Cheerleading Injuries in United States High Schools

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abstract

BACKGROUND AND OBJECTIVES: Approximately 400 000 students participate in US high school cheerleading annually, including 123 386 involved in competitive spirit squads. The degree of athleticism and the difficulty of cheerleading skills have increased in recent decades, renewing safety concerns. This study describes the epidemiology of high school cheerleading injuries and compares cheerleading injury rates and patterns relative to other sports.

METHODS: Data collected by the longitudinal, National High School Sports-Related Injury Surveillance Study from 2009/2010 through 2013/2014 were analyzed.

RESULTS: Injury rates in cheerleading ranked 18th of 22 sports, with an overall injury rate of 0.71 per 1000 athlete-exposures (AEs). Competition (0.85) and practice (0.76) injury rates were similar, whereas performance rates were lower (0.49). Although 96.8% of injured cheerleaders were girls, the overall injury rate was higher in boys (1.33 vs 0.69, rate ratio [RR]: 1.93, 95% confidence interval [CI]: 1.30–2.88). Although concussions were the most common cheerleading injury (31.1% of injuries), concussion rates were significantly lower in cheerleading (2.21 per 10 000 athlete-exposures) than all other sports combined (3.78; RR: 0.58, 95% CI: 0.51–0.66) and all other girls' sports (2.70; RR: 0.82, 95% CI: 0.72–0.93). Over half of all injuries occurred during stunts (53.2%).

CONCLUSIONS: Although safety remains a concern among cheerleaders, overall injury rates are lower than most other high school sports. Although overall injury rates are relatively low, cheerleading injuries may be more severe when they do occur. A detailed knowledge of cheerleading injury patterns relative to other sports is needed to drive targeted, evidence-based prevention efforts.

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Mr Currie conceptualized and designed the study, carried out data analyses, and drafted the initial manuscript; Drs Fields and Patterson critically reviewed the manuscript; Dr Comstock designed the data collection instruments, provided access to the data, contributed to design of the study, and critically reviewed the manuscript; and all authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: Approximately 65% of all sports-related catastrophic injuries among high-school girls reportedly result from cheerleading. However, some studies have indicated that overall cheerleading injury rates may be lower than or comparable to other sports within this age group.

WHAT THIS STUDY ADDS: This study used data from a national injury surveillance system to directly compare injury rates between high school-sanctioned cheerleading and other sports. This study also details the epidemiology of cheerleading injuries, with particular emphasis on concussions.

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Participation in cheerleading has increased for individuals aged 6 years and older from 3 039 000 in 1990 to 3 579 000 in 2003.[1] Although cheerleading's history is long, until relatively recently it was not considered a sport, even if participants were athletic. To establish itself as a sport, a relatively new high school sanctioned event, competitive spirit, is now available. Increases in skill difficulty and athleticism required of high school cheerleaders has renewed safety concerns.[2,3] The National Federation of State High School Associations (NFHS) estimates approximately 400 000 students participate in US high school cheerleading annually, including 123 386 involved in competitive spirit squads.[4,5] These numbers rank cheerleading the fourth most popular high school girls' athletic activity, and rank competitive spirit squads alone as the ninth most popular high school girls' sport.

Although several studies have described cheerleading injury epidemiology generally,[6–10] in terms of specific activities, mechanisms or diagnoses,[11–13] injuries presenting to emergency departments[14] and catastrophic injuries,[15,16] no study to date has examined the injury epidemiology of high school sanctioned cheerleading, comparing it to other sports. Using a large national sports injury surveillance data set, this study aimed to (1) describe injury rates and patterns in high school cheerleading, (2) compare injury rates and patterns by type of exposure (ie, practice, competition, or performance), and (3) compare injury rates and patterns in high school cheerleading to other sports.

METHODS

Data Collection

This study used data collected by High School Reporting Information Online (RIO), an Internet-based high school sports injury surveillance system described previously.[17,18] Briefly, the study began during the 2005/2006 academic year, using a nationally representative sample of US high schools with certified athletic trainers (ATs), stratified by school population and geographic region. The original sample included 9 sports.

Beginning in 2008/2009, High School RIO expanded the list of sports for which data were collected to eventually add 13 sports, including cheerleading. 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. Cheerleading injury data have been collected annually since 2009/2010. This study analyzed High School RIO cheerleading data from 2009/2010 through 2013/2014, with an average of 107 schools reporting cheerleading data annually during the study period (range: 70–147).

Definitions

An athletic exposure (AE) was defined as 1 athlete participating in 1 practice, competition, or performance. The performance exposure category was collected only for cheerleading and is differentiated from competition by whether the team is cheering at halftime or on the sidelines in support of another sports' event (performance) or participating themselves in a judged competition when a school coach or other school-sanctioned supervisor is present (competition). High School RIO only captures data on school-sanctioned cheerleading squads, thus cheerleading teams from private gyms, clubs, etc, are not included.

