

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

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**Context:** The National Collegiate Athletic Association (NCAA) has sponsored women's ice hockey championships since 2001, and sponsorship has grown over time.

**Background:** Routine examinations of injuries sustained by athletes are important for identifying and understanding patterns that can be used to inform sport safety practices.

**Methods:** Exposure and injury data collected in the NCAA 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 were used to examine differential injury rates.

**Results:** The overall injury rate was 5.89 per 1000 athlete-exposures; preseason injury incidence rose sharply during 2016–2017 through 2018–2019. Head/face injuries (15.2%),

knee injuries (13.2%), and shoulder injuries (12.9%) were the most commonly injured body parts, and injuries were most often classified as contusions (18.9%), strains (18.7%), and sprains (15.5%). Concussion (11.9%) was the most commonly reported specific injury, and concussion rates notably increased during 2017–2018 through 2018–2019.

**Summary:** Study findings were generally consistent with the existing epidemiological evidence. Injury incidence in preseason and the etiology of strains warrant further attention in this population.

**Key Words:** collegiate sports, descriptive epidemiology, injury surveillance

## Key Points

- Incidence trajectories of competition injuries and practice injuries were comparable across the study period, though competition injury rates were consistently higher than practice injury rates.
- Head/face injuries, knee injuries, and shoulder injuries accounted for the largest proportion of all injuries reported, and injuries were most prevalently classified as contusions, and strains.
- Injuries were most commonly attributed to player contact and apparatus contact; concussion was the most prevalently reported specific injury.

Ice hockey is a sport that is enjoyed and played by athletes of all ages worldwide. Ice hockey has a large presence in the United States as well, with nearly 400 000 youth athletes and over 150 000 adult athletes participating in USA Hockey–sanctioned programs<sup>1</sup> as of 2018–2019. Women's ice hockey has continued to gain traction at the collegiate level since the National Collegiate Athletic Association (NCAA) began sponsoring championships<sup>2</sup> in 2001. This is evidenced by the fact that 63 women's ice hockey teams competed as part of the NCAA during the 2000–2001 academic year, and sponsorship grew to 106 programs by the 2018–2019 academic year.<sup>3</sup> Given the increase in participation observed since 2001, it is imperative to the safety of NCAA women's ice hockey

athletes that the nature and frequency of injuries sustained during participation are clearly understood.

Sports injury surveillance is an effective method of routinely monitoring injury-related patterns in large athlete populations.<sup>4</sup> These findings are used to develop etiological hypotheses that may be subsequently explored by studying specific injuries and athlete subgroups.<sup>4</sup> The NCAA Injury Surveillance Program (ISP) is one such large-scale surveillance system intended to capture sport exposure and injury data among collegiate athletes. The NCAA ISP (originally the NCAA Injury Surveillance System) has been adapted and advanced over time, and it has captured data on women's ice-hockey-related injuries since 2001. As such, the NCAA ISP has been instrumental in understanding and assessing the burden of ice hockey-related injuries among participating athletes.<sup>2,5,6</sup> Previous study of NCAA wom-

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en's ice hockey-related injuries has indicated that the overall injury rate in this population is approximately 3 injuries per 1000 athlete-exposures (AEs).<sup>5</sup> Prior studies of this population have also reported higher rates of injury during competition (12.1–12.6 per 1000 AEs) than during practice (2.5–2.9 per 1000 AEs).<sup>2,5,6</sup> It has also been noted that the most commonly injured body parts among NCAA women's ice hockey players are the hip, thigh, and upper leg; head and face; and shoulder and clavicle.<sup>5</sup> Further, it has been indicated that most reported injuries in this population are strains, ligament sprains, and concussions.<sup>2,5,6</sup>

Although previous work has been done with this population, follow-up is necessary to appraise the changing landscape of the game. Continued monitoring will allow for follow-up studies of injury incidence and outcomes in this population, which will further help inform injury prevention practices. As such, the purpose of this study was to describe the epidemiology of ice hockey-related injuries captured among NCAA women's ice hockey players between 2014–2015 and 2018–2019.

