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Substance Use and Sports- or Physical Activity-Related Concussions Among High School Students

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Abstract

History of concussion is associated with substance use. Data from the 2017 National Youth Risk Behavior Survey ($N = 14,765$) were used in this study to examine associations between sports- or physical activity-related concussions and current cigarette, alcohol, and marijuana use among high school students, and whether other factors moderate those associations. In addition to having played on a sports team, potential moderators examined included persistent feelings of sadness or hopelessness, hours of sleep, and serious difficulty concentrating, remembering, or making decisions. The association between sports- or physical activity-related concussions and current cigarette, alcohol, and marijuana use was significant when controlling for sex, grade, and race/ethnicity and the potential moderators with the exception of cigarette smoking while controlling for hours of sleep. Those involved in the care of high school students after a concussion may consider assessing current cigarette, alcohol, and marijuana use.

Keywords

high school; athlete health; concussion; substance use; school nurse

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Declaration of Conflicting Interests

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Adolescents who participate in sports (Eime et al., 2013) and are physically active (Janssen & LeBlanc, 2010) have been shown to accrue numerous psychological, social, and health benefits including reduced substance use. For example, studies show that physically active youth are less likely to report marijuana use (King, 2016). Other studies, however, suggest that youth who participate in team sports show more rapid growth in problem alcohol use (Mays et al., 2010) and that youth who participate in contact sports specifically are more likely to report recent and early use of alcohol, cigarettes, and marijuana (Veliz et al., 2015). These studies suggest that elements of team sports and contact sports may confound the generally positive relationship between participation in sports and lower substance use among adolescents. A further consideration with respect to team sports and contact sports is concussion, which is a mild form of traumatic brain injury (TBI; DePadilla et al., 2018; Marar et al., 2012; Veliz et al., 2017). Sports such as football, boys' ice hockey, boys' lacrosse, and girls' soccer show the highest rates of concussion per exposure, defined as participation in an athletic practice or competition (Marar et al., 2012). TBI ranges from mild to severe; the former generally resolves within a short period, while the latter can result in partial or permanent disability (Centers for Disease Prevention and Control, 2015). Studies find that a history of concussion is associated with substance use among youth (Ilie et al., 2014). Research also suggests that TBI in childhood or adolescence appears to increase the likelihood of later alcohol abuse (Weil et al., 2016). Additionally, cross-sectional studies among adolescents have found that lifetime TBI is positively associated with past 12-month daily smoking, drinking alcohol and binge drinking, marijuana use, nonmedical use of opioid pain relievers, and problems with drug use (e.g., using drugs while driving, getting in trouble while using drugs; Ilie et al., 2014; Ilie, Boak, et al., 2015; Ilie, Mann, et al., 2015).

Given that factors such as depression or sadness (Bierhoff et al., 2019; Howard et al., 2019), sleep problems (McKnight-Eily et al., 2011; Mike et al., 2016), and difficulty concentrating (Bierhoff et al., 2019; Lee et al., 2011) are potential sequelae of concussions (Centers for Disease Control and Prevention [CDC], 2019) that are also associated with substance use among youth, it is possible that the association between concussions and substance use is stronger among youth who experience these factors. Additionally, it is also possible that sports team participation impacts the strength of the association between concussion and substance use, given that it has demonstrated associations with both health issues (DePadilla et al., 2018; Veliz et al., 2015). Understanding whether these other health factors or sports team participation moderate the association between concussions and substance use may further our understanding about the association among adolescents, which may help to identify students at greater risk for substance use following a concussion.

This study utilized data from the 2017 National Youth Risk Behavior Survey (YRBS) to examine two research questions. (1) Is a self-reported sports- or physical activity-related concussion during the 12 months before the survey associated with cigarette, alcohol, or marijuana use during the 30 days before the survey? (2) Do factors such as having played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep, or serious difficulty concentrating, remembering, or making decisions moderate the association between experiencing a concussion and substance use?

