

# Elbow Dislocation and Subluxation Injuries in the National Collegiate Athletic Association, 2009-2010 Through 2013-2014

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**Background:** Examination of the incidence of elbow dislocation and subluxation injuries in the collegiate athlete population is limited.

**Purpose:** To determine the incidence of elbow dislocation and subluxation injuries in the National Collegiate Athletic Association (NCAA) and investigate the risk factors involved.

**Study Design:** Descriptive epidemiology study.

**Methods:** All elbow subluxation and dislocation injuries from the 2009-2010 through 2013-2014 academic years in the NCAA Injury Surveillance Program database were extracted. The incidence was calculated for different injuries, sports, activity, time in game, competition status, and injury characteristics. Such differences were compared by use of risk ratios to determine risk factors for injury.

**Results:** The overall incidence of elbow instability injuries was 0.04 per 10,000 athlete-exposures (AEs). Elbow dislocations were more common, with 553 injuries (82.2%, 0.03/10,000 AEs), while elbow subluxations were the minority, with 119 injuries (17.8%, 0.01/10,000 AEs). Men's wrestling had the highest incidence of elbow instability (1.08/10,000 AEs), more than women's gymnastics (0.74), men's football (0.11), and women's volleyball (0.06). All injuries occurred via a contact mechanism, and 99.2% were new injuries. Sixty-nine percent of injuries kept athletes sidelined for more than 2 weeks. Injuries were 3 times more likely to occur in competition (0.08/10,000 AEs) than practice (0.03/10,000 AEs). Injuries sustained during competition were 1.4 times more likely to occur early in the match than late.

**Conclusion:** Elbow instability injuries are an infrequent but serious source of disability for select NCAA athletes, with a number of associated risk factors. Athletes sustaining these injuries, along with their coaches and medical providers, may benefit from these return-to-play data to best manage expectations and outcomes.

**Keywords:** NCAA; elbow injuries; elbow instability; athletic injuries; epidemiology; database

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The elbow is a complex joint that is crucial for effective transmission of forces from the shoulder to the hand. The elbow is stabilized by a number of structures: osseous constraint from its bony articulations, ligamentous structures such as the joint capsule, the medial (ulnar) collateral ligament, and the lateral collateral ligament complex. These are essential to the stability of the elbow joint and help to prevent subluxation and dislocation. Accurate diagnosis of elbow instability is vital to prevent delayed treatment and decrease the time needed for the athlete to return to play.

Although the incidence of elbow instability is low in the general population, such injuries are common in athletes and are frequently observed in contact sport and overhead throwing athletes.<sup>6,13,14,17,20,30</sup> Acute trauma, often occurring during contact with another player or the playing surface, can disrupt the ligamentous and/or

osseous architecture of the elbow and contribute to elbow instability. Overhead or contact athletes are prone to microtrauma at the elbow due to repetitive supraphysiological forces, which may result in instability.

Although more than 460,000 student athletes take part in 25 different sports in the National Collegiate Athletic Association (NCAA), the incidence of elbow instability and the implications on time away from sport are not well understood in the collegiate population.<sup>35</sup> For the athlete, such an injury can mean a premature end to a season or even a career. When comparing elbow dislocation to other elbow injuries, Dizdarevic et al<sup>18</sup> found that dislocation more often resulted in removal from sport for more than 3 weeks compared with nondislocation injuries (23.4% vs 6.9%, respectively) and more often required surgical treatment (13.6% vs 4.7%, respectively).

Given the complexity and serious implications of elbow injuries, the objective of this study was to characterize the incidence, risk factors, and prognosis of elbow subluxations and dislocations in NCAA athletes. While numerous investigations have reported the rates of injury in individual sports, the epidemiological patterns of elbow dislocation and subluxation injuries have not been described in the collegiate athlete population.<sup>8</sup> We sought to characterize these elbow injuries recorded in the NCAA Injury Surveillance Program (ISP) database, determine the incidence of elbow dislocation and subluxation, identify in which sports these injuries occur, and determine associated risk factors. This information will aid in counseling injured athletes and will allow physicians to set realistic return to play goals for these patients.

