

# Hand and Wrist Injuries Among Collegiate Athletes

## The Role of Sex and Competition on Injury Rates and Severity

Andrew M. Simpson,\* MD, Daniel P. Donato,<sup>†</sup> MD, Jacob Veith,<sup>‡§</sup> MD,  
David Magno-Padron,<sup>‡</sup> MD, and Jayant P. Agarwal,<sup>‡</sup> MD

*Investigation performed at the University of Utah School of Medicine, Salt Lake City, Utah, USA*

**Background:** There is a high incidence of hand and wrist injuries in athletes participating in collegiate sports, but there is little information published characterizing them.

**Purpose:** To characterize hand and wrist injuries in collegiate athletes using a large national database.

**Study Design:** Descriptive epidemiology study.

**Methods:** This retrospective cross-sectional analysis was designed using data from the National Collegiate Athletic Association (NCAA) Injury Surveillance Program database to identify hand and wrist injuries (exclusive of any radial or ulnar fractures) in male and female collegiate athletes participating in NCAA Division I, II, and III sports from 2004 to 2015. Descriptive analyses were performed on stratified data to examine the associations between these injuries and sport, event type, and sex.

**Results:** Men's ice hockey (8.25 per 10,000 athlete-exposures [AEs]) and women's ice hockey (8.21 per 10,000 AEs) had the highest rate of hand and wrist injuries in all exposures. In every sport except women's gymnastics ( $P = .107$ ), injuries were more commonly sustained during competition rather than during practice. Ligamentous injury to the phalynx was the most commonly sustained injury overall (1.416 per 10,000 AEs), and a metacarpal fracture was the most commonly sustained hand or wrist fracture (0.507 per 10,000 AEs). Injuries sustained during men's wrestling (14.08 days) and women's gymnastics (10.39 days) incurred the most time lost from sport. Surgery for hand and wrist injuries was most commonly required for men's football (0.413 per 10,000 AEs) and women's field hockey (0.404 per 10,000 AEs).

**Conclusion:** Hand and wrist injuries were common among collegiate athletes. Male athletes experienced injuries with more frequency and severity. Injuries occurred more commonly during competition. While the majority of injuries were minor and did not require surgery, certain sports conferred a much higher risk of significant injuries requiring a surgical intervention.

**Keywords:** hand injuries; wrist injuries; NCAA; collegiate sport injuries

<sup>§</sup>Address correspondence to Jacob Veith, MD, Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Utah, 30 North 1900 East, #3B400, Salt Lake City, UT 84132, USA (email: jacob.veith@utah.edu).

\*Division of Plastic and Reconstructive Surgery, Department of Surgery, Western University, London, Ontario, Canada.

<sup>†</sup>Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Texas Medical Branch, Galveston, Texas, USA.

<sup>‡</sup>Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Utah, Salt Lake City, Utah, USA.

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It is estimated that over 25% of all sport-related injuries involve the hand or wrist.<sup>4,5</sup> While many of these injuries are minor, more significant injuries requiring surgery and prolonged time away from sport can occur. Injuries involving the hand or wrist in student-athletes may also lead to impairments, affecting scholastic performance or employment. Despite their high incidence, there is relatively little published data on hand and wrist injury severity and patterns in collegiate athletics.

Over 490,000 student-athletes participated in sport at the collegiate level in the United States in 2016.<sup>17</sup> Since 1982, the National Collegiate Athletic Association (NCAA) has maintained a database of injuries sustained during sporting events as part of its mandate to ensure the health and safety of student-athletes.<sup>24</sup> In 2004, the Datalys Center for Sports Injury Research and Prevention began compiling and maintaining the Injury Surveillance Program (ISP) database based on information collected from reports

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filed by NCAA athletic trainers.<sup>20</sup> This information has been used to analyze injury patterns in specific sport disciplines. However, a comprehensive characterization of hand and wrist injuries in collegiate athletics has not been performed.<sup>1-3,7,8,12-15,22,26</sup>

The purpose of this study was to provide a descriptive analysis of hand and wrist injuries sustained during collegiate sporting events using data from the NCAA ISP database. The aim was to specifically compare the injury patterns, severity, and requirement for surgery in certain sports. We also sought to evaluate the implication of sex and whether the injury was sustained during practice or competition. It was hypothesized that injuries would be more likely to occur during competition, that male athletes would be more likely to sustain an injury compared with female athletes, and that team sports involving impact would be the most commonly associated with hand and wrist injuries.