Injuries reported to High School RIO:

1. Occurred during an organized high school practice, competition, or performance, and
2. Required medical attention by an AT or physician, and
3. Resulted in restriction of the athlete's participation for at least 1 day beyond the injury date (with the exception of fractures, concussions, heat illness/injuries, or dental injuries, which are reported regardless of time loss).

Injury diagnosis is based on the expert opinion of the ATs, with no study-specific diagnostic criteria given for any type of injury.

Statistical Analysis

Statistical analyses were completed by using SAS software, version 9.3 (SAS Institute, Cary, NC). Cheerleading was categorized as a coed sport in High School RIO; therefore, ATs were asked to provide exposure data stratified by gender as well as exposure type so that injury rates could be calculated by gender. Injury rates were calculated by using 2009/2010 through 2013/2014 data, and were calculated as the ratio of reportable injuries per 1000 AEs.

Rate ratios (RRs) and injury proportion ratios (IPRs) were calculated as follows:

$$\mathrm{RR} = \frac{(\#\,\text{of cheerleading injuries} / \#\,\text{of cheerleading AEs})}{(\#\,\text{of football injuries} / \#\,\text{of football AEs})}$$

$$\mathrm{IPR} = \frac{(\#\,\text{of practice concussions} / \#\,\text{of all practice injuries})}{(\#\,\text{of performance concussion} / \#\,\text{of all performance injuries})}$$

RRs and IPRs with 95% confidence intervals (CIs) not including 1.0 were considered statistically significant. Trends over time were calculated by using simple linear regression. Kruskal–Wallis tests were used to compare return to play time across cheerleading exposure types. Statistical significance was set at $\alpha = 0.05$.

The Institutional Review Board at Nationwide Children's Hospital in Columbus, Ohio, approved this study.

RESULTS

Injury Rates and Comparisons Across Sports

A total of 793 injuries were reported in 1 109 489 cheerleading exposures. Overall, cheerleading ranked 18th out of 22 sports, with an overall injury rate of 0.71 per 1000 AEs (Table 1). Cheerleading was ranked 19th in competition injury rates (0.85 per 1000 AEs), and 15th in practice injury rates (0.76 per 1000 AEs). The performance injury rate (0.49 per 1000 AEs) is reported only for cheerleading, preventing comparisons with other sports. Cheerleading's overall injury rate was significantly lower than that of all other sports combined (RR: 0.37, 95% CI: 0.35–0.40) and all other girls' sports combined (RR: 0.49, 95% CI: 0.46–0.53).

Cheerleading injury rates (Fig 1) have remained relatively constant over time overall (P = .13), in competition (P = .15), practice (P = .11), and performance (P = .40). No significant difference between competition (0.85 per 1000 AEs) and practice (0.76) injury rates (RR: 1.12, 95% CI: 0.87–1.45) existed; however, performance injury rates (0.49) were lower than both practice (RR: 0.64, 95% CI: 0.52–0.79) and competition (RR: 0.57, 95% CI: 0.42–0.78).

General Cheerleading Injury Characteristics

Overall

Girls (96.8%) represented most injuries, with only 3.2% of injured athletes being boys. Most cheerleading-related injuries were new (90.5%) and occurred during practice (78.8%). Overall, the most commonly injured body sites were the head/face (38.5%), ankle (11.7%), hand/wrist (9.3%), and trunk (7.7%) (Table 2). Concussions were the most common injury diagnosis (31.1%), followed by ligament sprains (20.2%), muscle strains (14.2%), and fractures (10.3%).

Comparison by Gender

A total of 752 female cheerleading injuries occurred in 1 090 705 AEs for

TABLE 1 Injury Rates by Sport and Exposure Type, National High School Sports-Related Injury Surveillance Study, United States, 2009/2010 through 2013/2014

