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Epidemiology of United States High School Sports-Related Fractures, 2008-09 to 2010-11

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Abstract

Background—High school athletes sustain millions of injuries annually, many of which are fractures. Fractures can severely affect athletes physically, emotionally, and financially and should be targeted with focused prevention methods.

Hypothesis—Patterns and primary mechanisms of fractures differ by sport and gender.

Study Design—Descriptive epidemiology study.

Methods—High school sports-related injury data were collected from academic years 2008-09 to 2010-11 for 18 sports and from 2009-10 to 2010-11 for 2 additional sports. We used linear regression to describe annual fracture rate trends and calculated fractures rates, rate ratios (RRs), and injury proportion ratios (IPRs).

Results—From 2008-09 to 2010-11, certified athletic trainers reported a total of 21,251 injuries during 11,544,455 athlete exposures (AEs), of which 2103 (9.9%) were fractures, with an overall rate of 1.82 fractures per 10,000 AEs. Fracture rates were highest in football (4.37 per 10,000 AE), boys' ice hockey (3.08), and boys' lacrosse (2.59). Boys sustained 79.1% of all fractures, and the overall rates of fractures were greater in boys' sports than in girls' sports for competition (RR, 2.82; 95% CI, 2.45-3.24) and practice (RR, 2.43; 95% CI, 2.07-2.86). The most commonly fractured body sites were the hand/finger (32.1%), lower leg (10.1%), and wrist (9.5%). Overall, 17.2% of fractures required surgery, which was higher than for all other injuries combined (IPR, 3.14; 95% CI, 2.81-3.52). The most common mechanism of fracture involved contact with another player (45.5%). Using linear regression, we found the proportion of all injuries that were fractures was inversely correlated with the athlete's age ($P = .02$) but was not correlated with the athletes' age- and gender-adjusted body mass index.

Conclusion—Fractures are a significant problem for high school athletes. Targeted preventive interventions should be implemented to reduce the burdens these injuries cause the athletes.

Keywords

surveillance; injury; high school RIO; reinjury

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Participation in US high school sports has risen steadily over the past 20 years with 7,628,377 participants in the 2009-10 academic year,¹⁴ representing 46% of the approximately 16.7 million high school students.²⁴ Sports-related injuries are a major source of morbidity for these athletes, with an estimated 2 million injuries occurring annually.¹⁵ Fractures, accounting for approximately 10% of all high school sports injuries, are a cause of school absence, costly diagnostic procedures and surgeries, and restricted physical activity and athletics participation.^{5, 9-11, 22}

As sports participation continues to increase in the United States, continued surveillance of rates and patterns of sports-related injury can contribute valuable information to prevention efforts and measure prevention effectiveness.²⁵ A prior study from the present authors assessed the epidemiology of fractures among US high school athletes from 2005-06 to 2008-09 in 9 sports: football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, wrestling, baseball, and softball.²² The National Collegiate Athletic Association (NCAA) has published information detailing fracture patterns among collegiate athletes in these and other sports,⁶ but high school athletes have been shown to have different injury patterns than do collegiate athletes.^{18, 27} Sports-related fracture data have been reported for girls' field hockey,^{13,16,28} girls' gymnastics,²¹ boys' ice hockey,²⁸ boys' and girls' lacrosse,^{7,8,28} and cheerleading,^{19,20} but these studies did not focus exclusively on fractures, were not limited to high school athletes, or were convenience samples from emergency department data with limited exposure information. The epidemiology of sports-related fractures among adolescents²⁶ and sports-related hand fractures³ has been described for a UK population, but these provided incidence data and did not include sports most commonly played in US high schools. One of the most detailed studies reporting the epidemiology of high school sports injuries was performed 10 years ago and was limited in geographic area.¹⁰

The objective was to describe the epidemiology of US high school sports-related fractures across a wide range of sports. We present rates and patterns of fractures from a convenience sample of US high schools for the 2008-09 to 2010-11 seasons for boys' football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, boys' wrestling, boys' baseball, girls' softball, girls' field hockey, girls' gymnastics, boys' ice hockey, boys' and girls' lacrosse, boys' and girls' swimming and diving, and boys' and girls' track and field, as well as 2009-10 to 2010-11 fracture data for boys' volleyball and cheerleading. We also provide national estimates of fractures for 9 sports from a randomized sample of US high schools. Our aims were to (1) describe rates of fractures by sport, (2) describe fracture patterns and severity, and (3) describe factors associated with fractures.

