

Rates and Patterns of Lower Extremity Sports Injuries in All Gender-Comparable US High School Sports

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Background: High school athletes with lower extremity sports injuries (LESIs) frequently present to the emergency department in the United States. Previous epidemiological studies have presented rates and mechanisms of LESIs in these athletes. No studies, however, have looked at LESIs in gender-comparable sports in an attempt to evaluate what differences exist between LESIs in boys and girls.

Purpose: To describe the epidemiology of LESIs among US high school athletes using a large national database of athletes in sports that could be considered gender comparable, given the rules of play and protective equipment.

Study Design: Descriptive epidemiology study.

Methods: Descriptive data from 2005 to 2016 were collected using the internet-based High School Reporting Information Online (High School RIO), a national high school sports injury surveillance system, for athletes participating in 8 gender-comparable sports (soccer, volleyball, basketball, baseball/softball, swimming and diving, track and field, cross-country, and tennis). Rates and patterns of injury were evaluated, with injury rates calculated as ratio of injuries per 10,000 athlete-exposures. Rate ratios (RRs) were calculated to compare the LESI rates in girls and boys.

Results: In both genders, LESI rates (per 10,000 athlete-exposures) were highest in soccer (girls, 15.87; boys, 11.68) followed by basketball (girls, 11.51; boys, 9.35), and were lowest in swimming and diving (girls, 0.70; boys, 0.39). Although injury rates were significantly higher in girls compared with boys in all sports, only in tennis was the RR greater than 2 (RR, 2.03; 95% CI, 1.17-3.54). Girls had a greater proportion of severe LESIs and injuries that received radiographic evaluation, such as magnetic resonance imaging, compared with boys for all sports except volleyball. Consistency in the mechanism of injury was demonstrated between genders within each sport.

Conclusion: This study demonstrated that LESIs are common among high school athletes and disproportionately affect girls more than boys, especially when looking at severe injuries and resource utilization. Further studies are needed to elucidate the cause of these findings. We hope that the awareness of gender-based differences in LESIs will lead to improvements in targeted efforts to decrease injury rates and injury severity.

Keywords: injury prevention; pediatric sports medicine; general sports trauma; female athlete; gender comparable; lower-extremity injury

Participation of students in organized high school sports in the United States (US) has been shown to have multiple benefits, including increased college enrollment,¹⁷ better health choices, and improved self-esteem, cognition, and academic achievement.³ Known mental health benefits include protection against developing an eating disorder in girls, decreased risk-taking in boys, and overall decreased incidence of mental health problems in all children.¹¹ However, with increased sports participation, there is a corresponding increase in sports-related injuries.¹³ An

average annual estimate of 8.6 million sports and recreation-related injury episodes have been reported across all ages, with injury rates highest among children aged 5-14 years.¹⁶

Sports-related injuries are commonly seen in the emergency department (ED) setting and account for 23% of all injury-related ED visits,¹⁸ with frequent lower extremity involvement.¹⁶ A previous study has focused on the epidemiology of lower extremity sports injury (LESI) in children presenting to the ED using data from athlete-exposure (AE). While these studies have not been gender focused, they have identified trends toward more severe LESIs in girls^{6,12,20} and have described gender-related differences in resource utilization.^{22,25}

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This study expands upon the data from a study⁴ published in 2007 that investigated LESI using the High School Sports-Related Injury Surveillance Study data set. Since 2007, this data set has been expanded to include additional schools and numbers for sports and participants recorded. Data on both genders for track and field and swimming and diving were collected from 2008-2009, boys' volleyball were collected from 2009-2010, both genders for cross-country were collected from 2011-2012, and both genders for tennis were collected from 2014-2015. With these additional data, we are able to provide a comprehensive understanding of injury rates, mechanisms, and patterns of LESIs in US high school athletes, with specific and unique focus on differences between male and female athletes in gender-comparable sports: soccer, volleyball, basketball, baseball/softball, swimming and diving, track and field, cross-country, and tennis. Sports such as football and field hockey were excluded, as they are each single-gender sports at the high school level. Additionally, we excluded boys' and girls' lacrosse because they differ dramatically with respect to playing rules and the protective equipment required and allowed.