## METHODS

This study was deemed exempt from review by our institutional review board on the basis of deidentified information. The study protocol was reviewed and approved by the Datalys Center for Sports Injury Research and Prevention and by the NCAA.

### Database

This study used data from the NCAA ISP from 2004 to 2015. The original purpose of the database was to “collect injury and exposure data from NCAA institutions in a variety of sports to influence risk management decision making” and “shape decisions regarding health and sports safety.”<sup>24</sup> The database is composed of two 5-year sets, from 2004 to 2009 and from 2010 to 2015, with both sets having slightly different variables, collection methods, and number of participating teams. Among these differences is the reporting of non-time loss injuries, which did not begin until the 2009-2010 season.<sup>20</sup> Starting in 2004, the ISP monitored 15 core sports, with several additional sports added over time. The ISP is composed of information submitted by athletic trainers from a convenience sample of NCAA-sponsored Division I, II, and III teams in both men’s and women’s sports, with all divisions reporting to the database voluntarily. Athletic trainers record data including athlete-exposures (AEs) and injuries.

For the purposes of the database and this study, an “exposure” refers to an organized team practice or competition occurring during the preseason, regular season, or postseason time period. An “AE” refers to an individual athlete’s participation in one of these defined events, either practice or competition. To be captured, an injury must occur as a result of an organized intercollegiate practice or competition and require the attention of an athletic trainer or physician. Only athletes whose injuries were sustained during actual play during competition were captured for this subset.<sup>20</sup> “Time loss” refers to the inability to participate in practice or competition in a registered sport, measured in increments of days with a minimum

duration of 1 day. The NCAA ISP database captures a mixed distribution of athletics. Sports captured exclusively for women include field hockey and softball, while exclusive men’s sports include baseball, football, and wrestling. Both sexes have college-level ice hockey, tennis, basketball, lacrosse, and soccer sports.

## Study Design

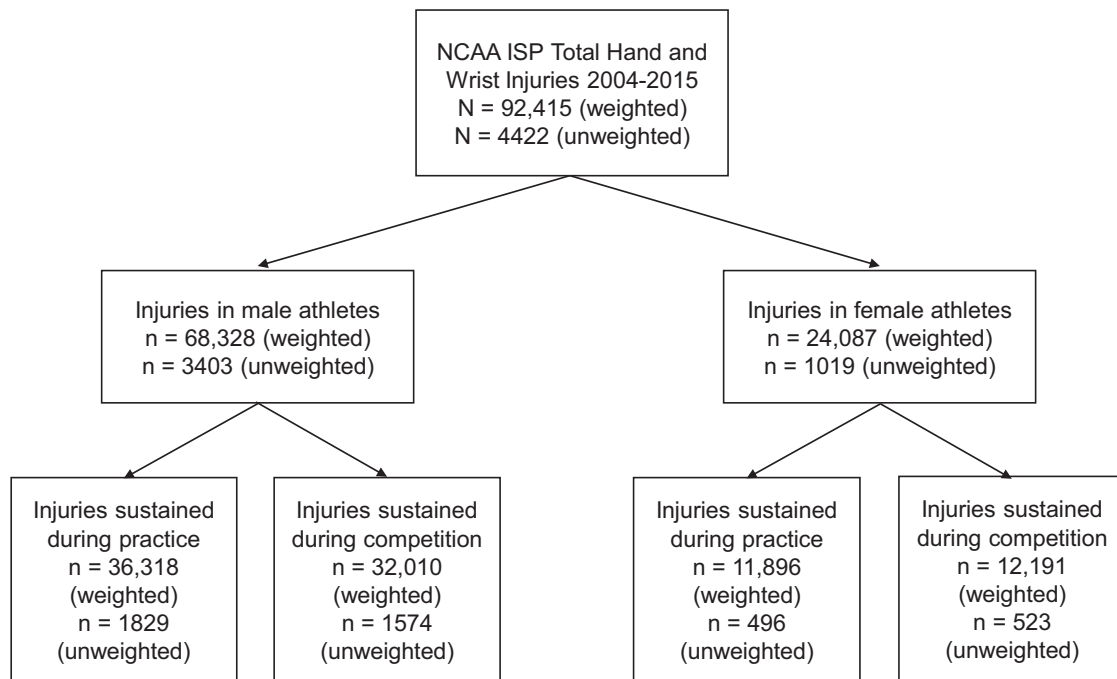
A retrospective, epidemiological cross-sectional analysis of hand and wrist injuries was performed using information contained within the 2004-2015 database. Injuries occurring in Division I, II, and III sports were analyzed together. All hand and wrist injuries identified were included. We recognize that other literature discussing hand and wrist injuries often includes fractures of the distal radius and ulnar styloid. However, the ISP database does not specify the location of such fractures. As such, any fractures involving the radius are grouped as “radial fractures,” and fractures of the ulnar styloid are grouped as “ulnar fractures.” Specific identifying information was applied to each exposure such as year, sport, and division. Each injury event is also given specific identifying information, and within these injury events, an athlete may experience multiple injuries but will remain under the same event/identifier; thus, it is not possible to determine if there were multiple injuries included in the same event. Distinctions were made between fractures and dislocations, as well as soft tissue injuries. Within these categories, several specific injuries were grouped to streamline data analysis. In total, 5 categories for fractures and dislocations were created: metacarpal fracture, phalangeal fracture, dislocation-phalanx, scaphoid fracture, and other carpal fracture. Additionally, 11 categories for soft tissue injuries were created: ligamentous injury-other wrist sprain; ligamentous injury-phalanx; ligamentous injury-triangular fibrocartilage complex, distal radioulnar joint, scapholunate; contusion-hand/finger; contusion-wrist; tendon-phalanx; tendon-wrist; wrist tenosynovitis; infection; nail bed; and soft tissue injury-other.