Materials and Methods

Data Collection

We collected data from the National High School Sports-Related Injury Surveillance System, High School RIO (Reporting Information Online), an Internet-based sports injury surveillance system. The surveillance study has been described previously^{4,17} In brief, high schools with 1 or more National Athletic Trainers' Association-affiliated certified athletic trainers (ATs) with valid e-mail addresses were invited to participate. Responding high schools were categorized into 8 strata based on school population (enrollment <1000 or >1000) and US census geographic region²³.

For the 9 sports included in the study since 2005-06 (football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, wrestling, baseball, and softball), 100 high schools were randomly chosen to participate (12 or 13 from each of the 8 strata). If a school dropped out of the study, a replacement from the same stratum was randomly selected to maintain the

100-school study population. Certified athletic trainers from participating high schools logged onto the study website weekly throughout the academic year to report injury incidence and athlete exposure information.

For the additional 11 sports added to the High School RIO study since 2008-09 (girls' field hockey, girls' gymnastics, boys' ice hockey, boys' and girls' lacrosse, boys' and girls' track and field, boys' and girls' swimming and diving, boys' volleyball, and cheerleading), not enough schools from the 8 strata volunteered to report for all sports, making it impossible to produce a randomly selected sample. Thus, exposure and injury data for these sports were collected from a convenience sample of US high schools. If an AT from a convenience sample school also reported information for athletes in 1 of the original 9 sports, these data were included in the overall convenience sample data but were not included in weighted national estimates.

Definition of Injury and Exposure

We defined athlete exposure (AE) as 1 athlete participating in 1 practice or competition. We defined a reportable injury as one that (1) occurred as a result of participation in an organized practice, competition, or performance; (2) required medical attention by an AT or physician; and (3) resulted in restriction of the athlete's participation for 1 or more days, although all fractures were reported, even if there was no time lost from sports participation. For each injury, ATs completed detailed injury reports on the injured athlete (age, height, weight, etc), the injury (site, diagnosis, severity, etc), and the injury event (activity, mechanism, etc). Throughout the study, reporters were able to view previously submitted information and update reports as needed.

Statistical Analysis

We analyzed our data using SPSS software, version 19.0 (SPSS Inc, an IBM Company, Chicago, Illinois). We calculated rates and rate comparisons using unweighted case counts for the combined original and convenience samples for all 20 sports. We calculated additional weighted analyses using national estimates from data reported by the 100 randomly selected high schools for the 9 original sports where the weights account for the total number of US schools and the number of participating study schools in each stratum. Linear regression was used to assess annual injury trends with *P* values <.05 considered statistically significant.

We calculated injury rates as the number of fractures per 10,000 AEs. We calculated injury rate ratios (RRs) and injury proportion ratios (IPRs) with *P* values and 95% confidence intervals (CIs). Confidence intervals not including 1.00 and *P* values <.05 were statistically significant. An RR or IPR >1.00 suggests increased risk, whereas an RR or IPR <1.00 suggests reduced risk. An example RR calculation is

$$RR = \frac{(\text{number competition fractures}/\text{number competition AEs})}{(\text{number practice fractures}/\text{number practice AEs})}$$

An example IPR calculation is

$$IPR = \frac{(\text{number football fractures}/\text{number total football injuries})}{(\text{number fractures in all other sports}/\text{number total injuries in all other sports})}$$

This study was approved by the Institutional Review Board at Nationwide Children's Hospital, Columbus, Ohio.

