HHS Public Access

Author manuscript

J Public Health Manag Pract. Author manuscript; available in PMC 2025 January 01.

Published in final edited form as:

J Public Health Manag Pract. 2024 ; 30(1): 99–110. doi:10.1097/PHH.0000000000001791.

The Role of Level of Play in Concussions in High School Athletes

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Abstract

Objectives: To examine level of play (LOP) as a risk factor for concussion severity and recovery-related outcomes among high school athletes, stratified by sex, and among boys, by sport (football, non-football male sports).

Design/Setting: Secondary analysis of data collected through the High School Reporting Information Online surveillance system for academic years 2007–2008 through 2018–2019.

Participants: A total of 9916 concussions were reported between the academic years 2007–2008 and 2018–2019 from 9 sports (5189 from football; 2096 from non-football male sports; 2631 from female sports).

Main Outcome Measure: Examined the association between LOP (Freshman, Junior Varsity [JV], and Varsity teams) and concussion outcomes (number of concussion symptoms, symptom resolution time [SRT], and time to return to play [RTP]).

Results: Compared with Varsity football athletes, concussed JV football athletes had on average 0.19 fewer concussion symptoms, longer SRT (>1 week vs <1 week: odds ratio [OR] = 1.3; 95% confidence interval [CI], 1.1–1.5), and longer RTP (1–3 weeks vs <1 week: OR = 1.5; 95% CI, 1.2–1.9; >3 weeks vs <1 week: OR = 1.6; 95% CI, 1.1–2.3). Compared with Varsity football athletes, Freshman football athletes had on average 0.48 fewer concussion symptoms, longer SRT

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Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

Human Participant Compliance Statement: These data are de-identified and considered exempt from human subjects review by CDC's institutional review board.

The authors declare no conflicts of interest.

(OR = 1.3; 95% CI, 1.1–1.5), and longer RTP (1–3 weeks vs <1 week: OR = 1.5; 95% CI, 1.1–2.0; >3 weeks vs <1 week: OR = 2.0; 95% CI, 1.3–3.0). Similarly, compared with female athletes on Varsity teams, concussed JV female athletes had longer RTP (1–3 weeks vs <1 week: OR = 1.8; 95% CI, 1.2–2.7). Trend analyses revealed an increase in the number of concussion symptoms between 2015–2016 and 2018–2019, a decrease between 2009–2010 and 2018–2019 for SRT of less than 1 week, and an increase between 2014–2015 and 2018–2019 for RTP of less than 1 week among Varsity football athletes. Among Varsity female athletes, there was a linear decrease during the study period for RTP of less than 1 week.

Conclusions: Despite a higher number of symptoms overall and in recent years, Varsity football players had shorter RTP than Freshman and JV athletes.

Keywords

athletes; concussion; high school; level of play; sex

From 2010–2016, there were an average of 283 000 emergency department visits each year among children for sports and recreation–related traumatic brain injuries (TBIs).[1] TBIs can result in short- and long-term difficulties, such as headache, dizziness, and problems with memory, sleep, balance, and mood/behavioral changes.[2] Outcomes for concussion (mild TBI) are often more severe, and recovery periods can be longer among youth and high school athletes than among adult athletes.[3–6] For example, one systematic review demonstrated evidence for increased vulnerability of persistent symptoms postconcussion among teenage athletes, particularly during high school.[6] Thus, prevention of concussions in high school athletes is particularly important as this age group may be more susceptible to long-term impacts due to the vulnerability of the developing brain and the increased potential for neuropsychological impairment that can impact academic and social outcomes.[2,7–10]

Data from the 2017 national Youth Risk Behavior Survey indicate that, overall, 15.1% (estimated number of 2.5 million) of high school students self-reported 1 or more sports- and physical activity–related concussions during the previous 12 months of the survey and 6.0% (estimated number of 1 million) reported 2 or more concussions.[11] In addition, a large, state-based injury surveillance system among high school athletes found that the median number of days for unrestricted return to play (RTP) was 11 days, with 71.8% taking more than 7 days to return and 13.1% taking longer than 21 days to return after being diagnosed for a sports-related concussion.[12] Thus, identifying factors associated with risk for more severe outcomes due to sports-related concussions is important, given the increased concern about high school sports concussion, especially as participation in high school sports continues to increase.[13]

Current national surveillance methods for TBI (including mild TBIs/concussions) in the United States are largely based on health care administration data, such as emergency department visits and hospitalizations.[14–16] However, not all individuals are evaluated and some may seek care in a nonhospital setting or not get diagnosed.[17–21] These methods do not capture these TBIs and likely underestimate the true burden of TBI in the United States. Thus, other sources for surveillance of TBI are needed to provide more comprehensive

estimates,[22] and ongoing national surveillance for high school sports concussion that does not require self-report is limited. One such surveillance system is the National High School Sports-Related Injury Surveillance Study's High School Reporting Information Online (HS RIO). HS RIO is an Internet-based sports injury surveillance system that captures data about high school athletes via athletic trainers (ATs).