Sport[a]	Overall Injuries	Overall Exposures	Injury Rate per 1000 AE	Competition Injuries	Competition Exposures	Injury Rate per 1000 AE	Practice Injuries	Practice Exposures	Injury Rate per 1000 AE	Performance Injuries	Performance Exposures	Injury Rate pre 1000 AE
Football	14 645	3 656 371	4.01	7759	619 082	12.53	6886	3 037 289	2.27	—	—	—
Girls' soccer	2891	1 176 083	2.46	1983	359 993	5.51	908	816 090	1.11	—	—	—
Boys' ice hockey	685	292 120	2.34	541	97 527	5.55	144	194 593	0.74	—	—	—
Boys' wrestling	2830	1 222 097	2.32	1177	320 083	3.68	1653	902 014	1.83	—	—	—
Boys' lacrosse	1158	551 168	2.10	717	169 819	4.22	441	381 349	1.16	—	—	—
Girls' basketball	2581	1 348 035	1.91	1492	415 950	3.59	1089	932 085	1.17	—	—	—
Girls' gymnastics	110	60 780	1.81	34	10 983	3.10	76	49 797	1.53	—	—	—
Girls' field hockey	789	463 098	1.70	380	147 299	2.58	409	315 799	1.30	—	—	—
Boys' soccer	2368	1 401 312	1.69	1499	419 351	3.57	869	981 961	0.88	—	—	—
Boys' basketball	2602	1 693 645	1.54	1364	511 308	2.67	1238	1 182 337	1.05	—	—	—
Girls' lacrosse	552	395 482	1.40	288	123 605	2.33	264	271 877	0.97	—	—	—
Girls' softball	1156	937 659	1.23	569	317 639	1.79	587	620 020	0.95	—	—	—
Girls' volleyball	1447	1 311 473	1.10	587	440 071	1.33	860	871 402	0.99	—	—	—
Girls' track and field	1080	1 111 953	0.97	256	213 509	1.20	824	898 444	0.92	—	—	—
Boys' baseball	1218	1 272 308	0.96	672	441 522	1.52	546	830 786	0.66	—	—	—
Girls' cross country	235	250 420	0.94	36	42 615	0.84	199	207 805	0.96	—	—	—
Boys' volleyball	41	53 208	0.73	18	19 345	0.93	23	36 863	0.62	—	—	—
Cheerleading	793	1 109 489	0.71	65	76 295	0.85	625	821 242	0.76	103	211 952	0.49
Boys' cross country	199	283 259	0.70	42	48 856	0.86	157	234 403	0.67	—	—	—
Boys' track and field	913	1 345 565	0.68	327	260 167	1.26	586	1 085 398	0.54	—	—	—
Girls' swimming and diving	159	495 535	0.32	29	93 161	0.31	130	402 374	0.32	—	—	—
Boys' swimming and diving	92	424 721	0.22	9	79 223	0.11	83	345 498	0.24	—	—	—

—, performance exposure category applies only to cheerleading

[a] Boys' volleyball and girls' gymnastics data available from 2009/2010 through 2011/2012. Boys' and girls' cross country data available from 2012/2013 through 2013/2014. Data from all other sports available for the duration of the study.

a female injury rate of 0.69 per 1000 AEs, whereas 25 male cheerleading injuries occurred in 18 784 AEs for a male injury rate of 1.33 per 1000 AEs. The injury rate was significantly higher among boys than girls (RR: 1.93, 95% CI: 1.30–2.88). Gender of injured athlete was missing for 2.0% of injuries.

The most common injury diagnoses for female athletes were concussions (31.6%), followed by ligament sprains (19.9%) and muscle strains (14.6%). For boys the most common injury diagnoses were ligament sprains (32.0%) followed by concussions (16.0%). The most commonly injured body parts among both genders were head/face (39.0% and 24.0%, respectively) and ankle (11.7% and 16.0%).

Comparison by Exposure Type

Concussions represented 33.1% of practice injuries, 27.7% of competition injuries, and 20.6% of all performance injuries, whereas ligament sprains represented 24.6% of competition, 22.6% of performance, and 19.3% of practice injuries (Table 2). A significantly higher proportion of practice injuries were concussions compared with performance injuries (IPR: 1.61, 95% CI: 1.08–2.39). Head/face injuries were most common in practice (41.0% of all practice injuries), followed by competition (30.8%) and performance (28.4%), whereas knee injuries were less common in practice (6.2%) than performances (11.8%) or competitions (10.8%). Ankle injuries were the second most commonly injured body part in all exposure types, representing 11.4% of practice, 16.9% of competition, and 10.8% of performance injuries.

Concussions

The most commonly reported concussion symptoms were headache (96.7%), dizziness/unsteadiness (78.4%), and concentration difficulty (53.9%). Amnesia (12.2%) and loss of consciousness (2.5%) were less common. Although symptoms resolved in less than 1 day for 10.6% of concussions, symptoms took over 6 days to resolve in 44.2% of concussions. A majority of concussions resulted in time loss between 1 and 3 weeks (60.7%). Concussion rates were significantly lower in cheerleading (2.21 per 10 000 AEs) than all other sports combined (3.78; RR: 0.58, 95% CI: 0.51–0.66) as well as compared with all other girls' sports (2.70; RR: 0.82, 95% CI: 0.72–0.93). Despite relatively low overall concussion rates, practice concussion rates (2.51 per 10 000 AEs) are higher in cheerleading than in most other sports, ranking third behind boys' football (4.78) and boys' wrestling (3.02).

