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## EPIDEMIOLOGY OF US HIGH SCHOOL SPORTS-RELATED LIGAMENTOUS ANKLE INJURIES, 2005/06-2010/11

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### Abstract

**Objective**—Describe ankle injury epidemiology among US high school athletes in 20 sports.

**Design**—Descriptive prospective epidemiology study.

**Setting**—Sports injury data for the 2005/06–2010/11 academic years were collected using an internet-based injury surveillance system, Reporting Information Online (RIO).

**Participants**—A nationwide convenience sample of US high schools.

**Assessment of Risk Factors**—Injuries sustained as a function of sport and gender.

**Main Outcome Measures**—Ankle sprain rates and patterns, outcomes, and mechanisms.

**Results**—From 2005/06–2010/11, certified athletic trainers reported 5,373 ankle sprains in 17,172,376 athlete exposures [AEs], for a rate of 3.13 ankle sprains per 10,000 AEs. Rates were higher for girls than boys (RR 1.25, 95% CI 1.17–1.34) in gender-comparable sports and higher in competition than practice for boys (RR 3.42, 95% CI 3.20–3.66) and girls (RR 2.71, 95% CI 2.48–2.95). The anterior talofibular ligament was most commonly injured (involved in 85.3% of sprains). Overall, 49.7% of sprains resulted in loss of participation from 1–6 days. While 0.5% of all ankle sprains required surgery, 6.6% of those involving the deltoid ligament required surgery. Athletes were wearing ankle braces in 10.6% of all sprains. The most common injury mechanism was contact with another person (42.4% of all ankle sprains).

**Conclusions**—Ankle sprains are a serious problem in high school sports, with high rates of recurrent injury and loss of participation from sport.

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## Keywords

epidemiology; ankle; sprain; high school; sports

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## INTRODUCTION

Participation in high school athletics has increased annually for 30 years, with 7,667,955 students participating during the 2010–2011 academic year.<sup>1</sup> This represents 46% of the 16.6 million US high school students.<sup>2</sup> Participation in athletics benefits students both physically and academically.<sup>3</sup> However, injuries are a major concern as both initial and recurrent injuries can have long-term impacts on the student's ability to participate in physical activities. One of the most commonly injured body sites in sports is the ankle.<sup>4-9</sup> This is also true for high school sports.<sup>10-12</sup> Sprains account for the majority of all ankle injuries.<sup>5</sup> Ankle sprains impose significant financial costs on injured students and their families,<sup>13</sup> restrict athletes from sports participation,<sup>10</sup> and can result in permanent long-term sequelae.<sup>14</sup>

Few epidemiologic studies, however, report detailed specific ligamentous ankle injury rates and patterns in high school sports. One of the most detailed high school studies was conducted over 10 years ago among a state-wide population, and thus may not reflect current national injury patterns.<sup>15</sup> Others reported general injury patterns in specific sports without providing details about ligamentous ankle injuries.<sup>16,17</sup> A recent US ankle sprain epidemiological study showed half of all sprains occurred during athletics and that ankle sprain rates in high-school aged children were among the highest in the country.<sup>18</sup> Continued injury pattern surveillance, necessary to assess prevention and rehabilitation effectiveness, is integral to the overall injury-prevention process.<sup>19</sup>

Our objective was to describe the epidemiology of US high school sports-related ligamentous ankle injuries. We provide rates and patterns of ligamentous ankle injuries with national estimates in 9 sports (football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, wrestling, baseball, and softball) for the 2005/06–2010/11 academic years.

Additionally, we provide rates and patterns from a convenience sample of US high schools for the 2008/09–2010/11 seasons for another 9 sports (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 2009/10–2010/11 data for boys' volleyball and cheerleading. Our aims were to (1) describe ligamentous ankle injury rates by sport, (2) describe ankle injury patterns by specific ligaments, and (3) describe factors associated with ligamentous ankle injuries.

## MATERIALS AND METHODS

### DATA COLLECTION

We collected data using the National High School Sports-Related Injury Surveillance System, High School RIO™ (Reporting Information Online), an Internet-based sports injury surveillance system described previously.<sup>10,20</sup> In brief, high schools with one or more

National Athletic Trainers' Association-affiliated certified athletic trainers (ATs) with valid email addresses were invited to participate. Interested high schools were categorized into eight strata based on school population (enrollment  $\leq 1000$ , or  $> 1000$ ) and US Census geographic region.<sup>21</sup> For the 9 sports originally included in the High School RIO study (football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, wrestling, baseball, and softball), 100 high schools were randomly selected 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. ATs logged onto the High School RIO™ 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 (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 each of the 8 strata offer all sports. Thus, exposure and injury data for these sports were collected from a convenience sample of US high schools with ATs. If an AT from a convenience sample school also reported information for athletes in one of the original 9 sports, these data were included in the overall convenience sample dataset but were not included in weighted national estimates.

