

# Epidemiology of Shoulder and Elbow Injuries Among US High School Softball Players, 2005-2006 Through 2016-2017

Gretchen D. Oliver,<sup>\*†</sup> PhD, Michael G. Saper,<sup>‡</sup> DO, Monika Drogosz,<sup>§</sup> MPH, Hillary A. Plummer,<sup>||</sup> PhD, Alan T. Arakkal,<sup>¶</sup> MS, R. Dawn Comstock,<sup>¶</sup> PhD, Adam W. Anz,<sup>||</sup> MD, James R. Andrews,<sup>§||</sup> MD, and Glenn S. Fleisig,<sup>§</sup> PhD

*Investigation performed at the University of Denver, Denver, Colorado, USA*

**Background:** Injury prevalence has been well described among baseball athletes; similarly, a better understanding of injuries in softball athletes is needed.

**Purpose:** To examine shoulder and elbow injury epidemiology among high school softball athletes in the United States.

**Study Design:** Descriptive epidemiological study.

**Methods:** Injury data were obtained from the National High School Sports-Related Injury Surveillance System, which captures data from a large national sample of US high schools. Annually, a random sample of 100 high schools provided a representative sample with respect to the 4 US Census geographic regions and 2 school sizes (cutoff point, 1000 students). Athletic trainers from participating schools reported data for athlete-exposures (AEs; practice or competition) and shoulder and elbow injuries from 2005-2006 through 2016-2017.

**Results:** A total of 239 shoulder injuries and 85 elbow injuries occurred within 2,095,329 AEs. The overall shoulder injury rate was 1.14 per 10,000 AEs, whereas the overall elbow injury rate was 0.41 per 10,000 AEs. Injuries to the shoulder were more likely to occur during competition as compared with practice (rate ratio, 1.28; 95% CI, 0.99-1.65). Half of the shoulder (50.4%) and elbow 48.9% injuries were due to an overuse/chronic mechanism. Of the athletes sustaining an injury, 86.8% with shoulder injuries and 93.0% with elbow injuries returned to play within 21 days. Only 16.7% of shoulder injuries and 17.5% of elbow injuries were sustained by pitchers.

**Conclusion:** Shoulder and elbow injury rates, time to return, and percentage of injuries among pitchers were far lower in high school softball than previously reported values for high school baseball. There were relatively low incidences of shoulder and elbow injuries in high school softball as compared with baseball, with few injuries requiring lengthy time to return to play.

**Keywords:** injury epidemiology; overuse; pitching; upper extremity

Softball participation in United States (US) high school athletes during the 2016-2017 school year approached the participation rates reported in baseball.<sup>1</sup> Associated with the increase in softball participation is an increase in pain and injury to the shoulder and elbow in these athletes.<sup>3,14-17</sup> Two recent epidemiologic studies reported the incidence of injuries in small samples of youth and high school softball pitchers and position players.<sup>16,18</sup> Pitchers seem to be most at risk for sustaining shoulder and elbow injury, potentially because of the repetitive nature of the pitching motion. In fact, pitchers are 2.6 times more likely to sustain an injury as compared with position players.<sup>16</sup> Injuries to pitchers frequently occur at the shoulder, whereas position players are more likely to injure the lower extremity.<sup>16,18</sup> Shoulder

and elbow injuries can result in time loss from sports participation, with 50% of shoulder and elbow injuries sustained by pitchers resulting in at least 2 weeks of time loss from softball participation.<sup>18</sup> Additionally, there is the financial burden to both families and the health care system to care for these injuries.

Understanding the epidemiology and etiology of injuries in softball is critical for the clinicians who treat these athletes, to counsel patients on injury risk and assist with development of injury prevention protocols. In a previous examination of high school softball athletes from 2005 to 2015, a total of 75 elbow injuries were reported, with an overall injury rate of 0.43 per 10,000 athlete-exposures (AEs).<sup>10</sup> With the overall injury rate (of all body parts) significantly higher for softball versus baseball athletes,<sup>10</sup> more examination into softball injuries is warranted. Despite the data on elbow injuries in softball athletes and established injury rates among high school baseball

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athletes, there is currently a lack of scientific evidence regarding shoulder injury rates in high school softball athletes.<sup>10,13</sup>

An examination of shoulder and elbow injury rates and patterns in high school baseball athletes revealed differences in the type of exposure (practice vs competition) as well as by position (position players vs pitchers).<sup>13</sup> Despite the similarities in baseball and softball participation rates,<sup>10</sup> shoulder and elbow injury rates and patterns in high school softball athletes remain unknown. Therefore, the purpose of this study was to examine the epidemiology of shoulder and elbow injuries in US high school softball athletes from 2005-2006 through 2016-2017. It was hypothesized that softball pitchers would sustain significantly more shoulder and elbow injuries than position players and that the overall shoulder and elbow injury rates would be similar to previously published injury rates in baseball pitchers.