## Statistical Analysis

All of the data requested from the ISP include specific weights for each sport and division. Rather than representing a registry of each event/injury taking place across the country, weighting performed by the ISP coordinators allows the data to be interpreted as national estimates based on the convenience sample of schools, sports, and events. The sample weights are calculated by the ISP using the following formula:

$$\begin{aligned} weight_{ijk} & \\ &= (No. \text{ of ISS schools}_{ijk} / No. \text{ of sponsoring schools}_{ijk})^{-1} \end{aligned}$$

where  $weight_{ijk}$  is the weight for sport  $i$  in division  $j$  in year  $k$ .<sup>20</sup> Sample weighting was performed based on information provided by the ISP database coordinators. Validation studies indicate that the ISP captures over 88% of all time-loss injuries requiring medical care.<sup>20</sup> The data presented in the



**Figure 1.** Flow diagram of inclusion. NCAA ISP, National Collegiate Athletic Association Injury Surveillance Program.

current study are representative of the weighted values determined by the ISP.

Rates are reported per 10,000 AEs. CIs were determined at 95%. *P* values of less than .05 using the Student *t* test were used to determine significance. All statistical analyses were performed using SAS Version 9.4 (SAS Institute).

## RESULTS

### Database

From 2004 through 2015, there were 4422 hand and wrist injuries, corresponding to 92,415 total events after standard weighting was applied. A further breakdown of injury observations is demonstrated in Figure 1.

### Injury Rates by Sport in Practice and Competition

The sports with the highest rates of hand and wrist injuries in all exposures were men's (8.25 per 10,000 AEs) and women's (8.21 per 10,000 AEs) ice hockey. Men's football (31.75 per 10,000 AEs) and men's ice hockey (22.32 per 10,000 AEs) were the sports associated with the highest injury rates during competition. The total injury rate for male athletes was 6.01 per 10,000 AEs, while the total injury rate for female athletes was 4.13 per 10,000 AEs. In all athletes (men and women), hand and wrist injuries occurred in 5.33 per 10,000 AEs, with 4.32 per 10,000 AEs occurring in practice and 12.34 per 10,000 AEs occurring in competition. Injuries were more frequently sustained during competition rather than practice in every sport ( $P < .001$ ), except women's gymnastics ( $P = .107$ ) (Table 1).