## STUDY DEFINITIONS

We defined athlete exposure (AE) as one athlete participating in one practice or competition. A reportable injury (1) occurred as a result of participation in organized practice, competition, or performance (cheerleading only), (2) required medical attention by an AT or physician, and (3) resulted in restriction of the athlete's participation for one or more days. For each injury, ATs completed detailed weekly online injury reports on the injured athlete (age, height, weight, etc.), injury (site, diagnosis, severity, etc.), and injury event (activity, mechanism, etc.). Throughout the study, reporters could view previously submitted information and update reports as needed.

## STATISTICAL ANALYSIS

We analyzed our data using SPSS software, version 19.0 (SPSS, Chicago, IL), calculating rates and rate comparisons using unweighted case counts for the convenience sample of all 20 sports. We calculated weighted analyses using national estimates from data reported by the 100 randomly selected high schools for the 9 original sports. Weighting factors are based on the inverse probability of selection into the study (based on school size and location). Simple linear regression was used to assess annual injury trends with  $p$ -values  $< 0.05$  considered statistically significant.

We calculated injury rates as the number of ankle sprains per 10,000 AE. We calculated injury rate ratios (RR) and injury proportion ratios (IPR) with  $p$ -values and 95% confidence intervals (CI). We considered CI not including 1.00 and  $p$ -values  $< 0.05$  statistically significant. An RR or IPR  $> 1.00$  suggests a risk association while an RR or IPR  $< 1.00$  suggests a protective association. We calculated RRs as follows:

$$RR = \frac{(\# \text{ competition ankle sprains} / \# \text{ competition AE})}{(\# \text{ practice ankle sprains} / \# \text{ practice AE})}$$

We calculated IPRs as follows:

$$IPR = \frac{(\# \text{ deltoid ligament injuries requiring surgery} / \# \text{ deltoid ligament injuries})}{(\# \text{ all other ankle ligament injuries requiring surgery} / \# \text{ all other ankle ligament injuries})}$$

This study was approved by the Institutional Review Board at (name blinded for review).

## RESULTS

### GENERAL

During 2005/06–2010/11, ATs from the original sample of schools reported 7,807 ligament sprains (30.5% of all injuries) of which 4,108 were ankle sprains (52.6% of all sprains), accounting for 16.0% of all injuries with a rate of 3.65 ankle sprains per 10,000 AEs. An estimated 1,370,545 ankle sprains occurred nationally in these 9 sports from 2005/06–2010/11, representing 16.7% of all injuries. In order to more broadly describe ankle injuries in a larger number of US high school sports, only data from the combined convenience and original samples will be discussed from this point forward.

During 2005/06–2010/11, ATs from the combined original and convenience samples reported 5,373 ankle sprains (88.9% of ankle injuries) in 17,172,376 AEs for an overall rate of 3.13 ankle sprains per 10,000 AEs, representing 15.3% of all injuries. Boys had a rate of 3.14 ankle sprains per 10,000 AEs and girls 3.11 per 10,000 AE, although in gender-comparable sports (soccer, volleyball, basketball, baseball/softball, lacrosse, swimming & diving, track & field), ankle sprain rates were higher for girls (RR 1.25, 95% CI 1.17–1.34). Sports with the highest rates were boys' basketball (5.16 ankle sprains per 10,000 AEs), girls' basketball (5.03), and girls' gymnastics (4.88) (Table 1). Girls were significantly more likely to sustain ankle sprains than boys in soccer (RR 1.46, 95% CI 1.29–1.66), softball/baseball (RR 1.65, 95% CI 1.29–2.12), and track and field (RR 2.18, 95% CI 1.44–3.31). No evidence of a difference existed in volleyball (RR 0.92, 95% CI 0.55–1.54), basketball (RR 0.98, 95% CI 0.88–1.08), or lacrosse (RR 1.10, 95% CI 0.78–1.54).

