Epidemiology of Shoulder Dislocations in High School and Collegiate Athletics in the United States: 2004/2005 Through 2013/2014

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Background: Shoulder dislocations occur frequently in athletes across a variety of sports. This study provides an updated descriptive epidemiological analysis of shoulder dislocations among high school and college athletes and compares injury rates and patterns across these age groups.

Hypothesis: There would be no difference in injury rates/patterns between high school and college athletes.

Study Design: Descriptive epidemiology study.

Level of Evidence: Level 3.

Methods: Shoulder dislocation data from the High School Reporting Information Online (RIO) and the National Collegiate Athletic Association (NCAA) Injury Surveillance Program (ISP) databases were analyzed from the 2004/2005 through 2013/2014 (NCAA) or 2005/2006 through 2013/2014 (RIO) academic years in 11 different sports. Rate ratios (RRs) and injury proportion ratios (IPRs) were calculated to make comparisons between age groups.

Results: During the study period, 598 shoulder dislocations were reported during 29,249,482 athlete-exposures (AEs) among high school athletes, for an overall shoulder dislocation rate of 2.04 per 100,000 AEs; 352 shoulder dislocations were reported during 13,629,533 AEs among college athletes, for an overall injury rate of 2.58 per 100,000 AEs. College athletes had a higher rate of shoulder dislocation than high school athletes (RR, 1.26; 95% CI, 1.11-1.44). However, the injury rate in football was lower in collegiate than high school athletes (RR, 0.52; 95% CI, 0.43-0.62). Surgery was performed to correct 28.0% of high school and 29.6% of college shoulder dislocations. Shoulder dislocations resulted in longer return-to-play times than other shoulder injuries.

Conclusion: Overall, shoulder dislocation rates were higher among collegiate than high school athletes. This may be due to greater contact forces involved in sports at higher levels of play, although the increased rate in high school football warrants additional research.

Clinical Relevance: Higher shoulder dislocation rates within collegiate athletics are likely due to the higher level of intensity at this level of play, with stronger and faster athletes resulting in more forceful collisions.

Keywords: shoulder dislocation; injury; High School RIO; NCAA Injury Surveillance Program; football; return to play

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Shoulder dislocations in high school and college athletes occur more frequently than in the general population and result in substantial morbidity and time lost from sport.^{7,10,11} Glenohumeral instability, which represents both shoulder dislocations and subluxations, occurs most often in the anterior direction,⁸ with nearly three-fourths of anterior dislocations occurring in males.⁶

Previous studies have analyzed epidemiologic trends of shoulder injuries¹⁰ and joint dislocations³ among US high school athletes as well as glenohumeral instability in college athletes,⁷ but to date, it does not appear that shoulder dislocation rates and patterns have been evaluated across these age groups. The purpose of this study was to describe and compare the epidemiology of shoulder dislocations among high school and college athletes using data from 2 large national sports injury surveillance systems.

METHODS

Data Sources

The Institutional Review Board at Nationwide Children's Hospital in Columbus, Ohio, and the Research Review Board at the National Collegiate Athletic Association (NCAA) approved this study. This study utilized data collected by the High School Reporting Information Online (HS RIO) and the NCAA Injury Surveillance Program (ISP) sports injury surveillance programs for the high school and collegiate levels, respectively.

High School Reporting Information Online

HS RIO is an Internet-based sport-related injury surveillance system that has captured injury and exposure data for 9 sports from a sample of 100 nationally representative high schools from the 2005/2006 through 2013/2014 academic years. The methodology of the HS RIO has been previously described.^{1,9} High schools eligible for the HS RIO must have a certified athletic trainer (AT). ATs from participating high schools report injury incidence and athlete-exposure (AE) information weekly throughout the academic year. For each injury, the AT completes a detailed injury report (<http://www.ucdenver.edu/academics/colleges/PublicHealth/research/ResearchProjects/piper/projects/RIO/Pages/Demo-Site.aspx>) on the injured athlete (age, height, weight), the injury (site, diagnosis, severity), and the injury event (activity, mechanism). Throughout each academic year, participating ATs are able to view and update previously submitted reports as needed with new information (eg, time loss).