## METHODS

The study methods were approved and permission to conduct the study was granted by the NCAA Research Review Board; the study was deemed exempt by our institutional review board.

### Data Collection

We retrospectively analyzed deidentified injury surveillance data from the NCAA-ISP for the 2009-2010 and 2013-2014 academic years for elbow subluxation and dislocation injuries and their associated sports exposures. The ISP uses a convenience sample of NCAA varsity teams from 25 sports; the number of programs varies by sport and by year. Athletic trainers, physicians, or other providers use a web-based system to enter data about injuries and exposure from all team-sanctioned practices and competition. Each injury requiring medical attention is recorded, even if the player returns within the same session. The data recorded include type of injury, body part injured, injury severity measures (time loss, need for surgery), mechanism of injury, time in game, and portion of season (preseason, regular season, or postseason). Select variables, such as date or particular time in season, are not available due to privacy concerns.

The incidence was provided in injuries per 10,000 athlete-exposures (AEs); an AE is defined as 1 athlete participating in a game or practice, regardless of the duration, during which he or she is exposed to a possibility of athletic injury.

## Statistical Methods

Each AE and each injury in the datasets are provided with a poststratification sampling weight to allow extrapolation from the reported sample to a national estimate of the NCAA population, which is used to counteract the annual variability of the convenience sample. Sampling weights are provided by the NCAA and are determined based on sport, division of competition, and academic year. The sampling weights were used for all analyses, and weighted numbers were reported. Injuries were then matched with the weighted exposure dataset for the 2009-2010 through 2013-2014 academic years.

The incidence of elbow instability was calculated as the total number of elbow subluxation or elbow dislocation injuries in the variable "Injury\_or\_Illness\_Code," divided by the number of AEs. For comparison with previous studies, incidence was reported as injuries per 10,000 AEs. Data regarding elbow instability injuries were further stratified by injury, sport, event type (throwing vs nonthrowing, contact vs noncontact), time in game (early vs late), portion of season (preseason, regular season, or postseason), outcome (including time loss and need for surgery), and chronicity (new vs recurrent). For time in game, "early" comprised warm-up, first half, first and second quarters, first period, innings 1 through 3, and game/set 1 and 2; "late" comprised half-time, second half, third and fourth quarters, second and third periods, innings 4 through 9, game/set 3 and 4, and overtime.

Based on large-sample assumptions for normal approximation to Poisson distribution, 95% CIs were used for all incidence rates. Risk ratios were used to determine the rates of injury sustained in competition and practice, time in game, and time in season. All risk ratios with 95% CIs that did not include 1.00 were considered statistically significant.

## RESULTS

A total of 672 weighted injuries were observed over 176 million AEs, for an overall incidence of 0.04 per 10,000 AEs (Table 1). Elbow dislocation comprised 82.2% of the instability injuries, with an incidence of 0.03 per 10,000 AEs, while the remaining 17.8% were elbow subluxations (incidence, 0.01/10,000 AEs). Together, these totaled 3.0% of all elbow injuries.

When injury rates were evaluated by sport, men's wrestling had both the highest incidence (1.08/10,000 AEs) of elbow instability injuries and the largest number of injuries (311 injuries, 46.3% of total) (Figure 1). This was followed by women's gymnastics (0.74/10,000 AEs; 49 injuries, 7.3% of total), men's football (0.11/10,000 AEs; 272 injuries, 40.5% of total), and women's volleyball (0.06/10,000 AEs;

<sup>8</sup>References 1-6, 10, 13, 14, 16, 21-23, 25-28, 31, 32, 37.

TABLE 1

Incidence of Elbow Instability Injuries in the NCAA-ISP, 2009-2010 Through 2013-2014 Academic Years, by Injury<sup>a</sup>

| Injury            | No. of Injuries (weighted) | % of Injuries | Incidence per 10,000 AEs | 95% CI    |
|-------------------|----------------------------|---------------|--------------------------|-----------|
| Elbow dislocation | 553                        | 82.2          | 0.03                     | 0.03-0.03 |
| Elbow subluxation | 119                        | 17.8          | 0.01                     | 0.01-0.01 |
| Total             | 672                        | 100.0         | 0.04                     | 0.04-0.04 |

<sup>a</sup>AE, athlete-exposure; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

40 injuries, 6.0% of total). No other sport had a recorded subluxation or dislocation event.