Ankle sprain trends over time were assessed using simple linear regression (Figure 1). Ankle sprain rates decreased significantly in boys' football ( $p = 0.006$ ), boys' wrestling ( $p = 0.005$ ), and girls' volleyball ( $p = 0.015$ ). Gender-comparable sports showed more significant decreases in rates for boys than girls in soccer ( $p = 0.028$  vs. 0.33), basketball ( $p = 0.041$  vs. 0.13), and baseball/softball ( $p = 0.051$  vs. 0.96).

### EXPOSURE TYPE

Overall, ankle sprain rates were higher in competition than practice for boys' (RR 3.42, 95% CI 3.20–3.66) and girls' (RR 2.71, 95% CI 2.48–2.95) sports (Table 1). Only boys' and girls' volleyball, boys' track and field, and cheerleading had no differences between competition and practice rates. The highest competition rates were in boys' football (15.01 ankle sprains per 10,000 competition AEs), girls' basketball (9.45), girls' soccer (9.41), and

girls' gymnastics (9.36). Practice rates were highest in boys' volleyball (3.83 per 10,000 AEs), girls' gymnastics (3.82), girls' volleyball (3.79), and boys' and girls' basketball (3.79 and 3.13, respectively).

### **SPECIFIC STRUCTURES INVOLVED**

Beginning in 2007/08, ATs could record specific ligamentous structures injured in ankle sprains even if "ligament sprain" was not the primary diagnosis. This allowed ATs to simultaneously report more serious injuries while also recording ligamentous involvement and applied to 473 injuries, most of which were fractures ( $n = 175$ ) or tendon injuries ( $n = 132$ ). These injuries will be included in this section only.

Anatomic structures involved in ankle sprains included the anterior talofibular ligament (ATFL) (3,326 total reported; involved in 85.3% of sprains), calcaneofibular ligament (CFL) (1,347; 34.5%), anterior inferior tibiofibular ligament (AITFL) (1,031, 26.4%), posterior talofibular ligament (PTFL) (478, 12.3%), deltoid ligament (212, 5.4%), and posterior inferior tibiofibular ligament (PITFL) (159, 4.1%) (Figure 2). The most common ligament injury patterns were an isolated ATFL (39.9% of all ankle sprains), ATFL + CFL (19.1%), ATFL + AITFL (9.2%), isolated AITFL (6.0%), ATFL + PTFL + CFL (4.4%), and ATFL + AITFL + CFL (4.1%). Isolated deltoid ligament injuries represented 2.6% of all ankle sprains. Additionally, 9.4% of all injuries involving the deltoid ligament and 6.9% of isolated deltoid ligament injuries had an associated fracture, compared to 1.7% of non-deltoid ligament injuries involving a fracture (IPR 5.61, 95% CI 3.45–9.11).

Diagnostic modalities used to identify injured structures reported in 5,348 ankle sprains (99.4%) were most commonly physical examination exclusively (64.6%) and physical examination with X-ray (28.0%). MRI was used in 112 cases (2.1% of all ankle sprains).

### **SURGERY AND TIME LOST FROM PARTICIPATION**

The most common outcome following ankle sprain was time lost from participation for 1–6 days (49.7% of all ankle sprains for which outcomes were reported) or 1–3 weeks (40.8%). Injuries involving multiple ligaments resulted in more time lost compared to all other injury patterns. Specifically, 15.7% of ATFL + PTFL + CFL sprains and 14.5% of ATFL + AITFL + CFL resulted in loss of participation for greater than 3 weeks, which was higher than all other injury patterns combined (IPR 2.89, 95% CI 1.97–4.24 and IPR 2.63, 95% CI 1.76–3.93, respectively). Recurrent ankle sprain outcomes (recurrence of a previously sprained ankle in the same or a previous academic year) did not differ significantly from primary ankle sprains.

Only 0.5% of ankle sprains were treated surgically. Recurrent ankle sprains (1.1%) were more likely than primary injuries (0.4%) to require surgery (IPR 2.69, 95% CI 1.21–5.96). Additionally, 6.6% of all ankle sprains involving the deltoid ligament required surgery, higher than patterns not involving the deltoid ligament (IPR 8.30, 95% CI 4.45–15.46). This trend persisted when controlling for associated fracture (fracture present IPR 3.05, 95% CI 1.49–6.24; fracture absent IPR 3.93, 95% CI 1.35–11.43).