Level of play (LOP) describes the competitive nature of a team or an athletic league/division. Data among emerging adult athletes show that increasing LOP (eg, competitive/elite teams vs recreational teams or Division I universities vs Division II or III universities) is associated with an increased risk for injury and concussion.[23–26] There are limited data on whether similar associations exist for high school athletes.[25–28] The goal of this study was to examine the association between LOP and concussion outcomes (number of concussion symptoms, symptom resolution time [SRT], and RTP times) among high school athletes using HS RIO data, stratified by sex, and among boys, by sport (football, non-football male sports). The authors hypothesized that athletes playing on Varsity teams (higher LOP) would have a greater number of reported concussion symptoms and longer SRT and RTP times.

Methods

Data collection

Data were collected for academic years 2007–2008 through 2018–2019 from the National High School Sports-Related Injury Surveillance Study's HS RIO, an Internet-based sports injury surveillance system, which has been described previously.[29,30] In short, HS RIO collects data from 100 nationally representative high schools through weekly reports from certified ATs affiliated with the National Athletic Trainers Association (NATA). These ATs detail athlete exposures (number of practices and competitions per week) and injury data (eg, diagnosis, mechanism, severity). Nationally representative injury data came from 9 sports (boys' football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, boys' wrestling, boys' baseball, and girls' softball). Analyses were limited to concussions. In addition, the data contain athletes with multiple, recurrent concussions.

Variable definitions

Indicators of concussion outcomes included number of concussion symptoms, SRT, and RTP times. Number of concussion symptoms was ascertained by a "check-all-that-apply" question to 15 different concussion symptoms. SRT was determined using the question: "Length of time until all concussion symptoms resolution time?" Response options spanned from less than 15 minutes to 22 days or more. For RTP, the AT reports the date of injury and the number of days it took the athlete to RTP; the response options are categorical and ranged from "Returned to activity in less than 1 day" to "Returned to activity in 22 days or more." Consistent with previous studies,[31–34] SRT and RTP were categorized into a binary variable (<1 week and ≥1 week) and a 3-level ordinal variable (<1 week, 1–3 weeks, and >3 weeks), respectively. Body mass index of the injured athlete and the presence of a medical professional on-site were examined as potential confounders due to evidence in the literature of a possible associations between these variables with severity of concussion outcomes or LOP.[35,36] Sex was reported by an AT. For concussions where the AT did not explicitly state

the athlete's sex, sex was determined on the basis of sport. This assumption was made, given that only 0.6% (N = 53) of athletes with a concussion played on opposite-sex teams where sex was documented.

Statistical analyses

Data were analyzed using SAS (version 9.4; Cary, North Carolina). In the primary analysis, LOP was defined as athletes playing on Freshman, Junior Varsity (JV), or Varsity teams. For the secondary analysis, LOP was defined as athletes playing up or playing at a level above their grade (eg, freshmen playing on the Freshman team vs freshmen playing at a higher level [JV or Varsity], sophomores playing on the JV team vs sophomores playing on the Varsity team).

Analyses were stratified by sex and, among boys, by sport (football, non-football male sports). Bivariate analyses examined LOP and potential confounders with the indicators of concussion outcomes. If LOP was significantly associated with the outcomes, multivariable regression models were conducted, controlling for potential confounders associated with both LOP and the concussion outcomes in the bivariate analyses. In the primary analysis, for groups with outcomes that were associated with increased odds of worse outcomes, trend analyses[37] for all outcomes were conducted to determine whether outcomes had changed by group encompassing each academic year. In addition, trend analyses were conducted for Varsity athletes. Because of model instability, groups (eg, Freshman and JV athletes) that did not consistently have a minimum of 10 observations per year were not conducted.[38] For the trend analysis, RTP was dichotomized into a binary variable (<1 week and ≥1 week).

Results

There were a total of 9916 concussions reported between the academic years 2007–2008 and 2018–2019 from 9 sports (5189 from football; 2096 from non-football male sports; 2631 from female sports) (Table 1). Descriptive statistics (Table 1) show that a higher percentage of concussions occurred among Varsity players (football: 46.0%; non-football male sports: 63.1%; female sports: 59.8%) than among JV (football: 33.4%; non-football male sports: 30.3%; female sports: 33.8%) and Freshman (football: 20.6%; non-football male sports: 6.7%; female sports: 6.4%) teams. Athletes concussed while playing female sports had a mean of 4.9 symptoms, followed by football (mean = 4.8) and non-football male sports (mean = 4.7). For SRT, concussed football players (64.7%) had the highest percentage of athletes with symptoms resolving in less than 1 week, followed by non-football male sports (64.2%) and female sports (57.4%).