Method

Sample and Survey Administration

The YRBS is a biennial, cross-sectional, and school-based survey that uses a three-stage cluster sampling design to produce a nationally representative sample of public and private school students in Grades 9–12. Following local parent permission procedures, students voluntarily complete an anonymous, self-administered questionnaire during one class period and record their responses on a computer-scannable answer sheet. An institutional review board (IRB) at CDC approved the protocol for the National YRBS (CDC IRB Approval of Continuation of Protocol #1969.0, “National Youth Risk Behavior Survey”). Additional details regarding YRBS sampling and psychometric properties are described elsewhere (Brener et al., 2002, 2013). In 2017, the school response rate was 75%, the student response rate was 81%, the overall response rate (The School Response Rate × The Student Response Rate) was 60%, and the sample size was 14,765 (Kann et al., 2018).

Variables

To assess self-reported sports- or physical activity-related concussion, the questionnaire provided respondents with the following definition: “A concussion is when a blow or a jolt to the head causes problems such as headaches, dizziness, being dazed or confused, difficulty remembering or concentrating, vomiting, blurred vision, or being knocked out.” Then respondents were asked, “During the past 12 months, how many times did you have a concussion from playing a sport or being physically active?” Given the distribution of the responses (84.9% = 0, 9.1% = 1, 6.0% = more than 1), the variable was dichotomized (0 vs. 1 or more) for this analysis. The dependent variables were current cigarette, alcohol, and marijuana use, with current use defined as use during the 30 days before the survey (see Table 1 for question wording, response categories, and analytic coding).

This study examined whether the following were potential moderators of the association between self-reported sports- or physical activity-related concussions and current cigarette, alcohol, and marijuana use: having played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep, and serious difficulty concentrating, remembering, or making decisions. Played on a sports team was defined as having played on one or more teams run by the student’s school or community group. Persistent feelings of sadness or hopelessness was defined as feeling so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities. Hours of sleep was measured as hours of sleep on an average school night. Serious difficulty concentrating, remembering, or making decisions was defined as having serious difficulty concentrating, remembering, or making decisions because of a physical, mental, or emotional problem.

The following demographic variables were included in this analysis: sex (male, female), grade (9, 10, 11, 12), and race/ethnicity (non-Hispanic White [“White”], non-Hispanic Black [“Black”], and Hispanic [which could be of any race]). The numbers of students from other racial/ethnic groups was too small for meaningful analysis and are not presented but remained in the analytic sample.

Statistical Analysis

First, prevalence estimates for current cigarette, alcohol, and marijuana use were calculated by sex, grade, race/ethnicity, sports- or physical activity-related concussion, and by the potential moderators: played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep, and serious difficulty concentrating, remembering, or making decisions. Second, χ^2 analyses identified whether there was an association between current cigarette, alcohol, or marijuana use and demographic variables, sports- or physical activity-related concussions, and the potential moderators. When χ^2 tests were significant for variables with more than two levels, *t* tests were used for pairwise comparisons.

Third, a series of logistic regression models were examined. The first set of models (Models A and B) used unadjusted and then adjusted (for sex, grade, and race/ethnicity) logistic regression, respectively, to assess the association between reporting a sports- or physical activity-related concussion and current cigarette, alcohol, or marijuana use. The next set of models used logistic regression (controlling for sex, grade, and race/ethnicity) to assess the association between sports- or physical activity-related concussions and cigarette, alcohol, or marijuana use; accounting for played on a sports team (Model C); persistent feelings of sadness or hopelessness (Model D); hours of sleep (Model E); and serious difficulty concentrating, remembering, or making decisions (Model F). Interaction effects were tested in Models C, D, E, and F to assess whether played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep, or serious difficulty concentrating, remembering, or making decisions moderated the association between sports- or physical activity-related concussions and current cigarette, alcohol, and marijuana use.

A weighting factor was applied to each record to adjust for school and student nonresponse and oversampling of Black and Hispanic students. Missing data were not imputed. SAS-callable SUDAAN Version 11.0.1 (Research Triangle Institute, Research Triangle Park, NC), which took into account the complex sampling design and sampling weights, was used to conduct all statistical analyses.

