Original Investigation

An Evidence-Based Discussion of Heading the Ball and Concussions in High School Soccer

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IMPORTANCE Soccer, originally introduced as a safer sport for children and adolescents, has seen a rapid increase in popularity in the United States over the past 3 decades. Recently, concerns have been raised regarding the safety of soccer ball heading (when an athlete attempts to play the ball in the air with his or her head) given the rise in concussion rates, with some calling for a ban on heading among soccer players younger than 14 years.

OBJECTIVES To evaluate trends over time in boys' and girls' soccer concussions, to identify injury mechanisms commonly leading to concussions, to delineate soccer-specific activities during which most concussions occur, to detail heading-related soccer concussion mechanisms, and to compare concussion symptom patterns by injury mechanism.

DESIGN, SETTING, AND PARTICIPANTS Retrospective analysis of longitudinal surveillance data collected from 2005-2006 through 2013-2014 in a large, nationally representative sample of US high schools. Participants were boys and girls who were high school soccer players.

EXPOSURES Concussions sustained during high school–sanctioned soccer games and practices.

MAIN OUTCOMES AND MEASURES Mechanism and sport-specific activity of concussion.

RESULTS Overall, 627 concussions were sustained during 1 393 753 athlete exposures (AEs) among girls (4.50 concussions per 10 000 AEs), and 442 concussions were sustained during 1 592 238 AEs among boys (2.78 concussions per 10 000 AEs). For boys (68.8%) and girls (51.3%), contact with another player was the most common concussion mechanism. Heading was the most common soccer-specific activity, responsible for 30.6% of boys' concussions and 25.3% of girls' concussions. Contact with another player was the most common mechanism of injury in heading-related concussions among boys (78.1%) and girls (61.9%). There were few differences in concussion symptom patterns by injury mechanism.

CONCLUSIONS AND RELEVANCE Although heading is the most common activity associated with concussions, the most frequent mechanism was athlete-athlete contact. Such information is needed to drive evidence-based, targeted prevention efforts to effectively reduce soccer-related concussions. Although banning heading from youth soccer would likely prevent some concussions, reducing athlete-athlete contact across all phases of play would likely be a more effective way to prevent concussions as well as other injuries.

JAMA Pediatr. 2015;169(9):830-837. doi:10.1001/jamapediatrics.2015.1062
Published online July 13, 2015.

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Soccer, originally introduced as a safer alternative to other pediatric sports,[1] has seen a rapid rise in the United States over the past 3 decades.[2] This popularity was mirrored in high school athletics. In 1969-1970, a total of 2217 schools fielded 49 593 boys' soccer players and 0 girls' soccer players.[3] In 2013-2014, a total of 11 718 schools fielded 417 419 boys' soccer players, and 11 354 schools fielded 375 564 girls' soccer players.[3] Soccer provides young athletes with multiple physical and psychosocial health benefits but also poses injury risks. High school–age soccer players most commonly sustain lower extremity injuries[4,5] but are also at risk of sustaining sports-related concussions.[6-8] The competition concussion rate among high school girls' soccer has been reported to be 9.2 per 10 000 athlete exposures (AEs), while the rate among high school boys' soccer was 5.3 per 10 000 AEs.[6]

Despite any concerns about injury, the US Women's National Team has been remarkably successful, winning 4 Olympic gold medals and 2 World Cups from 1991 through 2012 in soccer.[9] Recently, several former US Women's National Team stars (Brandi Chastain, Cindy Parlow Cone, and Joy Fawcett) joined the Sports Legacy Institute in establishing Parents and Pros for Safer Soccer, an organization calling for banning soccer ball *heading* (when an athlete attempts to play the ball in the air with his or her head) before the high school level as a means of reducing concussions.[10] This was not the first time the safety of heading has been called into question.[11-13]

Prior studies[4,6,14] have reported that heading is responsible for 31% to 37% of youth soccer–related concussions. Studies have measured heading-related accelerations and forces[15-17] and have implicated soccer heading as a cause of neurocognitive, neuropsychological, or postural control impairments.[18-21] One study[22] has reported an association with white matter microstructural and cognitive abnormalities. Heading appears to be the activity most frequently associated with soccer concussions, but banning heading may not be the best answer to reducing concussions. To date, no study seems to have explored trends in high school heading-related concussions over time, the soccer activity associated with concussions (ie, heading) coupled with the mechanism of concussion, or potential differences in heading-related vs non–heading-related concussion. Therefore, further investigation is needed to fill these gaps in the literature to shed additional light on this issue.

