

Rankings of High School Sports Injury Rates Differ Based on Time Loss Assessments

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Objective: To examine how injury definition inclusiveness affects the rank order of injury rates in 27 high school (HS) sports.

Design: The National Athletic Treatment, Injury and Outcomes Network (NATION) used certified athletic trainers (ATs) to collect injury and athlete-exposure (AE) data in practices and competitions for 27 HS sports during the 2011/2012 to 2013/2014 academic years. Time loss (TL) injuries resulted in ≥ 24 hours of participation restriction. Nontime loss (NTL) injuries resulted in < 24 hours of participation restriction.

Setting: Aggregate injury and exposure data collected from 27 HS sports.

Participants: High school student-athletes.

Interventions: Sports injury data from the National Athletic Treatment, Injury and Outcomes Network.

Main Outcome Measures: Time loss and TL + NTL injury rates were calculated. Sport-specific rates were placed in rank order, stratified by gender.

Results: Most of the 47 014 injuries reported were NTL (82.8%). Among boys' sports, TL injury rates were greatest in football (3.27/1000AE) and wrestling (2.43/1000AE); TL + NTL injury rates were greatest also in football (15.29/1000AE) and wrestling (11.62/1000AE). Among girls' sports, TL injury rates were greatest in soccer (1.97/1000AE) and basketball (1.76/1000AE); TL + NTL injury rates were greatest in field hockey and lacrosse (both 11.32/1000AE).

Submitted for publication September 14, 2015; accepted September 28, 2016. From the *Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC; †Department of Kinesiology, California State University at Long Beach, Long Beach, CA; ‡Datalys Center for Sports Injury Research and Prevention, Indianapolis, IN; and §Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC. Supported by the National Athletic Trainers' Association Research and Education Foundation (NATAREF), and the Central Indiana Corporate Partnership (CICP) Foundation in cooperation with BioCrossroads.

The authors report no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.cjsportmed.com). The content of this report is solely the responsibility of the authors and does not necessarily reflect the views of the NATAREF, CICP Foundation or BioCrossroads.

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Conclusions: The rank order of injury rates and the resulting injury prevention priorities may depend on injury definition inclusiveness, particularly in female HS sports.

Key Words: injury, surveillance, high school, time loss

(*Clin J Sport Med* 2017;27:548–551)

INTRODUCTION

Injury prevention priorities are based on several factors, often including injury incidence. Most epidemiologic investigations of injury burden among athletes have focused on time loss (TL) injuries, defined as those injuries resulting in at least 24 hours of lost participation time.^{1–4} As illustrated in the injury pyramid (Figure 1), a widely used concept in injury epidemiology,⁵ this definition captures the more serious sports-related injuries but excludes less-severe injuries that may be more frequent, such as nontime loss (NTL) injuries, defined as injuries resulting in less than 24 hours of lost participation time.²

Nontime loss injuries require significant amounts of time and care from sports medicine personnel.⁶ Furthermore, the proportion and distribution of TL and NTL injuries may fluctuate as the same injury may limit participation differently among individuals and sports. Nontime loss injuries are an important portion of the injury pyramid that has typically been excluded from sports injury epidemiologic studies. This study examined TL and TL + NTL injury rates across 27 high school (HS) sports to determine how the relative ranking of sports, according to injury incidence, depends on the number of levels from the injury pyramid included in the operational definition of injury.

METHODS

The National Athletic Treatment, Injury and Outcomes Network (NATION) used a convenience sample of HS sport programs that reported data for 27 sports across the 2011/2012 to 2013/2014 academic years. Its methodology has been previously described in depth.⁷ Certified athletic trainers (ATs) collected injury and exposure data in school-sanctioned practices and competitions during the preseason, regular season, and postseason.⁷ The National Athletic Treatment, Injury and Outcomes Network was deemed exempt by *<<deleted for review>>*.

Injuries were those that: (1) occurred as a result of participation in an organized practice or competition; and (2) received medical attention by an AT or physician.⁷ Time loss injuries resulted in ≥ 24 hours of restriction from participation. Nontime loss injuries resulted in < 24 hours of

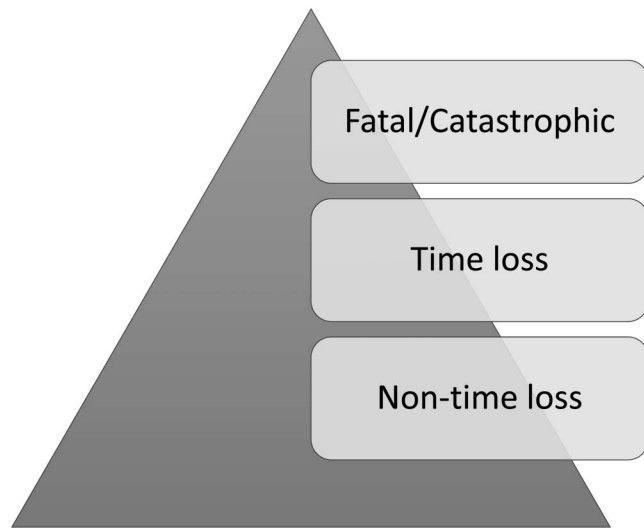


FIGURE 1. Injury pyramid concept.