Sport-Specific Cheerleading Injury Characteristics

Overall

Overall, the most common injury mechanisms included contact with another person (40.0%) and contact with the playing surface (36.6%) (Table 3). The most common activities leading to injury included stunts (53.2%), tumbling (20.5%), and pyramids (10.8%). Shoulder level stunts accounted for 14.8% of all stunt injuries, and extended above the shoulder level stunts account for 37.4%. Stunt injuries most commonly occurred during the dismount (32.0%). Of injuries occurring during dismount, 64.3% were dismounting to a cradle, whereas 35.7% were dismounting to the floor. Most stunt (55.8%) and pyramid (64.6%) injuries involved a triple base. Almost three-quarters of cheerleading injuries did not involve a rotation skill (73.5%), whereas 21.6% involved a single rotation and 4.9% involved a double rotation.

Stunts represented a large proportion of concussions (69.0%), with pyramids and tumbling representing an additional 15.7% and 9.1%, respectively. The most common injury mechanisms for concussions were contact with another person (58.9%) and contact with the playing surface (37.9%). Most stunt (60.2%) and pyramid (76.3%) related concussions resulted from contact with another person, whereas most tumbling (77.3%) concussions resulted from contact with the playing surface. Most athletes concussed due to player contact were struck by the

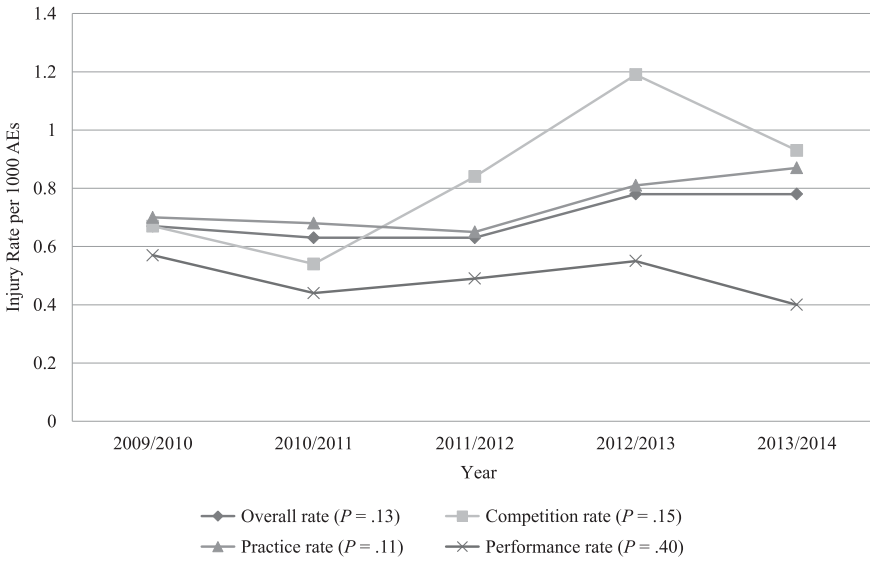

FIGURE 1
Cheerleading injury rates over time by exposure type, National High School Sports-Related Injury Surveillance Study, United States, 2009/2010 through 2013/2014.

other athlete's elbow (26.1%), head (17.6%), or foot (12.7%).

Bases accounted for 45.5% of all injuries, followed by flyers (36.0%) and spotters (9.9%). Position differed by gender; 65.2% of injured boys were bases and 13.0% were flyers, whereas 44.7% of injured girls were bases and 36.8% were flyers. Most base (83.5%) and back spotter (77.3%) concussions resulted from contact with another athlete, whereas 68.1% of flyer concussions resulted from contact with the playing surface. Most injuries occurred on mats (68.8%), but 11.6% occurred on basketball courts and 8.4% occurred on tracks.

Comparison by Exposure Type

Many competition and performance injuries resulted from contact with the playing surface (40.0% and 43.1%, respectively), whereas practice-related injuries commonly occurred as a result of contact with another person (43.0%; Table 3). The proportion of noncontact injuries was significantly higher in performance (19.6%) than practice (12.1%; IPR: 1.62, 95% CI: 1.03–2.53). Although stunt and pyramid injuries were more common in practice (57.1% and 11.8%, respectively) than performance (42.4% and 6.1%, respectively) or competition (31.8% and 9.5%, respectively), tumbling and jumping injuries were more common in both competition (34.9% and 11.1%, respectively) and performance (26.3% and 13.3%, respectively) than practice (18.1% and 6.4%, respectively).

Injury Severity

Overall

Of all cheerleading-related injuries, 34.3% resulted in return to play in <1 week, 40.7% in 1 to 3 weeks, 11.1% in 3 weeks or more, and 5.1% in medical disqualification (MDQ) for the season (97.4% of MDQs) or career (2.6% of MDQs). The most common injuries resulting in time loss of 3 weeks or more were concussions (35.4%), fractures (30.5%), and ligament sprains (15.9%). MDQs occurred most frequently as a result of fractures (29.0%) and dislocations (15.8%). Of all cheerleading injuries, 16.2% resulted in time loss of either >3 weeks or MDQ, the second highest proportion of all sports in High School RIO behind gymnastics.