The goal of this study was to describe the epidemiology of high school sports-related LESIs over multiple academic years in a large national sample of athletes, specifically looking at the differences in these injuries between genders in sports that were deemed gender comparable, given similar rules and mechanism of play. Our aims were to (1) describe the rates of injury by sport, (2) compare the rates of injury by gender, (3) describe the patterns and mechanism of injury, and (4) compare the differences between genders. To our knowledge, no previous study has described gender-comparable LESIs among US high school athletes. Such basic knowledge is needed to drive effective, evidence-based injury prevention efforts specifically targeted at athletes of different genders.

METHODS

Data Collection

Data were collected as part of the National High School Sports-Related Injury Surveillance Study using the internet-based High School Reporting Information Online (RIO) database for the academic years 2005-2006 through 2015-2016. High School RIO captures injury and AE information from a large sample of US high schools. Reports are submitted online weekly by National Athletic Trainers' Association (NATA)-affiliated certified athletic trainers (ATs) who have valid email addresses and who are willing to participate in the study. A detailed description of the study

has been provided previously.^{6,10-12,17,18} The study began during the 2005-2006 academic year using a nationally representative sample of 100 US high schools, stratified by school population and geographic region into 8 strata. The original sample consisted of 9 sports (including football). Beginning with academic year 2008-2009, High School RIO expanded the list of sports for which data were collected to 16 sports, including boys' ice hockey and lacrosse. Some sports have such strong regional popularity (ie, boys' ice hockey) that there are not enough schools offering the sport to fill each of the 8 strata. Therefore, schools not selected for the original sample offering any of the 26 sports (the original 9 or the added 13) were enrolled in a convenience sample, with the goal of enrolling at least 100 schools reporting for each sport. This methodology resulted in a large, nationally diverse convenience sample of US high schools reporting data on injuries sustained by boys' and girls' sports.

Reportable data included total AEs, rate of injuries per 10,000 AEs, outcomes of the injuries, mechanism of injury, the type of medical evaluation and imaging the injured athlete received, and some limited data on ligament type involved, although for each injury type more than 1 ligament injury could be reported.

The High School RIO database categorizes "boys" and "girls" sports but does not denote if these definitions are based on biological sex or gender identity. Each state's high school athletic association determines the category under which transgender athletes may play; thus, a small portion of athletes may be characterized in either category. For this reason, we have chosen the term *gender* instead of *sex* to discuss these 2 groups from the database.

Definition of Exposure and Injury

In High School RIO, an AE is defined as 1 athlete participating in 1 school-sanctioned practice or competition in which the athlete was exposed to the possibility of an athletic injury. Reportable injuries are defined as ones that (1) occurred as a result of participation in practice or competition, (2) required medical attention from an AT or physician, and (3) either restricted the athlete's participation in the sport for at least 1 day beyond the date of injury or resulted in any fracture, concussion, dental injury, or heat illness regardless of whether it resulted in a restriction of the student-athlete's participation. Injury outcomes were defined as (1) returned to activity in <1 day, (2) returned to activity in 1-2 days, (3) returned to activity in 7-9 days, (4) returned to activity in 10-21 days, (5) returned to activity in ≥ 22 days, (6) season ended before athlete returned to activity, (7) medical disqualification (MDQ) for the season, (8) MDQ for career, (9) permanent paralysis, (10) fatality, and (11) other. MDQ injuries were

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Ethical approval for this study was obtained from the institutional review board at Nationwide Children's Hospital, Columbus, Ohio, and the Colorado Multiple Institutional Review Board, Aurora, Colorado.

