence to suggest that improvements in shoulder pad design and technology reduce the linear acceleration of player-to-player and player-to-shoulder impacts.^{31,32} Due to the high velocity and physical nature of this sport, it may be difficult to eradicate the risk of AC joint sprains entirely; implementing shoulder pad standards may contribute to reducing the burden of injury, though future targeted studies will be warranted to assess their efficacy.

Table 3. Distribution of Injuries by Injury Activity and Playing Position, Stratified by Event Type^a

	Overall, (%)		Competitions, (%)		Practices, (%)	
	Injuries Reported	National Estimate	Injuries Reported	National Estimate	Injuries Reported	National Estimate
Activity						
Puck handling	228 (6.85)	1283 (7.08)	185 (7.99)	1061 (8.74)	43 (4.24)	221 (3.70)
Shooting	59 (1.77)	318 (1.76)	37 (1.60)	217 (1.79)	22 (2.17)	101 (1.69)
Blocking shot	369 (11.08)	1900 (10.49)	265 (11.44)	1305 (10.75)	104 (10.26)	594 (9.95)
Checking	738 (22.16)	3599 (19.87)	648 (27.98)	3170 (26.11)	90 (8.88)	429 (7.19)
Defending	196 (5.89)	920 (5.08)	142 (6.13)	644 (5.30)	54 (5.33)	276 (4.63)
Goaltending	159 (4.77)	1045 (5.77)	74 (3.20)	443 (3.65)	85 (8.38)	601 (10.07)
Passing	48 (1.44)	201 (1.11)	40 (1.73)	166 (1.37)	8 (0.79)	34 (0.57)
Receiving Pass	57 (1.71)	369 (2.04)	45 (1.94)	289 (2.38)	12 (1.18)	80 (1.34)
Face off	9 (0.27)	42 (0.23)	6 (0.26)	31 (0.26)	3 (0.30)	12 (0.20)
Skating	195 (5.86)	1227 (6.78)	100 (4.32)	569 (4.69)	95 (9.37)	657 (11.01)
General play	951 (28.56)	5295 (29.24)	608 (26.25)	3174 (26.14)	343 (33.83)	2121 (35.55)
Weights	6 (0.18)	34 (0.19)	0 (0.00)	0 (0.00)	6 (0.59)	34 (0.57)
Conditioning	10 (0.30)	49 (0.27)	4 (0.17)	21 (0.17)	6 (0.59)	28 (0.47)
Other/unknown	305 (9.16)	1827 (10.09)	162 (6.99)	1050 (8.65)	143 (14.10)	777 (13.02)
Position						
Forward	2053 (61.65)	11169 (61.68)	1466 (63.30)	7778 (64.06)	587 (57.89)	3391 (56.83)
Defenseman	991 (29.76)	5179 (28.60)	716 (30.92)	3571 (29.41)	275 (27.12)	1608 (26.95)
Goalkeeper	211 (6.34)	1346 (7.43)	94 (4.06)	559 (4.60)	117 (11.54)	787 (13.19)
Other/unknown	75 (2.25)	415 (2.29)	40 (1.73)	234 (1.93)	35 (3.45)	181 (3.03)

^a Data presented in the order of reported number, followed by the proportion of all injuries attributable to a given category. Data pooled across event types are presented overall, and separately for practices and competitions. National estimates were produced using sampling weights estimated on the basis of sport, division, and year. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition, and required medical attention by a team Certified Athletic Trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

Injury to the medial collateral ligament (MCL) was observed as the third most common injury among NCAA men’s ice hockey players in the present study and as one of the most prevalent types of knee injury across ice hockey levels.^{33–35} In ice hockey, MCL tears can occur when an athlete’s legs (or skate) gets tangled with another player’s leg (or skate) as they fall down, causing a twisting valgus force on the knee because the foot is in a fixed position.^{8,36} Although not extensively studied, it has been previously suggested that differential age (freshman vs senior), experience, skill level, and history of musculoskeletal injury between competitors is associated with MCL injury risk.³⁷ It has been noted in ice hockey players that preseason functional movement screens such as postural analysis, single-leg stance, hip mobility, pelvic alignment, and squat screen are likely to aid in identifying athletes at greater risk of sustaining a MCL tear.³⁸ In contrast to preventative techniques, the efficacy of prophylactic knee bracing has been observed to have little effect in reducing the risk of this injury in ice hockey players.³³ Identifying the distribution of MCL severity across ice hockey players may serve as a critical next step of investigation given differences in athletes’ plans of care.³⁹ Given the existing body of literature, implementation of preseason screenings, expanding the understanding of lower extremity biomechanics, and further attention toward the grade of MCL tears may all serve to reduce the burden of this injury among men’s ice hockey athletes. Taken together, the moderate yet clinically meaningful incidence of concussions, AC-joint sprains, and MCL tears precipitate the need for continued monitoring of these injuries after 2018–2019. It is important to note that factors such as preseason screening measures, impact biomechanics, and protective