## METHODS

Institutional review board approval was obtained prior to beginning this study. Shoulder and elbow data for US high school softball players were obtained from the National High School Sports-Related Injury Surveillance System through High School RIO (Reporting Information Online), an internet-based sports injury surveillance system that has been described previously.<sup>7,11</sup> In brief, prior to each academic year, high schools with 1 or more National Athletic Trainers' Association (NATA)-affiliated certified athletic trainers (ATs) with a valid email address were invited to participate. Responding high schools were categorized into 8 strata based on school size (enrollment  $\leq 1000$  or  $>1000$ ) and the 4 US census geographic regions.<sup>4</sup> Twelve or 13 schools from each of the 8 strata were randomly chosen to participate in the nationally representative sample of 100 schools. If a school withdrew during the study, another school from the same stratum was randomly selected for replacement to maintain the 100-school study population. ATs from participating high schools reported injury and AE information on the High School RIO website weekly throughout the academic year. Injury and exposure data used in this study were collected from school years 2005-2006 through 2016-2017. The methods employed mirrored

those of Saper et al<sup>13</sup> documenting elbow and shoulder injuries in high school baseball players.

## Definition of Injury and Exposure

An AE was defined as 1 athlete participating in 1 school-sanctioned practice or competition. A reportable injury was one that (1) occurred as a result of participation in an organized practice or competition, (2) required medical attention by a physician or an AT, and (3) resulted in a restriction of the athlete's participation for at least 1 day (except for fractures, concussions, heat illnesses or dental injuries, which were captured regardless of time loss). For each injury, the AT submitted a detailed report on the injured athlete (age, height, weight, etc), the injury (side of body, diagnosis, severity, etc), and the injury event (activity, mechanism, etc). Throughout the study, the ATs had access to all data and updated reports as needed.

## Statistical Analysis

Data were analyzed with SAS (v 9.4; SAS Institute). Injury rates were calculated as the number of shoulder or elbow injuries per 10,000 AEs. Subgroup differences were evaluated with rate ratios (RRs) or injury proportion ratios (IPRs) and 95% CIs. The RR calculation for comparing practice and competition shoulder injury rates was as follows:

$$RR = \frac{\left( \frac{\text{total No. of competition shoulder injuries}}{\text{total No. of competition softball AEs}} \right)}{\left( \frac{\text{total No. of practice shoulder injuries}}{\text{total No. of practice softball AEs}} \right)}$$

IPRs compared injury patterns. The IPR calculation comparing the proportion of noncontact shoulder injuries with noncontact elbow injuries was as follows:

$$IPR = \frac{\left( \frac{\text{No. of noncontact shoulder injuries}}{\text{total No. of shoulder injuries}} \right)}{\left( \frac{\text{No. of noncontact elbow injuries}}{\text{total No. of elbow injuries}} \right)}$$

Continuous variables (eg, age) were expressed as mean  $\pm$  SD, and categorical variables (eg, mechanism of injury) were expressed as number and percentage. Statistical differences in demographics between groups were examined with independent *t* tests. Comparison of categorical data

\*Address correspondence to Gretchen D. Oliver, PhD, School of Kinesiology, Auburn University, 301 Wire Rd, Auburn, AL 36840, USA (email: goliver@auburn.edu) (Twitter: @smml\_au).

<sup>†</sup>Sports Medicine and Movement Lab, School of Kinesiology, Auburn University, Auburn, Alabama, USA.

<sup>‡</sup>Department of Orthopaedics and Sports Medicine, University of Washington, Seattle, Washington, USA.

<sup>§</sup>American Sports Medicine Institute, Birmingham, Alabama, USA.

<sup>||</sup>Andrews Research and Education Foundation, Gulf Breeze, Florida, USA.

<sup>¶</sup>Department of Epidemiology, Colorado School of Public Health, University of Colorado Anschutz, Aurora, Colorado, USA.