## FACTORS ASSOCIATED WITH ANKLE SPRAIN

Recurrent ankle sprains accounted for 15.7% of all ankle sprains. Sports with the highest proportion of recurrent ankle sprains were cheerleading (20.8%), boys' basketball (20.1%), and girls' gymnastics (20.0%). There were no significant differences in the proportion of ankle sprains that were recurrent between boys and girls in gender-comparable sports.

ATs reported whether students were wearing braces at the time of injury and type of brace for 2,995 (55.7%) ankle sprains. Athletes were wearing braces when 317 ankle sprains occurred (10.6% of ankle sprains), but brace use varied by sport. Braces worn at the time of injury included lace up (75.4% of all braces worn at the time of injury), rigid frame (14.1%), and neoprene sleeves (8.6%). The proportions of ankle sprains that occurred while the athlete was wearing a brace were highest in girls' volleyball (19.1%), boys' basketball (17.1%), girls' basketball (15.3%), boys' football (11.7%), and girls' gymnastics (10.0%). Sports with overall ankle sprain rates >2.0 per 10,000 AEs with low ankle brace use at the time of injury include girls' soccer (5.7% of ankle sprains occurred with brace use), boys' soccer (4.5%), girls' lacrosse (0.0%), and boys' volleyball (0.0%). The proportion of sprains that occurred with and without brace use did not differ significantly between boys and girls in gender comparable sports.

Primary injury mechanisms for ankle sprains included contact with another person (42.4% of all ankle sprains), contact with the playing surface (26.7%), and non-contact (25.5%) (Table 2). Contact with another person was the most common mechanism in 9 sports including boys' ice hockey (60.0%), boys' basketball (52.8%), boys' football (50.9%), boys' volleyball (46.7%), girls' basketball (44.6%), girls' volleyball (41.9%), girls' soccer (39.8%), boys' soccer (36.9%), and boys' wrestling (36.6%). Contact with playing surface was the most common mechanism for cheerleading (68%), girls' gymnastics (66.7%), and girls' track and field (55.7%). Non-contact mechanisms were most common for boys' lacrosse (51.4%), boys' track and field (51.4%), girls' lacrosse (50.0%), and girls' field hockey (44.6%).

## DISCUSSION

High school athletes sustain millions of injuries annually, imposing substantial burdens to athletes and their families. The most common single injury is ankle sprain, accounting for 16% of all high school sports-related injuries. Although most do not require expensive diagnostic modalities or surgical interventions compared to injuries like fractures and knee injuries, the large number of ankle sprains demonstrates the need for targeted injury prevention measures. To our knowledge, this is the largest, most nationally representative epidemiological study of ankle sprains among US high school athletes. Thus it provides a valuable resource for those working to prevent ankle injuries. Efforts need to be directed at preventing injury (primary prevention) and reducing recurrence and severity in previously injured athletes (secondary and tertiary prevention).

To our knowledge, we are the first to report ankle sprain patterns by specific anatomic structure among US high school athletes. A study of elite soccer players in England<sup>7</sup> found ATFL involvement in 73% of ankle sprains, which is higher than we found for boys' soccer

(52.5%, data not shown) but lower than ATFL involvement across all sports (85.3%). Differences in injury rates and patterns may reflect training level (high school vs. professional) or physical differences between younger and older athletes. Although we could not compare injury rates because of rate reporting differences, if athletic training programs contribute to lower injury rates and different injury patterns, perhaps age-appropriate training principles and techniques could benefit high school athletes.

We found that ankle sprain rates have decreased over time. Additionally, the overall ankle sprain rates for boys and girls did not differ significantly. Rates were higher for girls in some gender-comparable sports (soccer, baseball/softball, and track and field) but not others (volleyball, basketball, and lacrosse). Although boys' and girls' lacrosse rules differ dramatically by required protective equipment and allowed player-player contact, the mechanics of player-ground contact (running, pivoting, and stopping) are similar. Some studies have reported higher ankle injury rates among female lacrosse players<sup>22</sup> while others found no difference,<sup>10</sup> and a study in the US Military Academy found higher ankle sprain risks in women.<sup>9</sup> ACL injury studies indicate higher injury rates among girls than boys.<sup>23-25</sup> Factors responsible for gender-based ACL injury pattern differences (including hormones, muscle strength, training, and gender-specific equipment) may also contribute to ankle sprain pattern differences. Modifiable risk factors should continue to be investigated and targeted with preventive efforts.