Results

Randomized Sample

During the 2008-09 to 2010-11 academic years, ATs from the original sample of schools reported 11,625 injuries during 5,640,505 AEs for an overall rate of 20.61 injuries per 10,000 AEs. Certified athletic trainers reported 1296 fractures representing 11.1% of the total injuries, with an overall rate of 2.30 per 10,000 AEs. An estimated 412,377 sport-related fractures occurred nationally in the 9 original sports. A significant increase in rates of competition-related football fractures occurred from 2008-09 to 2010-11 ($P = .009$), but no other significant trends were identified (Figure 1).

When comparing fracture rates for the 9 sports in the original random sample of schools and the combined original and convenience samples, rates did not differ significantly for competition, practice, or overall. Thus, only data from the combined convenience and original samples will be discussed from this point forward.

General

In the convenience sample of schools from 2008-09 to 2010-11, ATs reported 21,251 injuries during 11,544,455 AEs for an overall rate of 18.41 injuries per 10,000 AEs. The ATs reported 2103 fractures representing 9.9% of all injuries in the 20 sports, with an overall rate of 1.82 fractures per 10,000 AEs. Fracture rates were highest in football (4.37 per 10,000 AE), boys' ice hockey (3.08), and boys' lacrosse (2.59) and lowest in boys' and girls' track and field (0.22 and 0.32, respectively). No fractures were reported in boys' swimming and diving, 1 was reported in girls' swimming and diving, and 2 were reported in boys' volleyball (Table 1).

Boys sustained 79.1% of all fractures. Fracture rates were higher for boys than for girls in gender-comparable sports, including lacrosse (RR, 3.33; 95% CI, 2.03-5.47) and soccer (RR, 1.43; 95% CI, 1.11-1.83), but did not differ significantly in basketball, volleyball, track and field, swimming and diving, or boys' baseball and girls' softball.

The proportion of all injuries that were fractures was highest in boys' baseball (16.8%), girls' softball (13.6%), boys' ice hockey (12.9%), boys' lacrosse (11.7%), and boys' soccer (11.6%). The proportion of all injuries that were fractures was significantly higher for boys than for girls overall (IPR, 1.57; 95% CI, 1.42-1.74), in lacrosse (IPR, 2.38; 95% CI, 1.47-3.85), and in soccer (IPR, 1.81; 95% CI, 1.42-2.30) but did not differ significantly for boys' and girls' basketball (IPR, 1.26; 95% CI, 0.99-1.60), boys' baseball and girls' softball (IPR, 1.23; 95% CI, 0.94-1.61), boys' and girls' track and field (IPR, 0.91; 95% CI, 0.48-1.71), or boys' and girls' volleyball (IPR, 1.53; 95% CI, 0.39-6.11).

Exposure Type

Fractures were more likely to occur in competition than in practice for both boys (RR, 4.08; 95% CI, 3.70-4.49) and girls (RR, 3.51; 95% CI, 2.91-4.25). Fracture rates were significantly higher in competition than in practice in all sports except boys' volleyball, girls' gymnastics, girls' lacrosse, girls' track and field, and cheerleading (Table 1). Differences in fracture rates in competition and practice were greatest in boys' ice hockey (RR, 10.90; 95% CI, 5.72-20.78), girls' field hockey (RR, 8.98; 95% CI, 4.33-18.60), girls' soccer (RR, 6.54; 95% CI, 4.15-10.30), boys' soccer (RR, 6.32; 95% CI, 4.49-8.89), and football (RR, 5.94; 95% CI, 5.21-6.77). Overall fracture rates were greater in gender-comparable boys' than

girls' sports for competition (RR, 1.66; 95% CI, 1.39-1.97) and practice (RR, 1.24; 95% CI, 1.00-1.54).