Results

YRBS data showed that overall, the prevalence of current cigarette smoking was 8.8%, current alcohol use was 29.8%, and current marijuana use was 19.8% (Table 2). The prevalence of current cigarette, alcohol, and marijuana use varied significantly by sex, grade, race/ethnicity, having experienced a sports- or physical activity-related concussion, played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep, and serious difficulty concentrating, remembering, or making decisions.

The association between sports- or physical activity-related concussions and current cigarette (adjusted odds ratio [aOR] = 1.7, CI [1.4, 2.0]), alcohol (aOR = 2.0, CI [1.6, 2.4]), and marijuana use (aOR = 1.7, CI [1.4, 2.0]) was significant and remained significant when controlling for sex, grade, and race/ethnicity (Table 3; Model B).

After accounting for played on a sports team, reporting a sports- or physical activity-related concussion remained significantly associated with current cigarette smoking (aOR = 1.9,

CI [1.4, 2.7]), current alcohol use (aOR = 1.8, CI [1.3, 2.6]), and current marijuana use (aOR = 2.1, CI [1.4, 3.2]; Table 3; Model C). After accounting for persistent feelings of sadness or hopelessness, reporting a sports- or physical activity-related concussion remained significantly associated with current cigarette smoking (aOR = 1.5, CI [1.2, 1.9]), current alcohol use (aOR = 2.0, CI [1.7, 2.5]), and current marijuana use (aOR = 1.4, CI [1.1, 1.8]; Table 3; Model D).

After accounting for hours of sleep, reporting a sports- or physical activity-related concussion remained significantly associated with current alcohol use (aOR = 2.0, CI [1.6, 2.6]) and current marijuana use (aOR = 1.5, CI [1.1, 2.0]), but not with cigarette smoking (Table 3; Model E). Finally, after accounting for serious difficulty concentrating, remembering, or making decisions, reporting a sports- or physical activity-related concussion remained significantly associated with current cigarette smoking (aOR = 1.6, CI [1.2, 2.1]), current alcohol use (aOR = 2.1, CI [1.6, 2.7]), and current marijuana use (aOR = 1.6, CI [1.2, 2.1]; Table 3; Model F). No significant interaction effects were found between sports- or physical activity-related concussions and played on a sports team, persistent feelings of sadness or hopelessness, hours of sleep or serious difficulty concentrating, remembering, or making decisions on cigarette, alcohol, and marijuana use.

Discussion

In previous studies, experiencing a concussion has been associated with substance use among adolescents (Ilie et al., 2014). Sadness, sleep problems, and difficulty concentrating are commonly found among people who have experienced a concussion (CDC, 2019) and also are associated with substance use among adolescents (Bierhoff et al., 2019; Howard et al., 2019; Lee et al., 2011; McKnight-Eily et al., 2011; Mike et al., 2016). This study found that reporting a sports- or physical activity-related concussion during the 12 months before the survey was associated with current cigarette, alcohol, and marijuana use even after accounting for having played on a sports team, persistent feelings of sadness or hopelessness, or serious difficulty concentrating, remembering, or making decisions. Additionally, reporting a sports- or physical activity-related concussion was associated with current alcohol and marijuana use even after accounting for hours of sleep. There was not, however, a significant interaction effect between any of the potential moderators and concussions on current cigarette, alcohol, and marijuana use.

Finding that reporting a sports- or physical activity-related concussion was associated with current substance use is consistent with research among a birth cohort of adolescents that found that experiencing a mild TBI before age 16 was associated with increased risk of hazardous alcohol use at age 17 (Kennedy et al., 2017). Cross-sectional data also have shown that adolescents who reported experiencing a TBI during their lifetime were more likely to report cigarette, alcohol, and marijuana use (Ilie et al., 2014). It has been hypothesized, however, that TBI and substance use are both associated with other unknown or unmeasured factors, such as having risk-taking personality traits (Allen et al., 2016). Indeed, risky behavior in adolescence (Pharo et al., 2011), including playing sports with greater risk of injury (McEwan et al., 2019), has been associated with the traits of impulsivity, sensation seeking, and aggression (McEwan et al., 2019; Pharo et al., 2011).