## METHODS

### Study Data

Women's ice hockey-related exposure and injury data collected in the NCAA ISP during 2014–2015 through 2018–2019 were examined in this study. The methods of the NCAA ISP have been reviewed and approved as an exempt study by the NCAA Research Review Board. The methods of the surveillance program are detailed in a separate manuscript within this special issue.<sup>7</sup> In brief, athletic trainers (ATs) at participating institutions contributed relevant injury and exposure 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 AT or physician (regardless of time loss). Scheduled team practices and competitions were considered reportable exposures for this study. Data from 16 (18% of membership with sponsored programs) participating programs in 2014–2015, from 7 (7% of membership with sponsored programs) in 2015–2016, from 10 (10% of membership with sponsored programs) in 2016–2017, from 13 (13% of membership with sponsored programs) in 2017–2018, and from 20 (19% of membership with sponsored programs) in 2018–2019 qualified for inclusion in analyses. Qualification criteria are detailed in the aforementioned methods manuscript.<sup>7</sup>

### Statistical Analysis

One AE was defined as 1 athlete participating in 1 exposure event (practice or competition). Injury counts and rates (per 1000 AEs) were examined across levels of event type (practice, competition), season segment (preseason, regular season, postseason), and time loss (time loss [TL], non-time loss [NTL]). Poststratification sample weights by sport and division have been established within the surveillance system to compute national estimates of injury events on the basis of the sampled teams; weighted and unweighted rates were estimated for the present study, and results are presented in terms of unweighted rates (due to low frequencies of injury observations across levels of

certain covariates) unless otherwise specified. Temporal patterns in injury rates across the study period were described using stratified rate-profile plots (stratified by levels of the aforementioned 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 time loss (TL, NTL), body parts injured, injury diagnoses, mechanism of injury, playing positions, and activities. 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, and all analyses were conducted using SAS version 9.4 (SAS Institute).

## RESULTS

A total of 920 women's ice hockey injuries from 156 195 AEs were reported to the NCAA ISP during 2014–2015 through 2018–2019 (rate = 5.89/1000 AEs). This equated to a national estimate of 7651 injuries overall (Table 1). Across the study period, the overall competition-related injury rate was higher than the practice-related injury rate (IRR = 3.15; 95% CI = 2.77, 3.59). Trajectories of competition- and practice-related injury rates were also comparable across the study period (Figure A). Whereas decreases in practice and competition injury rates were observed between 2015–2016 and 2016–2017, increases in both rates were observed between 2016–2017 and 2017–2018 (Figure A).

### Injuries by Season Segment

A total of 111 preseason injuries (national estimate: 1101), 775 regular season injuries (national estimate: 6267), and 34 postseason injuries (national estimate: 283) were reported during 2014–2015 through 2018–2019 (Table 2). The rate of postseason injuries was lower than the rate of preseason (IRR = 0.49; 95% CI = 0.33, 0.71) and regular season (IRR = 0.54; 95% CI = 0.38, 0.76) injuries. Preseason and regular season injury rates were comparable across the study period, aside from 2015–2016 (Figure B); preseason injury rates in 2015–2016 were higher than in any other year during the study period (Figure B). Temporal patterns in postseason injury rates were not examined due to low frequencies ( $n \leq 5$ ) of postseason injuries reported during certain years of the study period.

### Time Loss

Approximately one-third of all reported injuries (34.2%) resulted in TL of  $\geq 1$  day (TL was not recorded in approximately 16% of all reported injuries), and TL injuries accounted for comparable proportions of practice (33.1%) and competition (35.2%) injuries. Rates of competition-related and practice-related TL injuries mirrored each other across the study period. Throughout the study period, rates of competition-related TL injuries were consistently higher than practice-related TL injury rates (Figure C). Decreases in competition-related and practice-related TL injury rates were observed between 2015–2016 and 2016–2017, and both rates were relatively stable thereafter during the final years of the study (Figure C).