The objectives herein were to use data from a large national high school sports injury surveillance study to (1) evaluate trends over time in boys' and girls' soccer concussions, (2) identify injury mechanisms commonly leading to concussions, (3) delineate soccer-specific activities during which most concussions occur, (4) detail heading-related soccer concussion mechanisms, and (5) compare concussion symptom patterns by injury mechanism. Such detail is required to drive effective evidence-based prevention efforts.

At a Glance

- For boys (68.8%) and girls (51.3%), contact with another player was the most common concussion mechanism.
- Heading was the most common soccer-specific activity, responsible for 30.6% of boys' concussions and 25.3% of girls' concussions.
- Contact with another player was the most common mechanism of injury in heading-related concussions among boys (78.1%) and girls (61.9%).
- These data indicate that, although banning heading from youth soccer would likely prevent some concussions, reducing athlete-athlete contact across all phases of play would likely be a more effective way to prevent concussions as well as other injuries.

Methods

Data Collection

We analyzed data collected from 2005-2006 through 2013-2014 by the National High School Sports-Related Injury Surveillance Study's High School Reporting Information Online (High School RIO), an Internet-based sports injury surveillance system previously described elsewhere.[23,24] Briefly, eligible high schools with 1 or more National Athletic Trainers' Association–affiliated certified athletic trainers (ATs) with valid email addresses were annually invited to participate in High School RIO. Responding high schools were categorized into 8 strata based on school population (enrollment ≤1000 or >1000) and US Census geographic region.[25] Twelve or 13 schools were randomly selected from each stratum to compose the nationally representative 100-school sample. If a study school dropped out during the academic year, a replacement from the same stratum was randomly chosen to maintain the 100-school study population. The unit of participant enrollment is the school, not the athlete. Athletic trainers from participating high schools logged on to the study website weekly during the academic year to report injury incidence and AE information for 9 sports (boys' baseball, basketball, football, soccer, and wrestling and girls' basketball, soccer, softball, and volleyball). Only soccer injuries were analyzed herein. This surveillance study was approved by the Nationwide Children's Institutional Review Board, Columbus, Ohio, and the need to obtain informed consent or assent was waived.

Definition of Injury and Exposure

An AE was defined as one high school athlete participating in one school-sanctioned soccer practice or competition. Reportable injuries (1) occurred as a result of participation in a sanctioned soccer practice or competition, (2) required medical attention by an AT or a physician, and (3) restricted the athlete's sport participation for more than 1 day or resulted in any fracture, concussion, or dental injury even if participation was not restricted. For each reported injury, ATs completed injury reports by providing information about the athlete (eg, age, height, weight), injury (eg, body site, diagnosis), and injury event (eg, competition vs practice). Additional information included 2 separate variables capturing mechanism of injury (athlete-athlete contact, athlete–playing surface contact, or athlete–playing apparatus contact) and sport-specific activity associated with injury (eg, heading, goaltending, ball handling, or dribbling). Athletic trainers participating in High School RIO are instructed to use their best professional judgment to identify and report the precipitating event that was

Table 1. Overall Concussions and Heading-Related Concussions in Boys' and Girls' Soccer by Injury Mechanism, National High School Sports-Related Injury Surveillance Study, Original Sample, 2005-2006 Through 2013-2014

Variable	Boys' Soccer		Girls' Soccer	
	Frequency[a]	National Estimate, No. (%)[b]	Frequency[a]	National Estimate, No. (%)[b]
Injury Mechanism for All Concussions				
Contact with another player	296	165 791 (68.8)	326	181 855 (51.3)
Contact with playing surface	62	32 153 (13.3)	109	68 087 (19.2)
Contact with playing apparatus, including ball	72	40 999 (17.0)	182	102 766 (29.0)
Total[c]	432	240 998 (100)	623	354 249 (100)
Injury Mechanism for Heading-Related Concussions				
Contact with another player	107	58 235 (78.1)	100	53 764 (61.9)
Contact with playing surface	13	4606 (6.2)	8	5119 (5.9)
Contact with playing apparatus, including ball	16	11 404 (15.3)	49	28 049 (32.3)
Total[c]	137	74 610 (100)	157	86 932 (100)

[a] Frequencies do not add up to totals due to censure of a small number of injury reports in which the mechanism was described as "other."