External support devices have been discussed at length in the literature, with no current "best practice" recommended.<sup>4</sup> Over the six-year study period, braces were being worn when 10.6% of ankle sprains occurred but patterns varied widely by sport. Some studies suggest ankle bracing and taping are effective at preventing ankle sprains,<sup>26-28</sup> while others found no effect or increased risks with brace use.<sup>29,30</sup> Although a collegiate athletics study suggested that external support devices should be widely implemented to select group of players at high ankle injury risk,<sup>4</sup> a meta-analysis found ankle supporting-devices including taping, semi-rigid braces, and lace-up braces have minimal effects on non-elite athletes.<sup>31</sup> Large-scale trials evaluating brace efficacy, specifically effectiveness across sports, body-mass-index [BMI] categories, and athletes with and without prior ankle injury are needed to determine the appropriate role of bracing in ankle sprain prevention efforts.

We found 15.7% of all ankle sprains were recurrent, with most recurrent ankle sprains in sports involving frequent jumping and landing including cheerleading, gymnastics, and basketball. Prior injury has been identified as a strong risk factor for future ankle sprain,<sup>15,22,32</sup> underscoring the need for adequate rehabilitation and post-injury protection to speed the healing process and minimize risks of reinjury. Though recurrent injuries may benefit more from therapy than new injuries, all students who sustain an ankle sprain should be encouraged to participate in post-injury physical therapy or other training programs such as balance boards, which have been shown to have beneficial effects in reducing ankle sprain risk.<sup>30,33,34</sup> One study even recommended that ankle stabilizers should be used for 12 months after ankle sprain because of the high reinjury risk.<sup>35</sup> Potential barriers to students' participation in therapy such as time, financial, or other concerns should be evaluated in further investigations.

As with all studies, ours had limitations. We limited our sample to high schools with ATs which restricted our population. However, this ensured a medically-trained professional documented injuries thus increasing quality and consistency of our data. Additionally, because athlete exposures were unit- rather than time-based, we could not report participation/exposure 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 ankle injury patterns in all 20 sports. Despite these limitations, this study is the largest nationwide epidemiologic description of ligamentous ankle injuries among US high school athletes.

## CONCLUSION

We believe that participation in high school sports will likely continue to increase in the US. Ankle sprains, one of the most prevalent injuries among US high school athletes, impose substantial time and financial burdens on athletes, families, and the healthcare system. In many gender-comparable sports, girls sustained ankle sprains at higher rates than boys. Recurrent ankle sprains accounted for a large percentage of all ankle sprains, and sprains involving the deltoid ligament more often were treated with surgery than ankle sprains involving other structures. It is important that primary, secondary, and tertiary prevention methods be developed to reduce the incidence and severity of ankle sprains in US high school athletes.

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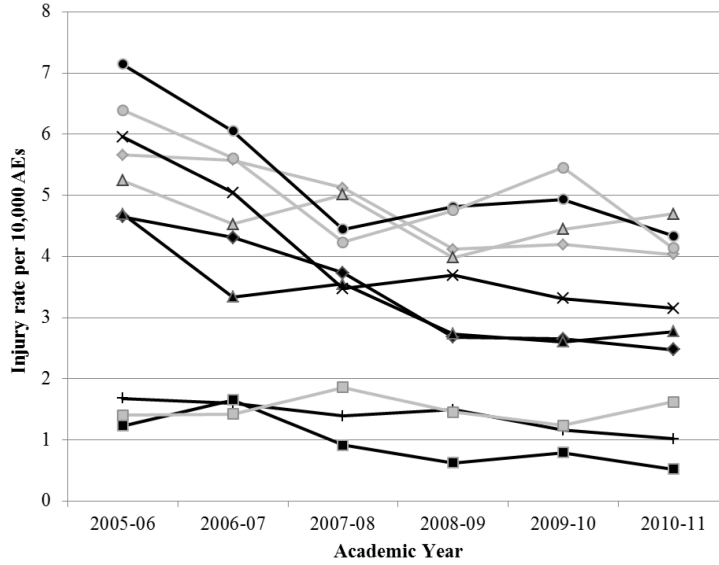
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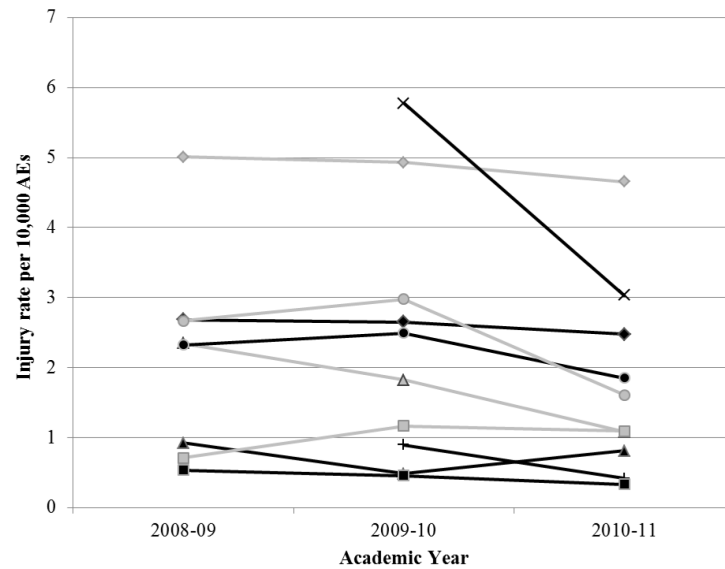
**FIGURE 1A.** Rates of ankle sprains per 10,000 athlete exposures by sport in 9 sports, High School Sports-Related Injury Surveillance Study, United States, 2005/06–2010/11. *a,b,c*