equipment (eq. helmets, shoulder pads) are not captured within the NCAA ISP. Future studies should aim to measure these factors to better understand the most commonly observed injuries in men’s ice hockey.

In summary, participation in NCAA men’s ice hockey continues to grow, and it is critical to capture and report emerging injury trends in an effort to better equip sports medicine and coaching staff to manage injuries. Furthermore, it has been shown that educating stakeholders on signs and symptoms of such serious injuries, such as concussions, leads to positive outcomes and should remain as a part of an ongoing dialogue aimed at improving the safety of men’s ice hockey.^{25,40,41} Although the NCAA ISP is capable of generally describing injury risk exposures, there remain new opportunities to augment surveillance and enhance the methods of capturing ice hockey-specific characteristics.⁴² Being able to explain specific characteristics of injured athletes may also lead to ways of not only making the game safer by reducing injury risk, but also improving the evaluation and management of such injuries as they naturally occur.

ACKNOWLEDGEMENTS

The NCAA Injury Surveillance Program was funded by the NCAA. The Datalys Center is an independent nonprofit organization that manages the operations of the NCAA ISP. The content of this report is solely the responsibility of the authors and does not necessarily represent the official views of the funding organization. We thank the many ATs who have volunteered their time and efforts to submit data to the NCAA-ISP. Their efforts are greatly appreciated and have had a tremendously positive effect on the safety of collegiate student-athletes.