[b] Percentages calculated from national estimates do not add up to 100% due to censure of the "other" category and to rounding.

[c] Data are missing for 10 boys' and 4 girls' soccer concussions due to missing injury mechanism information.

Table 2. Concussions in Boys' and Girls' Soccer by Sport-Specific Activity, National High School Sports-Related Injury Surveillance Study, Original Sample, 2005-2006 Through 2013-2014

Soccer-Specific Activity	Boys' Soccer		Girls' Soccer	
	Frequency	National Estimate, No. (%)[a]	Frequency	National Estimate, No. (%)[a]
Heading	137	74 610 (30.6)	157	86 932 (25.3)
Defending	59	29 098 (11.9)	128	80 114 (23.3)
General playing	63	41 888 (17.2)	87	50 547 (14.7)
Goaltending	51	33 614 (13.8)	77	35 241 (10.2)
Chasing loose ball	43	22 687 (9.3)	53	35 579 (10.3)
Receiving pass	24	12 918 (5.3)	33	21 325 (6.2)
Ball handling or dribbling	21	11 865 (4.9)	30	14 289 (4.2)
Blocking shot	9	5032 (2.1)	13	4664 (1.4)
Passing with foot	<5	NA	12	5581 (1.6)
Shooting with foot	<5	NA	5	2960 (0.9)
Other	21	11 817 (4.9)	12	7036 (2.0)
Total[b]	428	243 529 (100)	607	344 268 (100)

Abbreviation: NA, not available.

[a] Percentages calculated from national estimates may not add up to 100% due to rounding.

[b] Data are missing for 14 boys' and 20 girls' soccer concussions due to missing sport-specific activity information.

the proximate cause of the injury. They could view and update submitted injury reports as needed throughout the study period. For this study, analyses were restricted to concussions, with each injury event resulting in a concussion representing a case. This study included all concussions (new and recurrent) sustained by girls' and boys' high school soccer players that were reported to High School RIO.

Statistical Analysis

Data were analyzed using statistical software (SAS, version 9.3; SAS Institute Inc). We calculated national estimates using weighted analyses from data reported by the nationally representative 100-school sample. In High School RIO, weighting factors are determined by the inverse probability of selection into the study (based on school size and location). Both national estimates and actual numbers of injuries are listed in **Table 1** and **Table 2**, but all reported percentages are weighted percentages based on national estimates (with the exception of **Table 3** and **Table 4**, in which only actual numbers of injuries are reported).

To investigate soccer-related concussions over time, we evaluated trends over a 9-year period from 2005-2006 through 2013-2014 using linear regression. Comparisons of player-player and player-apparatus concussions were analyzed using rate ratios (RRs) with 95% CIs, Fisher exact tests, *t* tests, or Wilcoxon rank sum tests depending on the distribution of the outcome variable. Statistical significance for all tests was set at $P < .05$.

Results

Concussion Rates and National Estimates

In girls' soccer, 627 concussions were sustained during 1 393 753 AEs from 2005-2006 through 2013-2014 for a rate of 4.50 concussions per 10 000 AEs. In boys' soccer, 442 concussions were

Table 3. Symptoms of Concussions Resulting From Contact With Another Player and From Contact With a Playing Apparatus, National High School Sports-Related Injury Surveillance Study, Original Sample, 2005-2006 Through 2013-2014