restriction from participation. A reportable athlete-exposure (AE) was defined as one student-athlete participating in one school-sanctioned practice or competition.⁷

Time loss and TL + NTL injury rates were calculated per 1000AE overall and by competitions and practices. Sport-specific rates were placed in rank order from largest to smallest, stratified by gender.

RESULTS

During the 2011/2012 to 2013/2014 academic years, 47 014 injuries were reported across 4 156 355AE. Most injuries occurred during practices (74.7%); 17.2% were TL (Table 1).

Time Loss Injury Rates

Among boys' sports, TL injury rates were greatest in football (3.27/1000AE) and wrestling (2.43/1000AE; Figure 2). Findings were similar within competitions and practices (see **Figures, Supplemental Digital Content 1**, <http://links.lww.com/JSM/A125> and **Supplemental Digital Content 3**, <http://links.lww.com/JSM/A127>). Among girls' sports, TL injury rates were greatest in soccer (1.97/1000AE) and basketball (1.76/1000AE; Figure 2). Findings were similar in competitions; however, gymnastics had the largest practice TL injury rate (1.37/1000AE; see **Figures, Supplemental Digital Content 2**, <http://links.lww.com/JSM/A126> and **Supplemental Digital Content 4**, <http://links.lww.com/JSM/A128>).

Time Loss + Nontime Loss Injury Rates

The largest TL + NTL injury rates among boys' sports were in football (15.29/1000AE) and wrestling (11.62/1000AE; Figure 3). Findings were similar within competitions and practices (see **Figures, Supplemental Digital Content 1**, <http://links.lww.com/JSM/A125> and **Supplemental Digital Content 3**, <http://links.lww.com/JSM/A127>). Among girls' sports, the largest TL + NTL injury rates were in field hockey and lacrosse (both 11.32/1000AE; Figure 3). Findings were similar in practices; however, the largest competition TL +

TABLE 1. Proportion of Injuries in High School Sports That Are Time Loss* by Sport

| Sport | % (n) of Injuries That Are TL | | |
|---------------|-------------------------------|-------------|-------------|
| | Overall | Competition | Practice |
| Boys total | 18.5 (5870) | 27.4 (2192) | 15.5 (3678) |
| Baseball | 13.9 (158) | 20.2 (69) | 11.2 (89) |
| Basketball | 21.2 (566) | 25.5 (220) | 19.2 (346) |
| Crew | 0 | 0 | 0 |
| Cross-country | 8.5 (97) | 11.9 (19) | 7.9 (78) |
| Football | 21.4 (3626) | 32.2 (1324) | 18.0 (2302) |
| Golf | 0 | 0 | 0 |
| Indoor track | 4.6 (70) | 7.3 (12) | 4.3 (58) |
| Lacrosse | 15.3 (273) | 24.5 (145) | 10.7 (128) |
| Outdoor track | 9.9 (158) | 12.9 (38) | 9.2 (120) |
| Soccer | 16.6 (316) | 24.3 (186) | 11.4 (130) |
| Swim and dive | 17.3 (18) | 25.0 (4) | 15.9 (14) |
| Tennis | 7.6 (9) | 12.1 (4) | 5.8 (5) |
| Wrestling | 21.0 (579) | 26.6 (171) | 19.2 (408) |
| Girls total | 14.4 (2194) | 22.9 (895) | 11.4 (1299) |
| Basketball | 21.0 (507) | 26.9 (247) | 17.4 (260) |
| Crew | 2.6 (5) | 0 | 3.1 (5) |
| Cross-country | 12.3 (148) | 20.0 (30) | 11.2 (118) |
| Field hockey | 13.0 (220) | 23.0 (99) | 9.6 (121) |
| Golf | 0 | 0 | 0 |
| Gymnastics | 16.1 (45) | 16.7 (9) | 16.0 (36) |
| Indoor track | 5.8 (88) | 5.0 (9) | 5.9 (79) |
| Lacrosse | 13.9 (159) | 23.3 (80) | 9.9 (79) |
| Outdoor track | 11.0 (158) | 18.5 (37) | 9.8 (121) |
| Soccer | 18.4 (342) | 30.3 (199) | 11.9 (143) |
| Softball | 16.4 (174) | 21.6 (70) | 14.1 (104) |
| Swim and dive | 17.1 (27) | 0 | 19.6 (27) |
| Tennis | 12.0 (21) | 18.0 (9) | 9.6 (12) |
| Volleyball | 13.9 (300) | 19.1 (106) | 12.0 (194) |
| Overall total | 17.2 (8064) | 25.9 (3087) | 14.2 (4977) |

*Resulting in lost participation time of at least 24 hours.