**Table 1. Reported and National Estimates of Injuries, Athlete Exposures (AEs), and Rates per 1000 AEs by Event Type and Season Segment<sup>a</sup>**

	Number AEs Rate per 1000 AEs (95% CI)					
	Overall		Practices		Competitions	
	Reported	National Estimate	Reported	National Estimate	Reported	National Estimate
Preseason	111 16 645 6.67 (5.43, 7.91)	1101 146 191 7.53 (6.29, 8.77)	104 16 060 6.48 (5.23, 7.72)	1057 142 337 7.43 (6.18, 8.67)	7 585 11.97 (3.10, 20.83)	44 3854 11.42 (2.55, 20.28)
Regular season	775 129 063 6.00 (5.58, 6.43)	6267 999,017 6.27 (5.85, 6.70)	293 88 219 3.32 (2.94, 3.70)	2365 680 630 3.47 (3.09, 3.86)	482 40 844 11.80 (10.75, 12.85)	3902 318 388 12.26 (11.20, 13.31)
Postseason	34 10 487 3.24 (2.15, 4.33)	283 82 856 3.42 (2.33, 4.51)	11 7427 1.48 (0.61, 2.36)	87 58 667 1.48 (0.61, 2.36)	23 3060 7.52 (4.44, 10.59)	196 24 189 8.10 (5.03, 11.17)
Overall	920 156 195 5.89 (5.51, 6.27)	7651 1 228 064 6.23 (5.85, 6.61)	408 111 705 3.65 (3.30, 4.01)	3509 881 633 3.98 (3.63, 4.33)	512 44 490 11.51 (10.51, 12.51)	4142 346 431 11.96 (10.96, 12.95)

<sup>a</sup> 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 type and season segment. Data pooled association-wide are presented overall, and separately for practices and competitions and pre, regular, and post season segments. 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.

### Injury Characteristics

Head/face injuries (15.2%), knee injuries (13.2%), and shoulder injuries (12.9%) accounted for the largest proportion of all injuries reported during 2014–2015 through 2018–2019. Hip/groin (11.5%) and trunk (11.1%) injuries were also common. Whereas head/face injuries accounted for larger proportions of competition injuries than practice injuries, knee injuries and shoulder injuries were comparably prevalent among both competition and practice injuries (Table 2). Player-contact (27.8%) and apparatus-contact (27.8%) injuries accounted for the largest proportion of all reported injuries. Whereas player-contact injuries accounted for a larger proportion of competition injuries than practice injuries, apparatus-contact injuries accounted for comparable proportions of injuries reported during both event types (Table 2).

Overall, most women’s ice hockey injuries reported during 2014–2015 through 2018–2019 were contusions (18.9%), strains (18.7%), and sprains (15.5%). Whereas contusions and sprains were more prevalent among competition injuries than practice injuries, strains accounted for a larger proportion of practice injuries than competition injuries (Table 3). Concussions (11.9%) were the most commonly reported specific injury during the study period. Concussion incidence remained stable between 2014–2015 through 2017–2018, then increased during the final year of the study (Figure D).