	Boys' Soccer, No. (%)			Girls' Soccer, No. (%)		
Specific Symptom Reported[a]	Contact With Another Player (n = 296 Concussions)	Contact With Playing Apparatus (n = 72 Concussions)	*P* Value	Contact With Another Player (n = 326 Concussions)	Contact With Playing Apparatus (n = 182 Concussions)	*P* Value
Loss of consciousness	16 (5.4)	3 (4.2)	>.99	7 (2.1)	2 (1.1)	.50
Transient amnesia	65 (22.0)	5 (6.9)	<.01[b]	50 (15.3)	21 (11.5)	.29
Concentration difficulty	148 (50.0)	33 (45.8)	.60	185 (56.7)	117 (64.3)	.11
Confusion or disorientation	119 (40.2)	25 (34.7)	.42	137 (42.0)	70 (38.5)	.45
Dizziness or unsteadiness	214 (72.3)	54 (75.0)	.77	238 (73.0)	134 (73.6)	.92
Drowsiness	61 (20.6)	22 (30.6)	.08	100 (30.7)	79 (43.4)	<.01[b]
Headache	264 (89.2)	69 (95.8)	.11	307 (94.2)	176 (96.7)	.28
Hyperexcitability	5 (1.7)	1 (1.4)	>.99	12 (3.7)	3 (1.6)	.28
Irritability	23 (7.8)	7 (9.7)	.63	27 (8.3)	30 (16.5)	<.01[b]
Nausea	78 (26.4)	13 (18.1)	.17	107 (32.8)	57 (31.3)	.77
Tinnitus	30 (10.1)	9 (12.5)	.53	24 (7.4)	17 (9.3)	.50
Sensitivity to light or visual disturbance	111 (37.5)	23 (31.9)	.26	128 (39.3)	89 (48.9)	.04[b]
Sensitivity to noise	58 (19.6)	13 (18.1)	.87	75 (23.0)	62 (34.1)	<.01[b]
Other	23 (7.8)	9 (12.5)	.24	28 (8.6)	18 (9.9)	.63
Total No. of symptoms reported, mean (SD)[c]	4.1 (2.4)	3.9 (2.2)	.54	4.3 (2.4)	4.7 (2.3)	.07

[a] Comparison is by Fisher exact test (2 × 2 table in which a symptom was endorsed or not endorsed).

[b] Comparison is statistically significant at $P < .05$.

[c] Comparison is by independent 2-sample *t* test with Satterthwaite approximation.

Table 4. Time Loss and Symptom Resolution Time for Concussions Resulting From Contact With Another Player and From Contact With a Playing Apparatus, National High School Sports-Related Injury Surveillance Study, Original Sample, 2005-2006 Through 2013-2014

Variable	Boys' Soccer, No. (%)			Girls' Soccer, No. (%)		
Time to Return to Play[a]	Contact With Another Player (n = 285 Concussions)	Contact With Playing Apparatus (n = 67 Concussions)	*P* Value[b]	Contact With Another Player (n = 309 Concussions)	Contact With Playing Apparatus (n = 164 Concussions)	*P* Value[b]
<1 wk	64 (22.4)	13 (19.4)	.14	53 (17.2)	26 (15.9)	.21
1-3 wk	176 (61.8)	37 (55.2)		183 (59.2)	89 (54.3)	
>3 wk[c]	45 (15.8)	17 (25.4)		73 (23.6)	49 (29.9)	
Concussion Symptom Resolution Time[d]	Contact With Another Player (n = 287 Concussions)	Contact With Playing Apparatus (n = 65 Concussions)	*P* Value[b]	Contact With Another Player (n = 319 Concussions)	Contact With Playing Apparatus (n = 166 Concussions)	*P* Value[b]
<1 h	37 (12.9)	10 (15.4)	.05[e]	31 (9.7)	11 (6.6)	.02[e]
1 h to <1 d	38 (13.2)	3 (4.6)		27 (8.5)	11 (6.6)	
1 d to 1 wk	149 (51.9)	28 (43.1)		165 (51.7)	77 (46.4)	
>1 wk	63 (22.0)	24 (36.9)		96 (30.1)	67 (40.4)	

[a] Data are missing for 16 boys' and 35 girls' concussions with missing or "other" return to play information.

[b] Comparison is by Wilcoxon rank sum test.

[c] Included are categories of medical disqualification, athlete chose not to continue, athlete was released from team, and season ended before athlete returned to play.

[d] Data are missing for 16 boys' and 23 girls' concussions with missing concussion symptom resolution time information.