Beginning in 2008/2009, the HS RIO expanded the list of sports for which data were collected to add 13 sports. Nationally representative samples could not be recruited for each additional sport due to geographic variability in popularity of some sports, so they are characterized as a convenience sample. This study utilizes all shoulder dislocations in all sports from both the original and the convenience samples of the HS RIO during the 2005/2006 through 2013/2014 academic years, with the

Table 1. Included sports

Male	Female
Baseball	Softball
Cross country	Cross country
Football	Field hockey
Ice hockey	Gymnastics
Lacrosse	Lacrosse
Basketball	Basketball
Soccer	Soccer
Swimming and diving	Swimming and diving
Track and field	Track and field
Wrestling	Volleyball

exception of cheerleading and boys' volleyball, which are not collected in the NCAA ISP and therefore were excluded from all analyses due to lack of comparability. This left 20 sports included in this study (Table 1).

A reportable injury in the HS RIO was defined as an injury that (1) occurred as a result of participation in an organized practice or competition, (2) required medical attention by a certified AT or physician, and (3) resulted in restriction of the student-athlete's participation or performance for 1 or more days beyond the day of injury. Only the principal injury was captured.

NCAA Injury Surveillance Program

The NCAA ISP is an Internet-based surveillance system that depends on a convenience sample of teams with ATs voluntarily reporting injury and exposure data. The NCAA ISP has been previously described.⁴ Participation in the NCAA ISP, while voluntary, is available to all NCAA institutions. For each injury event, the AT completes a detailed event report on the injury or condition (site, diagnosis) and the circumstances (activity, mechanism, event type [ie, competition or practice]). The ATs are able to view and update previously submitted information as needed over the course of a season. In addition, ATs also provide the number of student-athletes participating in each practice and competition.

A reportable injury in the NCAA ISP was defined as an injury that (1) occurred as a result of participation in an organized practice or competition and (2) required medical attention by a certified AT or physician. The NCAA ISP included multiple injuries that occurred from 1 injury event. In addition, the NCAA surveillance system included non-time-loss injuries. However, to enhance comparability with the HS RIO, only time-loss injuries are utilized in this study.

Variables

Both the NCAA ISP and HS RIO collect body part and primary diagnosis information for each injury. For the purposes of this study, eligible injuries included a body site of the shoulder and primary diagnosis of dislocation (subluxations were excluded). Return to play after injury was categorized as follows: 1 to 2 days, 3 to 6 days, 7 to 9 days, 10 to 21 days, 22+ days, and season-ending injuries. Season-ending injuries included those in which the athlete chose not to continue, was medically disqualified (for either the season or career), or the season ended before the athlete could return to play. For statistical comparisons, the season-ending category was considered the most severe of an ordinal return-to-play time variable. For football, mechanism codes differ slightly between the NCAA ISP and HS RIO, so the broad categories of tackling, blocking, being tackled, and being blocked were used, with all other mechanisms being collapsed into an “other” category. ATs for both the HS RIO and NCAA ISP could record a shoulder dislocation as being recurrent from the same or previous academic year.

Statistical Analysis

Data were analyzed using SAS software (version 9.3; SAS Institute). Injury rates were calculated as the number of injuries divided by the number of AEs for both high school and collegiate athletes and are presented per 100,000 AEs. An AE is defined as a single athlete participating in a single practice or competition. Rate ratios (RRs) and injury proportion ratios (IPRs) with 95% CIs were calculated as follows to compare injury rates and proportions between age groups:

$$RR = \frac{\frac{(\# \text{ of NCAA shoulder dislocations})}{(\# \text{ of NCAA AEs})}}{\frac{(\# \text{ of HS shoulder dislocations})}{(\# \text{ of HS AEs})}}$$

$$IPR = \frac{\frac{(\# \text{ of NCAA player-player contact shoulder dislocations})}{(\# \text{ of all NCAA shoulder dislocations})}}{\frac{(\# \text{ of HS player-player contact shoulder dislocations})}{(\# \text{ of all HS shoulder dislocations})}}$$

Statistical significance was set at $\alpha = 0.05$, with IPR and RR CIs not including 1.0 considered statistically significant. A nonparametric Kruskal-Wallis test was used to compare ordinal time loss from sport between high school and collegiate levels of play.