Surgery was required for 4.0% of all cheerleading injuries, most frequently for fractures (38.7%) and ligament sprains (29.0%). Sites most commonly requiring surgery were the knee (41.9%) and head/face and shoulder/clavicle (16.1% each). The most

TABLE 2 Cheerleading Injury Body Part and Diagnosis by Type of Exposure, National High School Sports-Related Injury Surveillance Study, United States, 2009/2010 through 2013/2014

	Competition, *N* (%)	Rate per 10 000 AEs	Practice, *N* (%)	Rate per 10 000 AEs	Performance, *N* (%)	Rate per 10 000 AEs	Overall, *N* (%)	Rate per 10 000 AEs
Body part injured[a]								
Head/face[b]	20 (30.8)	2.62	256 (41.0)	3.12	29 (28.4)	1.37	305 (38.5)	2.75
Neck	3 (4.6)	0.39	30 (4.8)	0.37	5 (4.9)	0.24	38 (4.8)	0.34
Shoulder/clavicle	4 (6.2)	0.52	39 (6.2)	0.47	8 (7.8)	0.38	51 (6.4)	0.46
Arm/elbow	4 (6.2)	0.52	29 (4.6)	0.35	1 (1.0)	0.05	34 (4.3)	0.31
Hand/wrist	5 (7.7)	0.66	59 (9.4)	0.72	10 (9.8)	0.47	74 (9.3)	0.67
Trunk[c]	2 (3.1)	0.26	51 (8.2)	0.62	8 (7.8)	0.38	61 (7.7)	0.55
Hip	0 (0.0)	0.00	4 (0.6)	0.05	1 (1.0)	0.05	5 (0.6)	0.05
Thigh/upper leg	3 (4.6)	0.39	14 (2.2)	0.17	3 (2.9)	0.14	20 (2.5)	0.18
Knee	7 (10.8)	0.92	39 (6.2)	0.47	12 (11.8)	0.57	58 (7.3)	0.52
Lower leg	2 (3.1)	0.26	12 (1.9)	0.15	6 (5.9)	0.28	20 (2.5)	0.18
Ankle	11 (16.9)	1.44	71 (11.4)	0.86	11 (10.8)	0.52	93 (11.7)	0.84
Foot	3 (4.6)	0.39	17 (2.7)	0.21	6 (5.9)	0.28	26 (3.3)	0.23
Other	1 (1.5)	0.13	4 (0.6)	0.05	2 (2.0)	0.09	7 (0.9)	0.06
Total	65 (100.0)	8.52	625 (100.0)	7.61	102 (100.0)	4.81	792 (100.0)	7.14
Injury diagnosis[d]								
Concussion	18 (27.7)	2.36	206 (33.1)	2.51	21 (20.6)	0.99	245 (31.1)	2.21
Ligament sprain	16 (24.6)	2.10	120 (19.3)	1.46	23 (22.6)	1.09	159 (20.2)	1.43
Muscle strain	5 (7.7)	0.66	89 (14.3)	1.08	18 (17.7)	0.85	112 (14.2)	1.01
Fracture	7 (10.8)	0.92	60 (9.7)	0.73	14 (13.7)	0.66	81 (10.3)	0.73
Contusion	5 (7.7)	0.66	47 (7.6)	0.57	6 (5.9)	0.28	58 (7.4)	0.52
Other	14 (21.5)	1.83	100 (16.1)	1.22	20 (19.6)	0.94	134 (17.0)	1.21
Total	65 (100.0)	8.52	622 (100.0)	7.57	102 (100.0)	4.81	789 (100.0)	7.11

[a] Excludes 1 performance injury missing primary body part injured.
[b] Head/face includes head, eyes, ears, nose, mouth, and teeth.
[c] Trunk includes chest, t-spine, ribs, abdomen, lower back, l-spine, and pelvis.
[d] Excludes 3 practice and 1 performance injuries missing primary injury diagnosis.

common body part and diagnosis combinations leading to surgery included knee sprains (29.0%), nose fractures (12.9%), and shoulder dislocations/subluxations (12.9%).

Comparison by Exposure Type

Return to play time and need for surgery by exposure type are presented in Table 4. Time loss of 1 to 3 weeks most commonly occurred for competition (40.0%) and practice (42.5%) injuries, whereas performance injuries most commonly resulted in time loss of <1 week (38.7%). No significant difference between exposure type and time to return to play ($P = .24$) existed.