- ◆ Total
- ♦ Football
- ▲ Boys' Soccer
- △ Girls' Soccer
- × Girls' Volleyball
- Boys' Basketball
- Girls' Basketball
- + Wrestling
- Baseball
- Softball

*a*Reflects rates for combined original and convenience samples.

*b*“Total,” is the total rate for combined original and convenience sample data for only the original 9 sports.

*c*Significant trends (see text): Total ( $p = 0.002$ ), boys' football ( $p = 0.006$ ), boys' soccer ( $p = 0.028$ ), boys' wrestling ( $p = 0.005$ ), and girls' volleyball ( $p = 0.015$ ), and boys' basketball ( $p = 0.041$ )



**FIGURE 1B.**

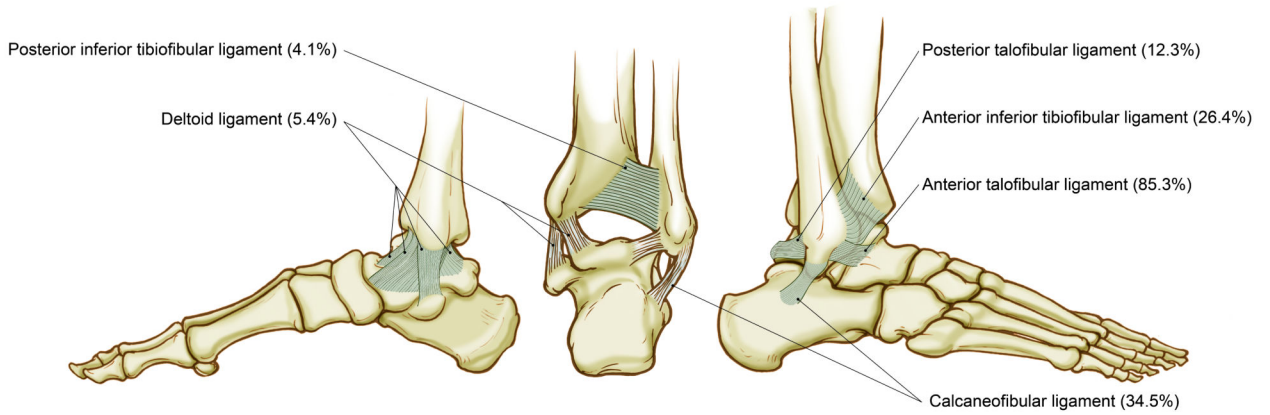
Rates of ankle sprains per 10,000 athlete exposures by sport, High School Sports-Related Injury Surveillance Study, United States, 2005/06–2010/11.<sup>a,b,c</sup>

- ◆ Total
- ▲ Boys' Ice Hockey
- ▲ Girls' Field Hockey
- × Boys' Volleyball
- Boys' Lacrosse
- Girls' Lacrosse
- Boys' Track and Field
- Girls' Track and Field
- ◆ Girls' Gymnastics + Cheerleading

<sup>a</sup>Boys' and girls' swimming and diving not included because only 2 girls' swimming and diving ankle sprains were recorded.