Level of play and concussion outcomes

Football—Unadjusted analyses demonstrated that the number of symptoms, SRT, and RTP were associated with LOP (*P*s < .001) (Table 2). In addition, SRT was associated with the presence of a medical professional (*P* = .04). After adjustment for sport-type characteristics that were significantly associated (if any) with the concussion outcomes, regression models found that compared with Varsity teams, concussed JV athletes had on average 0.19 fewer concussion symptoms (*P* = .046), longer SRT (>1 week vs <1 week: odds ratio [OR] =

1.3; 95% confidence interval [CI], 1.1–1.5), and longer RTP (1–3 weeks vs <1 week: OR = 1.5; 95% CI, 1.2–1.9; >3 weeks vs <1 week: OR = 1.6; 95% CI, 1.1–2.3). Compared with Varsity teams, Freshman athletes had on average 0.48 fewer concussion symptoms (P < .001), longer SRT (OR = 1.3; 95% CI, 1.1–1.5), and longer RTP (1–3 weeks vs <1 week: OR = 1.5; 95% CI, 1.1–2.0); >3 weeks vs < 1 week: OR = 2.0; 95% CI, 1.3–3.0) (data not shown).

Non-football male sports—Among concussed male athletes, LOP was not significantly associated with any concussion outcome (number of concussion symptoms, SRT, and RTP) for the bivariate analyses (Table 2). Thus, no regression modeling was conducted for non-football male sports.

Female sports—Unadjusted analyses demonstrated that RTP was associated with LOP (P = .02) (Table 2); no other sport-type characteristics were associated with RTP for the bivariate analyses. A regression model found that compared with Varsity teams, concussed female athletes on JV teams (1–3 weeks vs <1 week: OR = 1.8; 95% CI, 1.2–2.7; >3 weeks vs <1 week: OR = 1.7; 95% CI, 0.97–2.8) had longer RTP for 1 to 3 weeks (data not shown). There were not significant associations for LOP with the number of concussion symptoms and SRT among concussed female athletes (Table 2); thus, no regression modeling was conducted for these 2 concussion outcomes.

Trend analyses—Among Varsity football athletes, there was a significant linear increase in the prevalence of the number of concussion symptoms between 2015–2016 and 2018–2019. For SRT of less than 1 week, there was a significant linear decrease between 2009–2010 and 2018–2019; in addition, there was a significant linear decrease in the prevalence of RTP of less than 1 week in Varsity football players between 2007–2008 and 2014–2015, followed by a significant linear increase between 2014–2015 and 2018–2019 (Figure 1).

Among Varsity female athletes, there was no change in the prevalence of number of concussion symptoms throughout the duration of the study. However, there was a significant linear decrease in both the prevalence of SRT of less than 1 week during the study period and the prevalence of RTP of less than 1 week between 2007–2008 and 2018–2019 (Figure 2).

Playing up and concussion outcomes

Compared with Freshman athletes on the Freshman team, concussed freshmen football athletes “playing up” had on average 0.42 more concussion symptoms (P = .01), and compared with sophomore athletes on the JV team, concussed sophomore football players “playing up”had shorter RTP (1–3 weeks vs <1 week: OR = 0.5; 95% CI, 0.3–0.8; >3 weeks vs <1 week: OR = 0.4; 95% CI, 0.2–0.7) (data not shown). In addition, compared with sophomore athletes on the JV team, concussed sophomore female athletes “playing up” had shorter RTP (1–3 weeks vs <1 week: OR = 0.4; 95% CI, 0.2–0.9).

Discussion

This study examined LOP as a potential risk factor for concussion outcomes among high school athletes. Descriptive statistics demonstrated a higher percentage of concussions occurred among high school athletes with increasing LOP, which has been demonstrated previously in the literature.[39,40] The results also showed that among concussed football players, SRT and RTP were shorter for Varsity athletes than for Freshmen and JV athletes. However, concussed Varsity football players had a higher number of symptoms, which is a proxy for injury severity. Contrary to finding of previous studies,[6,40–43] we would expect to find longer SRT and RTP in a group that has a greater number of symptoms. This pattern of results was not found among non-football male athletes or female athletes, similar to other studies[44,45] of increasing LOP among youth versus college athletes. However, among concussed female athletes, RTP was also shorter for Varsity athletes than for JV athletes.