Body Site

Overall, the most commonly fractured body sites were the hand/finger (32.1%), lower leg (10.1%), wrist (9.5%), clavicle (8.9%), and forearm (7.3%) (see the Appendix, available online at <http://ajs.sagepub.com/supplemental/>). The hand/finger was the most commonly fractured body site in 11 of the 20 sports, including football (35.7%), boys' soccer (20.5%), girls' volleyball (22.6%), boys' and girls' basketball (24.5%, 44.9%), wrestling (32.7%), baseball (35.6%), softball (58.5%), girls' field hockey (46.7%), and boys' and girls' lacrosse (27.3%, 36.8%). Other sports' most commonly fractured body sites included the foot in girls' track and field (30.0%), nose in cheerleading (25.9%), wrist in boys' ice hockey (25.0%) and boys' track and field (35.3%), lower leg in girls' soccer (18.4%), ankle in girls' volleyball (22.6%), and elbow, wrist, and foot in gymnastics (2 counts each of 9 total fractures). Both boys' volleyball fractures were to the lower leg; the single fracture in girls' swimming and diving was a lower spine fracture.

Outcomes

Overall, 17.2% of fractures required surgery, which was higher than for all other injuries combined (IPR, 3.14; 95% CI, 2.81-3.52). Of all fractures requiring surgery, most involved the hand/finger (22.0%), lower leg (15.7%), nose (13.1%), forearm (9.4%), and ankle (9.1%). Fractured body sites most often requiring surgery were the thigh/upper leg (58.8%), mouth/teeth (44.4%), nose (40.0%), head/face (34.9%), and knee (31.8%). Fractures accounted for 25.6% of all injuries requiring surgery, the second largest surgery-requiring diagnosis after ligament sprains.

There were nonsignificant differences between proportions of boys' and girls' fractures requiring surgery overall (17.1%, 17.5%; IPR, 0.98; 95% CI, 0.78-1.23), in soccer (17.6%, 26.0%; IPR, 0.68; 95% CI, 0.42-1.08), and in lacrosse (17.4%, 31.6%; IPR, 0.55; 95% CI, 0.25-1.24). There were few differences between other gender-comparable sports, including boys' and girls' basketball (16.2%, 12.4%; IPR, 1.31; 95% CI, 0.70-2.46), boys' baseball and girls' softball (17.0%, 15.0%; IPR, 1.13; 95% CI, 0.58-2.23), or boys' and girls' track and field (31.3%, 10.0%; IPR, 3.13; 95% CI, 0.70-14.0).

Compared with other injuries, a greater proportion of fractures resulted in >3 weeks lost from participation in athletics (IPR, 5.20; 95% CI, 4.76-5.67) or medical disqualification from participation (IPR, 4.14; 95% CI, 3.70-4.62). In gender-comparable sports, a greater proportion of fractures resulted in either >3 weeks lost from participation or medical disqualification in boys' versus girls' basketball (IPR, 1.53; 95% CI, 1.09-2.15).

Recurrent fractures, or a refracture of a previously fractured body site in either the same or previous academic year, represented 4.3% of all fractures. The proportion of fractures that were recurrent was not significantly different between boys' and girls' overall (IPR, 0.98; 95% CI, 0.60-1.61) or in gender-comparable sports. The proportion of fractures that were recurrent was significantly higher for girls' lacrosse than for all other sports (IPR, 3.75; 95% CI, 1.30-10.8). Overall, the proportion of fractures that were recurrent was significantly lower than the proportion of all other injuries that were recurrent (IPR, 0.37; 95% CI, 0.31-0.46).

Fractures accounted for a large proportion of all injuries requiring imaging, including plain radiographs (25.3%), magnetic resonance imaging (MRI) scans (7.1%), and computed tomography (CT) scans (5.6%). The ATs reported that 7.6% of fractures were imaged with MRI and 2.4% with CT scans.