One study of adolescents, however, examined whether alcohol use was predictive of TBI during the past 12 months due to sports injuries compared to TBI due to other causes and did not find an association (Ilie, Boak, et al., 2015). It may be that sensation seeking is predictive of risk-taking that may result in a TBI more generally and, therefore, not specific to the activity in which the TBI was experienced, such as sports. Finally, based on the findings of this study, sports team participation was negatively associated with cigarette smoking, independent of whether a student reported a sports- or activity-related concussion, suggesting that the association between sports team participation and substance use may vary by the substance.

Interactions between concussions and the potential moderators were not significant in the models predicting current substance use. However, consistent with the literature (Bierhoff et al., 2019; Howard et al., 2019; Lee et al., 2011; McKnight-Eily et al., 2011; Mike et al., 2016), persistent feelings of sadness or hopelessness, hours of sleep, and serious difficulty concentrating, remembering, or making decisions were significantly associated predictors in the majority of the models predicting cigarette, alcohol, and marijuana use, in some cases with larger effect sizes than reporting a concussion. This indicates the importance of considering symptom presentation when a concussion is reported as these factors accounted for variability in the substance use outcomes, independent of self-reported concussion. Interestingly, although potential symptoms of a TBI include cognitive and emotional symptoms as well as sleep disturbances (CDC, 2019), the only evidence of confounding between TBI and the potential moderators was that reporting a concussion was no longer associated with cigarette smoking when accounting for hours of sleep.

Limitations

These data are generalizable only to students enrolled in school. Nationwide, in 2013, of persons aged 16–17 years, approximately 5% were not enrolled in high school and lacked a high school credential (McFarland et al., 2016). Given that the data are self-reported, we do not know the extent of underreporting or overreporting of behaviors or experiences included in this study, and these students' self-reported concussions were not validated (e.g., through medical record review). In general, however, YRBS questions demonstrate good test–retest reliability (Brener et al., 2002). Students may have reported concussions that occurred prior to the 12 months before the survey (Jobe et al., 1993) or attributed a symptom provided in the definition of a concussion that is common when a concussion has not occurred, such as a headache (Mailer et al., 2008). Additionally, it is unknown what proportion of concussions occurred during organized sports participation versus another type of physical activity. Finally, the study was cross-sectional, consequently, these data do not allow for a determination of whether the concussion occurred before or after the substance use, or how much time elapsed between the concussion and the substance use.

Implications for School Nurse Practice

The findings of this study suggest that there is an association between reporting a sports- or physical activity-related concussion and current cigarette, alcohol, and marijuana use. These associations remained significant even after accounting for having played on a sports

team, persistent feelings of sadness or hopelessness, and serious difficulty concentrating, remembering, or making decisions. The consistency of significant associations between TBI and multiple types of substance use in this study and others is cause for concern. For example, recovery after TBI can be negatively impacted among those who continue to use alcohol (Weil et al., 2016). One of the seven core roles for school nurses identified by the National Association of School Nurses is promoting health through health education, affirming that nurses can play a critical role in educating students about substance use (Council on School Health, 2008). Further, school nurses can also provide concussion prevention education (Diaz & Wyckoff, 2013), and qualitative research has shown that school nurses can be critical in supporting students after a concussion (Sarmiento et al., 2019). Due to the lack of visible signs indicating a concussion has occurred, it is hypothesized that initially, face-to-face communication may be more beneficial in managing the injury (Weber Rawlins et al., 2020). School nurses and athletic trainers are often among the on-site health care providers in secondary schools (Weber et al., 2018; Welch Bacon et al., 2017), suggesting that school nurses may have more opportunities to assess students' well-being after a concussion than other health care providers. School nurses also play a critical concussion management role by serving as a liaison between school, home, and a child's doctor (CDC, 2018). School nurses can ensure that a child's concussion is managed properly and oversee the implementation of academic supports and care plans upon returning to school (Blackwell et al., 2017; CDC, 2018). They can also collaborate with other stakeholders, including athletic trainers, on returning to activity (Diaz & Wyckoff, 2013), even though they may not oversee the return-to-play progression directly (Weber et al., 2018). This study also found that persistent feelings of sadness or hopelessness, getting less than 7 hours of sleep, and serious difficulty concentrating, remembering, or making decisions were consistently associated with an increase in the odds of substance use in models that included reporting a sports- or physical activity-related concussion. Therefore, school nurses involved in the care of high school students after a concussion might ask about symptom presentation and current cigarette, alcohol, and marijuana use if substance use is a concern and counsel students that using substances may delay their recovery (Weil et al., 2016). If a substance use disorder is identified, referral to a specialist in substance use treatment may be warranted. Research examining the role of school nurses in concussion prevention and management is needed to better understand the challenges they face and how they can be better supported through tools and education (Weber Rawlins et al., 2020).