For football, shorter SRT and RTP combined with a higher number of symptoms among Varsity athletes compared with other levels of play could indicate that as the level of competition increases, there may be increased pressure for athletes to be medically cleared to play sooner. This is consistent with studies that show that RTP may be impacted by the perceived urgency and/or pressure of the athletes, coaches, teammates, and parents for the athlete to RTP.[46–48] Alternatively, because ATs are more readily available in Varsity sports,[36] this potentially results in more comprehensive and consistent injury management leading to shorter SRT and quicker clearance to RTP. In addition, parents of varsity football athletes may be more motivated to seek RTP clearance and medical appointments more quickly. Finally, ATs and coaches play a vital role in concussion prevention, recognition, and management. Although increasing access to full-or part-time ATs is challenging and varies widely by state,[49] ATs serve as an on-field health care provider and can keep athletes from returning to play prematurely. High school coaches are also often relied upon to assess an athlete's health after a suspected concussion due to lack of access of on-site health care providers and may have the responsibility of removing an athlete from play. While most states require high school coaches to receive educational materials or training about concussion,[50] coaches are often under pressure to win and/or believe that it is not their role to assess or manage concussion and prefer to leave it to a health care provider.[51] Therefore, communication about concussion is also an important aspect to concussion safety, as coach communication and views on concussion positively impact athletes' intention to report concussion symptoms.[52] However, a recent study found that 42.5% of youth athletes reported that they did not receive any sort of concussion information from their coaches in the past 12 months.[53] Thus, increasing coach-to-athlete communication about concussion safety is important, as research suggests that concussion symptom reporting is increased when coaches communicate with athletes about concussion.[54]

This study increases understanding of the relationship between symptom profile and RTP care and may help inform dissemination and implementation of RTP guidelines and protocols. Trend analyses suggest that returning to play too soon may still be a problem among Varsity football athletes: our results demonstrated while the number of concussion symptoms (proxy for injury severity) increased between 2015–2016 and 2018–2019, shorter RTP (<1 week) increased during this similar time period, contrary to other

published studies.[6,41,42] During the time frame of this study (between 2009 and 2014), youth sports concussion laws were passed in all 50 states and the District of Columbia to improve the recognition and management of youth sports concussion.[55] Most laws included variations of 3 components that were modeled after the 2009 Zackery Lystedt Law by the state of Washington: (1) annual concussion education for athletes, parents, and coaches; (2) removing a young athletes from play if a concussion was suspected; and (3) medical clearance for RTP (though different states have different definitions of which health care professional can provide clearance).[56] As youth sports concussion laws and policies in high school sports continue to change, concussion recognition, evaluation, and management remain important topics. For example, there was a substantial increase in the number of reported concussions and concussion-related emergency department visits among youth after implementation of these laws,[57,58] but a decrease in recurrent concussions (subsequent concussions after the initial concussion).[57] These effects were likely due to greater identification and reporting of concussions.[57] One reason for this might be due to concussion education, especially as it is a primary component of youth sports concussion laws, that describes concussion symptoms and the importance of not returning to play too soon. For example, in 2003, the Centers for Disease Control and Prevention (CDC) launched a small set of educational materials (https://www.cdc.gov/headsup/index.html) to help health care providers diagnose and manage concussions. Over the last 20 years, the CDC HEADS UP campaign has grown into a cohesive suite of educational initiatives that share a common goal—to help protect children and adolescents from concussions and other serious brain injuries by raising awareness, enhancing knowledge, and informing action to improve prevention, recognition, and response to concussions. CDC HEADS UP offers free materials for health care providers, coaches, parents, school professionals, sports officials, and kids and teens. In addition, previous evaluations[59–67] of the CDC HEADS UP campaign have demonstrated positive effects on knowledge, attitudes, and intentions concerning concussion identification and response among health care providers, ATs, parents, youth, and high school sports coaches, as well as increased communication about concussion safety.

However, studies using national data to examine changes in outcomes (such as SRT or RTP) pre- and postlaw, the youth sports concussion laws are mixed and the few that have been done are state-specific. For example, one study[68] examined return to recovery before and after Ohio's concussion law was enacted. That study found that return to recovery, as well as symptom duration, was faster for patients after the law than before ($P < .001$). However, this may, in part, be affected by the fact that patients also presented to the concussion clinics earlier post versus prelaw period and thus received treatment earlier, and prior research has demonstrated that patients who receive clinical care sooner recover faster from concussion.[69,70] Conversely, another study[33] examined the number of days out of play among high school athletes before and after Washington's concussion law; that study found a greater number of days after the law was passed (almost 7 days higher), which it attributed to increased awareness of concussion and a more careful approach to concussion management. Based on the few studies that have examined concussion outcomes before and after youth concussion law were passed, our results for Varsity football athletes returning earlier to play between 2014–2015 and 2018–2019 despite having a higher number of concussion symptoms are unclear. But our results might, in part, be affected

by a shorter return to recovery that was seen in one state after youth sports concussion laws were enacted. However, studies using national data examining concussion outcomes among high school athletes are warranted before supporting this conclusion as another study found the longer return-to-recovery times. Regardless, returning to play too soon is associated with worse outcomes (eg, longer recovery, recurrence or worsening of symptoms, persistent symptoms) and has implications for secondary prevention efforts and may create opportunities for further concussions or other catastrophic injuries, such as second impact syndrome.[71–74]