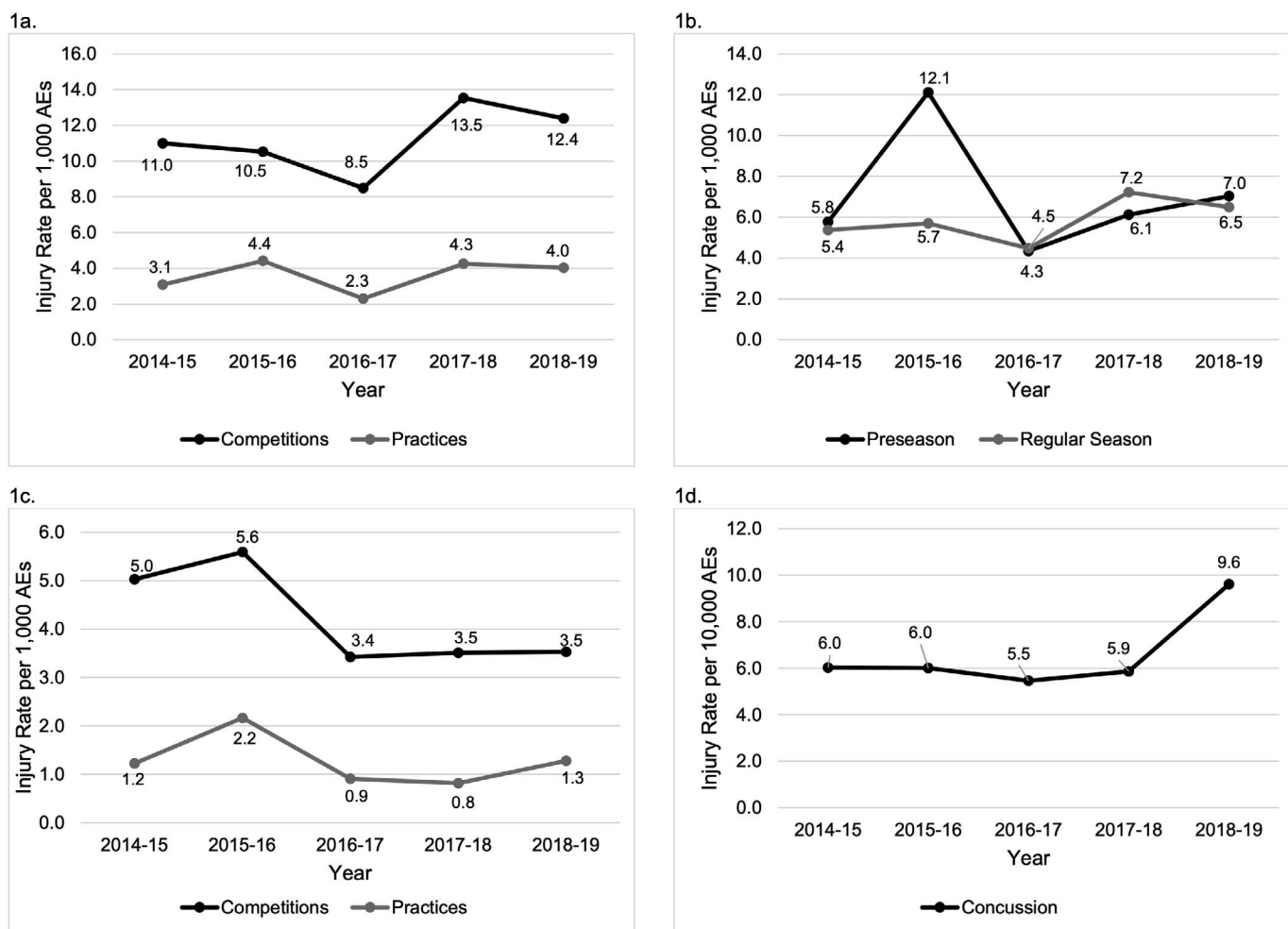
### Injuries by Ice Hockey-Specific Activities and Playing Positions

Most injuries in women’s ice hockey during the study period occurred during general play (42.6%). Overall, notable proportions of all injuries were also attributable to blocking a shot (9.9%), defending (8.3%), and skating (8.0%). General play and defending injuries accounted for

larger proportions of competition injuries than of practice injuries (Table 4). With regards to playing position, injuries to forwards (58.7%) accounted for the largest proportions of all reported injuries.