Conclusion

The findings of this study suggest that the assessment of substance use and concussion symptoms may be warranted among athletes who experience a concussion. Future studies can examine whether there are other symptoms or behaviors that can help us understand the association in order to better identify risk or protective factors for substance use in the context of concussion.

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Table 1. Variable Names, Question Wording, and Response Options—Youth Risk Behavior Survey, 2017.

Variable Name	Question	Response Options	Analytic Coding(s)
Current cigarette smoking	During the past 30 days, on how many days did you smoke cigarette?	"0 days," "1 or 2 days," "3–5 days," "6–9 days," "10–19 days," "20–29 days," and "all 30 days"	0 days 1 days
Current alcohol use	During the past 30 days, on how many days did you have at least one drink of alcohol?	"0 days," "1 or 2 days," "3–5 days," "6–9 days," "10–19 days," "20–29 days," and "all 30 days"	0 days 1 days
Current marijuana use	During the past 30 days, how many times did you use marijuana?	"0 times," "1 or 2 times," "3–9 times," "10–19 times," "20–39 times," and "40 or more times"	0 times 1 times
Played on a sports team	During the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)	"0 teams, 1 team, 2 teams, and 3 or more teams"	0 teams 1 team
Persistent feelings of sadness or hopelessness	During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities	"Yes" and "No"	Yes No
Hours of sleep	On an average school night, how many hours of sleep do you get?	"4 or less hrs," "5 hrs," "6 hrs," "7 hrs," "8 hrs," "9 hrs," and "10 or more hrs"	<7 hrs, 7–8 hrs 9 hrs
Serious difficulty concentrating, remembering, or making decisions	Because of a physical, mental, or emotional problem, do you have serious difficulty concentrating, remembering, or making decisions?	"Yes" and "No"	Yes No
Sports- or physical activity–related concussion	During the past 12 months, how many times did you have a concussion from playing a sport or being physically active?	"0 times," "1 time," "2 times," "3 times," and "4 or more times"	0 times 1 times

Table 2.

Descriptive Statistics and Associations Between Study Variables and Substance Use—Youth Risk Behavior Survey, 2017.^a