### Specific Injury Types

Ligamentous injuries of the phalanx (1.416 per 10,000 AEs) were the most common injuries among all athletes across all events. Metacarpal fractures (0.507 per 10,000 AEs) were the most common fractures among all athletes. All specific injuries were more common among male athletes compared with female athletes ( $P < .001$ ) (Table 2).

### Injuries Requiring a Surgical Intervention

The overall surgery rate for hand and wrist injuries sustained in men's and women's collegiate sports was 0.201 per 10,000 AEs, with 3.78% of injuries requiring surgery. The overall surgery rate for hand and wrist fractures was 0.130 per 10,000 AEs, with 11.90% of all fractures requiring surgery. Injuries sustained during women's field hockey were the most likely to require surgery (7.51% of all injuries), while the rate of fractures requiring surgery was greatest in women's gymnastics at 27.37%. The surgery rate for hand and wrist injuries among male athletes was 0.254 (95% CI, 0.241-0.267) per 10,000 AEs, with 4.22% of injuries requiring surgery. The rate of surgery in female athletes with hand and wrist injuries was 0.109 (95% CI, 0.093-0.125) per 10,000 AEs, with 2.65% of all injuries requiring surgery. The surgery rate for hand and wrist fractures among male athletes was 0.160 (95% CI, 0.128-0.192) per 10,000 AEs, with 11.46% of fractures requiring surgery. The database did not report injuries requiring surgery in women's lacrosse, which were therefore not included in Table 3. The surgery rate for hand and wrist fractures among female athletes was 0.078

TABLE 1  
Hand and Wrist Injury Rate by Sport and Sex Sustained During Practice and Competition<sup>a</sup>

	Injury Rate per 10,000 AEs			Competition vs Practice		
	All Exposures	Competition	Practice	OR	95% CI	P Value
<b>Men's sports</b>						
Baseball	5.57	10.66	2.89	3.68	3.55-3.82	<.001
Basketball	6.63	14.07	4.67	3.01	2.89-3.13	<.001
Football	6.85	31.75	4.35	7.29	7.13-7.46	<.001
Ice hockey	8.25	22.32	3.95	5.65	5.25-6.09	<.001
Lacrosse	6.81	17.74	4.49	3.95	3.72-4.20	<.001
Soccer	2.51	4.11	2.07	1.98	1.85-2.13	<.001
Wrestling	5.31	8.19	4.94	1.66	1.50-1.83	<.001
Total	6.01	15.71	4.81	3.27	3.22-3.32	<.001
<b>Women's sports</b>						
Basketball	4.03	7.54	2.99	2.52	2.39-2.65	<.001
Field hockey	5.38	15.20	2.02	7.51	6.68-8.45	<.001
Gymnastics	3.62	4.43	3.52	1.27	0.95-1.71	.107
Ice hockey	8.21	16.77	5.13	3.27	2.83-3.78	<.001
Lacrosse	1.85	4.97	1.06	4.72	4.12-5.41	<.001
Soccer	2.35	5.30	1.41	3.76	3.52-4.02	<.001
Softball	5.46	8.96	3.13	2.86	2.73-3.00	<.001
Volleyball	5.56	5.94	5.40	1.10	1.04-1.16	.001
Total	4.13	8.34	3.42	2.43	2.38-2.49	<.001
Overall	5.33	12.34	4.32	2.86	2.75-2.97	<.001

<sup>a</sup>AE, athlete-exposure; OR, odds ratio.

TABLE 2  
Hand and Wrist Injury Rate by Type of Injury Among Male and Female Athletes<sup>a</sup>