Factors Associated with Fractures

The most common mechanism of fracture overall, contact with another player (45.5%), was the most common mechanism for 7 sports, including football (60.0%), boys' soccer (48.2%), girls' soccer (44.3%), girls' volleyball (38.7%), boys' basketball (47.3%), girls' basketball (37.4%), and boys' lacrosse (44.3%). Contact with a playing apparatus (eg, ball, stick) was the most common mechanism for boys' baseball (59.2%), girls' softball (76.5%), girls' field hockey (71.7%), girls' gymnastics (55.6%), and girls' lacrosse (42.1%). Fractures in boys' ice hockey most often occurred from contact with a player or the playing surface (35.8% each). Contact with the playing surface was the most common mechanism for boys' wrestling (55.4%), boys' track and field (58.8%), and cheerleading (40.7%). Overuse was the most common mechanism in girls' track and field (30.0%). The 2 boys' volleyball fractures resulted from contact with a person and contact with a playing apparatus, and the single girls' swimming and diving fracture was reported as an overuse injury. Overall, a higher proportion of boys' fractures resulted from contact with another person (IPR, 1.82; 95% CI, 1.55-2.13) or the playing surface (IPR, 1.40; 95% CI, 1.15-1.70), and a higher proportion of girls' fractures resulted from contact with a playing apparatus (IPR, 2.85; 95% CI, 2.41-3.38).

We evaluated the proportion of all injuries that were fractures by age, level of competition, and age- and gender-specific body mass index (BMI) category. The proportion of injuries that were fractures was significantly lower for varsity level of competition than for junior varsity, freshman, combined, or other levels (IPR, 0.71; 95% CI, 0.66-0.77). Overall, the proportion of all injuries that were fractures decreased with increasing athlete age ($P = .02$). We calculated the proportion of all injuries that were fractures by age for different levels of competition (freshman, junior varsity, varsity, combined) and age- and gender-based BMI category (<5th, 6th-25th, 26th-50th, 51st-85th, 86th-95th, >95th). For level of competition, the proportion of injuries that were fractures decreased with increasing age only at the junior varsity level ($P = .011$). For BMI category, the proportion of injuries that were fractures decreased in boys' sports with increasing age at the 25th to 50th ($P = .016$), 51st to 85th ($P = .004$), and 86th to 95th ($P = .002$) BMI percentiles, but there was no statistically significant association between the proportion of injuries that were fractures and age among girls.

Discussion

This study evaluated data captured by the National High School Sports-Related Injury Surveillance System for 20 different sports. Our findings highlight the fact that although the number of high school students participating in sports is steadily increasing, as is the number of sports-related injuries, so too are fractures. Fractures are a major source of financial, physical, and emotional strain on students and their families. Targeted prevention methods need to be instituted to reduce the numbers of sports-related fractures among US high school students.

Our findings were largely consistent with our previous report discussing US high school fractures from 2005-06 to 2008-09 in 9 sports for overall and sport-specific fracture rates by exposure type and sport.²² In the present study expanded to 20 sports, we found that fractures represent approximately 10% of all US high school sports-related injuries, which is consistent with prior reports in football,¹⁸ boys' and girls' lacrosse,⁸ and cheerleading,²⁰ but is slightly higher than a study of individual sports conducted more than a decade ago.¹⁵ Our finding that fracture rates are higher in competition than practice is consistent with reports of high school injuries in general¹⁰ but differs from a previously reported girls' lacrosse study that found injuries were more common in practice.⁸ Finally, we found fractures are one of the most severe injuries in terms of frequent need for surgical management and extensive

time lost from participation, which is consistent with previous reports.^{5,27} These findings illustrate the continued prevalence of fractures among US high school athletes despite studies citing their many harmful effects. Significant research has been devoted to developing prevention methods for reducing ligamentous knee injuries such as specialized training, conditioning, and education. Among high school students, injury mechanisms for fractures and ligament injuries are often the same because of the unique anatomic and physiologic features of skeletal immaturity in adolescents. Our study identified the most often fractured body sites and the most common mechanisms of fractures by sport, but additional, prospective studies of high school athletes could further identify risk factors of fractures that could lead to improved prevention methods.