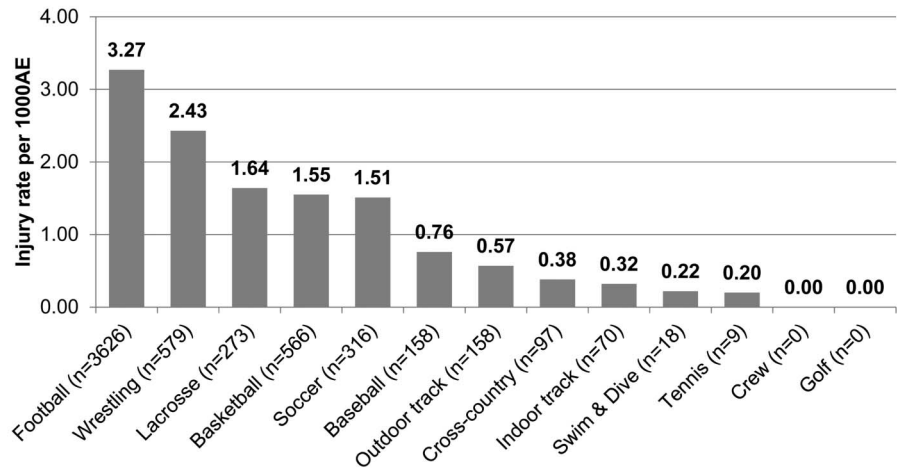
NTL injury rates were in soccer (17.08/1000AE) and gymnastics (14.24/1000AE; see **Figures, Supplemental Digital Content 2**, <http://links.lww.com/JSM/A126> and **Supplemental Digital Content 4**, <http://links.lww.com/JSM/A128>).

Comparison of Time Loss and Time Loss + Nontime Loss Injury Rates

When comparing rank orders of TL injury rates to TL + NTL injury rates among boys' sports, minimal differences were found. The largest increase in ranking from TL to TL + NTL injury rates occurred in indoor track practice injury rates (up from ninth to fifth). The largest decrease in ranking occurred in basketball practice injury rates (down from third to sixth).

Among girls' sports, rank orderings differed between TL and TL + NTL injury rates. The largest increases in ranking occurred in crew overall injury and practice injury rates (both up from 13th to 6th). The largest decreases in ranking occurred in basketball practice and overall injury rates (down from second to ninth, and second to seventh, respectively).

Boys' TL injury rates



Boys' TL+NTL injury rates

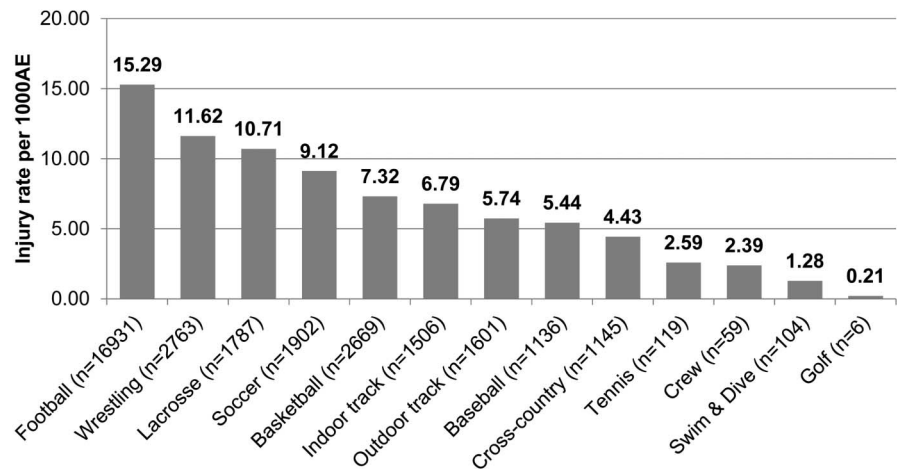


FIGURE 2. Boys' TL and TL + NTL injury rates per 1000 athlete-exposures (AE) by sport.