### SUMMARY

This study aimed to describe the epidemiology of ice hockey–related injuries among NCAA women’s ice hockey athletes during 2014–2015 through 2018–2019. During the study period, the competition-related injury rate was higher than the practice-related injury rate, which is consistent with the existing literature in this population.<sup>2,5,6</sup> The incidence trajectories of practice- and competition-related injuries mirrored each other, with notable fluctuations observed between 2015–2016 and 2017–2018. It may be relevant to more closely examine this window to identify changes in playing rules and policies, as well as injury prevention and management practices that may have contributed to the initial reduction in injury rates followed by the sharp increase observed between 2016–2017 and 2017–2018. Notably, rates of competition-related TL injuries in particular, did not follow a similar pattern during this window. Given that TL in this context can be considered a reflection of postinjury recovery,<sup>8</sup> this indicates that the burden of competition-related injuries requiring a recovery process has remained stable in this population, although competition-related injury incidence has fluctuated. As with practice- and competition-related injury rates, preseason and regular season injury rates also appeared to decrease sharply between 2015–2016 and 2016–2017. Whereas the consistency in incidence trajectories across levels of event type and season segment is unsurprising, the observed results strengthen the justification for examining this time period more closely. Furthermore, given the steadily increasing



**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 (postseason rates not displayed due to low injury frequencies reported). **C,** Depicts rates (per 1000 AEs) of time loss injuries stratified by event type (practices, competitions). **D,** Depicts rates (per 10,000 AEs) of most commonly reported injury. Rates presented in all panels are unweighted and based on reported data.

preseason injury rates observed during the latter years of the study, it may also be relevant to target preseason injuries for further examination and closely monitor preseason injury rates after 2018–2019 to determine whether the upward trajectory is maintained. Because preseason in women’s ice hockey may involve reacclimatization to ice-related gameplay for some athletes, it is reasonable to suggest that risk of preseason injury is exacerbated by an inherent need for a period of familiarization with such gameplay. Future studies should examine the various phases of preseason to determine whether injury risk is elevated during the early stages. Such research may also consider the dynamics of off-season training and capture the transition from off-season training to preseason training in NCAA women’s ice hockey. Given the current data collection methods of the NCAA ISP, data captured within the surveillance system is not well positioned to examine this transitional period, and future studies involving targeted off-season data collection may be needed to better understand preseason injury risk in this population.

The head/face, knee, and shoulder were among the most commonly injured body parts among NCAA women’s ice

hockey athletes during 2014–2015 through 2018–2019. The prevalence of head, face, and knee injuries in practices and competitions were found to be consistent with existing literature.<sup>5</sup> In contrast, shoulder injuries were previously reported to be more prevalent in competition than practice, dissimilar to the observations of the present study.<sup>5</sup> The most common injury mechanisms in women’s ice hockey were contact related, specifically player contact and apparatus contact (which includes boards, glass, puck, and stick).<sup>9</sup> Given the rules of women’s ice hockey and considering that nearly a quarter of injuries were attributed to player contact, it may be reasonable to infer that player contact may be occurring unintentionally.<sup>6,10</sup> The burden of injuries resulting from unintentional contact has been highlighted by previous researchers examining high school and youth skill levels in which unintentional player contact has been observed to be associated with a higher incidence of attributed injuries and more severe injuries.<sup>11–13</sup> Player and apparatus contact (among practice and competition) in women’s ice hockey may be unavoidable; nonetheless, targeted injury prevention strategies aimed to maximize an athlete’s control (and reactivity) on the ice and to limit excessive unintentional contact (player or apparatus) may

**Table 2. Distribution of Injuries by Body Part, Mechanism, and Injury Diagnosis; Stratified by Event Type<sup>a</sup>**