DISCUSSION

This study is the first to use data from a large national high school sports injury surveillance system to describe the injury epidemiology of high school cheerleading, and to directly compare injury rates in cheerleading to other sports. Although studies revealing high rates of catastrophic injury in cheerleading have understandably resulted in safety concerns,[2,14] we found cheerleading has a relatively low injury rate compared with other high school sports in terms of all time-loss injuries (18th of 22 sports studied). Other researchers have also noted cheerleading injury rates

TABLE 3 Mechanism of Injury, Cheerleading Activity, and Position Among Injured Cheerleaders, National High School Sports-Related Injury Surveillance Study, United States, 2009/2010 through 2013/2014

	Competition, *N* (%)	Rate per 10 000 AEs	Practice, *N* (%)	Rate per 10 000 AEs	Performance, *N* (%)	Rate per 10 000 AEs	Overall, *N* (%)	Rate per 10 000 AEs
Mechanism of injury[a]								
Athlete-athlete contact	20 (30.8)	2.62	266 (43.0)	3.24	28 (27.5)	1.32	314 (40.0)	2.83
Athlete-surface contact	26 (40.0)	3.41	217 (35.1)	2.64	44 (43.1)	2.08	287 (36.6)	2.59
No contact	10 (15.4)	1.31	75 (12.1)	0.91	20 (19.6)	0.94	105 (13.4)	0.95
Overuse/chronic	5 (7.7)	0.66	39 (6.3)	0.47	3 (2.9)	0.14	47 (6.0)	0.42
Athlete-apparatus contact	1 (1.5)	0.13	4 (0.7)	0.05	1 (1.0)	0.05	6 (0.8)	0.05
Other	3 (4.6)	0.39	17 (2.8)	0.21	6 (5.9)	0.28	26 (3.3)	0.23
Activity at time of injury[b]								
Stunt	20 (31.8)	2.62	350 (57.1)	4.26	42 (42.4)	1.98	412 (53.2)	3.71
Tumble	22 (34.9)	2.88	111 (18.1)	1.35	26 (26.3)	1.23	159 (20.5)	1.43
Pyramid	6 (9.5)	0.79	72 (11.8)	0.88	6 (6.1)	0.28	84 (10.8)	0.76
Jump	7 (11.1)	0.92	39 (6.4)	0.47	13 (13.1)	0.61	59 (7.6)	0.53
Warm-up	1 (1.6)	0.13	6 (1.0)	0.07	3 (3.0)	0.14	10 (1.3)	0.09
Other	7 (11.1)	0.92	35 (5.7)	0.43	9 (9.1)	0.42	51 (6.6)	0.46
Position at time of injury[c]								
Base	28 (45.9)	3.67	284 (47.9)	3.46	29 (30.2)	1.37	341 (45.5)	3.07
Flyer	20 (32.8)	2.62	218 (36.8)	2.65	32 (33.3)	1.51	270 (36.0)	2.43
Back spotter	3 (4.9)	0.39	50 (8.4)	0.61	11 (11.5)	0.52	64 (8.5)	0.58
Front spotter	0 (0.0)	0.00	7 (1.2)	0.09	3 (3.1)	0.14	10 (1.3)	0.09
Other	10 (16.4)	1.31	34 (5.7)	0.41	21 (21.9)	0.99	65 (8.7)	0.59

[a] Excludes 7 practice and 1 performance injuries due to missing injury mechanism data.
[b] Excludes 2 competition, 12 practice, and 4 performance injuries due to missing cheerleading activity data.
[c] Excludes 4 competition, 32 practice, and 7 performance injuries due to missing cheerleading position data.

TABLE 4 Cheerleading Injury Time Loss and Need for Surgery by Type of Exposure, National High School Sports-Related Injury Surveillance Study, United States, 2009/2010 through 2013/2014

	Competition, *N* (%)	Rate per 10 000 AEs	Practice, *N* (%)	Rate per 10 000 AEs	Performance, *N* (%)	Rate per 10 000 AEs	Overall, *N* (%)	Rate per 10 000 AEs
Time to return to play[a]								
Less than 1wk	16 (26.7)	2.10	198 (34.3)	2.41	36 (38.7)	1.70	250 (34.3)	2.25
1 wk to 3 wk	24 (40.0)	3.15	245 (42.5)	2.98	28 (30.1)	1.32	297 (40.7)	2.68
3 wk or more[b]	20 (33.3)	2.62	134 (23.2)	1.63	29 (31.2)	1.37	183 (25.1)	1.65
Need for surgical repair of injury[c]								
Surgery required	2 (3.1)	0.26	22 (3.6)	0.27	7 (7.1)	0.33	31 (4.0)	0.28
Surgery not required	62 (96.9)	8.13	591 (96.4)	7.20	91 (92.9)	4.29	744 (96.0)	6.71

[a] Excludes 5 competition, 48 practice, and 10 performance injuries missing time loss data.
[b] Includes MDQ, athlete chose not to continue, season ended before athlete returned to play, and return after 3 weeks or more.
[c] Excludes 1 competition, 12 practice, and 5 performance injuries missing need for surgery data.

are low[2,6] or comparable[7] relative to other sports. Despite the low injury rate, our study revealed that cheerleading had the second highest proportion of injuries resulting in time loss of at least 3 weeks or MDQ of all 22 sports studied. These findings of low overall injury rates despite historically high catastrophic injury rates in cheerleading (65% of female injuries) relative to other sports[2,16] demonstrate that although cheerleading is relatively safe overall, when injuries do occur, they may be more severe. Thus, prevention efforts should focus on activities placing cheerleaders at risk for severe injuries. Understanding the epidemiology of cheerleading injuries is the important first step toward that goal.