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Ethical approval for this study was obtained from the St Vincent's Health System Institutional Review Board.

TABLE 1  
Shoulder and Elbow Injury Rates by Exposure Type<sup>a</sup>

	Competitions			Practices			Overall			Rate Ratio <sup>c</sup> (95% CI)
	Injuries, n	AEs, n	Rate <sup>b</sup>	Injuries, n	AEs, n	Rate <sup>b</sup>	Injuries, n	AEs, n	Rate <sup>b</sup>	
Shoulder	96	721,983	1.33	143	1,373,346	1.04	239	2,095,329	1.14	1.28 (0.99-1.65)
Elbow	30	721,983	0.42	55	1,373,346	0.40	85	2,095,329	0.41	1.04 (0.67-1.56)

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

<sup>b</sup>Per 10,000 AEs.

<sup>c</sup>Competitions to practices. Statistically significant if 95% CI does not contain 1.00.

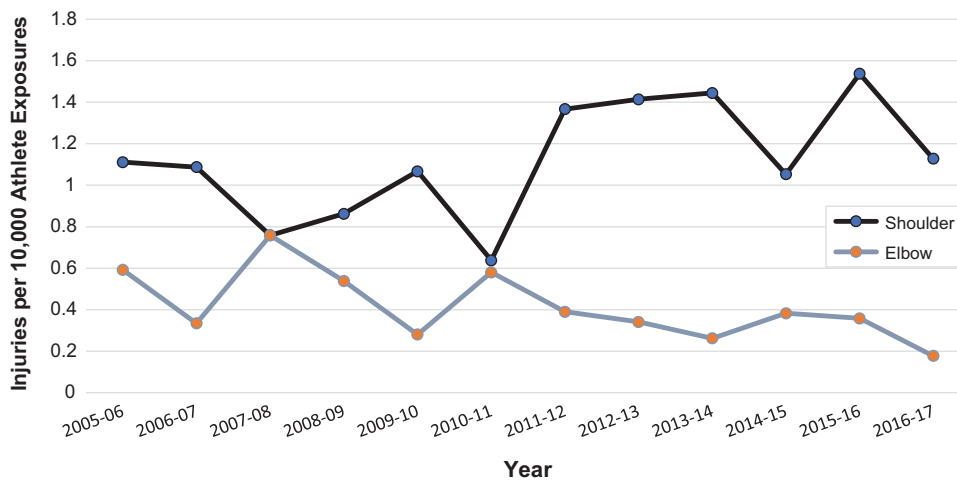


Figure 1. Overall shoulder and elbow injury rates in US high school softball players from 2005-2006 through 2016-2017.

was performed with a Pearson  $\chi^2$  test. The Fisher exact test was used in cases where the expected cell size count was <5. *P* values <.05 and 95% CIs not containing 1.00 were considered statistically significant.

RESULTS

Overall Injury Patterns

From 2005-2006 through 2016-2017, High School RIO captured 239 shoulder injuries and 85 elbow injuries in 2,095,329 AEs, resulting in a shoulder injury rate of 1.14 and an elbow injury rate of 0.41 per 10,000 AEs (Table 1). The shoulder injury rate was significantly higher than that of the elbow (RR, 2.81; 95% CI, 2.20-3.60). When injury rates were examined over time, shoulder injury rates were higher than elbow injury rates, except for the periods 2007-2008 and 2010-2011, when shoulder and elbow injury rates were fairly similar (Figure 1). Injury rates were higher in competition than in practices for the shoulder (RR, 1.28; 95% CI, 0.99-1.65), whereas rates of elbow injuries were fairly even between competition and practice (RR, 1.04; 95% CI, 0.67-1.56) (Table 1).

All shoulder and elbow injury characteristics for high school softball players are presented in Table 2. Most

injuries to both the shoulder (82.8%) and the elbow (87.1%) were considered new injuries. For about half of the shoulder injuries (50.4%) and elbow injuries 48.9%, the basic mechanism was overuse/chronic. The most common shoulder injuries were muscle strains (30.6%) and tendinitis (23.5%), while the majority of elbow injuries were tendinitis (32.9%), contusion (23.5%), or ligament sprain (17.7%). Injuries were fairly evenly spread among player positions, with pitchers sustaining 16.7% of the shoulder injuries and 17.5% of the elbow injuries.