TABLE 1
Total Athlete-Exposures, Rate per 10,000, and Rate Ratios for Each Gender-Comparable High School Sport
in Order of Highest Injury Rate per 10,000 per Gender and per Sport

	Lower Extremity Injuries			
	Count	Total Athlete-Exposures	Rate per 10,000	Rate Ratios (95% CI)
Total	20,967	25,463,838	8.23	
Girls	11,820	12,933,049	9.14	1.25 (1.22-1.29)
Boys	9147	12,530,789	7.30	
Soccer				
Girls	3891	2,451,681	15.87	1.36 (1.30-1.42)
Boys	3305	2,829,719	11.68	
Basketball				
Girls	3139	2,728,105	11.51	1.23 (1.17-1.29)
Boys	3212	3,434,763	9.35	
Volleyball				
Girls	1677	2,541,005	6.60	1.43 (0.97-2.10)
Boys ^a	26	56,208	4.63	
Track and field ^b				
Girls	1545	1,814,336	8.52	1.38 (1.28-1.49)
Boys	1356	2,199,652	6.16	
Softball ^c	999	1,926,833	5.18	1.58 (1.44-1.73)
Baseball ^c	851	2,586,571	3.29	
Cross-country ^d				
Girls	469	501,866	9.35	1.53 (1.33-1.75)
Boys	350	571,866	6.12	
Swimming and diving ^b				
Girls	59	838,430	0.70	1.78 (1.14-2.78)
Boys	29	735,384	0.39	
Tennis ^e				
Girls	41	130,793	3.13	2.03 (1.17-3.54)
Boys	18	116,626	1.54	

^aData collected from 2009-2010 to 2015-2016.

^bData collected from 2008-2009 to 2015-2016.

^cBaseball and softball are single-gender sports at the high school level but were retained in this analysis because they can be deemed gender comparable given similarity in playing rules and protective equipment required and allowed.

^dData collected from 2011-2012 to 2015-2016.

^eData collected from 2014-2015 to 2015-2016.

defined as season- or career-ending injuries as determined by a clinician. We considered severe injuries to be defined as those that caused an athlete to be out for >3 weeks or medically disqualified.

For each reported injury, ATs complete a detailed injury report including athlete characteristics, injury information (ie, site, diagnosis, and severity), and injury event information (ie, activity and mechanism). Throughout the study period, submitted information could be reviewed and updated by the ATs if necessary.

Statistical Analysis

Data analysis was conducted using SPSS software (v 22.0; IBM Corp). In addition to descriptive statistics, rates and rate comparisons were calculated using unweighted case counts from this convenience sample of US schools reporting injuries in gender-comparable sports. Injury rates were calculated as the ratio of injuries per 10,000 AEs. Rate ratios (RRs) were calculated with 95% CIs. An RR > 1.00 indicates an association exists, with a CI not including 1.00

considered statistically significant. For example, the calculation comparing the overall rate of injury between boys' and girls' soccer was as follows:

$$\frac{\text{Total number of boys' soccer LESIs}}{\text{Total number of boys' soccer AEs}} \times 10,000$$

Table 1 lists the RRs and CI for all gender-comparable sports. Tables 2 and 3 list reportable data from the High School RIO database. Table 2 shows the top 3 LESIs per sport that resulted in the player being medically disqualified. A limitation of the data set is that not every lower extremity injury reported lists the specific ligament injured. There are data reported on the specific ligament injured in each general site, but they are limited and not associated with MDQ in a sport. Table 3 shows the top 3 most common mechanisms of injury leading to MDQ (no contact, player-to-player contact, or over-use) by sport.

Figure 1 shows the percentage of athletes with a severe injury (as defined above) by gender-comparable sport. Figure 2 reveals the percentage of LESIs that resulted in either a magnetic resonance imaging (MRI) or a radiograph

TABLE 2
The Top 3 Types of LESIs Leading to Medical Disqualification, by Gender and Sport^a