RESULTS

Overall Injury Patterns

A total of 598 shoulder dislocations were reported in 29,249,482 AEs among high school athletes, for an overall rate of 2.04 per

100,000 AEs, while 352 shoulder dislocations were reported in 13,629,533 NCAA AEs, for an overall injury rate of 2.58 per 100,000 AEs. The shoulder dislocation rate was higher in NCAA athletes than high school athletes (RR, 1.26; 95% CI, 1.11-1.44).

Shoulder dislocation rates were significantly higher in the collegiate athletes in boys'/men's lacrosse, baseball, soccer, and basketball as well as girls'/women's basketball (Figure 1). Football was the only sport in which collegiate athletes had a significantly lower injury rate than high school athletes (RR, 0.52; 95% CI, 0.43-0.62).

In both age groups, dislocation rates were higher in competitions than practices (HS: RR, 4.76; 95% CI, 4.03-5.62; NCAA: RR, 4.23; 95% CI, 3.43-5.22). Sports in which dislocation rates were not significantly higher in competitions are listed in Table 2.

Injury Characteristics

While a majority of shoulder dislocations were new injuries (HS, 63.7%; NCAA, 60.0%), a substantial proportion were recurrent from either the same year (HS, 14.5%; NCAA, 12.9%) or previous years (HS, 21.8%; NCAA, 27.1%). Most shoulder dislocations in both high school and NCAA sports occurred due to player-player contact (65.4% and 67.3%, respectively) (Table 3). No differences existed between high school and NCAA sports in the distribution of shoulder dislocations by mechanism of injury.

Football, which had the highest injury rate among high school athletes and the fourth highest injury rate among collegiate male athletes, had the greatest number of shoulder dislocations in both age groups (HS RIO, $n = 376$; NCAA ISP, $n = 176$), thereby justifying a deeper examination of football shoulder dislocations. Tackling was the most common mechanism of injury among high school and collegiate football players, though the proportion of injuries sustained during tackling was significantly higher in high school athletes (IPR, 1.32; 95% CI, 1.08-1.61) (Table 4). Defensive players (linebacker, defensive end, defensive back/cornerback/safety, and defensive tackle) sustained the majority of shoulder dislocations in both high school (60.4%) and collegiate (58.5%) athletes.

Among other sports with at least 10 shoulder dislocations, including boys'/men's ice hockey, boys'/men's and girls'/women's basketball, and wrestling, the most common injury mechanism was player-player contact. Notable exceptions in which nonplayer contact (ie, player-surface contact, player-apparatus contact) was the most common mechanism for both high school and collegiate athletes included boys'/men's soccer (HS, 68.2%; NCAA, 61.1%) and boys'/men's baseball (HS, 59.1%; NCAA, 72.7%).

Severity of Injury

Surgery was performed in similar proportions of high school (28.0%) and collegiate (29.6%) shoulder dislocations. Shoulder dislocations were more severe than other shoulder injuries, as only 5.7% (IPR, 4.94; 95% CI, 4.12-5.92) and 7.4% (IPR, 3.99; 95% CI, 3.30-4.82) of all other shoulder injuries required surgery in high school and NCAA athletes, respectively. Shoulder dislocations also kept athletes out of play longer than other

Figure 1. Shoulder dislocation rates by sport and age group, High School Reporting Information Online (HS RIO) (2005/2006-2013/2014) and National Collegiate Athletic Association (NCAA) Injury Surveillance Program (ISP) (2004/2005-2013/2014). Only sports in which at least 1 shoulder dislocation occurred in both high school and NCAA are stratified. *Significant difference in shoulder dislocation rates between HS RIO and NCAA ISP. †Total rates also include women's/girls' field hockey, women's/girls' lacrosse, women's/girls' gymnastics, and men's/boys' and women's/girls' swimming and diving, track and field, and cross country.

Table 2. Sports in which shoulder dislocation rates were not significantly higher in competition compared with practice

High School Sport	RR (95% CI)	College Sport	RR (95% CI)
Girls' volleyball	0.39 (0.05-3.37)	Women's volleyball	7.23 (0.75-69.47)
Girls' softball	3.83 (0.96-15.33)	Men's basketball	2.11 (0.78-5.71)
Girls' lacrosse	4.43 (0.40-48.87)	Women's basketball	2.15 (0.98-4.75)
Girls' track and field	2.13 (0.19-23.47)	Women's softball	5.71 (0.64-51.10)

RR, rate ratio.