The incidence of injury depended on timing within a game and setting of the session. Early-in-game injuries occurred with an incidence of 0.05 per 10,000 AEs, whereas the late-in-game injury incidence was 0.04 per 10,000 AEs, for a risk ratio of 1.4-fold (95% CI, 1.1-1.8;  $P = .126$ ) (Figure 2A). Injuries were sustained in competition at an incidence of 0.08 per 10,000 AEs versus an incidence in practice of 0.03, with a calculated risk ratio of 3.0 (95% CI, 2.6-3.5;  $P < .0001$ ) (Figure 2B). Right-sided injuries comprised 25.3% of the total.

New injuries comprised 99.2%, while those recurrent from a previous academic year made up the remaining 0.8%. All injuries were due to a contact mechanism, with 66.8% due to contact with a surface and 33.2% due to contact with a person. All injuries in gymnastics were due to person-to-surface contact, while all volleyball injuries were caused by person-to-person contact. The majority of injuries in wrestling (69.8%) and football (67.2%) were due to surface contact, while the remainder were due to person-to-person contact.

Although the absolute number of injuries was lower in competition (40.1%), the incidence was significantly higher in comparison with practice, with an incidence of 0.08 per 10,000 AEs (compared with 0.03/10,000 AEs, a 3.0-fold difference [95% CI, 2.6-3.5;  $P < .0001$ ]). The injury incidence was slightly but significantly higher during the regular season (0.05/10,000 AEs; 95% CI, 0.04-0.05) than during either the preseason (0.02/10,000 AEs; 95% CI, 0.02-0.03) or the postseason (0.01/10,000 AEs; 95% CI, 0.00-0.01). All of these findings were statistically significant, with play in the regular season conferring a risk ratio of 2.1-fold and 8.6-fold over the preseason and postseason, respectively. Athletes in Division I had a significantly higher incidence (0.05/10,000 AEs; 95% CI, 0.05-0.06) versus Division II (0.03/10,000 AEs) and Division III (0.03/10,000 AEs). Competing in Division I conferred a 1.6-fold increased risk compared with Division II and a 2.1-fold compared with Division III ( $P < .0001$ ).

Variability was found among the outcomes following injury, although most injuries were severe: 0% of players returned to play within 1 week, and 68.7% were out for more than 2 weeks (Figure 3). Despite this, 95.2% of injuries were managed nonoperatively, and a 1.3% required surgery; management of 3.5% was unknown.

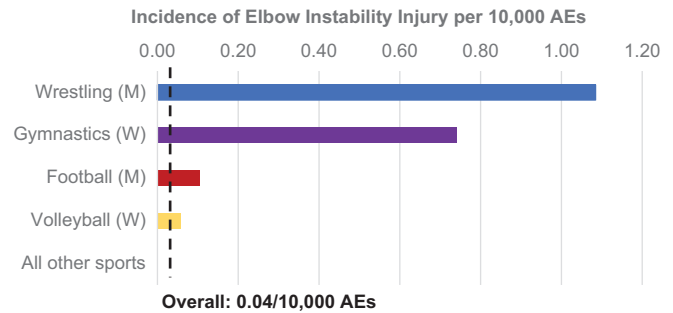


Figure 1. Incidence of elbow instability injuries in the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP), 2009-2010 through 2013-2014 academic years, by sport. No other sports had elbow dislocation or subluxation injuries. AEs, athlete-exposures; M, men; W, women.