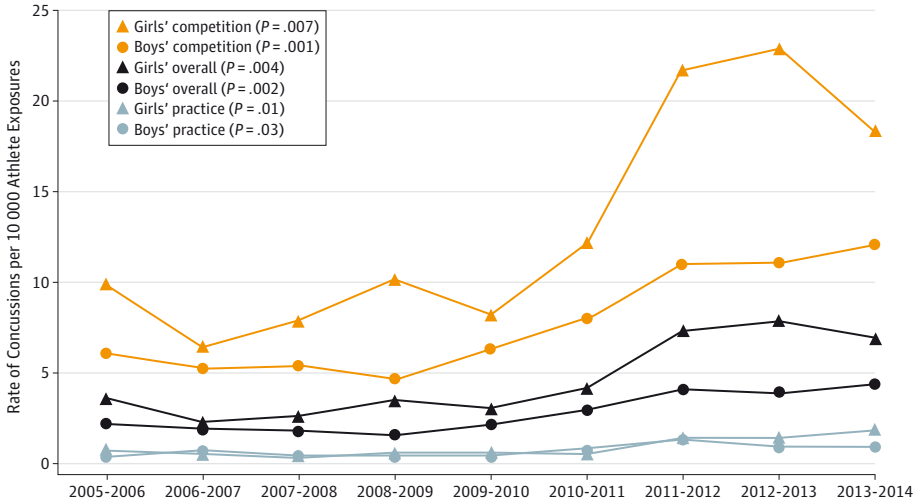
[e] Comparison is statistically significant at $P < .05$.

sustained during 1 592 238 AEs for a rate of 2.78 concussions per 10 000 AEs. Of the 9 original sports included in High School RIO, the girls' soccer concussion rate during this study period ranked second (behind only football), and the boys' soccer concussion rate ranked fifth (behind football, girls' soccer, wrestling, and girls' basketball). During the study period, an estimated 248 860 concussions occurred nationally among boys' soccer players, and 355 511 concussions occurred nationally among girls' soccer players.

Concussion Trends Over Time

In girls' soccer, overall concussion rates ($P = .004$), competition concussion rates ($P = .007$), and practice concussion rates ($P = .01$) increased significantly over the study period, although there was a decrease in the competition concussion rate in 2013-2014 (**Figure**). In boys' soccer, overall concussion rates ($P = .002$), competition concussion rates ($P = .001$), and practice concussion rates ($P = .03$) increased significantly over the 9-year study period.

Figure. Concussion Rates Over Time in Boys' and Girls' Soccer, National High School Sports-Related Injury Surveillance Study, Original Sample, 2005-2006 Through 2013-2014



Statistically significant trends over time were observed for all data.

Mechanisms of Concussions

For boys (68.8%) and girls (51.3%), player-player contact was the most common concussion mechanism (Table 1). Contact with a playing apparatus (which included contact with the ball) (17.0%) and contact with the playing surface (13.3%) had minor roles as concussion mechanisms among boys, while contact with a playing apparatus (29.0%) and contact with the playing surface (19.2%) were more common concussion mechanisms among girls. Of those concussions resulting from contact with a playing apparatus, 95.8% of boys' concussions and 97.8% of girls' concussions resulted from contact with the ball.

Soccer-Specific Activities During Which Concussions Occurred

Rates of concussion resulting from heading have not changed significantly over time among boys ($P = .10$) but increased significantly over time among girls ($P = .03$). Heading-related concussion rates were significantly higher during competition than practice among boys (RR, 11.0; 95% CI, 7.2-17.5) and girls (RR, 15.1; 95% CI, 9.7-24.5).

Heading was the soccer-specific activity during which almost one-third of boys' concussions (30.6%) and just over one-quarter of girls' concussions (25.3%) occurred (Table 2). Additional soccer-specific activities accounting for at least 10% of boys' concussions included general play (17.2%), goaltending (13.8%), and defending (11.9%). Among girls, additional soccer-specific activities accounting for at least 10% of concussions included defending (23.3%), general play (14.7%), goaltending (10.2%), and chasing loose balls (10.3%).

Mechanisms of Heading-Related Concussions

Contact with another player was the most common mechanism of injury in heading-related concussions among boys (78.1%) and girls (61.9%) (Table 1). Contact with a playing apparatus was less common, accounting for 15.3% of heading-related concussions among boys and 32.3% among girls. However, 64 of 65 heading-related concussions having an injury mechanism of contact with a playing apparatus were specifically due to contact with the ball (the remaining one had a reported mechanism of "other").