We found that boys were more likely to sustain fractures than girls in both competition and practice in gender-comparable sports such as soccer. Although boys' and girls' lacrosse differ in rules, regulations, and required protective equipment, the proportion of fractures resulting from person-to-person contact and contact with an apparatus did not differ significantly for boys' and girls' lacrosse. Because girls' lacrosse is a noncontact sport, we expected to find a difference in the primary mechanisms of injury, but our results are consistent with another lacrosse study that reported high numbers of person-to-person contact injuries in girls' lacrosse.⁸ The high prevalence of person-to-person contact-related fractures should raise awareness among players, coaches, and officials about closer adherence to the rules of the game. Alternatively, additional requirements for protective equipment in girls' lacrosse such as helmets or arm protection could be introduced in an effort to reduce the incidence of fractures. Additional research could determine what, if any, protective equipment or rules changes would be most effective.

We investigated the relationship that age, BMI, and level of competition have on the proportion of injuries that were fractures. We found that increasing age was inversely correlated with the proportion of all injuries that were fractures for boys but that no such association existed for girls. In addition, increasing BMI was not associated with increased proportions of fractures for either boys or girls. A detailed study in North Carolina¹⁰ found no association between BMI and increased injury rates after adjusting for other risk factors but found that increasing age was also unrelated to overall risk of injury. A separate review of multiple sports reported that older, more experienced athletes are more likely to sustain injuries than younger athletes.¹² Much of the age-based patterns are likely due to persistently open growth plates and skeletal immaturity in adolescents,² and gender differences could be explained by earlier skeletal maturity among girls. However, nutritional deficiencies in young male athletes, which have been described as a source of injury among adolescent female athletes,¹ may also contribute to increased proportions of fractures in younger boys. The BMI data for uninjured athletes were not reported, which would have allowed us to calculate fracture risks for student athletes based on BMI. In addition, fractures were reported by body site, but reports did not include specific fracture types (eg, Wagstaff, triplane) or classification (eg, Salter-Harris), which could have helped in better understanding the changing fracture pattern with aging and skeletal maturation. Continued research should focus on the causes of fractures in these younger athletes to determine if nutritional supplementation could reduce fracture incidence.

Time and financial burdens that fractures place on athletes and their families are also important. Accurate diagnosis of fractures requires radiographic imaging and may necessitate advanced imaging such as MRIs and CT scans to further delineate fracture patterns or evaluate questionably negative radiographs. Although reinjury rates were lower for fractures than for other injuries, adequate healing time must be allowed to prevent recurrent fractures during the recovery period when students want to participate in sports and enjoy the benefits of an active lifestyle. Studies have also reported that academic

performance and school attendance may be negatively affected by casts and other postinjury management options.⁹ Specifically, the high prevalence of hand and finger fractures among high school athletes identified in this study may restrict school- or work-related activities that involve writing or typing. Future studies should continue to evaluate students who sustain fractures to determine the effect of fracture management on subsequent sports participation as well as school performance.

As with all studies, ours had limitations. We limited our sample to high schools with ATs, which restricted our population. However, this ensured that a medically trained professional documented injuries, thus increasing the data quality and consistency. In addition, because athlete exposures were unit based rather than time based, we were unable to report injury rates by minute or hour of practice and competition. However, this limitation was necessary to reduce reporter burden. Finally, the convenience sample of high schools did not allow us to provide national estimates for fractures and fracture patterns in all 20 sports. Despite these limitations, this study remains one of the largest nationwide epidemiologic studies describing fractures in US high school athletes. Such national data are essential to guide fracture prevention strategies.