Girls' Sports		Boys' Sports	
Sport	Specific Injury	Sport	Specific Injury
Softball		Baseball	
1	Ankle sprain/strain (n = 318, 32%)	1	Ankle sprain/strain (n = 233, 27%)
2	Knee sprain/strain (n = 147, 15%)	2	Thigh/upper leg sprain/strain (n = 167, 20%)
3	Thigh/upper leg sprain/strain (n = 137, 14%)	3	Knee sprain/strain (n = 70, 8%)
Basketball		Basketball	
1	Ankle sprain/strain (n = 1415, 45%)	1	Ankle sprain/strain (n = 1728, 54%)
2	Knee sprain/strain (n = 531, 17%)	2	Knee sprain/strain (n = 287, 9%)
3	Thigh/upper leg sprain/strain (n = 187, 6%)	3	Thigh/upper leg sprain/strain (n = 130, 4%)
Cross-country		Cross-country	
1	Ankle sprain/strain (n = 70, 15%)	1	Lower leg shin splints (n = 42, 12%)
2	Lower leg shin splints (n = 58, 12%)	2	Thigh/upper leg sprain/strain (n = 37, 11%)
3	Hip sprain/strain (n = 37, 8%)	3	Ankle sprain/strain (n = 37, 11%)
Soccer		Soccer	
1	Ankle sprain/strain (n = 1192, 30%)	1	Ankle sprain/strain (n = 830, 25%)
2	Knee sprain/strain (n = 683, 17%)	2	Thigh/upper leg sprain/strain (n = 503, 15%)
3	Thigh/upper leg sprain/strain (n = 495, 13%)	3	Knee sprain/strain (n = 376, 11%)
Swimming and diving		Swimming and diving	
1	Thigh/upper sprain/strain (n = 8, 13%)	1	Knee sprain/strain (n = 7, 24%)
2	Knee sprain/strain (n = 8, 13%)	2	Thigh/upper leg sprain/strain (n = 4, 14%)
3	Knee tendinitis (n = 6, 10%)	3	Lower leg sprain/strain (n = 3, 10%)
Tennis		Tennis	
1	Ankle sprain/strain (n = 16, 39%)	1	Ankle sprain/strain (n = 5, 28%)
2	Knee sprain/strain (n = 6, 15%)	2	Knee sprain/strain (n = 3, 17%)
3	Thigh/upper leg sprain/strain (n = 4, 10%)	3	Foot sprain/strain (n = 2, 11%)
Track and field		Track and field	
1	Thigh/upper sprain/strain (n = 448, 29%)	1	Thigh/upper sprain/strain (n = 515, 38%)
2	Ankle sprain/strain (n = 175, 11%)	2	Hip sprain/strain (n = 142, 10%)
3	Lower leg sprain/strain (n = 145, 9%)	3	Ankle sprain/strain (n = 122, 9%)
Volleyball		Volleyball	
1	Ankle sprain/strain (n = 969, 58%)	1	Ankle sprain/strain (n = 21, 81%)
2	Knee sprain/strain (n = 156, 9%)	2	Lower leg fracture (n = 2, 8%)
3	Thigh/upper leg sprain/strain (n = 78, 5%)	3	Knee sprain/strain (n = 1, 4%)

^aData in parentheses indicate number and percentage of all LESIs resulting in medical disqualification within each sport. Only the top 3 most common types of injury are shown. LESI, lower extremity sports injury.

of all LESIs for each gender-comparable sport. The figure is not meant to be additive, but it allows for an easy comparison of sports, genders, and 2 different imaging modalities.

RESULTS

Over the 10-year study period, there were 20,967 LESIs with 25,463,353 AEs, or 8.23 injuries per 10,000 AEs. The total number of injuries, AEs, and rates of LESIs in gender-comparable sports are presented in Table 1. The highest injury rates among both genders were seen in soccer (girls, 15.87; boys, 11.68) with an RR of 1.36 (95% CI, 1.30-1.42), followed by basketball, cross-country, track and field, volleyball, and softball/baseball. The lowest injury rates were seen in tennis and in swimming and diving. Girls had a higher rate of injury compared with boys across all 8 gender-comparable sports (9.14 vs 7.30 per 10,000 AEs; RR, 1.25; 95% CI, 1.22-1.29). In each individual sport also, girls had a higher rate of LESIs, with the highest rate of injury seen in girls' soccer at 15.87. Only tennis, with a low rate of

LESIs in both girls and boys, had an RR greater than 2 (RR, 2.03; 95% CI, 1.17-3.54).