	Overall		Competitions		Practices	
	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)
<b>Body part</b>						
Head/face	140 (15.22)	1141 (14.91)	96 (18.75)	781 (18.86)	44 (10.78)	361 (10.29)
Neck	36 (3.91)	319 (4.17)	24 (4.69)	225 (5.43)	12 (2.94)	94 (2.68)
Shoulder	119 (12.93)	1022 (13.36)	70 (13.67)	622 (15.02)	49 (12.01)	400 (11.40)
Arm/elbow	53 (5.76)	398 (5.20)	35 (6.84)	234 (5.65)	18 (4.41)	164 (4.67)
Hand/wrist	94 (10.22)	724 (9.46)	49 (9.57)	385 (9.30)	45 (11.03)	339 (9.66)
Trunk	102 (11.09)	897 (11.72)	53 (10.35)	466 (11.25)	49 (12.01)	430 (12.25)
Hip/groin	106 (11.52)	928 (12.13)	38 (7.42)	294 (7.10)	68 (16.67)	634 (18.07)
Thigh	32 (3.48)	262 (3.42)	21 (4.10)	138 (3.33)	11 (2.70)	123 (3.51)
Knee	121 (13.15)	938 (12.26)	75 (14.65)	581 (14.03)	46 (11.27)	356 (10.15)
Lower leg	22 (2.39)	184 (2.40)	8 (1.56)	49 (1.18)	14 (3.43)	135 (3.85)
Ankle	45 (4.89)	352 (4.60)	22 (4.30)	180 (4.35)	23 (5.64)	171 (4.87)
Foot	29 (3.15)	291 (3.80)	14 (2.73)	121 (2.92)	15 (3.68)	170 (4.84)
Other	21 (2.28)	195 (2.55)	7 (1.37)	65 (1.57)	14 (3.43)	131 (3.73)
<b>Mechanism</b>						
Player contact	256 (27.83)	2042 (26.69)	198 (38.67)	1565 (37.78)	58 (14.22)	477 (13.59)
Surface contact	113 (12.28)	914 (11.95)	68 (13.28)	581 (14.03)	45 (11.03)	333 (9.49)
Apparatus contact	256 (27.83)	1985 (25.94)	150 (29.30)	1107 (26.73)	106 (25.98)	879 (25.05)
Out of bounds contact	10 (1.09)	101 (1.32)	4 (0.78)	40 (0.97)	6 (1.47)	61 (1.74)
Noncontact	129 (14.02)	1164 (15.21)	45 (8.79)	405 (9.78)	84 (20.59)	759 (21.63)
Overuse	73 (7.93)	712 (9.31)	15 (2.93)	165 (3.98)	58 (14.22)	547 (15.59)
Other/unknown	83 (9.02)	733 (9.58)	32 (6.25)	280 (6.76)	51 (12.50)	453 (12.91)
<b>Diagnosis</b>						
Abrasion/laceration	15 (1.63)	113 (1.48)	12 (2.34)	88 (2.12)	3 (0.74)	25 (0.71)
Concussion	109 (11.85)	919 (12.01)	72 (14.06)	607 (14.65)	37 (9.07)	312 (8.89)
Contusion	174 (18.91)	1320 (17.25)	105 (20.51)	725 (17.50)	69 (16.91)	594 (16.93)
Dislocation/subluxation	39 (4.24)	365 (4.77)	26 (5.08)	250 (6.04)	13 (3.19)	116 (3.31)
Fracture	32 (3.48)	268 (3.50)	16 (3.13)	131 (3.16)	16 (3.92)	137 (3.90)
Illness/infection	1 (0.11)	16 (0.21)	0 (0.00)	0 (0.00)	1 (0.25)	16 (0.46)
Inflammatory condition	52 (5.65)	462 (6.04)	18 (3.52)	207 (5.00)	34 (8.33)	255 (7.27)
Spasm	29 (3.15)	227 (2.97)	20 (3.91)	163 (3.94)	9 (2.21)	64 (1.82)
Sprain	143 (15.54)	1149 (15.02)	94 (18.36)	755 (18.23)	49 (12.01)	394 (11.23)
Strain	172 (18.70)	1540 (20.13)	80 (15.63)	628 (15.16)	92 (22.55)	912 (25.99)
Other	154 (16.74)	1272 (16.63)	69 (13.48)	589 (14.22)	85 (20.83)	683 (19.46)