Pitchers Versus Position Players

The characteristics of combined shoulder and elbow injuries in pitchers and position players are presented in Table 3. Data for injury reports not including a position were excluded from this analysis. It should be noted that there was a large discrepancy in total number of injured pitchers (n = 51) and position players (n = 247). However, it should also be noted that the number of athletic exposures is likely greater for position players than for pitchers. The majority of pitcher (77.1%) and nonpitcher (65.8%) injuries occurred at the varsity level. The most common mechanism of injury in softball pitchers (60.8%) and position players 49.2% was overuse/chronic, though there was no statistical difference between the groups. For pitchers, the highest proportions of

TABLE 2  
 Characteristics of Shoulder Injuries (n = 239)  
 and Elbow Injuries (n = 85) in All Players<sup>a</sup>

Characteristic <sup>b</sup>	Shoulder, n (%)	Elbow, <sup>c</sup> n (%)	IPR (95% CI)
<b>Laterality<sup>d</sup></b>			
Right	182 (82.4)	56 (74.7)	1.10 (0.95-1.28)
Left	38 (17.2)	19 (25.3)	0.68 (0.42-1.10)
Bilateral	1 (0.5)	0 (0.0)	NA
<b>New injury or recurrence</b>			
New injury	197 (82.8)	74 (87.1)	0.95 (0.86-1.05)
Recurrence (this academic year)	15 (6.3)	3 (3.5)	1.79 (0.53-6.02)
Recurrence (prior academic year)	25 (10.5)	7 (8.2)	1.28 (0.57-2.84)
Other	1 (0.4)	1 (1.2)	NA
<b>Position</b>			
Infielder	80 (36.0)	19 (23.8)	1.52 (0.99-2.33)
Outfielder	54 (24.3)	22 (27.5)	0.88 (0.58-1.35)
Pitcher	37 (16.7)	14 (17.5)	0.95 (0.54-1.67)
Catcher	27 (12.2)	13 (16.3)	0.75 (0.41-1.38)
Base runner	14 (6.3)	2 (2.5)	NA
Batter	7 (3.2)	9 (11.3)	<b>0.28 (0.11-0.73)</b>
Other	3 (1.4)	1 (1.3)	NA
<b>Time loss</b>			
<1 wk	95 (40.6)	51 (60.0)	<b>0.68 (0.54-0.85)</b>
1-3 wk	95 (40.6)	26 (30.6)	1.33 (0.93-1.89)
>3 wk	13 (5.6)	2 (2.4)	2.34 (0.54-10.25)
Did not return <sup>e</sup>	31 (13.2)	6 (7.0)	1.88 (0.81-4.34)
<b>Basic injury mechanism</b>			
Overuse/chronic	118 (50.4)	41 (48.9)	1.03 (0.80-1.33)
Noncontact	60 (25.6)	16 (19.0)	1.35 (0.82-2.20)
Contact with playing surface	30 (12.8)	3 (3.6)	<b>3.59 (1.13-11.45)</b>
Contact with playing apparatus	9 (3.8)	20 (23.8)	<b>0.16 (0.08-0.34)</b>
Contact with another person	9 (3.8)	1 (1.2)	NA
Other <sup>f</sup>	8 (3.4)	3 (3.6)	NA
<b>Diagnosis</b>			
Tendinitis	56 (23.5)	28 (32.9)	0.71 (0.49-1.04)
Muscle strain	73 (30.6)	7 (8.2)	<b>3.72 (1.79-7.77)</b>
Ligament sprain	15 (6.3)	15 (17.7)	<b>0.36 (0.18-0.70)</b>
Contusion	9 (3.8)	20 (23.5)	<b>0.16 (0.08-0.34)</b>
Subluxation	21 (8.8)	1 (1.2)	NA
Tendon strain	13 (5.4)	5 (5.9)	0.93 (0.34-2.53)
Other	13 (5.4)	2 (2.4)	2.32 (0.53-10.08)
Dislocation	11 (4.6)	0 (0.0)	NA
Torn cartilage	7 (2.9)	0 (0.0)	NA
Nerve injury	6 (2.5)	1 (1.2)	NA
Inflammation	5 (2.1)	2 (2.4)	NA
Separation	4 (1.7)	0 (0.0)	NA
Hyperextension	1 (0.4)	3 (3.6)	NA
Bursitis	2 (0.8)	0 (0.0)	NA
Fracture	1 (0.4)	1 (1.2)	NA
Internal injuries	1 (0.4)	0 (0.0)	NA

<sup>a</sup>IPR, injury proportion ratio; NA, not applicable.