DISCUSSION

Injury data have helped prioritize areas of need to better protect the health and safety of student-athletes.^{1-3,8} Using a TL-only injury definition may identify sports that have higher incidence of more severe injuries. However, this definition captures only a portion of the injury pyramid (Figure 1) and excludes those injuries that may alter, but not prevent, participation.⁴

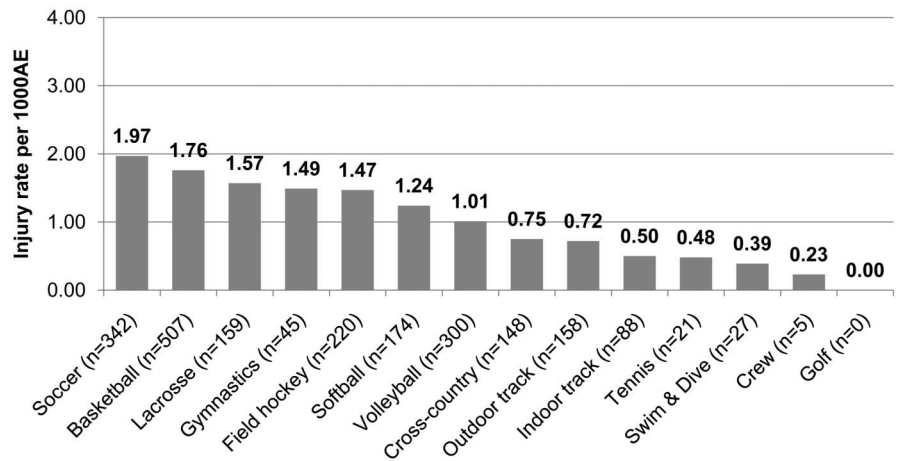
Our findings suggest that the sports determined to be high incidence depend on how fully we capture the injury pyramid, particularly for HS females. Among boys' sports, football and wrestling had the highest injury rates regardless of injury definition, likely because both sports allow player-player contact. The greater shifts among girls' sports may be due to varying proportions of overuse injuries in girls' sports,⁹ the higher rate of overuse injuries in girls than boys,⁹ and many overuse injuries not being captured with a TL definition.¹⁰ Our findings highlight the need to consider how resulting injury incidence captured by surveillance is affected by the extent that the entire injury pyramid is captured.

However, the variation in costs and data quality depending on the injury definition must be considered. Future work is needed to quantify the costs and benefits of the various levels of injury capture.

Limitations

Our findings may not be generalizable to HSs without access to ATs. Injuries that student-athletes did not present to ATs will have not been collected. There also could be a bias to underreport NTL injuries, as these are typically less severe in nature. Additionally, factors aside from injury severity affect the amount of lost participation time, including game/practice schedules. Finally, although we examine differences in injury rates based on time loss assessments (ie, numerator data), we do not examine the calculation of at-risk exposure time (ie, denominator data). Although the use of AE aims to reduce the reporting burden of ATs providing data, it has also been criticized for overestimating exposure time and consequently underestimating injury rates.¹¹

Girls' TL injury rates



Girls' TL+NTL injury rates

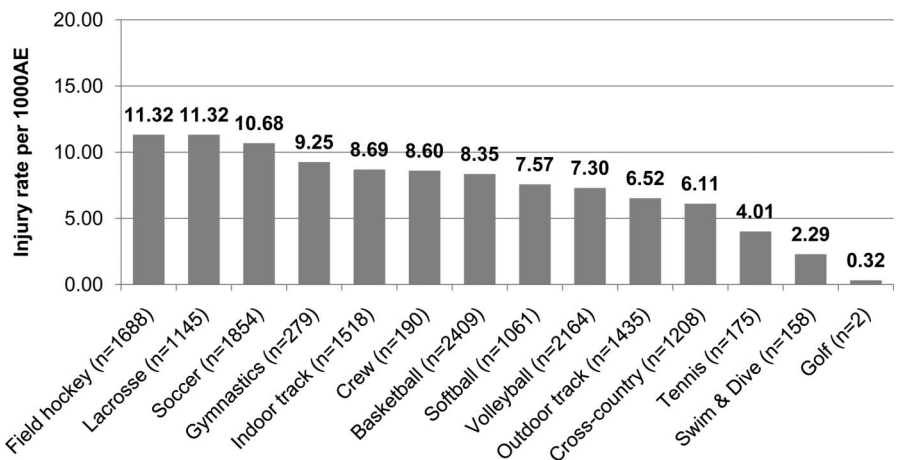


FIGURE 3. Girls' TL and TL + NTL injury rates per 1000 athlete-exposures (AE) by sport.

CONCLUSIONS

Identification of sports with the highest injury rates and the resulting injury prevention priorities may depend on the extent that we capture the entire injury pyramid, particularly for HS females. Future surveillance efforts must consider these costs and benefits of the level of injury capture.

ACKNOWLEDGMENTS

This study would not be possible without the assistance of the many high school athletic trainers who participated in the program.

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