Results also demonstrated that concussed female athletes on the Varsity team had shorter RTP than athletes on the JV team. This may be due to increased access to ATs in Varsity sports[36] and more recent youth sports concussion laws requiring clearance to RTP, which, in turn, may result in quicker identification of concussions and more comprehensive management of concussion symptoms, which has been associated with quicker recovery (eg, quicker RTP).[69,70] However, the trend results showed that the percentage of Varsity female athletes with SRT and RTP of less than 1 week over time has decreased, meaning fewer are returning to play as quickly, while their severity of injury (number of concussion symptoms) has stayed the same. Given the lack of change in the number of concussion symptoms, possible reasons for a decrease in shorter SRT and RTP in Varsity female athletes could include reporting behavior and/or cultural norms. Specifically, females have been shown to be more likely to report concussion symptoms,[75,76] which may make females more comfortable reporting that their symptoms have not yet resolved. In addition, coaches, parents, and medical professionals might be more protective of female athletes in recognizing concussion symptoms and/or identifying occurrence following injury.[76] One possible interpretation of the trend results is that, over time, the community is being more protective of female athletes.

The secondary analyses examined whether concussions experienced while “playing up” were more severe than those experienced while playing at the level expected for an athlete’s particular grade. Taken together, the results do not provide consistent evidence for there being increased concussion severity and recovery-related outcomes among concussed athletes who are “playing up.” Future research is needed, as this was the first study to our knowledge that examined LOP and concussion outcomes among high school athletes instead of comparing LOP across age (eg, high school athletes vs college or professional athletes or vs younger athletes).

There were several limitations to this study. Eligibility to participate in HS RIO was limited to high schools with NATA-affiliated ATs; thus, our results may not be generalizable to high schools without ATs. In addition, for the data to be nationally representative, this study was limited to 9 sports (boys’ football, boys’ and girls’ soccer, girls’ volleyball, boys’ and girls’ basketball, boys’ wrestling, boys’ baseball, and girls’ softball). Other sports that have been found to have relatively high concussion rates were not included. Certain sports (such as football) have a greater presence of ATs than other sports (such as softball).[36] Therefore, concussions may not have come to the attention of ATs unless they were more severe for these other less commonly observed sports. To account for this potential bias, the analyses were stratified for football, non-football male sports, and female sports. Also,

in this study, symptom severity was not directly measured and is a limitation of the data. Instead, symptom count served as a proxy for severity of concussion. Finally, not all schools or sports with a school have all levels of teams defined in this study (eg, some schools do not have Freshman teams for some sports). HS RIO data do not capture this information and thus a limitation of the data is that some younger athletes may be playing on a higher level of team due to lack of availability of lower-level teams.

Conclusions

These results suggest that concussed male Varsity football players may be at increased odds for a greater number of concussion symptoms, yet cleared to play sooner than average compared with their younger counterparts. These results have implications for secondary prevention efforts, as this may suggest that some football players are returning to play sooner than is recommended in contrast to female Varsity athletes, for whom SRT and RTP of less than 1 week decreased over time while the number of concussion symptoms was stable. Therefore, messages addressing greater pressure to RTP before full symptom resolution may be important for these athletes and those who care for them after a concussion. In addition, high school coaches are often relied upon to assess an athlete's health. While most states require high school coaches to receive educational materials or training about concussion,[50] coaches often believe that it is not their role to assess or manage concussion.[51] Although increasing access to full- or part-time ATs is challenging, ATs play a key role in concussion prevention efforts, serve as an on-field health care provider, and can keep athletes from returning to play prematurely.

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Implications for Policy & Practice

- LOP is an important factor to consider, with higher competitive level being associated with an increased risk for injury and concussion.[23,27,28] Our findings suggest that high school Varsity football players may be returning to play prematurely.
- Developing effective strategies to prevent returning to play too soon by supporting best practices can protect athletes from additional injury.[77]
- Policy makers can consider taking these challenges into consideration when revising and updating RTP protocols and may help facilitate the implementation and enforcement of such protocols by US high schools, including those without an AT.
- This study may help health care providers to better manage RTP guidelines and protocols by increasing understanding and dissemination of the relationship between symptom profile and RTP to care.