<sup>b</sup>"Total" is the rate for combined original and convenience sample data for all 20 sports.

<sup>c</sup>None of these trends were significant at  $p = 0.05$ .

**FIGURE 2.**

Specific ligamentous structures involved in ankle sprains among US high school athletes shown in medial (left), posterior (middle) and lateral (right) views, High School Sports-Related Injury Surveillance Study, United States, 2005/06–2010/11.<sup>a,b</sup>

<sup>a</sup>Percentages represent the proportion of all ankle sprains involving the indicated ligament.

<sup>b</sup>Anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), anterior inferior tibiofibular ligament (AITFL), posterior talofibular ligament (PTFL), posterior inferior tibiofibular ligament (PITFL)

TABLE 1

Total number of ankle sprains and rates of ankle sprain per 10,000 athlete exposures by sport and type of exposure, High School Sports-Related Injury Surveillance Study, United States, 2005/06–2010/11.<sup>a</sup>

|                                  | Count | Rates |             |          |             | RR (95% CI) <sup>b</sup>      |
|----------------------------------|-------|-------|-------------|----------|-------------|-------------------------------|
|                                  |       | Total | Competition | Practice | Performance |                               |
| Total                            | 5373  | 3.13  | 6.30        | 2.02     | 0.44        | 3.13 (2.96–3.30)              |
| Boys                             | 3348  | 3.14  | 6.73        | 1.97     |             | 3.42 (3.20–3.66)              |
| Girls                            | 2025  | 3.11  | 5.69        | 2.10     | 0.44        | 2.71 (2.48–2.95)              |
| Football                         | 1667  | 4.67  | 15.01       | 2.55     |             | 5.88 (5.34–6.48)              |
| Soccer                           |       |       |             |          |             |                               |
| Boys                             | 429   | 3.14  | 6.31        | 1.78     |             | 3.55 (2.92–4.30)              |
| Girls                            | 538   | 4.59  | 9.41        | 2.48     |             | 3.80 (3.19–4.52)              |
| Volleyball                       |       |       |             |          |             |                               |
| Boys <sup>c</sup>                | 15    | 4.24  | 5.05        | 3.83     |             | 1.32 (0.47–3.70)              |
| Girls                            | 452   | 3.90  | 4.10        | 3.79     |             | 1.08 (0.89–1.31)              |
| Basketball                       |       |       |             |          |             |                               |
| Boys                             | 831   | 5.16  | 8.42        | 3.79     |             | 2.22 (1.94–2.55)              |
| Girls                            | 660   | 5.03  | 9.45        | 3.13     |             | 3.02 (2.59–3.52)              |
| Wrestling                        | 167   | 1.36  | 2.02        | 1.13     |             | 1.78 (1.30–2.43)              |
| Baseball                         | 112   | 0.91  | 1.57        | 0.55     |             | 2.86 (1.96–4.18)              |
| Softball                         | 140   | 1.50  | 2.74        | 0.85     |             | 3.24 (2.30–4.56)              |
| Girls' field hockey <sup>d</sup> | 57    | 1.78  | 2.89        | 1.28     |             | 2.26 (1.35–3.80)              |
| Girls' gymnastics <sup>d</sup>   | 30    | 4.88  | 9.36        | 3.82     |             | 2.45 (1.17–5.15)              |
| Boys' ice hockey <sup>d</sup>    | 16    | 0.72  | 1.40        | 0.40     |             | 3.51 (1.27–9.64)              |
| Lacrosse <sup>d</sup>            |       |       |             |          |             |                               |
| Boys                             | 76    | 2.24  | 4.22        | 1.36     |             | 3.11 (1.97–4.90)              |
| Girls                            | 60    | 2.45  | 4.40        | 1.59     |             | 2.76 (1.66–4.59)              |
| Swimming and diving <sup>d</sup> |       |       |             |          |             |                               |
| Boys                             | 0     | 0.00  | 0.00        | 0.00     |             | N-A <sup>e</sup>              |
| Girls                            | 2     | 0.06  | 0.00        | 0.08     |             | N-A <sup>e</sup>              |
| Track and field <sup>d</sup>     |       |       |             |          |             |                               |
| Boys                             | 35    | 0.45  | 0.48        | 0.44     |             | 1.09 (0.48–2.50)              |
| Girls                            | 61    | 0.98  | 1.96        | 0.75     |             | 2.61 (1.55–4.38)              |
| Cheerleading <sup>c</sup>        | 25    | 0.68  | 1.71        | 0.63     | 0.44        | 1.30 (0.56–3.01) <sup>f</sup> |

<sup>a</sup>RR, rate ratio; CI, confidence interval

<sup>b</sup>Compares the ankle sprain rates during competition to rates during practice.