	All Athletes		Male Athletes		Female Athletes		P Value
	Injury Rate <sup>b</sup>	95% CI	Injury Rate <sup>b</sup>	95% CI	Injury Rate <sup>b</sup>	95% CI	
<b>Fractures and dislocations</b>							
Metacarpal fracture	0.507	0.452 to 0.561	0.654	0.577 to 0.731	0.247	0.183 to 0.311	<.001
Phalangeal fracture	0.474	0.414 to 0.534	0.493	0.413 to 0.572	0.442	0.356 to 0.528	<.001
Dislocation-phalanx	0.422	0.367 to 0.477	0.566	0.485 to 0.646	0.169	0.115 to 0.222	<.001
Scaphoid fracture	0.112	0.084 to 0.139	0.146	0.107 to 0.184	0.051	0.020 to 0.083	<.001
Other carpal fracture	0.075	0.051 to 0.099	0.102	0.065 to 0.139	0.027	0.010 to 0.043	<.001
<b>Soft tissue injuries</b>							
Ligamentous injury—other wrist sprain	0.691	0.620 to 0.761	0.817	0.721 to 0.913	0.469	0.373 to 0.564	<.001
Ligamentous injury—phalanx	1.416	1.321 to 1.510	1.434	1.316 to 1.551	1.384	1.227 to 1.541	<.001
Ligamentous injury—TFCC, DRUJ, scapholunate	0.097	0.068 to 0.126	0.117	0.076 to 0.157	0.063	0.030 to 0.096	<.001
Contusion—hand/finger	0.770	0.688 to 0.852	0.817	0.709 to 0.925	0.688	0.563 to 0.813	<.001
Contusion—wrist	0.156	0.124 to 0.188	0.183	0.138 to 0.229	0.108	0.068 to 0.147	<.001
Tendon—phalanx	0.186	0.147 to 0.225	0.213	0.162 to 0.265	0.137	0.079 to 0.196	<.001
Tendon—wrist	0.109	0.082 to 0.136	0.120	0.084 to 0.156	0.090	0.050 to 0.131	<.001
Wrist tenosynovitis	0.079	0.049 to 0.108	0.083	0.041 to 0.124	0.072	0.037 to 0.106	<.001
Infection	0.010	0.003 to 0.017	0.012	0.003 to 0.021	0.008	-0.003 to 0.019	<.001
Nail bed	0.060	0.033 to 0.088	0.062	0.026 to 0.098	0.056	0.014 to 0.099	<.001
Soft tissue injury—other	0.164	0.129 to 0.199	0.191	0.144 to 0.239	0.117	0.067 to 0.166	<.001

<sup>a</sup>DRUJ, distal radioulnar joint; TFCC, triangular fibrocartilage complex.

<sup>b</sup>Per 10,000 athlete-exposures.

TABLE 3  
Rate of Hand and Wrist Injuries Requiring Surgery by Sport and Sex

	All Injuries			Fractures		
	Surgery Rate <sup>a</sup>	95% CI	% Requiring Surgery	Surgery Rate <sup>a</sup>	95% CI	% Requiring Surgery
<b>Men's sports</b>						
Baseball	0.121	0.057 to 0.184	2.17	0.088	0.033 to 0.144	6.01
Basketball	0.208	0.125 to 0.290	3.13	0.191	0.113 to 0.268	18.12
Football	0.413	0.368 to 0.459	6.03	0.239	0.203 to 0.275	14.79
Ice hockey	0.189	0.051 to 0.326	2.29	0.079	-0.012 to 0.170	3.75
Lacrosse	0.340	0.132 to 0.548	4.99	0.180	0.042 to 0.319	9.76
Soccer	0.047	0.005 to 0.088	1.85	0.028	-0.004 to 0.061	5.66
Wrestling	0.085	0.000 to 0.169	1.59	0.065	-0.010 to 0.140	4.17
Total	0.254	0.241 to 0.267	4.22	0.160	0.128 to 0.192	11.46
<b>Women's sports</b>						
Basketball	0.116	0.051 to 0.181	2.88	0.083	0.027 to 0.139	9.28
Field hockey	0.404	0.083 to 0.726	7.51	0.284	0.020 to 0.549	13.34
Gymnastics	0.191	-0.081 to 0.462	5.28	0.191	-0.080 to 0.462	27.37
Ice hockey	0.008	-0.008 to 0.025	0.10	0.008	-0.008 to 0.025	1.00
Soccer	0.028	-0.005 to 0.061	1.20	0.157	-0.007 to 0.041	3.11
Softball	0.245	0.136 to 0.354	4.48	0.024	0.078 to 0.256	15.16
Volleyball	0.028	-0.012 to 0.069	0.51	0.433	-0.012 to 0.069	6.21
Total	0.109	0.093 to 0.125	2.65	0.078	0.045 to 0.111	13.80
Overall	0.201	0.191 to 0.212	3.78	0.130	0.104 to 0.157	11.90

<sup>a</sup>Per 10,000 athlete-exposures.