Variables	Respondents % [95% CI] ^b	Current Cigarette, Alcohol, and Marijuana Use		
		Current Cigarette Smoking % [95% CI] ^c	Current Alcohol Use % [95% CI] ^c	Current Marijuana Use % [95% CI] ^c
Total		8.8 [7.2, 10.7]	29.8 [27.3, 32.4]	19.8 [18.1, 21.6]
Demographics				
Sex				
Female	50.7 [48.1, 53.3]	7.8 [6.0, 9.9]	31.8 [28.7, 35.1]	19.6 [17.4, 22.0]
Male	49.3 [46.7, 51.9]	9.8 [8.3, 11.6]	27.6 [25.1, 30.1]	20.0 [18.2, 21.8]
<i>p</i> Value	.003	<.001		.75
Grade				
9	27.3 [25.7, 29.0]	5.2 [3.8, 7.0]	18.8 [16.4, 21.4]	13.1 [11.1, 15.4]
10	25.7 [24.6, 26.8]	7.6 [6.2, 9.3]	27.0 [23.9, 30.4]	18.7 [16.9, 20.7]
11	23.9 [23.3, 24.6]	9.5 [7.4, 12.0]	34.4 [31.1, 37.9]	22.6 [20.2, 25.2]
12	23.1 [22.0, 24.2]	13.4 [10.9, 16.2]	40.8 [37.0, 44.8]	25.7 [22.9, 28.7]
<i>p</i> Value	<.001 ^d	<.001 ^d		<.001 ^d
Race/ethnicity ^e				
White, non-Hispanic	59.6 [54.3, 64.7]	11.1 [9.0, 13.6]	32.4 [29.0, 36.0]	17.7 [15.5, 20.0]
Black, non-Hispanic	14.9 [12.2, 18.1]	4.4 [3.2, 5.9]	20.8 [16.6, 25.8]	25.3 [22.9, 27.9]
Hispanic	25.5 [21.3, 30.1]	7.0 [5.8, 8.6]	31.3 [28.3, 34.5]	23.4 [19.9, 27.4]
<i>p</i> Value	<.001 ^f	<.001 ^g		<.001 ^h
Sports- or physical activity-related concussions				
No concussion	84.9 [83.4, 86.4]	8.0 [6.5, 9.8]	27.9 [25.5, 30.4]	18.5 [16.8, 20.3]
One or more concussions	15.1 [13.6, 16.6]	12.8 [10.7, 15.3]	41.3 [37.1, 45.7]	27.1 [24.6, 29.8]
<i>p</i> Value	<.001	<.001		<.001
Potential moderators				
Played on a sports team				
Yes	54.3 [50.6, 58.0]	6.9 [5.8, 8.1]	31.7 [29.1, 34.5]	19.2 [17.6, 21.0]
No	45.7 [42.0, 49.4]	10.9 [8.2, 14.3]	27.9 [24.8, 31.2]	20.5 [17.9, 23.4]

Variables	Respondents % [95% CI] ^b	Current Cigarette, Alcohol, and Marijuana Use		
		Current Cigarette Smoking % [95% CI] ^c	Current Alcohol Use % [95% CI] ^c	Current Marijuana Use % [95% CI] ^c
<i>p</i> Value		.003	.019	.321
Persistent feelings of sadness or hopelessness				
Yes	31.5 [29.6, 33.4]	14.7 [11.5, 18.5]	41.3 [38.2, 44.5]	30.4 [27.8, 33.2]
No	68.5 [66.6, 70.4]	6.1 [5.1, 7.2]	24.7 [22.4, 27.2]	14.8 [13.2, 16.6]
<i>p</i> Value		<.001	<.001	<.001
Hours of sleep				
<7	45.7 [43.6, 47.9]	11.3 [8.5, 14.9]	35.3 [31.6, 39.1]	24.4 [22.0, 27.0]
7-8	48.3 [46.3, 50.3]	6.2 [5.1, 7.4]	26.2 [23.6, 29.0]	15.7 [13.9, 17.7]
9	6.0 [5.2, 6.9]	9.8 [7.5, 12.8]	20.3 [17.3, 23.7]	16.0 [12.8, 19.8]
<i>p</i> Value		<.001ⁱ	<.001^j	<.001^k
Serious difficulty concentrating, remembering, or making decisions				
Yes	32.0 [30.1, 34.0]	14.0 [11.3, 17.3]	37.6 [34.7, 40.5]	27.3 [25.4, 29.3]
No	68.0 [66.0, 69.9]	6.8 [5.7, 8.1]	27.2 [24.6, 30.1]	16.4 [14.5, 18.6]
<i>p</i> Value		<.001	<.001	<.001

Note. Boldface indicates statistical significance ($p < .05$). χ^2 *p* values are presented. When χ^2 tests were significant for variables with more than two levels, *t* tests were used for pairwise comparisons. CI = confidence intervals.

^aWeighted percentages are presented.

^bColumn percentages are presented.

^cRow percentages are presented.

^dPrevalence among ninth-grade students was significantly lower than among 10th-, 11th-, and 12th-grade students. Prevalence among 10th-grade students was significantly lower than among 11th- and 12th-grade students.

^eThe racial/ethnic distribution does not add up to 100% because the sample sizes for other racial/ethnic subgroups were too small for meaningful inferential analysis and are not presented here.