The types of injuries that most commonly resulted in an MDQ by sport are described in Table 2. Ankle sprain was the predominant injury resulting in MDQ for many sports (baseball, basketball, soccer, tennis, and volleyball in boys; softball, basketball, cross-country, soccer, tennis, and volleyball in girls) and accounted for more than 40% of the injuries that resulted in MDQ for basketball and volleyball in both genders. Specifically, the anterior talofibular ligament was the most commonly strained ligament in all sports regardless of gender with the exception of boys' swimming and diving, which had no ankle injuries reported. In all girls' sports except cross-country and track and field, knee sprain was the second-most common injury resulting in MDQ. For girls, the most common knee ligament sprained was the anterior cruciate ligament (ACL) in soccer (30.1%), basketball (30.8%), softball (5.2%), and track and field (2.6%). For girls' swimming and diving, cross-country, tennis, and volleyball, the most commonly sprained ligament was the patellar tendon (1.0%, 3.6%, 0.3%, and 8.0%, respectively). For boys'

TABLE 3
The Top 3 Mechanisms Associated With LESIs Leading to Medical Disqualification,
by Gender, Sport, and Sport-Specific Activity^a

Girls' Sports			Boys' Sports		
Sport	Mechanism	Sport-Specific Activity	Sport	Mechanism	Sport-Specific Activity
Softball	No contact (31)	Running bases (29)	Baseball	No contact (41)	Running bases (36)
Basketball	No contact (36)	Jumping/landing (28)	Basketball	Player/player (40)	Jumping/landing (37)
Cross-country	Overuse/chronic (62)	Running (83)	Cross-country	Overuse/chronic (61)	Running (84)
Soccer	Player/player (39)	General play (27)	Soccer	Player/player (40)	General play (26)
Swimming and diving	Overuse/chronic (41)	100-yd/m freestyle (20)	Swimming and diving	Overuse/chronic (34)	100-yd/m freestyle (28)
Tennis	No contact (68)	Hyperextension from sliding (34)	Tennis	No contact (61)	Felt muscle strain lunging for ball during match (100)
Track and field	Overuse/chronic (39)	200-m dash (12)	Track and field	Overuse/chronic (30)	100-m dash (16)
Volleyball	Player/player (30)	Blocking (54)	Volleyball	Player/player (38)	Blocking (35)

^aData in parentheses indicate percentage of all LESIs resulting in medical disqualification within each sport. LESI, lower extremity sports injury.

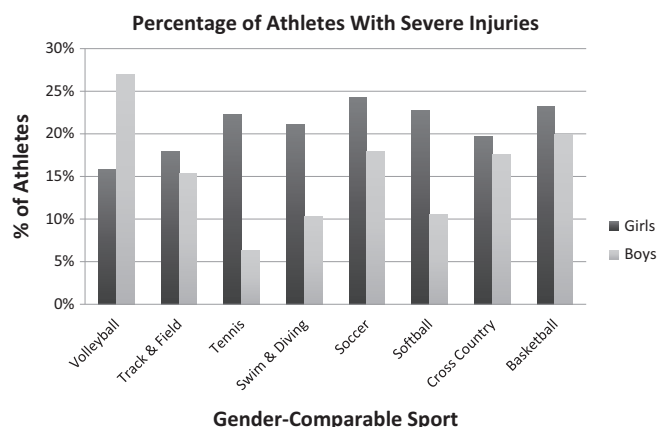


Figure 1. Percentage of athletes with severe injuries (defined as time out of sport >3 weeks or medical disqualification) in each gender-comparable sport. Percentages were calculated as the number of severe injuries of all reported lower extremity sports injuries for that sport for each gender.

basketball and tennis, knee sprain was the second-most common injury. The most common knee ligament sprained in boys was the patellar tendon in basketball (14.1%), baseball (3.5%), swimming and diving (0.6%), track and field (6.4%), cross-country (3.4%), tennis (0.3%), and volleyball (0.2%). Only in boys' soccer was the medial collateral ligament the most commonly injured ligament (17.7%).

The mechanisms of injury by sport are listed in Table 3. Aside from basketball, there were no gender-specific differences in mechanisms of injury by sport. In boys' basketball, player-to-player contact resulted in 40% of the MDQs, as opposed to girls' basketball where injuries were primarily from noncontact mechanisms. Girls had a higher percentage of severe injuries than boys for all sports with the exception of volleyball, where 26.9% of boys who reported LESIs had severe injuries compared with 15.9% of girls in volleyball (Figure 1). Many injuries were evaluated radiographically, but the percentage of radiographic evaluations was overall

higher in girls in the majority of sports (Figure 2). MRI evaluation was highest in basketball for both genders, as 17.9% of imaging studies were MRIs for girls and 10.4% for boys. Girls received more MRIs in all sports compared with boys.