TABLE 4  
Time Loss After Hand and Wrist Injuries by Sport

	% of Injuries						Mean Time Lost per Injury, d	95% CI
	<1 d	1-7 d	8-14 d	15-30 d	31-60 d	>60 d		
<b>Women's sports</b>								
Gymnastics	47.3	14.3	16.4	12.1	7.6	2.3	10.39	4.38 to 16.41
Ice hockey	46.5	36.8	8.7	4.8	0.9	2.3	10.22	-2.91 to 23.34
Soccer	47.8	31.5	9.8	7.1	2.0	1.8	8.73	5.41 to 12.05
Field hockey	23.1	56.6	7.2	4.4	4.4	4.4	7.84	4.22 to 11.46
Softball	37.1	35.9	10.7	9.0	5.5	1.7	6.89	3.62 to 10.16
Volleyball	46.7	41.0	5.8	3.5	2.8	0.2	3.71	2.71 to 4.71
Basketball	76.3	14.1	5.1	0.0	3.3	1.2	3.11	0.83 to 5.38
Lacrosse	60.3	27.4	10.6	1.7	0.0	0.0	1.91	0.83 to 3.00
Total	46.9	32.8	9.2	5.4	4.1	1.5	6.79	5.63 to 7.95
<b>Men's sports</b>								
Wrestling	41.9	15.9	10.0	13.1	11.3	7.8	14.08	7.75 to 20.41
Baseball	44.7	21.7	12.2	9.1	9.3	3.0	11.29	6.85 to 15.73
Basketball	49.2	33.9	5.3	4.6	4.6	2.4	6.43	4.43 to 8.44
Ice hockey	52.7	24.8	11.3	6.4	3.8	0.9	5.88	4.03 to 7.73
Lacrosse	46.7	31.9	9.9	6.0	5.5	0.0	5.37	3.76 to 6.99
Football	47.2	34.7	9.3	4.0	3.9	0.9	5.10	4.41 to 5.80
Soccer	45.5	39.4	7.5	2.4	5.0	0.2	4.54	2.96 to 6.12
Total	52.0	28.4	8.2	4.9	5.0	1.6	7.29	5.81 to 8.77
Overall	50.5	29.7	8.5	5.0	4.8	1.5	7.14	6.05 to 8.23

(95% CI, 0.045-0.111) per 10,000 AEs, with 13.80% of fractures requiring surgery (Table 3).

Time Loss After an Injury

The mean time loss for all injuries in male and female athletes was 7.14 days (95% CI, 6.05 to 8.23). Hand

and wrist injuries sustained during wrestling led to the longest mean time loss in men's sports at 14.08 days (95% CI, 7.75 to 20.41). In women's sports, gymnastics at 10.39 days (95% CI, 4.38 to 16.41) and ice hockey at 10.22 days (95% CI, -2.91 to 23.34) had the highest mean time loss after hand and wrist injuries (Table 4).

TABLE 5  
Time Loss and Injury, Surgery, and Fracture Rates by Sex<sup>a</sup>

	Female Athletes		Male Athletes		P Value
	Value	95% CI	Value	95% CI	
Mean time lost per injury, d	6.79	5.63-7.95	7.29	5.81-8.77	<.001
Total injury rate per 10,000 AEs	4.13	3.88-4.37	6.01	5.80-6.21	<.001
Total surgery rate per 10,000 AEs	0.109	0.093-0.125	0.254	0.241-0.267	<.001
Fracture surgery rate per 10,000 AEs	0.078	0.045-0.111	0.160	0.128-0.192	<.001

<sup>a</sup>AE, athlete-exposure.

### Comparison of Male and Female Athlete Injury Patterns

Male athletes were significantly more likely to be injured (6.01 vs 4.13 per 10,000 AEs, respectively;  $P < .001$ ), had longer mean time loss after an injury (7.29 vs 6.79 days, respectively;  $P < .001$ ), and were more likely to undergo surgery after any injury (0.254 vs 0.109 per 10,000 AEs, respectively;  $P < .001$ ) and after a fracture (0.160 vs 0.078 per 10,000 AEs, respectively;  $P < .001$ ) compared with female athletes (Table 5).