<sup>b</sup>Some characteristics do not total to the full sample size (239 shoulder injuries or 85 elbow injuries) due to unavailable information. Some percentages do not sum to 100.0% because of rounding.

<sup>c</sup>The elbow is the reference for all IPRs. Values in bold are statistically significant (95% CI excludes 1.00) Categories with ≤3 case counts were not evaluated for significance.

<sup>d</sup>Some injuries were bilateral; therefore, the totals do not add to 100.0%. Laterality was in reference to the injury location, not indicative of hand dominance.

<sup>e</sup>Includes medical disqualification, athlete choosing not to continue, season ending, or an unspecified reason.

<sup>f</sup>Includes illness, contact with an out-of-bounds object, or an unspecified reason.

injury diagnoses were tendinitis (29.4%) and muscle strain (27.5%). Similarly, tendinitis (26.0%) and muscle strain (24.8%) were the most common diagnoses for position players. Injuries resulting in more than 3 weeks missed were rare for pitchers (2.0%) and position players (4.9%).

## DISCUSSION

The current study evaluated data from the National High School Sports-Related Injury Surveillance System, High School RIO program, to examine the epidemiology of shoulder and elbow injuries among US high school softball athletes during 12 academic years, from 2005-2006 through 2016-2017. The results indicate that shoulder and elbow injury rates were most frequently related to overuse/chronic mechanism in softball athletes. When high school softball athletes sustained shoulder and elbow injuries, the severity was usually minor, and they were able to return to play quickly. Players were able to return to play in <1 week for about half of all injuries and in 1 to 3 weeks for most of the other injuries. Overall injury rates were significantly greater for the shoulder (1.14 per 10,000 AEs) than the elbow (0.41 per 10,000 AEs). Shoulder injury rates were greater than elbow injury rates for most years except in the years 2007-2008 and 2010-2011, when they were similar. It should be noted that the shoulder injury rates reported in the current study were slightly higher than those reported by Krajnik et al<sup>7</sup> (1.0 per 10,000 AEs), while the elbow injury rates were slightly lower than has previously been reported (0.43 per 10,000 AEs) in softball athletes.<sup>10</sup>

By design, the current study used methods similarly employed for a baseball study by Saper et al<sup>13</sup> to allow for direct comparison of results (Table 4). The rate of shoulder injuries was slightly lower in softball than baseball. Similarly, in softball, pitchers sustained 16.7% of all reported shoulder injuries, while in baseball, pitchers sustained 39.6% of all shoulder injuries. Differences between the sports were even more dramatic for the elbow. The rate of elbow injuries in softball (0.41 per 10,000 AEs) was less than half that for baseball (0.86 per 10,000 AEs), and pitchers represented only a small percentage of softball elbow injuries (17.5%) as opposed to more than half of all baseball elbow injuries (56.9%). When softball pitchers were injured, it was rare (2.3%) for the pitcher to require >3 weeks to return to play, in contrast to baseball where 21.0% required >3 weeks. Thus, the current study did not support the hypothesis that shoulder and elbow injury rates among softball pitchers are similar to the high injury rates observed in baseball pitchers.

There are several differences between softball and baseball that may be related to the differences in injury rates, including the fact that most high school softball players are female whereas most baseball players are male. Male ball-players have greater height and weight and produce greater shoulder and elbow forces and torques during overhand throwing.<sup>5</sup> While softball windmill pitching and baseball overhand pitching produce similar magnitudes of normalized shoulder and elbow forces and torques, the motions of the arm and body are significantly different.<sup>2,12,21</sup>

TABLE 3  
 Characteristics of Shoulder and Elbow Injuries in Pitchers (n = 51) and Position Players (n = 247)<sup>a</sup>