DISCUSSION

This study analyzed 10 seasons of data from high schools nationally, with specific focus on differences in LESIs, injury severity, mechanism, and medical evaluation in gender-comparable sports. Among each of the 8 sports compared, girls had a higher rate of LESIs regardless of the difference in the number of AEs. Not surprisingly, sports that had lower rates of player-to-player contact, including tennis, swimming and diving, and cross-country, had the lowest rates of injuries in both groups.

Our data are consistent with the previous literature on LESIs.^{1,4,10,21} Compared with boys, girls tended to have a higher percentage of knee injuries resulting in MDQ, but ankle sprains were the most common type of LESI in both groups. Girls had a higher number of total injuries for each specific injury type in every gender-comparable sport studied, with the exception of track and field. Differences in boys' versus girls' track and field events, including weights and hurdle distances, may contribute to variances in injury rates in this particular sport.

With the exception of volleyball, a higher percentage of severe injuries were seen in girls' sports compared with boys' sports. While our study did not examine the cause of this difference, variation in net height between boys' and girls' volleyball and blocking against possibly higher forces may be contributing factors. Additionally, boys' volleyball was the only sport that included lower leg fracture, as opposed to sprain, as 1 of the top 3 types of injuries.

Another study²⁴ is consistent with our data, showing a high number of injuries leading to MDQ in noncontact sports among all genders. Overuse injuries were common in sports that typically lacked player-to-player contact. The sports selected for gender comparison in our study demonstrated similar mechanisms of injury among both boys and

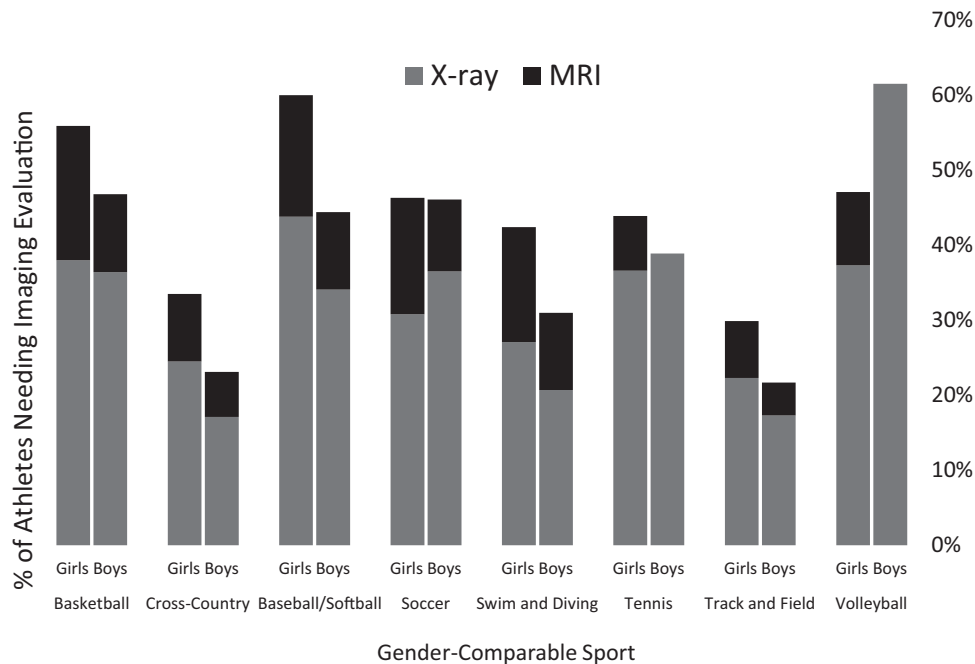


Figure 2. Use of radiograph or magnetic resonance imaging (MRI) to evaluate injury as a percentage of athletes needing imaging to compare the overall use of different image modalities in injuries. Athletes who received MRIs did not necessarily receive radiographs and vice versa.

girls with the exception of basketball, where girls' injuries resulted from noncontact action in contrast to boys'.