REFERENCES

- USA hockey annual report 2018/2019. USA Hockey website. https://cdn3.sportngin.com/attachments/document/583d-1727727/Annual_Report_1819_USA_Hockey.pdf#_ga=2.162630396.1105027376.1615433844-1161548583.1615433842
- NCAA sports sponsorship and participation rates database. National Collegiate Athletic Association website. <http://www.ncaa.org/about/resources/research/ncaa-sports-sponsorship-and-participation-rates-database>. Published 2020. Accessed July 3, 2020.
- Agel J, Dompier TP, Dick R, Marshall SW. Descriptive epidemiology of collegiate men's ice hockey injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *J Athl Train*. 2007;42(2):286–294.
- van Mechelen W, Hlobil H, Kemper HCG. Incidence, severity, aetiology, and prevention of sports injuries: a review of concepts. *Sport Med*. 1992;14(2):82–99. doi:10.2165/00007256-199214020-00002
- Chandran A, Nedimyer AK, Register-Mihalik JK, DiPietro L, Kerr ZY. Comment on: "Incidence, Severity, Aetiology and Prevention of Sports Injuries: A Review of Concepts." *Sports Med*. 2019;49(10):1621–1623. doi:10.1007/s40279-019-01154-1
- Dick R, Agel J, Marshall SW. National Collegiate Athletic Association Injury Surveillance System commentaries: introduction and methods. *J Athl Train*. 2007;42(2):173–182.
- Kerr ZY, Dompier TP, Snook EM, et al. National Collegiate Athletic Association Injury Surveillance System: review of methods for 2004–2005 through 2013–2014 data collection. *J Athl Train*. 2014;49(4):552–560. doi:10.4085/1062-6050-49.3.58
- Agel J, Harvey EJ. A 7-year review of men's and women's ice hockey injuries in the NCAA. *Can J Surg*. 2010;53(5):319–323.
- Lynall RC, Mihalik JP, Pierpoint LA, et al. The first decade of web-based sports injury surveillance: descriptive epidemiology of injuries in US high school boys' ice hockey (2008–2009 through 2013–2014) and National Collegiate Athletic Association men's and women's ice hockey (2004–2005 through 2013–2014). *J Athl Train*. 2018;53(12):1129–1142. doi:10.4085/1062-6050-176-17
- NCAA ice hockey 2014–15 and 2015–16 rules and interpretations. National Collegiate Athletic Association website. <https://www.ncaapublications.com/p-4363-2014-15-and-2015-16-ice-hockey-rules-and-interpretations-due-late-fall-2014.aspx>. Accessed December 18, 2020.
- NCAA ice hockey 2016–17 and 2017–18 rules and interpretations. National Collegiate Athletic Association website. <https://www.ncaapublications.com/p-4396-2016-17-and-2017-18-ncaa-ice-hockey-rules-interpretations.aspx>. Accessed December 18, 2020.
- NCAA ice hockey 2018–19 and 2019–20 NCAA rules and interpretations. National Collegiate Athletic Association website. <https://www.ncaapublications.com/p-4561-2018-19-and-2019-20-ncaa-ice-hockey-rules-interpretations.aspx>. Accessed August 27, 2020.
- Chandran A, Morris SN, Wasserman EB, Boltz A, Collins CL. Methods of the National Collegiate Athletic Association Injury Surveillance Program, 2014–2015 Through 2018–2019. *J Athl Train*. 2021;56(7):616–621.
- Occupational outlook handbook: athletic trainers. US Bureau of Labor Statistics website. <https://www.bls.gov/ooh/healthcare/athletic-trainers.htm>. Updated September 1, 2020. Accessed October 6, 2020.
- Register-Mihalik JK, Marshall SW, Kay MC, et al. Perceived social norms and concussion-disclosure behaviours among first-year NCAA student-athletes: implications for concussion prevention and education. *Res Sport Med*. 2021;9(1):1–11. doi:10.1080/15438627.2020.1719493
- Tuominen M, Stuart MJ, Aubry M, Kannus P, Parkkari J. Injuries in men's international ice hockey: a 7-year study of the International Ice Hockey Federation Adult World Championship tournaments and Olympic Winter Games. *Br J Sports Med*. 2015;49(1):30–36. doi:10.1136/bjsports-2014-093688
- Anderson GR, Melugin HP, Stuart MJ. Epidemiology of injuries in ice hockey. *Sports Health*. 2019;11(6):514–519. doi:10.1177/1941738119849105
- Zuckerman SL, Kerr ZY, Yengo-Kahn A, Wasserman E, Covassin T, Solomon GS. Epidemiology of sports-related concussion in NCAA athletes from 2009–2010 to 2013–2014. *Am J Sports Med*. 2015;43(11):2654–2662. doi:10.1177/0363546515599634
- Clark JM, Post A, Hoshizaki TB, Gilchrist MD. Protective capacity of ice hockey helmets against different impact events. *Ann Biomed Eng*. 2016;44(12):3693–3704. doi:10.1007/s10439-016-1686-3
- Kroshus E, Baugh CM. Concussion education in US collegiate sport: what is happening and what do athletes want? *Health Educ Behav*. 2015;43(2):182–190. doi:10.1177/1090198115599380
- Schmidt JD, Weber ML, Suggs DW II, et al. Improving concussion reporting across National College Athletic Association divisions using a theory-based, data-driven, multimedia concussion education intervention. *J Neurotrauma*. 2020;37(4):593–599. doi:10.1089/neu.2019.6637
- Broglio SP, McCrea M, McAllister T, et al; CARE Consortium Investigators. A national study on the effects of concussion in collegiate athletes and US military service academy members: the NCAA–DoD Concussion Assessment, Research and Education (CARE) Consortium structure and methods. *Sport Med*. 2017;47(7):1437–1451. doi:10.1007/s40279-017-0707-1
- Campbell-McGovern C, D'Alonzo BA, Cooper M, Putukian M, Wiebe DJ. Ivy League–Big Ten Epidemiology of Concussion Study. *Inj Prev*. 2018;24(4):319–320. doi:10.1136/injuryprev-2018-042831
- McCrory P, Meeuwisse W, Dvořák J, et al. Consensus statement on concussion in sport—the 5th International Conference on Concussion in Sport held in Berlin, October 2016. *Br J Sports Med*. 2017;51(11):838–847. doi:10.1136/bjsports-2017-097699
- Covassin T, Elbin RJ, Sarmiento K. Educating coaches about concussion in sports: evaluation of the CDC's "Heads Up: Concussion in Youth Sports" initiative. *J Sch Health*. 2012;82(5):233–238. doi:10.1111/j.1746-1561.2012.00692.x
- Macpherson A, Rothman L, Howard A. Body-checking rules and childhood injuries in ice hockey. *Pediatrics*. 2006;117(2):e143–e147. doi:10.1542/peds.2005-1163.
- Rowson S, Duma SM. Development of the STAR evaluation system for football helmets: integrating player head impact exposure and risk of concussion. *Ann Biomed Eng*. 2011;39(8):2130–2140. doi:10.1007/s10439-011-0322-5
- Popkin CA, Nelson BJ, Park CN, et al. Head, neck, and shoulder injuries in ice hockey: current concepts. *Am J Orthop (Belle Mead NJ)*. 2017;46(3):123–134.
- Hibberd EE, Kerr ZY, Roos KG, Djoko A, Dompier TP. Epidemiology of acromioclavicular joint sprains in 25 National Collegiate Athletic Association sports: 2009–2010 to 2014–2015 academic years. *Am J Sports Med*. 2016;44(10):2667–2674. doi:10.1177/0363546516643721
- Melvin PR, Souza S, Mead RN, Smith C, Mulcahey MK. Epidemiology of upper extremity injuries in NCAA men's and women's ice hockey. *Am J Sports Med*. 2018;46(10):2521–2529. doi:10.1177/0363546518781338
- Richards D, Ivarsson BJ, Scher I, Hoover R, Rodowicz K, Cripton P. Ice hockey shoulder pad design and the effect on head response during shoulder-to-head impacts. *Sport Biomech*. 2016;15(4):385–396. doi:10.1080/14763141.2016.1163414
- Kendall M, Post A, Rousseau P, Hoshizaki TB. The effect of shoulder pad design on reducing peak resultant linear and rotational acceleration in shoulder-to-head impacts. In: Ashare A, Ziejewski, eds. *The Mechanism of Concussion in Sports*. ASTM International; 2014:142–152. doi:10.1520/STP155220120150