Characteristic <sup>b</sup>	Pitchers, Mean ± SD or n (%)	Position Players, <sup>c</sup> Mean ± SD or n (%)	P Value or IPR <sup>d</sup> (95% CI)
Age, y	16.02 ± 1.16	15.92 ± 1.25	.62
Height, in	65.45 ± 3.11	64.85 ± 3.31	.27
Weight, lb	149.16 ± 28.75	141.84 ± 19.6	.11
Laterality <sup>e</sup>			
Right	43 (89.6)	177 (79.4)	<b>1.15 (1.03-1.29)</b>
Left	4 (8.3)	46 (20.6)	0.41 (0.16-1.09)
Year in school			
Freshman	11 (21.6)	68 (27.9)	.27
Sophomore	11 (21.6)	66 (27.0)	
Junior	18 (35.3)	55 (22.5)	
Senior	11 (21.6)	55 (22.5)	
Play level			
Varsity	37 (77.1)	150 (65.8)	.29
Junior varsity	10 (20.8)	57 (25.0)	
Freshman	1 (2.1)	12 (5.3)	
Combined	0 (0.0)	9 (3.9)	
Time loss			
<1 wk	21 (42.0)	113 (46.5)	0.90 (0.63-1.28)
1-3 wk	22 (44.0)	89 (36.6)	1.20 (0.84-1.71)
>3 wk	1 (2.0)	12 (4.9)	NA
Did not return <sup>f</sup>	6 (12.0)	29 (11.9)	1.01 (0.44-2.29)
Basic injury mechanism			
Overuse/chronic	31 (60.8)	120 (49.2)	1.24 (0.96-1.59)
Noncontact	14 (27.5)	54 (22.1)	1.24 (0.75-2.05)
Contact with playing surface	3 (5.9)	27 (11.1)	0.53 (0.17-1.69)
Contact with playing apparatus	3 (5.9)	23 (9.4)	0.62 (0.19-2.00)
Contact with another person	0 (0.0)	10 (4.1)	NA
Other <sup>g</sup>	0 (0.0)	10 (4.1)	NA
Diagnosis			
Tendinitis	15 (29.4)	64 (26.0)	1.13 (0.70-1.82)
Muscle strain	14 (27.5)	61 (24.8)	1.11 (0.67-1.82)
Ligament sprain	6 (11.8)	20 (8.1)	1.45 (0.61-3.42)
Tendon strain	5 (9.8)	12 (4.9)	2.01 (0.74-5.46)
Contusion	3 (5.9)	23 (9.3)	0.63 (0.20-2.02)
Other	3 (5.9)	11 (4.5)	NA
Subluxation	1 (1.9)	19 (7.7)	NA
Torn cartilage	1 (1.9)	5 (2.0)	NA
Hyperextension	1 (1.9)	3 (1.2)	NA
Internal injuries	1 (1.9)	0 (0.0)	NA
Nerve injury	1 (1.9)	3 (1.2)	NA
Dislocation	0 (0.0)	10 (4.1)	NA
Separation	0 (0.0)	4 (1.6)	NA
Fracture	0 (0.0)	2 (0.8)	NA
Inflammation	0 (0.0)	7 (2.8)	NA
Bursitis	0 (0.0)	2 (0.8)	NA

<sup>a</sup>IPR, injury proportion ratio; NA, not applicable.

<sup>b</sup>Some characteristics do not total to the full sample size (51 pitcher injuries or 247 position player injuries) due to unavailable information. Some percentages do not sum to 100.0% because of rounding.

<sup>c</sup>Position players include outfielders, infielders, batters, catchers, base runners, and other nonpitching positions.

<sup>d</sup>The position player is the reference for all IPRs. Values in bold are statistically significant (95% CI excludes 1.00). Categories with ≤1 were not evaluated for significance. P values derived from an independent-samples *t* test performed for continuous variables.

<sup>e</sup>Some injuries were bilateral; therefore, the totals do not add to 100.0%. Laterality was in reference to the injury location, not indicative of hand dominance.

<sup>f</sup>Includes medical disqualification, athlete choosing not to continue, season ending, or an unspecified reason.

<sup>g</sup>Includes illness, contact with an out-of-bounds object, or an unspecified reason.

Differences in the physical properties of the balls and bats, the size of the field, and the strength and speed of the athletes may also be injury risk factors beyond the scope of the current study.