Multiple theories have been proposed¹³ to explain the higher rate of lower extremity injuries in women versus men, including anatomic differences,² hormonal changes during puberty,²³ the physics involved in landing,^{7,26} and reporting differences.⁸ A study⁸ of gender-comparable concussion injuries noted that girls tend to have more injuries documented because of increased reporting to a provider or parent. A 2018 study⁷ of all sports injuries (not specifically for high school athletes) postulated smaller ACL size and calf girth as possible explanations for the higher rate of injuries in girls and also discussed the physics involved in the landing, with a high loading rate in girls. Further investigation is needed to determine the cause of variations in specific lower extremity injuries between girls and boys.

Regardless of the specific factor or factors leading to the higher number of overall injuries in girls as compared with boys, our results also suggest a higher number of severe LESIs occurring in female athletes. One previous study²⁰ has shown that girls tend to have more severe ankle injuries and often require surgery. In our study, girls received more MRI evaluations than boys across all sports. The overall impact of these injuries on high school athletes is difficult to quantify, but it includes damage to growing bone and tissue,¹⁵ time away from sports,⁵ increased medical costs, and reduced academic participation.

Given that LESIs disproportionately affect girls over boys in high school sports, there is a need for further research that focuses on injury prevention, especially regarding the most common types of injuries such as ankle and knee

sprains. Previous studies looking at personal protective gear have focused primarily on maxillofacial¹⁴ and head injuries,⁹ with limited studies on lower extremity protection such as cleats, shin guards, or knee pads. Given the impact LESIs can have, improving protective and/or preventive care for girls in particular could potentially reduce the disparity in LESI rates among girls. A 2019 study¹⁹ reviewed injury prevention programs and found that exercise interventions had the most effect on decreasing injury rates in pre-Olympic athletes. Endurance and strengthening programs may be targeted at areas with the highest likelihood of injuries for each gender-comparable sport given our results. Strengthening specific ligaments could potentially reduce certain LESIs and decrease ED visits and MRI evaluation, thereby ultimately reducing resource utilization.

Limitations

Only high schools with NATA-affiliated ATs are eligible for inclusion in High School RIO. Thus, the findings of this study may not be generalizable to schools without ATs. Another limitation of High School RIO is that only time-loss injuries are captured, with the exception of concussions, fractures, heat illnesses, and dental injuries, which means that the number of injuries reported in this study is underestimated. Limiting the surveillance study to time-loss injuries, however, provides information on clinically important injuries while maintaining a feasible reporting time burden on the high school ATs. Additionally, exposures were captured as the numbers of AEs instead of hours or minutes of AEs, thereby prohibiting us from providing a

more exact time-based injury rate. In this large national database, it is not feasible for high school ATs to accurately capture minutes of practice and competition exposures for all athletes in all sports, as they are not present during all activities. Specific diagnoses were not able to be collected, given the limitations of the High School RIO data set. Data collection also relied on coaches and team staff, who may have imperfect recall and are unable to record all data for all AEs and injuries.

While we attempted to select sports that appeared to be most gender comparable, differences in play and rules of conduct between boys' and girls' sports may have affected injury patterns. We used duration out of play and season-ending injuries as imperfect proxies for injury severity, understanding that we are unable to account for differences in individual temperament and healing times, return-to-play rules among teams and leagues, and time from injury until end of season. Additional specific medical evaluation and follow-up data would have been useful as a marker for severity. Our data set does not account for other gender identifications which may have existed in the study population. Additionally, the heterogeneity of the population could not be controlled given the large sample population across the country.

CONCLUSION

For all of the benefits of organized high school athletics, injuries are common and can be severe, especially in the lower extremity. This 10-season study demonstrates that patterns of lower extremity injuries exist in specific sports and between genders, but tend to affect girls more commonly and more severely than boys in comparable high school sports. Awareness of these differences should lead to further research focusing on improvements in training methods and/or protective equipment specific to girls and boys to decrease overall rates of injury as well as health care resource utilization.

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