<sup>a</sup> 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.

be considered by sports medicine and coaching staffs.<sup>14,15</sup> Furthermore, even though body checking is outside the bounds of women's ice hockey playing regulations, it may be salient to examine the enforcement of this rule in game situations (by coaches, referees, parents, and spectators) and identify potential challenges associated with its practical application.<sup>16,17</sup> Information regarding foul play is not collected within the NCAA ISP; therefore, targeted, small-sample studies may be needed to better study injuries resultant of foul or aggressive play as they have been examined previously.<sup>16-21</sup>

Most injuries reported during the study period were contusions and strains, which is also consistent with previous findings in this population.<sup>5</sup> Strains were most commonly associated with the hip/groin region, and coupled with previously reported findings, the high prevalence of strains (particularly to the hip/groin) observed in this study suggest that the nature and etiology of such injuries warrant further attention in this population.<sup>22,23</sup> The biomechanics of ice skating require that the hip/groin are able to withstand significant tensile (and

compressive) forces throughout a large range of motion that differs depending on skate speed and direction.<sup>24</sup> Overuse and exertion of these groups lead to muscle fatigue and, by extension, a strength imbalance. As repetitive movements are an inherent element of ice skating,<sup>25</sup> the propensity for overuse and noncontact mechanisms of injuries among these muscle groups may be significant in women's ice hockey athletes. This is further evidenced in that hip/groin injuries constituted a higher proportion of practice injuries than competition injuries, as did strain diagnoses that were attributed to noncontact and overuse mechanisms.<sup>5</sup> Despite the high proportion of injuries attributed to contact mechanisms, these findings support the rationale to engage in targeted initiatives aimed at reducing the incidence of overuse or noncontact injuries in the hip/groin region.<sup>26,27</sup> Precise measurements of exposure time and workload are needed to examine this paradigm more comprehensively. Given that the NCAA ISP captures aggregated exposure information at the team level, it is difficult to further expand on these findings using data captured within the NCAA ISP. Future studies may specifically examine these

**Table 3. Distribution of Injuries by Injury Activity and Playing Position; Stratified by Event Type<sup>a</sup>**

	Overall		Competitions		Practices	
	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)
<b>Activity</b>						
Puck handling	53 (5.76)	373 (4.88)	31 (6.05)	229 (5.53)	22 (5.39)	144 (4.10)
Shooting	18 (1.96)	192 (2.51)	9 (1.76)	89 (2.15)	9 (2.21)	102 (2.91)
Blocking shot	91 (9.89)	590 (7.71)	51 (9.96)	283 (6.83)	40 (9.80)	307 (8.75)
Checking	18 (1.96)	144 (1.88)	16 (3.13)	131 (3.16)	2 (0.49)	13 (0.37)
Defending	76 (8.26)	730 (9.54)	56 (10.94)	491 (11.85)	20 (4.90)	240 (6.84)
Goaltending	59 (6.41)	499 (6.52)	28 (5.47)	240 (5.79)	31 (7.60)	259 (7.38)
Passing	8 (0.87)	69 (0.90)	3 (0.59)	30 (0.72)	5 (1.23)	39 (1.11)
Receiving Pass	10 (1.09)	58 (0.76)	6 (1.17)	43 (1.04)	4 (0.98)	15 (0.43)
Face-off	7 (0.76)	39 (0.51)	6 (1.17)	32 (0.77)	1 (0.25)	7 (0.20)
Skating	74 (8.04)	547 (7.15)	29 (5.66)	189 (4.56)	45 (11.03)	358 (10.20)
General play	392 (42.61)	3364 (43.97)	233 (45.51)	2022 (48.82)	159 (38.97)	1343 (38.27)
Weights	6 (0.65)	58 (0.76)	1 (0.20)	6 (0.14)	5 (1.23)	53 (1.51)
Conditioning	10 (1.09)	129 (1.69)	1 (0.20)	7 (0.17)	9 (2.21)	123 (3.51)
Other/unknown	98 (10.65)	859 (11.23)	42 (8.20)	352 (8.50)	56 (13.73)	507 (14.45)
<b>Position</b>						
Forward	540 (58.70)	4386 (57.33)	311 (60.74)	2500 (60.36)	229 (56.13)	1886 (53.75)
Defenseman	262 (28.48)	2171 (28.38)	154 (30.08)	1226 (29.60)	108 (26.47)	945 (26.93)
Goaltender	96 (10.43)	795 (10.39)	41 (8.01)	335 (8.09)	55 (13.48)	460 (13.11)
Other/unknown	22 (2.39)	299 (3.91)	6 (1.17)	82 (1.98)	16 (3.92)	218 (6.21)