Patterns of Concussion Symptoms by Mechanism of Injury

There were few differences in specific concussion symptoms reported by athletes injured as a result of contact with another player and those injured as a result of contact with a playing apparatus (Table 3). The exception among boys was transient amnesia, reported in 22.0% of athletes injured as a result of contact with another player but in only 6.9% of those injured as a result of contact with a playing apparatus ($P < .01$). Among girls, higher percentages of athletes were concussed as a result of contact with a playing apparatus vs as a result of contact with another player for those reporting irritability (16.5% vs 8.3%, $P < .01$), drowsiness (43.4% vs 30.7%, $P < .01$), sensitivity to noise (34.1% vs 23.0%, $P < .01$), and sensitivity to light or visual disturbance (48.9% vs 39.3%, $P = .04$). Neither sex had significant differences in the mean numbers of symptoms reported by athletes concussed as a result of contact with another player compared with athletes concussed as a result of contact with a playing apparatus.

Time Loss and Symptom Resolution Time by Mechanisms of Concussions

Neither sex had significant differences in time loss from sport participation among athletes concussed as a result of contact with another player and those injured as a result of contact with a playing apparatus (Table 4). However, there were significant differences in symptom resolution time among boys ($P = .05$) and girls ($P = .02$), with athletes concussed as a result of contact with another player being slightly more likely to have a shorter symptom resolution time than athletes injured as a result of contact with a playing apparatus.

Discussion

Given the intense focus on sports-related concussions over the past few years, the renewed questioning of the safety of heading in soccer and recent calls for banning heading among players younger than 14 years are understandable. However, evidence-based, targeted prevention efforts are needed to effectively reduce soccer-related concussions. To that end, previous researchers discussing the safety and risk of soccer heading may have been asking the wrong question.[11-13] The first question should be: During which sport-specific soccer activity do concussions most commonly occur? If heading is identified as the highest-risk activity with regard to concussion, the next question is: Why is this so? Our study addressed these questions by evaluating boys' and girls' soccer concussion data captured over 9 years by High School RIO, a large nationally representative high school sports-related injury surveillance system.

Results showed that heading is the activity responsible for the highest proportion of concussions in boys' (30.6%) and girls' (25.3%) soccer. This outcome is consistent with prior publications reporting findings based on fewer years of High School RIO surveillance efforts. Yard et al[4] reported that 36.7% of concussions were sustained when heading, and Marar et al[6] reported that the activity most frequently associated with concussions among boys (31.1%) and girls (27.7%) was heading. A recent study[14] of concussions among female middle school soccer players reported that heading accounted for 30.5% of concussions. Therefore, it appears that heading generally accounts for approximately 30% of soccer concussions across sexes and in high school and middle school players.

A detailed look at heading-related soccer concussions in this study revealed that player-player contact was the most common mechanism of concussion among boys (78.1%) and girls (61.9%). Contact with a playing apparatus (which included contact with the ball, goalpost, etc) was a less frequent mechanism of heading-related concussions among boys (15.3%) and girls (32.3%). These results were consistent with prior literature.[6] In addition, rates of concussion resulting from heading were significantly higher during competition (where heading opportunities are limited, but many are contested) than practice (where most athletes participate in frequent heading drills, which are mostly uncontested) among boys (RR, 11.0) and girls (RR, 15.1). Taken together, this finding indicates that player-player contact occurring during contested heading is more frequently linked to concussions than ball-head impacts alone. This observation is consistent with video analyses of FIFA tournaments and professional soccer matches reporting that the most common cause of head injury was athlete-athlete contact during heading.[26,27] Therefore, it appears across wide age and competitive continua that the ball striking the head during heading has less of a role in soccer concussions than the athlete-athlete contact that occurs during contested or challenged heading opportunities.

Banning heading is unlikely to eliminate athlete-athlete contact or the resultant injuries. Athlete-athlete contact was the most common mechanism of all concussions among boys (68.8%) and girls (51.3%) regardless of the soccer-specific activity during which the injury occurred. These trends are consistent with prior literature.[4] Therefore, we postulate that banning heading from soccer will have limited effectiveness as a primary prevention mechanism (ie, in preventing concussion injuries) unless such a ban is combined with concurrent efforts to reduce athlete-athlete contact throughout the game.