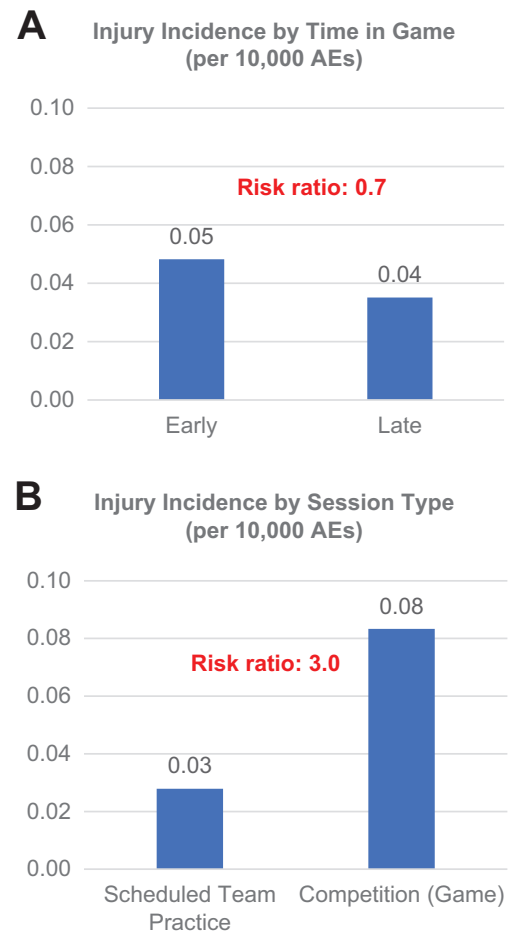
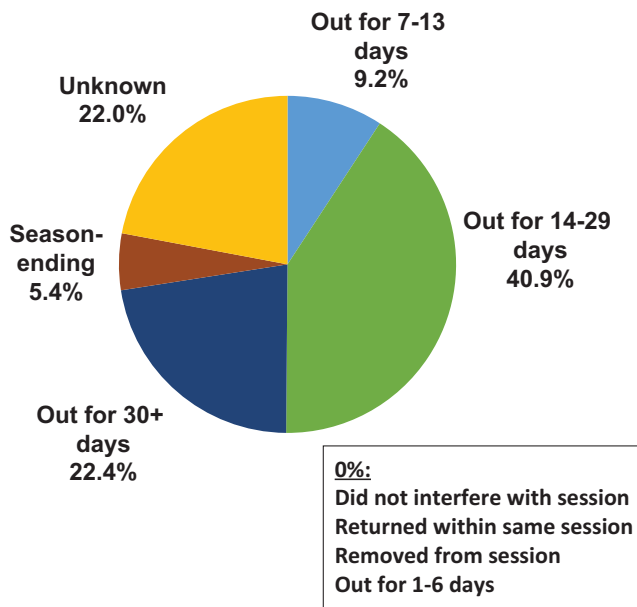


Figure 2. Incidence of elbow instability injuries by (A) time in game and (B) session type. “Early” includes warm-up, first half, first and second quarters, first period, innings 1-3, and game/set 1 and 2. “Late” includes half-time, second half, third and fourth quarters, second and third periods, innings 4-9, game/set 3 and 4, and overtime. AEs, athlete-exposures.



**Figure 3.** Time lost after elbow dislocation or subluxation injury in the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP), 2009-2010 through 2013-2014 academic years.

## DISCUSSION

The objective of this study was to characterize the epidemiological patterns and the implications of elbow instability in NCAA athletes. For all instability injuries, the most common mechanism was contact with another player. Interestingly, this finding illustrates that injuries were more likely to occur during competition and were more likely to occur later in a game. We found that the highest incidence of elbow instability occurred in men's wrestling, followed by women's gymnastics, men's football, and women's volleyball.

The literature has shown that elbow instability poses a problem for athletes at all levels, although minor differences exist among these populations.<sup>7,8,18,24,29</sup> In a retrospective study looking at 10 years of upper extremity injuries in National Football League (NFL) players, Carlisle et al<sup>8</sup> determined that elbow injuries were the most common type of upper extremity injury and found elbow subluxations to occur at an incidence of 0.19 per 10,000 AEs, similar to our findings among NCAA football players (0.11/10,000 AEs). Carlisle et al<sup>8</sup> and Kenter et al<sup>24</sup> reported that elbow dislocations and subluxations in NFL players represented 12% and 18% of all elbow injuries, respectively, substantially higher than the 3.0% found in NCAA players. This difference may be due to higher-energy injuries in the NFL, the cumulative impact of repetitive trauma, different methods of data analysis, or a combination thereof.