<sup>c</sup>Data collected from 2009/10–2010/11.

<sup>d</sup>Data collected from 2008/09–2010/11.

<sup>e</sup>Rate ratios could not be calculated because there were no competition ankle sprains.

<sup>f</sup>“Performance” ankle sprains were combined with “Competition” for RR.

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TABLE 2

Primary injury mechanisms for ankle sprains for 18 sports by percentages of all ankle sprains, High School Sports-Related Injury Surveillance Study, United States, 2005/06–2010/11<sup>a</sup>

|                                  | Contact with another person | Contact with playing surface | Contact with playing apparatus | No contact | Other <sup>b</sup> | Total <sup>c</sup> |
|----------------------------------|-----------------------------|------------------------------|--------------------------------|------------|--------------------|--------------------|
| Total                            | 42.4                        | 26.7                         | 4.0                            | 25.5       | 1.4                | 100                |
| Boys                             | 46.3                        | 24.5                         | 2.7                            | 25.2       | 1.3                | 100                |
| Girls                            | 36.0                        | 30.2                         | 6.2                            | 26.0       | 1.5                | 100                |
| Football                         | 50.9                        | 22.0                         | 0.5                            | 25.1       | 1.4                | 100                |
| Soccer                           |                             |                              |                                |            |                    |                    |
| Boys                             | 36.9                        | 29.6                         | 8.2                            | 24.6       | 0.7                | 100                |
| Girls                            | 39.8                        | 23.4                         | 8.2                            | 27.3       | 1.3                | 100                |
| Volleyball                       |                             |                              |                                |            |                    |                    |
| Boys <sup>d</sup>                | 46.7                        | 40.0                         | 0.0                            | 13.3       | 0.0                | 100                |
| Girls                            | 41.9                        | 32.5                         | 3.1                            | 21.1       | 1.3                | 100                |
| Basketball                       |                             |                              |                                |            |                    |                    |
| Boys                             | 52.8                        | 24.7                         | 0.2                            | 21.4       | 0.8                | 100                |
| Girls                            | 44.6                        | 26.0                         | 0.9                            | 27.1       | 1.4                | 100                |
| Wrestling                        | 36.6                        | 29.2                         | 0.0                            | 32.9       | 1.2                | 100                |
| Baseball                         | 8.0                         | 33.0                         | 34.8                           | 21.4       | 2.7                | 100                |
| Softball                         | 8.6                         | 42.9                         | 32.9                           | 14.3       | 1.4                | 100                |
| Girls' field hockey <sup>e</sup> | 12.5                        | 28.6                         | 10.7                           | 44.6       | 3.6                | 100                |
| Girls' gymnastics <sup>e</sup>   | 0.0                         | 66.7                         | 6.7                            | 26.7       | 0.0                | 100                |
| Boys' ice hockey <sup>e</sup>    | 60.0                        | 13.3                         | 6.7                            | 20.0       | 0.0                | 100                |
| Lacrosse <sup>e</sup>            |                             |                              |                                |            |                    |                    |
| Boys                             | 20.3                        | 27.0                         | 1.4                            | 51.4       | 0.0                | 100                |
| Girls                            | 11.7                        | 31.7                         | 5.0                            | 50.0       | 1.7                | 100                |
| Track and field <sup>e</sup>     |                             |                              |                                |            |                    |                    |
| Boys                             | 5.7                         | 25.7                         | 8.6                            | 51.4       | 8.6                | 100                |
| Girls                            | 1.6                         | 55.7                         | 4.9                            | 32.8       | 4.9                | 100                |
| Cheerleading <sup>d</sup>        | 16.0                        | 68.0                         | 0.0                            | 12.0       | 4.0                | 100                |

<sup>a</sup>Boys' and girls' swimming and diving (0 and 2 total ankle sprains, respectively) not included

<sup>b</sup>Includes "contact with out-of-bounds object" and "overuse/chronic" injuries.

<sup>c</sup>Some rows do not sum to 100% because of rounding.

<sup>d</sup>Data collected from 2009/10–2010/11.

<sup>e</sup>Data collected from 2008/09–2010/11.