Table 3. General mechanism of shoulder dislocations and position of injured athlete, HS RIO (2005/2006-2013/2014) and NCAA ISP (2004/2005-2013/2014)

Mechanism of Injury ^a	HS RIO, ^b n (%)	NCAA ISP, ^b n (%)	IPR (95% CI)
Player-player contact	386 (65.4)	237 (67.3)	1.04 (0.95-1.15)
Other contact ^c	161 (27.3)	90 (25.6)	1.05 (0.84-1.31)
Noncontact	30 (5.1)	22 (6.3)	1.25 (0.73-2.13)
Other ^d	13 (2.2)	3 (0.9)	2.55 (0.73-8.89)

HS RIO, High School Reporting Information Online; IPR, injury proportion ratio; NCAA ISP, National Collegiate Athletic Association Injury Surveillance Program.

^aMechanism of injury missing for 8 HS and 0 NCAA dislocations.

^bBoldfaced entries in HS and NCAA columns indicate the higher proportion used as the numerator in the IPR.

^cIncludes contact with playing apparatus and contact with playing surface.

^dIncludes contact with object out of bounds, unknown mechanism.

Table 4. Football-specific mechanism of shoulder dislocation and position of injured athlete, HS RIO (2005/2006-2013/2014) and NCAA ISP (2004/2005-2013/2014)

	HS RIO, n (%) ^a	NCAA ISP, n (%) ^a	IPR (95% CI) ^b
Mechanism of injury ^c			
Tackling	199 (53.9)	72 (40.9)	1.32 (1.08-1.61)
Being tackled	69 (18.7)	28 (15.9)	1.18 (0.79-1.75)
Blocking	57 (15.5)	23 (13.1)	1.18 (0.75-1.85)
Being blocked	18 (4.9)	14 (8.0)	1.63 (0.83-3.20)
Other	26 (7.1)	39 (22.2)	3.14 (1.98-4.99)
Position of injured athlete ^d			
Linebacker	88 (24.4)	13 (13.8)	1.76 (1.03-3.01)
Defensive end	27 (7.5)	10 (10.6)	1.42 (0.71-2.83)
Defensive back/cornerback/safety	69 (19.1)	24 (25.5)	1.34 (0.89, 2.00)
Defensive tackle	34 (9.4)	8 (8.5)	1.11 (0.53-2.31)
Running back/slot back	30 (8.3)	8 (8.5)	1.02 (0.49-2.16)
Special teams	10 (2.8)	7 (7.4)	2.69 (1.05-6.87)
Flanker/wide receiver	32 (8.9)	8 (8.5)	1.04 (0.50-2.18)
Off tight end	14 (3.9)	6 (6.4)	1.65 (0.65-4.17)
Off guard	18 (5.0)	4 (4.3)	1.17 (0.41-3.38)
Quarterback	13 (3.6)	2 (2.1)	1.69 (0.39-7.37)
Other/unknown	26 (7.2)	4 (4.3)	1.69 (0.61-4.73)

HS RIO, High School Reporting Information Online; IPR, injury proportion ratio; NCAA ISP, National Collegiate Athletic Association Injury Surveillance Program.

^aBoldfaced values indicate greater proportion used as numerator in the IPR calculation.

^bBoldfaced values denote statistically significant differences between HS and NCAA athletes.

^cMechanism of injury missing for 7 HS and 0 NCAA dislocations.

^dPosition of injured athlete missing for 15 HS and 82 NCAA dislocations.

shoulder injuries. Among high school athletes, 36.9% of shoulder dislocations were season-ending compared with 11.4% of all other shoulder injuries (IPR, 3.43; 95% CI, 2.96-3.98). Among college athletes, 28.4% of shoulder dislocations were season-ending compared with 9.6% of all other shoulder injuries (IPR, 2.94; 95% CI, 2.44-3.55) (Figure 2). There was no significant difference between high school and collegiate athletes regarding return-to-play time ($P = 0.07$).

DISCUSSION

Based on the results of this study, shoulder dislocations occurred at a significantly greater rate among college athletes than high school athletes. However, perhaps the most significant finding from this study was the similarly high proportion of

shoulder dislocations that required surgery and/or were season-ending among high school and collegiate athletes, demonstrating the severity of shoulder dislocations compared with other shoulder injuries.