Conclusion

Participation in high school sports will likely continue to increase in the United States. The number of fractures sustained by high school athletes will likely also increase unless underlying risk factors are better controlled. Consequences of fractures include expensive surgeries, diagnostic testing, and restricted sports participation, which can severely affect adolescent athletes and their families. Decisions regarding the time to return to play must balance benefit of sports participation with risk of reinjury. Targeted, sport-specific changes such as rule changes or additional required protective equipment in girls' lacrosse may yield immediate results in fracture rate reduction. Our findings underscore the need for the development, implementation, and evaluation of targeted, evidence-based fracture prevention programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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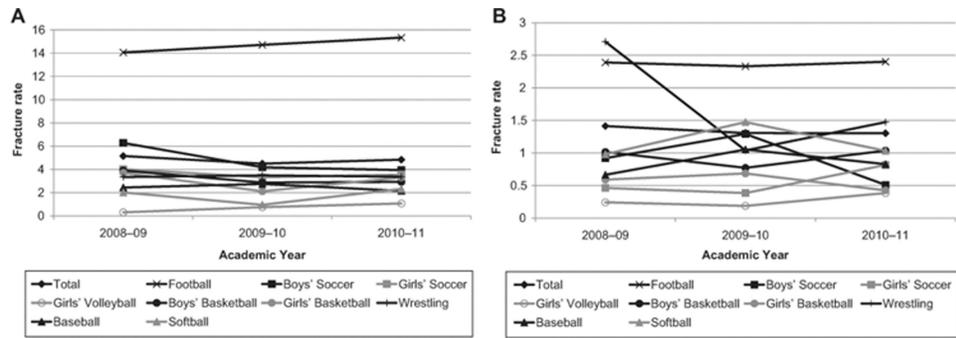


Figure 1. Rates of competition-related fractures (A) and practice-related fractures (B) per 10,000 athlete exposures by sport, High School Sports-Related Injury Surveillance Study, United States, 2008-09 to 2010-11.

Table 1
Total Number of Fractures and Rates of Fractures per 10,000 Athlete Exposures by Sport and Type of Exposure, High School Sports-Related Injury Surveillance Study, United States, 2008-09 to 2010-11^a

	Rates per 10,000 Athlete Exposures					RR (95% CI) ^b
	Count	Total	Competition	Practice	Performance	
Total	2103	1.82	4.05	1.06	0.58	3.82 (3.51-4.17)
Boys	1663	2.40	5.59	1.37		4.08 (3.70-4.49)
Girls	440	0.95	1.98	0.56	0.58	3.51 (2.91-4.25)
Football	902	4.37	14.17	2.39		5.94 (5.21-6.77)
Soccer						
Boys	167	2.01	4.89	0.77		6.32 (4.49-8.89)
Girls	98	1.41	3.40	0.52		6.54 (4.15-10.30)
Volleyball						
Boys ^c	2	0.57	0.84	0.43		1.98 (0.12-31.63)
Girls	31	0.44	0.67	0.32		2.09 (1.03-4.22)
Basketball						
Boys	147	1.57	3.15	0.90		3.51 (2.53-4.89)
Girls	107	1.42	2.90	0.76		3.81 (2.57-5.63)
Wrestling	168	2.32	3.34	1.96		1.70 (1.25-2.33)
Baseball	104	1.47	2.58	0.88		2.91 (1.97-4.32)
Softball	82	1.53	2.16	1.21		1.79 (1.16-2.75)
Girls' field hockey	46	1.44	3.68	0.41		8.98 (4.33-18.60)
Girls' gymnastics	9	1.46	2.55	1.21		2.12 (0.53-8.46)
Boys' ice hockey	68	3.08	8.00	0.73		10.90 (5.72-20.78)
Lacrosse						
Boys	88	2.59	4.98	1.53		3.26 (2.13-4.99)
Girls	19	0.78	0.93	0.71		1.32 (0.52-3.35)
Swimming/diving						
Boys ^d	0	0.00	0.00	0.00		
Girls ^d	1	0.03	0.00	0.04		

	Rates per 10,000 Athlete Exposures					RR (95% CI) ^b
	Count	Total	Competition	Practice	Performance	
Track and field						
Boys	17	0.22	0.62	0.13		4.91 (1.90-12.73)
Girls	20	0.32	0.51	0.28		1.85 (0.71-4.81)
Cheerleading ^c	27	0.73	0.68	0.78	0.58	0.79 (0.32-1.96) ^e

^aCI, confidence interval; RR, rate ratio.

^bCompares the rates of fracture during competition with the rates of fracture during practice.

^cData for boys' volleyball and cheerleading were collected from 2009-10 to 2010-11.

^dRate ratios could not be calculated because there were no competition fractures.

^e"Performance" fractures were combined with "Competition" for cheerleading RR.