Banning heading may be a secondary prevention mechanism (ie, as a way to reduce the severity of the soccer concussions that occur). Results of research exploring the biophysiological effects of heading are mixed. There have been reports of increased cognitive impairment associated with greater self-reported heading exposure in male soccer players,[18] altered postural control in collegiate players who performed headers in a controlled laboratory setting,[21] and abnormal white matter microstructure and poorer neurocognitive performance associated with increased self-reported heading exposure in amateur soccer players.[22] Conversely, several studies capturing heading exposure through athlete self-report or video analysis have failed to directly correlate heading with encephalopathy,[28] concussion symptoms,[29] neuropsychological or neurocognitive test performance,[29-33] or balance.[32] Similarly, several studies in controlled practice or laboratory settings have found that heading the ball does not appear to be associated with neuropsychological or neurocognitive test performance[34-36] or postural control measures.[37]

Consistent with a prior study,[38] we found no significant difference in the number of concussion symptoms reported in either sex and few significant differences in the type of concussion symptoms reported following athlete-athlete contact compared with athlete-apparatus contact. Although athletes concussed via athlete-apparatus contact had a small but significantly increased symptom resolution time compared with athletes concussed via athlete-athlete contact, there were no significant differences in return to play time in either sex.

The limitations of this study are largely limitations of the National High School Sports-Related Injury Surveillance Study. First, only schools with National Athletic Trainers' Association–affiliated ATs were eligible to participate. Although this inclusion criterion may limit the generalizability of results, it ensured that medically trained professionals documented injuries, thereby increasing data quality and consistency. Second, AEs were based on units of participation rather than time. While time-based AEs may be more precise, it was not feasible for ATs to submit time-based reports for every athlete under their care due to the large study population. Third, participating ATs were only able to report injuries of which they were aware. Therefore, High School RIO data likely underestimated the actual number of concussions sustained by high school soccer players. However, reporting was restricted to ATs, again to ensure that high-quality data were reported by medically trained professionals. Despite these limitations, the National High School Sports-Related Injury Surveillance Study provides the most

comprehensive database of soccer concussion generally, as well as heading-related concussions specifically, sustained by US high school athletes to date.

Conclusions

Up to half of all youth sports-related injuries may be preventable.[39] Evidence-based, targeted prevention efforts are the most effective at driving meaningful clinical or public health change. However, to effectively drive change in sports, the possible level of cultural acceptance of proposed interventions must also be considered. Banning heading from youth soccer, while preventing some concussions, may not be culturally acceptable. Soccer has been allowed to become a more physical sport over time because more athlete-athlete contact is occurring, without a concurrent increase in the frequency of fouls or sanctions awarded by referees.[40] It may be more culturally tolerable to the soccer community to attempt to reduce athlete-athlete contact across all phases of play through better enforcement of existing rules, enhanced education of athletes on the rules of the game, and improved coaching of activities such as heading. We believe that reducing athlete-athlete contact across all phases of play will more effectively prevent concussions, as well as other injuries, than will simply banning heading.

ARTICLE INFORMATION

Accepted for Publication: April 14, 2015.

Published Online: July 13, 2015. doi:10.1001/jamapediatrics.2015.1062.

Author Contributions: Dr Comstock and Mr Currie had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Comstock, Fields.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Comstock, Grubenhoff, Fields.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Comstock, Currie, Pierpoint.
Obtained funding: Comstock.
Administrative, technical, or material support: Comstock.
Study supervision: Comstock.

Conflict of Interest Disclosures: None reported.

Funding/Support: This study was funded in part by grants R49/CE000674-01 and R49/CE001172-01 from the Centers for Disease Control and Prevention. Research funding was also provided by the National Federation of State High School Associations, National Operating Committee on Standards for Athletic Equipment, DonJoy Orthotics, and EyeBlack.

Role of Funder/Sponsor: The funding sources had no role in the design and conduct of the study; management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Disclaimer: The content of this report is solely the responsibility of the authors and does not necessarily represent the official views of the Centers for Disease Control and Prevention or any of the other institutions that provided financial support for this research.

Additional Contributions: We thank the certified athletic trainers who report data to High School RIO, without whose dedication this research would not be possible.

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