<sup>a</sup> 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.

movements using granular measurements of exposure time and workload to better understand strains in this population and posit preventive strategies.

Concussions were the most commonly reported specific injury during the study period. Overall, concussion rates in the present study generally were comparable to those reported in previous studies of this population.<sup>5,28</sup> Whereas concussion incidence in the present study remained relatively stable during the earlier years of the study, it increased between 2017–2018 and 2018–2019. Given that ISP participation among women’s ice hockey programs was higher in 2018–2019 than in previous years, it is important to direct further attention toward this finding. Indeed, the relatively higher participation suggests that the 2018–2019 estimates are more reflective of the concussion burden in this population than estimates from prior years, and close monitoring of concussion rates after 2018–2019 may be needed to determine the stability of these findings and better inform nuanced intervention strategies. Concussion incidence in contact sports such as women’s ice hockey is an important topic for discussion, particularly considering the potential long-term neurocognitive implications of concussive injury.<sup>29</sup> Although body checking is considered illegal in women’s ice hockey, previous studies of concussions in this population have reported that approximately 50% of reported concussions may be attributed to player contact<sup>30</sup> and have suggested that further attention may be directed towards improving women’s ice hockey athletes’ ability to brace head impacts from player collisions.<sup>6</sup> Among groups in which body checking is prohibited, studies have primarily attributed concussion incidence and more deleterious head impact biomechanics to unanticipated player collisions.<sup>13,31–33</sup> Findings of the present study, coupled with the existing literature may

prompt ATs to heighten their awareness of unintentional collisions that may result in concussions in this population. Whereas future studies of head-impact biomechanics will be critical in better understanding the exposure dynamics of concussions in women’s ice hockey, efforts to improve concussion-related knowledge, awareness, and reporting intentions may also be used to augment playing rule adaptations to reduce the incidence of concussions in this population. In discussing future directions following the work presented here, it remains critical to acknowledge that these findings may not represent larger association-wide patterns. Although ISP participation among women’s ice hockey programs was at its healthiest during the final year of this study, the overall participation observed during 2014–2015 through 2018–2019, as well as the heterogeneity in participation between each year, limit the external validity of these findings. Therefore, continued and expanded monitoring of this population is critical for informing targeted studies and interventions such as those discussed above.

Routine monitoring of NCAA women’s ice hockey injuries is critical in capturing the evolving burden of injury in this population. In addition to traditional examinations of overall injury incidence, injury surveillance should specifically involve monitoring trajectories of most commonly reported injuries to elucidate temporal patterns in injury incidence. As discussed herein, the ability to obtain stable and generalizable findings from injury surveillance data is directly related to participation in injury surveillance programs. As such, healthy participation in injury surveillance is a primary determinant of the inferential capacity and utility of surveillance data. Ultimately, surveillance-based studies involving significant proportions of the target population are important not only

in identifying emerging patterns, but also in developing targeted studies and injury prevention strategies.

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