We found cheerleading injury rates were comparable between competition (0.85 per 1 000 AEs) and practice (0.76), whereas performance rates were lower (0.49). This is similar to reports from a previous study.[6] However, our finding that practice and competition injury rates were similar makes cheerleading unusual compared with other high school sports where injury rates tend to be significantly higher in competition than practice.[18] This may be due to the similarity in activities between practice and competition in cheerleading (ie, learning and performing stunts or maneuvers), as compared with sports like ice hockey or football, where much less player–player contact is initiated in practice than in competition leading to fewer injuries.

Concussions represented 31.1% of all cheerleading injuries, which is much higher than reported in previous studies, which ranged from 4% to 6%.[6,9] Although injury definitions were similar between studies, the time periods were different. Our findings reflect the increased concussion rates seen in other high school sports over the study period, possibly due to increased awareness and changes in diagnostic criteria over the past decade.[19] Although overall concussion rates were significantly lower in cheerleading than all other sports combined, as well as compared with all other girls' sports, the higher rate of concussions in practice compared with other sports highlights a point for further study and for targeted prevention efforts.

We found most injuries occurred during stunts (53.2%), consistent with previous studies.[6,9,10] Similar to Shulz et al,[9] we found the most common injury mechanism was contact with another athlete (40.0%); however, Shields and Smith[6] reported basing/spotting was most common. This discrepancy may be explained by different mechanism and position definitions, as we found that bases were the most common position injured (45.5%), but basing was not a separate mechanism category. Taken together, these studies indicate that bases are at particular risk of injury from contact with another athlete during stunts. Future research should focus on identifying ways to better protect bases during stunts.

Cheerleading athletes have historically been marginalized as supportive performers, and only recently has the activity been acknowledged as a sport. As Mueller[20] notes, the decision by the NFHS to request spirit (cheerleading) be included in High School RIO is a step toward better understanding and preventing cheerleading injuries. Other positive steps are being made to improve cheerleading safety. The NFHS Spirit Rules Book, updated annually, is a valuable resource for high school coaches because the NFHS Spirit Rules Committee uses epidemiologic data to inform evidence-based decision-making regarding rules to make participation safer.[21] The American Association of Cheerleading Coaches and Administrators also has a Cheerleading Safety Manual[22] and offers Spirit Safety Certifications for coaches in collaboration with the NFHS.[23] Future research is needed to determine which safety efforts are most effective. For example, although compelling arguments have been made that state-level classification of cheerleading/spirit as an official high school sport would likely reduce injuries,[2,20] comparing rates and patterns within states pre- and postsports classification, and comparing across states with and without sports classification have not yet been done.

The limitations of this study are primarily associated with the High School RIO data set. Generalizability of results is partially sacrificed by requiring reporters to be ATs. Not all schools use the services of ATs, and injury patterns between schools with and without ATs may differ. However, utilizing ATs makes reporting more reliable, because all reporters have had similar sports medicine training. Whether these patterns differ and subsequently affect injury rates and patterns should be an area of future research with more clearly defined exposures. An additional limitation of this study is that it does not account for variation in activities performed by cheerleading squads present in US high schools. Because the data set does not stratify exposures based on cheerleading activity, we cannot say whether squads who are more competitive or elite have different injury rates than less competitive squads who perform more of a traditional support role. Future studies of cheerleading injury stratifying exposure by cheerleading activity could provide further insight into the relative safety of specific types of cheerleading. Despite these limitations, this study is important because it provides the first direct comparison of injury rates between

cheerleading and other high school sports, and the first in depth exploration of cheerleading injuries using a large national high school sports injury surveillance data set.

CONCLUSIONS

As high school cheerleading participation and athleticism continue to increase,[1,3] data relating to injury patterns can provide insight into improving cheerleading safety. Associations governing cheerleading have recognized the need to be proactive in driving evidence-based changes relating to the safety of cheerleaders. This in-depth look at high school cheerleading injury epidemiology provides further evidence that can be used to inform policymakers, parents, coaches, ATs, and athletes regarding injury risks and potential intervention strategies. Although cheerleading injury research has increased in recent years, cheerleading remains less well studied than other sports.[6,8] Additional research on the effect of state-level sport categorization on injury patterns may assist future evidence-based prevention efforts.