Previous studies have examined various characteristics of glenohumeral instability and shoulder dislocations among high school or collegiate athletes.^{3,7,10} Owens et al⁷ used the NCAA Injury Surveillance System (ISS) to analyze the epidemiology of glenohumeral instability incidents among collegiate athletes from 1989 to 2004. This group found an overall incidence for glenohumeral instability of 0.12 per 1000 AEs. Although this rate is significantly higher than that reported in the present study, this study was restricted to frank dislocations rather than all glenohumeral instability incidents. As expected, Owens et al⁷ found a significantly higher incidence rate for men compared

Figure 2. Return-to-play time for athletes sustaining a shoulder dislocation by age group, High School Reporting Information Online (HS RIO; 2005/2006-2013/2014) and National Collegiate Athlete Association (NCAA) Injury Surveillance Program (2004/2005-2013/2014). Return-to-play time was missing for 66 HS and 13 NCAA shoulder dislocations.

with women. However, when analyses were limited to sex-comparable sports, no significant difference existed.⁷ This same phenomenon was found in a study by Kerr et al³ using the HS RIO database to analyze joint dislocations/separations during the 2005 through 2009 academic years.

The proportion of recurrent shoulder dislocations was similar between high school and collegiate athletes. Leroux et al⁵ used an administrative database to determine the incidence of primary closed reductions for anterior shoulder dislocations among patients aged 10 to 16 years, reporting the greatest incidence among males aged 16 years (164.4 per 100,000 person-years). However, patients in their study aged 14 to 16 years had a rate of repeat closed reduction similar to that of patients aged 17 to 20 years from a previous publication.⁶ These results agree with our findings in that the proportion and rate of recurrent glenohumeral instability is not inherently greater in college-aged patients compared with high school patients. Thus, there must be other factors involved resulting in the higher overall dislocation rate found in the present study among collegiate athletes.

Consistent with this study's results, previous studies^{3,7} have reported that shoulder dislocation rates are highest in contact sports, particularly football. Furthermore, Cho et al² showed collision athletes (eg, football, wrestling, ice hockey, soccer athletes) have a higher failure rate after arthroscopic anterior shoulder stabilization compared with noncollision athletes. However, no study has demonstrated an increased rate of shoulder dislocations associated with higher levels of play within various sports. This study showed a significantly higher rate of shoulder dislocations in collegiate wrestling, men's lacrosse, men's and women's basketball, baseball, and men's soccer compared with their high school counterparts, with only

football demonstrating a significantly higher rate of shoulder dislocations at the high school level. This trend toward higher dislocation rates within collegiate athletics is likely due to the increased level of intensity at this level of play, with stronger and faster athletes resulting in more forceful collisions. However, the higher dislocation rate within high school football compared with collegiate football is an interesting finding and should be investigated further.

Another important finding from the present study was the severity of shoulder dislocations compared with other shoulder injuries both in terms of the proportion of injuries requiring surgery and the proportion that were season-ending. Leroux et al⁶ reported that 13.3% of patients aged 16 to 70 years underwent surgical stabilization after a primary anterior shoulder dislocation requiring closed reduction. This percentage is significantly lower than our data, though recurrent shoulder dislocations were included in our study, and athletes with recurrent dislocations would likely undergo surgery at a greater rate than those with a primary dislocation. Kerr et al³ found that among all joint dislocations in US high school athletes, 11.8% required surgery. Again, this is a significantly lower percentage of patients requiring surgery compared with the numbers found in the present study, likely indicating that shoulders are inherently more unstable after dislocation, thereby necessitating surgical treatment. This indicates a need for development of more effective prevention strategies among these patients. Furthermore, this study provides important prognostic information for orthopaedic surgeons and patients.

The limitations of this study are largely associated with the limitations of the datasets available from the 2 national sports injury surveillance systems. In particular, these surveillance systems rely on accurate reporting of injuries by athletic trainers. In addition, the HS RIO database only includes injuries that result in a loss of playing time of at least 1 day; thus, for comparison purposes, this study only included shoulder dislocations from the NCAA ISP that resulted in loss of playing time. This means some cases of shoulder dislocation (those that did not result in loss of playing time) were missed. However, this likely represents only a small number of injuries given the severity of shoulder dislocation. Finally, the data presented in this study are limited to popular high school and college sports in the United States and therefore may not be generalizable across all sports within all age ranges.

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