33. Tegner Y, Lorentzon R. Evaluation of knee braces in Swedish ice hockey players. *Br J Sports Med.* 1991;25(3):159–161. doi:10.1136/bjism.25.3.159
34. Tuominen M, Stuart MJ, Aubry M, Kannus P, Tokola K, Parkkari J. Injuries in women's international ice hockey: an 8-year study of the World Championship tournaments and Olympic Winter Games. *Br J Sports Med.* 2016;50(22):1406–1412. doi:10.1136/bjsports-2015-094647
35. Kluczynski MA, Kang JV, Marzo JM, Bisson LJ. Magnetic resonance imaging and intra-articular findings after anterior cruciate ligament injuries in ice hockey versus other sports. *Orthop J Sports Med.* 2016;4(5):2325967116646534. doi:10.1177/2325967116646534
36. LaPrade RF, Wijdicks CA, Griffith CJ. Division I intercollegiate ice hockey team coverage. *Br J Sports Med.* 2009;43(13):1000–1005. doi:10.1136/bjism.2009.067884
37. Grant JA, Bedi A, Kurz J, Bancroft R, Miller BS. Incidence and injury characteristics of medial collateral ligament injuries in male collegiate ice hockey players. *Sports Health.* 2013;5(3):270–272. doi:10.1177/1941738112473053
38. Wolfinger CR, Davenport TE. Physical therapy management of ice hockey athletes: from the rink to the clinic and back. *Int J Sports Phys Ther.* 2016;11(3):482–495.
39. Miyamoto RG, Bosco JA, Sherman OH. Treatment of medial collateral ligament injuries. *J Am Acad Orthop Surg.* 2009;17(3):152–161. doi:10.5435/00124635-200903000-00004
40. Black AM, Yeates KO, Babul S, Nettel-Aguirre A, Emery CA. Association between concussion education and concussion knowledge, beliefs and behaviours among youth ice hockey parents and coaches: a cross-sectional study. *BMJ Open.* 2020;10(8):e038166. doi:10.1136/bmjopen-2020-038166
41. Register-Mihalik JK, Guskiewicz KM, McLeod TC, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train.* 2013;48(5):645–653. doi:10.4085/1062-6050-48.3.20
42. Donskov AS, Humphreys D, Dickey JP. What is injury in ice hockey: an integrative literature review on injury rates, injury definition, and athlete exposure in men's elite ice hockey. *Sports (Basel).* 2019;7(11):227. doi:10.3390/sports7110227

Address correspondence to Avinash Chandran, PhD, MSM, Datalys Center for Sports Injury Research and Prevention, 6151 Central Avenue, Suite 117, Suite 500, Indianapolis, IN 46202. Address email to avinashc@datalyscenter.org.