### DISCUSSION

The NCAA Injury Surveillance System has made significant advancements since its inception in 1982. The ISS was renamed the ISP in 2009 after it transitioned to a fully electronic system with the ability to incorporate data from different injury documentation applications and electronic medical records. This database has been used to report and analyze numerous injuries across 15 major collegiate sports.<sup>10</sup> This database has been used extensively to characterize a range of injuries across different sports and athletes. However, relatively little has been published characterizing hand and wrist injuries in these athletes. We present a descriptive analysis and characterization of hand and wrist injuries sustained in collegiate sports, revealing data on their frequency and severity across sports and sexes along with the impact of these injuries on the athlete's ability to compete.

We evaluated 92,415 hand and wrist injuries on a weighted sample in collegiate athletes between 2004 and 2015. Overall, male athletes appeared to suffer from higher rates of injuries, injuries requiring surgery, and fractures requiring surgery compared with female athletes. Men's and women's ice hockey had the highest overall rates of injury. Fractures of the metacarpals and phalanges were the most common fractures experienced by male and female athletes, respectively, while ligamentous injuries as a

whole accounted for the highest rate of soft tissue injuries across both sexes. Injuries sustained during men's wrestling and women's gymnastics incurred the most time lost from sport. Surgery for hand and wrist injuries was most commonly required for men's football and women's field hockey.

The discrepancy in injury rates, severity, and time loss between male and female athletes is well-evidenced in our study (Table 5) and has been shown across different injuries as well.<sup>9,14,19,20,28</sup> Kay et al<sup>18</sup> revealed that 3183 severe injuries (>21 days of time lost) were recorded across all sports and sexes, accounting for almost 10% of sustained injuries from the 2009 to 2014 seasons. Men's football and men's ice hockey accounted for almost 50% of all severe injuries over this time, and the proportion of fractures resulting in severe injuries was higher in men versus women. When they evaluated hand and wrist injuries between sexes, they revealed that the proportion of severe injuries was greater in men than in women.<sup>18</sup> Because of the nature of the data set, the ability to examine injury causality is limited. The differences observed between injury rates in male and female athletes may be because of inherent differences between game-playing strategy or the self-reporting nature of injuries. Higher force generation during male sports likely exists because of increased athlete weight and aggressive play style. This was supported in a comparison between men's and women's ice hockey in which the magnitude of acceleration after head impact was greater in male than female athletes.<sup>27</sup> Further studies of the factors leading to injury differences are warranted.

As previously stated, we have revealed differences in injury rates between sexes across specific sports. In lacrosse, male athletes sustained hand and wrist injuries requiring surgery in 0.340 per 10,000 AEs, while no instances of surgery were captured for female athletes participating in lacrosse in the database. Men's and women's lacrosse have different rules and equipment requirements that may explain this observation. In women's lacrosse, body contact is prohibited, while men's lacrosse allows aggressive physical contact. Both men's and women's lacrosse mandate wearing gloves, suggesting that aggressive physical contact contributes to both the overall number and severity of injuries. Field hockey, a sport played only by women, also involves the use of a stick but does not require the use of gloves; yet, it incurs an injury rate roughly 3 times greater than women's lacrosse. In 2018, injury patterns in collegiate women's field hockey were described by Lynall et al<sup>23</sup> using the NCAA ISP database. Hand and wrist injuries were the second most common injuries sustained during competition, accounting for 15.4% of injuries over a 6-year span. Furthermore, roughly half of all the injuries sustained were caused by ball or stick contact.<sup>23</sup> Prior literature on hand injuries in stick-handling sports at the college level has revealed a 2-fold increased risk for hand injuries in field hockey versus sports mandating glove use.<sup>6</sup> These findings, in conjunction with the findings described in the current study, could provide further support to the notion that protective gloves should be considered mandatory in collegiate field hockey athletes to

possibly decrease the risk of hand and wrist injuries. These sentiments have been echoed by other authors as well.<sup>6</sup>