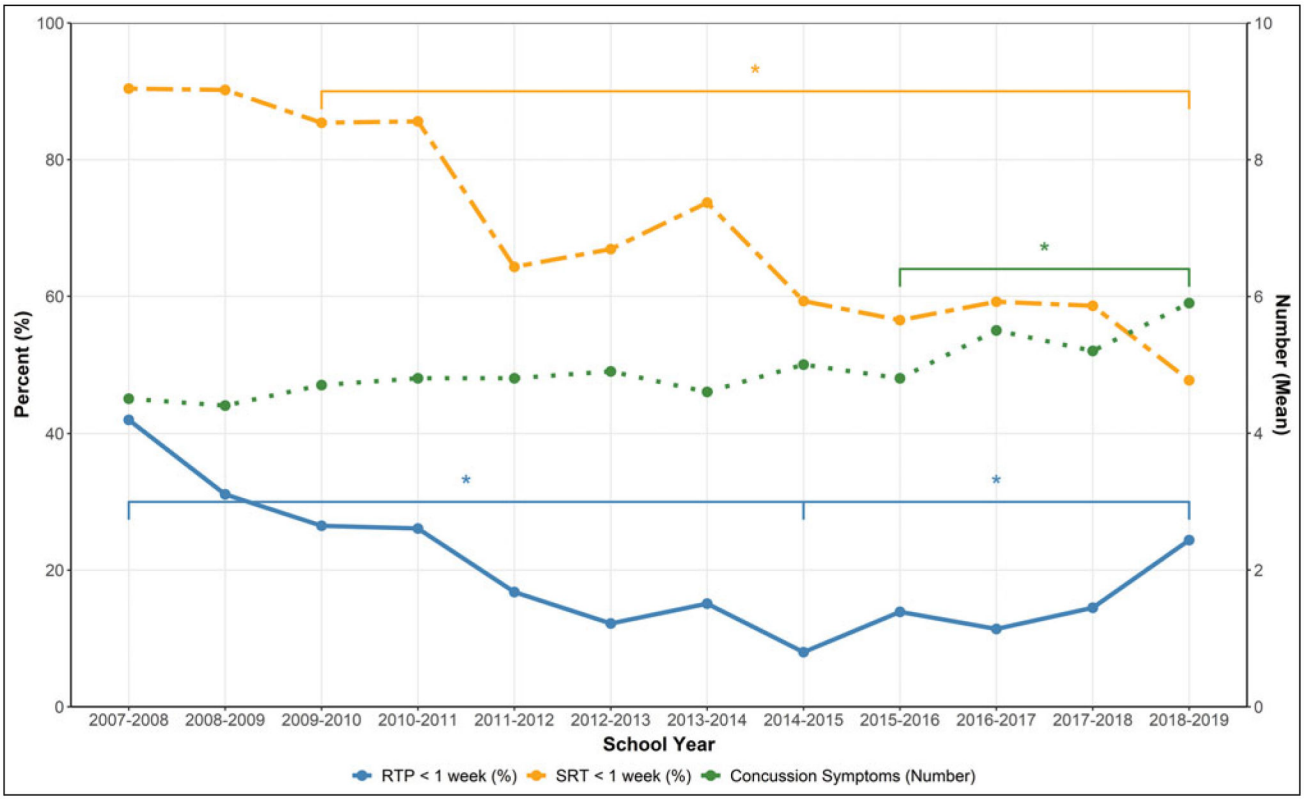

FIGURE 1.

Trends in Concussion Outcomes Among High School Varsity Football Athletes—High School Reporting Information Online (HS RIO) Surveillance System, Academic Years 2007–2008 Through 2018–2019

Abbreviations: RTP, return to play; SRT, symptom resolution time.

*Indicates a significant linear change. This figure is available in color online (www.JPHMP.com).