The epidemiological patterns of elbow instability have been well studied in high school athletes.<sup>18</sup> Dizdarevic et al<sup>18</sup> reported that elbow dislocations in high school athletes occurred at an incidence of 0.04 per 10,000 AEs (9.2%

of all elbow injuries), the same as the incidence seen in our NCAA population (0.04/10,000 AEs). Dizdarevic et al further found that men's wrestling and woman's gymnastics were the most common sports in which elbow dislocations occurred, a finding that was mirrored in our data. However, those authors noted that the incidence of elbow dislocation in wrestling and gymnastics in high school athletes was 0.27 and 0.25 per 10,000 AEs, respectively, significantly lower than our findings in NCAA athletes (1.08 and 0.74/10,000 AEs, respectively). This corroborates the notion that as athletes become stronger and faster and accumulate wear and tear, their incidence of injury may increase commensurately.

However, this finding may not hold true for the general, nonathlete population. Data from the National Electronic Injury Surveillance System reported by Stoneback et al<sup>34</sup> demonstrated that elbow dislocation in the general population most commonly occurs between the ages of 10 and 19 years, with 45% of dislocations occurring in people over the age of 10 during participation in sports. In a retrospective study comparing the epidemiological patterns of injury in collegiate and high school wrestling athletes, Yard et al<sup>38</sup> showed overall injury to the elbow to be more common in high school athletes compared with collegiate athletes. These discrepancies may be related to the differences in criteria for reporting injury and exposure specific to the database used in each study.

Fatigue has been studied as a risk factor for injury, and a number of explanatory theories have been posited, including loss of proprioception and increased weakness.<sup>9,11,33,36</sup> Accounting for the difference in AEs, we found a significantly higher incidence (1.4-fold increase) of early-in-game versus late-in-game injuries. This may be due to either the small numbers of injured athletes (270 weighted injuries in competition) or another cause.

The current study has a number of limitations. It is a retrospective analysis of the NCAA-ISP, a prospectively collected database that collects data from a convenience sample of institutions sponsoring intercollegiate sports and that assigns weights to injuries and exposures to allow extrapolation to the entire NCAA population; many sponsoring schools are not sampled. This introduces the possibility for either overestimation or underestimation of the true incidence of injury. This database also generally relies on entry of the injuries by the team trainers, without confirmation of the diagnosis by physicians, which could have led to either overreporting or underreporting of injury rates. The athletic trainers are limited to the confines of the designed system in that it is a simplified system, with no allowance for free-text comments (such as the position of injuries or events leading up to an injury) or classification of injury severity. The NCAA-ISP does not provide any diagnostic imaging results or physical examination findings and does not differentiate between similar pathological conditions (eg, simple dislocation vs a "terrible triad" injury). Furthermore, clinical follow-up (aside from time loss and need for surgery) and treatment decision making are not captured in this database. The type of surgical repair as well as the time it took for an athlete to return to play following surgical reconstruction are not given. The

use of the term *season-ending* does not include specific information regarding the timing of the injury within the season, which is withheld by the NCAA for privacy. Thus, *season-ending* could mean any number of actual days lost and reflects a complex decision by the athlete, physicians, coaches, and parents to remove the athlete from play. Despite these limitations, this method of data collection has been validated previously in a number of epidemiological studies of American collegiate athletics.<sup>11</sup> Therefore, we believe that this method allows the most current and representative presentation of elbow subluxation and dislocation in NCAA athletes.

## CONCLUSION

Elbow dislocations and subluxations are infrequent injuries among NCAA athletes but have severe consequences: In our study, no athletes returned to play within a week, and 68.7% were out for 2 weeks or more. All injuries were sustained after a contact mechanism and were more likely to occur in competition (compared with practice). Wrestlers and gymnasts were particularly affected, with football and volleyball players affected to a lesser extent. Athletic governing bodies, particularly wrestling and gymnastic organizations, may benefit from these epidemiological data as a means to track the effect of rule changes or other safety measures. Athletes sustaining injuries, along with their coaches and medical providers, may use these return-to-play data to best manage expectations and outcomes. Future directions include multivariable analysis to determine independent risk factors for time lost to injury.

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