In the current study, shoulder and elbow injury rates were higher in competitions than in practices. These results are similar to general findings of softball and baseball injury reporting.<sup>10,11,13,16</sup> Our study found that the

TABLE 4  
Comparison of Shoulder and Elbow  
Injuries in Softball and Baseball<sup>a</sup>

Characteristic <sup>b</sup>	High School Softball (Current Study)	High School Baseball (Saper et al) <sup>13</sup>
Academic years studied	2005-2006 through 2016-2017	2005-2006 through 2014-2015
No. of high schools monitored each year	100	100
Shoulder injuries		
Per 10,000 AEs	1.14	1.39
Sustained by pitchers, %	16.7	39.6
Elbow injuries		
Per 10,000 AEs	0.41	0.86
Sustained by pitchers, %	17.5	56.9
Pitcher injuries requiring >3 wk to return to play, %	2.3	21.0

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

shoulder had the highest competition injury rate (1.33 per 10,000 AEs). This is in agreement with other reports of higher competition injury rates, as well as greater reported shoulder injury rates.<sup>3,16</sup> Bonza et al<sup>3</sup> examined the incidence of shoulder injury in high school athletes and found that shoulder injury rates and patterns varied by sport, with large proportions of total injuries reported for football, wrestling, baseball, and softball. Higher injury rates in competition may occur because athletes are exerting greater effort in competition than practice or because practices focus more on skill development and may include many repetitions of specific actions.

With respect to mechanism of injury, noncontact and overuse accounted for a high proportion of shoulder injuries (76.0%) and elbow injuries (67.9%). Unlike injury mechanisms in baseball athletes,<sup>13</sup> the contact mechanism of injury in softball athletes (player to player, player to playing surface, player to playing apparatus) did not account for the majority of injuries to the shoulder (20.4%) or the elbow (28.6%). Further examination into the contact injuries revealed that more shoulder injuries (12.8%) occurred from contact with the playing surface, while more elbow injuries (23.8%) were the result of contact with a playing apparatus. These findings agree with what has been previously reported in the baseball literature, which postulated getting hit by a pitch as a possible mechanism of elbow injury.<sup>13</sup>

For the majority of shoulder (81.2%) and elbow (90.6%) injuries, the softball player returned to sport within 3 weeks. These findings are in agreement with previous examinations of softball injury rates where most injuries were minor and did not require >3 weeks of time loss.<sup>9,16,19</sup> Injuries during the high school softball season cause minimal disability, which may be reflective of injury management and recognition. Thus, the financial burden to families and the health care system to care for these minor injuries is subsequently low. The injury rates that were observed should be interpreted with caution, as the high

school softball season represents a small portion of a competitive athlete's softball participation. Competitive softball athletes often place more emphasis on participation on elite travel teams than their high school team. Future studies should aim to examine shoulder and elbow injury rates in softball athletes participating on elite travel teams, as these teams may have more rigorous practice and game schedules, which place an athlete at greater risk of injury.

This study had limitations, most of which were associated with the restrictions of the injury surveillance database. Only high schools with NATA-affiliated certified ATs are eligible to participate in High School RIO, which likely limits the generalizability of our findings in schools without an AT. The ATs were not required to report minor injuries that did not result in time loss; thus, the injuries reported are an underestimate of all sustained injuries and are more likely to exclude minor injuries, such as those resulting in chronic pain but not missed participation. Additionally, injury reporting diagnosis and compliance with the surveillance system methodology were ultimately at the discretion of the individual AT. However, publicly available High School RIO annual summary reports containing detailed information on internal validity checks indicate a high degree of accuracy and completeness of the captured data.<sup>6,13,20</sup> Additionally, a study comparing the accuracy of AT and physician diagnoses in sports medicine found high agreement.<sup>8</sup> Another limitation of the database is that it does not allow for the investigation of the full spectrum of treatment information that might affect clinical practice. The RIO database does not account for specific measures of exposure, such as number of games or innings played and pitch counts. Despite the limitations, this study provides the most comprehensive epidemiological investigation to date of shoulder and elbow injuries among the largest and most representative sample of US high school softball athletes.

## CONCLUSION

Shoulder injuries in high school softball were more common than elbow injuries, and shoulder injury rates were relatively constant over time while elbow injury rates decreased significantly over time. Injured athletes usually returned to sport within 3 weeks. Approximately 17% of shoulder and elbow injuries were sustained by pitchers. The rates of elbow injury, percentage of shoulder and elbow injuries in pitchers, and percentage of injuries requiring lengthy time to return were much lower for high school softball compared with previously published data for high school baseball. These findings from a large, nationally representative sample of US high schools are clinically relevant both for providing updated epidemiological data on softball injuries for clinicians counseling patients on injury risks and for providing trend-over-time data to clinicians evaluating body site-specific injury prevention efforts.

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