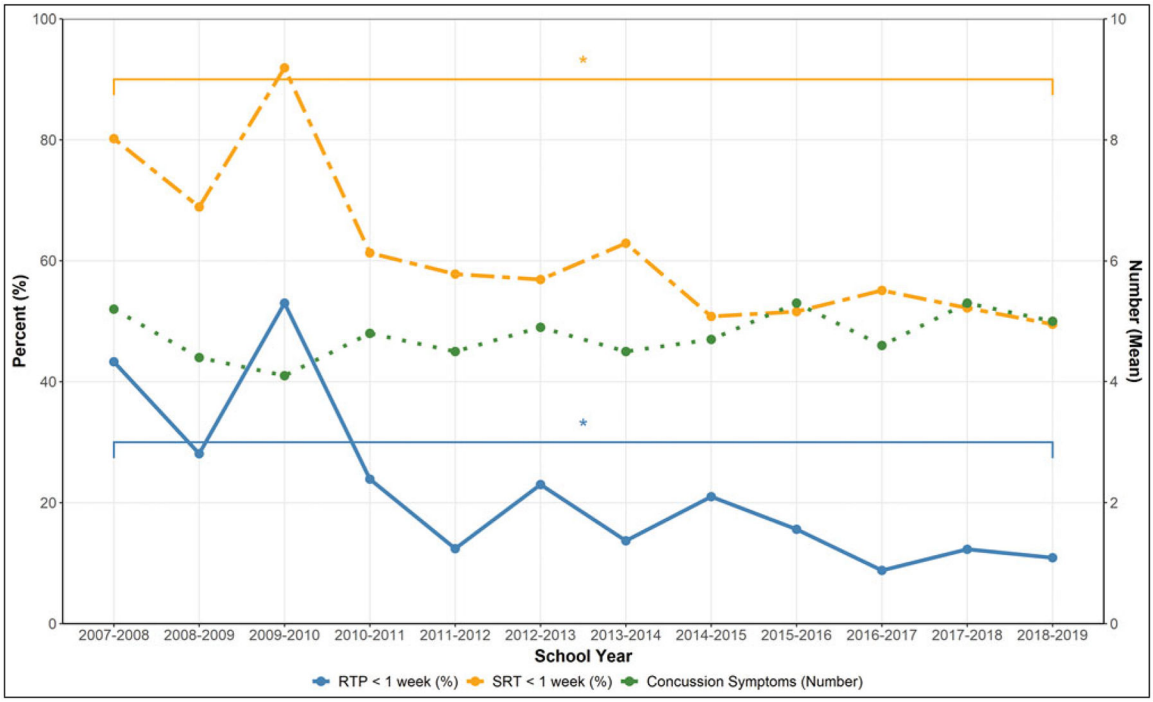

FIGURE 2.

Trends in Concussion Outcomes Among High School Varsity Female Athletes—High School Reporting Information Online (HS RIO) Surveillance System, Academic Years 2007–2008 Through 2018–2019

Abbreviations: RTP, return to play; SRT, symptom resolution time.

*Indicates a significant linear change. This figure is available in color online (www.JPHMP.com).

TABLE 1

Demographic Characteristics of Concussed High School Student Athletes by Sports Type—High School Reporting Information Online (HS RIO) Surveillance System, Academic Years 2007–2008 Through 2018–2019

	Football		Non-Football Male Sports[a]		Female Sports[b]		Total	
Characteristic	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**
Total	5189	44.9	2096	22.4	2631	32.7	9916	100
Age,y								
Mean	4273	15.6	1663	15.9	2203	15.6	8139	15.7
Sex								
Male	5175	99.7	2071	99.2	14	0.6	7260	67.2
Female	14	0.3	25	0.8	2617	99.4	2656	32.8
Level of play								
Varsity	2137	46.0	1144	63.1	1414	59.8	4695	54.4
JV	1622	33.4	652	30.3	898	33.8	3172	32.8
Freshman	1112	20.6	187	6.7	240	6.4	1539	12.7
Year in school								
Freshman	1572	31.4	575	26.1	797	31.1	2944	30.1
Sophomore	1359	26.5	533	26.2	731	28.5	2623	27.1
Junior	1184	23.1	471	25.1	589	23.9	2244	23.8
Senior	949	19.0	442	22.6	444	16.6	1835	19.0
Number of concussion symptoms								
Mean	5136	4.8	2074	4.7	2617	4.9	9827	4.8
Symptom resolution time								
<1 wk	3088	64.7	1238	64.2	1433	57.4	5759	62.2
≥1 wk	1784	35.3	727	35.8	1039	42.6	3550	37.8
Return to play								
<1 wk	659	16.7	255	16.8	306	17.4	1220	17.0
1–3 wk	2881	73.8	1206	75.8	1473	72.8	5560	73.9
>3 wk	350	9.5	127	7.4	195	9.9	672	9.1
Body mass index								
Mean	3643	25.3	1423	22.7	1825	22.2	6891	23.7

Characteristic	Football		Non-Football Male Sports[a]		Female Sports[b]		Total	
	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean
Presence of medical professional								
Yes	4341	95.4	1599	82.7	1982	82.5	7922	88.3
No	193	4.6	285	17.3	384	17.5	862	11.7

Abbreviation: JV, Junior Varsity.