^fPrevalence among non-Hispanic, White students was significantly higher than among non-Hispanic, Black and Hispanic students. Prevalence among Hispanic students was significantly higher than among non-Hispanic, Black students.

^gPrevalence among non-Hispanic, White students was significantly higher than among non-Hispanic, Black students. Prevalence among Hispanic students was significantly higher than among non-Hispanic, Black students.

^hPrevalence among non-Hispanic, White students was significantly lower than among non-Hispanic, Black, and Hispanic students.

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^jPrevalence among students who slept less than 7 hrs was significantly higher than among those who slept 7–8 hrs. Prevalence among students who slept 7–8 hrs was significantly lower than among those who slept greater than 9 hrs.

^jPrevalence among students who slept less than 7 hrs was significantly higher than among those who slept 7–8 hrs and those who slept greater than 9 hrs. Prevalence among students who slept 7–8 hrs was significantly higher than among those who slept greater than 9 hrs.

^kPrevalence among students who slept less than 7 hrs was significantly higher than among those who slept 7–8 hrs and those who slept greater than 9 hrs.

Table 3.

Association Between Substance Use and Potential Moderators—Youth Risk Behavior Survey, 2017.

Models	Current Use of Cigarettes aOR [95% CI]	Current Use of Alcohol aOR [95% CI]	Current Use of Marijuana aOR [95% CI]
Model A			
Sports- or physical activity-related concussions			
Yes	1.7 [1.4, 2.0]	1.8 [1.6, 2.1]	1.6 [1.4, 1.9]
No	1.0	1.0	1.0
Model B ^a			
Sports- or physical activity-related concussions			
Yes	1.7 [1.4, 2.0]	2.0 [1.6, 2.4]	1.7 [1.4, 2.0]
No	1.0	1.0	1.0
Model C ^{a,b}			
Sports- or physical activity-related concussions			
Yes	1.9 [1.4, 2.7]	1.8 [1.3, 2.6]	2.1 [1.4, 3.2]
No	1.0	1.0	1.0
Played on a sports team			
Yes	0.5 [0.4, 0.7]	1.2 [1.0, 1.4]	0.9 [0.7, 1.0]
No	1.0	1.0	1.0
Model D ^{a,b}			
Sports- or physical activity-related concussions			
Yes	1.5 [1.2, 1.9]	2.0 [1.7, 2.5]	1.4 [1.1, 1.8]
No	1.0	1.0	1.0
Persistent feelings of sadness or hopelessness			
Yes	2.8 [2.0, 3.9]	2.1 [1.9, 2.5]	2.6 [2.2, 3.1]
No	1.0	1.0	1.0
Model E ^{a,b}			
Sports- or physical activity-related concussions			
Yes	1.3 [0.9, 1.9]	2.0 [1.6, 2.6]	1.5 [1.1, 2.0]
No	1.0	1.0	1.0
Hours of sleep			
<7	1.7 [1.3, 2.3]	1.4 [1.2, 1.7]	1.5 [1.3, 1.7]
7–8	1.0	1.0	1.0
9	1.8 [1.1, 2.9]	0.7 [0.6, 0.9]	0.9 [0.7, 1.2]
Model F ^{a,b}			
Sports- or physical activity-related concussions			
Yes	1.6 [1.2, 2.1]	2.1 [1.6, 2.7]	1.6 [1.2, 2.1]
No	1.0	1.0	1.0
Serious difficulty concentrating, remembering, or making decisions			
Yes	2.5 [1.9, 3.2]	1.6 [1.3, 1.9]	1.9 [1.6, 2.3]

Models	Current Use of Cigarettes aOR [95% CI]	Current Use of Alcohol aOR [95% CI]	Current Use of Marijuana aOR [95% CI]
No	1.0	1.0	1.0

Note. Boldface indicates statistical significance ($p < .05$). aOR = adjusted odds ratios; CI = confidence intervals.

^aModels were adjusted for sex, grade, and race/ethnicity.

^bInteractions between potential moderators and sports- or physical activity-related concussions were tested and none were found to be statistically significant.

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