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ABBREVIATIONS

AEs: athlete-exposures
AT: certified athletic trainer
CI: confidence interval
IPR: injury proportion ratio
MDQ: medical disqualification
NFHS: National Federation of State High School Associations
RIO: Reporting Information Online
RR: rate ratio

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REFERENCES

1. American Sports Data Inc. The Superstudy of Sports Participation. Vol II. *Recreational Sports 2003*. Hartsdale, NY: American Sports Data, Inc; 2004
2. LaBella CR, Mjaanes J; Council on Sports Medicine and Fitness. Cheerleading injuries: epidemiology and recommendations for prevention. *Pediatrics*. 2012;130(5):966–971 10.1542/peds.2012/2480
3. Giannone L, Williamson TL. A philosophy of safety awareness. In: George GS, ed. *American Association of Cheerleading Coaches and Administrators Cheerleading Safety Manual, Revised Edition*. Memphis, TN: UCA Publications Department; 2006:1–4
4. National Federation of State High School Associations. News Release: Survey indicates approximately 400,000 high school cheerleaders. Available at: www.ihsa.org/archive/announcements/nfhs_cheerleading_release.pdf. Accessed January 27, 2015
5. National Federation of State High School Associations. 2013–2014 High school athletics participation survey. Available at: www.nfhs.org/ParticipationStatics/PDF/2013-14_Participation_Survey_PDF.pdf. Accessed January 25, 2015
6. Shields BJ, Smith GA. Cheerleading-related injuries in the United States: a prospective surveillance study. *J Athl Train*. 2009;44(6):567–577
7. Jacobson BH, Hubbard M, Redus B, et al. An assessment of high school cheerleading: injury distribution, frequency, and associated factors. *J Orthop Sports Phys Ther*. 2004;34(5):261–265
8. Jacobson BH, Redus B, Palmer T. An assessment of injuries in college cheerleading: distribution, frequency, and associated factors. *Br J Sports Med*. 2005;39(4):237–240 10.1136/bjsm.2004.014605
9. Schulz MR, Marshall SW, Yang J, Mueller FO, Weaver NL, Bowling JM. A prospective cohort study of injury incidence and risk factors in North Carolina high school competitive cheerleaders. *Am J Sports Med*. 2004;32(2):396–405
10. Hutchinson MR. Cheerleading injuries: patterns, prevention, case reports. *Phys Sportsmed*. 1997;25(9):83–96
11. Shields BJ, Fernandez SA, Smith GA. Epidemiology of cheerleading stunt-related injuries in the United States. *J Athl Train*. 2009;44(6):586–594
12. Shields BJ, Smith GA. Epidemiology of cheerleading fall-related injuries in the United States. *J Athl Train*. 2009;44(6):578–585
13. Schulz MR. Athletic injuries among North Carolina high school athletes: The epidemiology of concussion and cheerleading injuries. The University of North Carolina at Chapel Hill, ProQuest, UMI Dissertations Publishing. 2002; No. 3070909

14. Shields BJ, Smith GA. Cheerleading-related injuries to children 5 to 18 years of age: United States, 1990-2002. *Pediatrics*. 2006;117(1):122–129

15. Muller FO, Cantu RC. *Catastrophic Sports Injury Research. 27th Annual Report, Fall 1982–Spring 2013*. Chapel Hill, NC: National Center for Catastrophic Sport Injury Research; 2013. Available at: nccsir.unc.edu/reports/. Accessed February 11, 2015

16. Boden BP, Tacchetti R, Mueller FO. Catastrophic cheerleading injuries. *Am J Sports Med*. 2003;31(6):881–888

17. Centers for Disease Control and Prevention (CDC). Sports-related injuries among high school athletes--United States, 2005-06 school year. *MMWR Morb Mortal Wkly Rep*. 2006;55(38):1037–1040

18. Rechel JA, Yard EE, Comstock RD. An epidemiologic comparison of high school sports injuries sustained in practice and competition. *J Athl Train*. 2008;43(2):197–204

19. Rosenthal JA, Foraker RE, Collins CL, Comstock RD. National high school athlete concussion rates from 2005-2006 to 2011-2012. *Am J Sports Med*. 2014;42(7):1710–1715

20. Mueller FO. Cheerleading injuries and safety. *J Athl Train*. 2009;44(6):565–566

21. National Federation of State High School Associations. *2014–2015 Spirit Rules Book*. Indianapolis, IN: National Federation of State High School Associations; 2014

22. American Association of Cheerleading Coaches and Administrators. *American Association of Cheerleading Coaches and Administrators Cheerleading Safety Manual*, Revised Edition. Memphis, TN: UCA Publications Department; 2006

23. American Association of Cheerleading Coaches and Administrators Spirit Safety Certification. Available at: http://nfhslearn.com/courses/10000. Accessed February 11, 2015

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