[a]Sports (and frequencies) include soccer (n = 696; 11.4%), wrestling (n = 726; 5.4%), basketball (n = 486; 3.7%), and baseball (n = 188; 1.9%).

[b]Sports (and frequencies) include soccer (n = 1155; 19.6%), basketball (n = 770; 6.2%), volleyball (n = 410; 3.4%), and softball (n = 296; 3.5%).

TABLE 2

Bivariate Associations With Concussion Outcomes for the Team (Primary) Analysis—High School Reporting Information Online (HS RIO) Surveillance System, Academic Years 2007–2008 Through 2018–2019

	Number of Symptoms				SRT					
	Continuous				≤1 wk		≥1 wk			
Sport-Type Characteristics	**n**	**Weighted Percentage or Mean**	**Test Statistic**	***P***	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**	**Test Statistic**	***P***
Football										
Level of play			11.2	<.001					19.7	<.001
Freshman	1097	4.5			633	61.5	412	38.5		
JV	1614	4.8			923	61.5	606	38.5		
Varsity	2111	5.0			1348	68.8	651	31.2		
Body mass index			0.001	.0501					−1.7	.09
Continuous	5189	25.3			2285	25.2	1195	25.6		
Presence of medical professional			1.1	.26					4.1	.04
Yes	4299	4.8			2470	62.5	1601	37.5		
No	185	5.1			85	53.5	86	46.5		
Non-football male sports [a]										
Level of play			1.31	.27					4.3	.11
Freshman	183	4.7			114	68.3	63	31.7		
JV	649	4.5			366	60.4	235	39.6		
Varsity	1130	4.8			699	66.0	381	34.0		
Body mass index			0.001	.39					1.1	.29
Continuous	2096	22.7			866	22.9	496	22.6		
Presence of medical professional			−1.1	.29					2.8	.09
Yes	1580	4.7			919	63.9	572	36.1		
No	282	4.5			149	56.8	117	43.2		
Female sports [a]										
Level of play			0.33	.72					3.4	.18
Freshman	238	5.0			117	49.7	105	50.3		
JV	894	4.9			461	56.6	375	43.4		

Sport-Type Characteristics	Number of Symptoms				SRT					
	Continuous				≤1 wk		≥1 wk			
	n	Weighted Percentage or Mean	Test Statistic	*P*	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean	Test Statistic	*P*
Varsity	1406	4.8			818	58.8	525	41.2		
Body mass index			<0.001	.86					0.6	.52
Continuous	2631	22.2			1029	22.2	718	22.1		
Presence of medical professional			−0.50	.62					5.4	.02
Yes	1969	4.9			1074	57.6	786	42.4		
No	383	4.8			165	48.1	188	51.9		

Sport-Type Characteristics	RTP							
	≤1 wk		1–3 wk		≥3 wk			
	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean	n	Weighted Percentage or Mean	Test Statistic	*P*
Football								
Level of play							18.9	.001
Freshman	117	13.9	633	74.7	85	11.4		
JV	176	14.5	900	76.2	119	9.4		
Varsity	335	20.0	1154	71.8	120	8.2		
Body mass index							1.6	.20
Continuous	496	25.1	2078	25.3	230	25.9		
Presence of medical professional							0.5	.78
Yes	457	14.6	2420	75.5	301	10.0		
No	13	12.5	101	75.9	16	11.6		
Non-football male sportd [b]								
Level of play							5.1	.27
Freshman	19	13.6	124	77.5	13	8.9		
JV	66	16.8	364	73.6	36	9.6		
Varsity	155	17.5	662	76.8	64	5.7		
Body mass index							0.34	.71
Continuous	183	23.0	851	22.7	80	22.9		
Presence of medical professional							6.2	.04
Yes	167	15.3	913	77.8	98	6.9		

	RTP							
	≤1 wk		1–3 wk		≥3 wk			
Sport-Type Characteristics	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**	**n**	**Weighted Percentage or Mean**	**Test Statistic**	***P***
No	18	9.1	173	79.1	21	11.8		
Female sports [a]								
Level of play							11.9	.02
Freshman	26	15.6	131	73.2	23	11.2		
JV	75	12.2	517	78.0	70	9.9		
Varsity	192	19.8	789	70.4	96	9.7		
Body mass index							0.1	.90
Continuous	226	22.1	1057	22.2	127	22.2		
Presence of medical professional							0.6	.74
Yes	209	16.3	1100	74.2	141	9.6		
No	26	14.3	228	74.1	33	11.5		

Abbreviations: JV, Junior Varsity; RTP, return to play; SRT, symptom resolution time.

[a]Sports include soccer, volleyball, basketball, and softball.

[b]Sports include soccer, basketball, wrestling, and baseball.