Gymnastics, although performed by both male and female athletes at the college level, is only captured as a women's sport in the NCAA ISP. Female collegiate gymnasts incurred the third highest risk of hand and wrist injuries requiring surgery, with a rate of 0.191 per 10,000 AEs. Despite the third lowest injury rate of 3.62 per 10,000 AEs, injuries sustained during gymnastics required surgery 5.28% of the time, with fractures requiring surgery 27.37% of the time; these represent the second highest and highest values for these injuries in the cohort, respectively. Gymnasts also experienced the most time loss after hand and wrist injuries. Compared with other women's sports, hand and wrist injuries sustained by female gymnasts were more significant and required surgery for fractures or dislocations more often than other collegiate sports captured in the data set. When injury severity was evaluated in collegiate athletes across the 2009 to 2013 academic years, women's gymnastics was found to have the second highest rate of severe injuries across all sports and sexes and also the highest rate in women's sports.<sup>18</sup> This is possibly because of the complex movements, high speeds, and high forces between the equipment and floor generated during gymnastics, combined with limited options for personal protective equipment. Although little protective equipment is worn by gymnasts, the equipment has received safety redesigns to soften the high forces incurred during landing and floor contact, which have translated to decreases in injury rates since the late 1980s.<sup>25</sup> Even so, the severity of their injuries remains a noteworthy finding that warrants future investigation into injury prevention programs, such as mandatory wrist guards, in the hope to further mitigate their risk of injuries.

Both sexes participate in college-level ice hockey, tennis, basketball, lacrosse, and soccer. Previous studies have demonstrated increased athlete injury rates in competition compared with practice; however, this observation has not been examined in the context of hand and wrist injuries.<sup>11,16</sup> There were increased rates of injury during competition in both men's and women's sports. Rates of injury were significantly increased in every sport except for gymnastics, which likely reflects the individual nature of gymnastics with similar loads and forces generated by the athletes in both competitive and practice situations. Practice also requires multiple repetitions, which may increase the opportunities for an injury to occur (see Table 1).

This study has limitations. As it is restricted to the sports collected in the NCAA ISP database, the information and subsequent analysis may not be generalizable to other sports or to non-college level athletics. As the goal of this study was to contribute an overarching view on hand and wrist injuries in collegiate athletes as a whole, athletes were not separated based on division; seniority; preseason, regular season, or postseason activity; player position; or playing surface. Also, specific mechanisms of injury that are available in several sports were not evaluated (eg, ball contact, player contact). Several limitations inherent to the database should be mentioned. First, although distal radius and ulnar styloid fractures are closely associated with hand

and wrist injuries, the database does not specify the level at which the fracture occurred; therefore, such injuries were excluded from our analysis. Second, it was not possible to describe the causality of differing injury rates and severity between male and female athletes. The data generated are based on voluntary reports from athletic trainers, and although the high number of reports across all sports should reduce bias, in some cases, the information may be limited. It is prudent to recognize that there are differences in the database from 2004 to 2009 and from 2010 to 2015, with one such difference being that non-time loss was not documented until 2009. As this change was uniform across all sports and sexes, this variation should not affect overall findings. The 2 database subsets have been previously combined in similar analyses.<sup>10,21</sup> Complete and accurate documentation of non-time loss injuries can be of benefit to athletic trainers and their athletic departments. For example, a trend toward increasing and decreasing non-time loss and time-loss injuries, respectively, may give insight into the effectiveness of protocols focused on preventing injuries.<sup>21</sup>

## CONCLUSION

Hand and wrist injuries were common among collegiate athletes. Male athletes tended to be injured more often than female athletes, with an overall higher surgery rate and time loss due to an injury. Although the majority of injuries were minor, some injuries had a greater rate of surgery and required significant time away from sport. Such injuries included specific fractures of the hand and wrist. However, our analysis did not allow an identification of which injuries resulted in the greatest time lost. Gymnastic injuries appeared to be more serious than injuries sustained in other sports and could be a result of the limited protective equipment available to these athletes. It is possible that the use of protective gloves in field hockey may decrease the number of injuries to the level of other similar sports in which gloves are mandated. If so, this information could be used to counsel patients on the inherent risks of collegiate sporting activities and may serve to improve discussions regarding injury mitigation in the case of glove use in sport. Further studies investigating the role of individual sports, player position, division of play, psychosocial effects of injuries, and specific injury patterns are warranted.

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