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Sports-Related Concussions and Adverse Health Behaviors Among Middle and High School Students

Kelly Sarmiento, MPH^{*†}, Gabrielle F. Miller, PhD[†], Sherry Everett Jones, PhD, MPH, JD[‡]

[†]Division of Injury Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia, USA.

[‡]Division of Adolescent and School Health, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention, Atlanta, Georgia, USA.

Abstract

Background: Concussions affect millions of youths in the United States each year, and there is concern about long-term health effects from this injury.

Purpose: To examine the association between sports- or physical activity–related concussion and health risk behaviors among middle and high school students in 9 states.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: Data from the 2019 middle school and high school Youth Risk Behavior Survey were used for this analysis. Nine states were identified that included the same question on concussion and similar questions on health risk behaviors in their 2019 Youth Risk Behavior Survey. Students were asked to self-report whether they had 1 sports- or physical activity–related concussions during the 12 months preceding the survey. Self-reported concussion was the primary outcome of interest. Other variables included sex, race/ethnicity, played on a sports team, were physically active 5 or more days/week, ever tried cigarette smoking, ever used an electronic vapor product, academic grades, drank alcohol, were in a physical fight, seriously considered attempting suicide, made a suicide plan, and attempted suicide.

Results: Among the 9 states, 18.2% of middle school students and 14.3% of high school students self-reported 1 sports- or physical activity–related concussions. Among both middle school and high school students, the prevalence of 1 sports- or physical activity–related concussions was higher among students who played on a sports team, were physically active 5 or more days per week, had ever tried cigarette smoking, had ever used an electronic vapor product, had seriously considered attempting suicide, had made a suicide plan, and had attempted suicide compared with those who had not engaged in those behaviors. The prevalence of sports- or

*Address correspondence to Kelly Sarmiento, MPH, Division of Injury Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Atlanta, GA 30341, USA (ksarmiento@cdc.gov). Investigation performed at Centers for Disease Control and Prevention, Atlanta, Georgia, USA

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physical activity–related concussion was consistently higher among middle school students than high school students across sex, race/ethnicity, and adverse health behaviors.

Conclusion: Middle school students with a history of concussion warrant attention as an at-risk population for concussions and adverse health behaviors. Health care providers may consider screening students for adverse health behaviors during preparticipation examinations and concussion evaluations.

Keywords

traumatic brain injury; YRBS; brain; injury; sport

A concussion is caused by an external force to the head or body and is associated with neuronal dysfunction involving a cascade of ionic, metabolic, and physiologic events.^{14,17,31,33} This cascade, as well as microscopic axonal dysfunction, may lead to clinical signs and symptoms, such as headache, nausea, irritability, sadness, difficulty concentrating, and sleeping more or less than usual.^{6,14} For most youth, concussion symptoms resolve within 1 to 3 months.² However, youth with a history of > 1 concussion are more likely to experience a longer recovery and more severe symptom presentation.^{10,32,35,36}

Compared with adults, high school– and middle school–aged athletes are more susceptible to sports- or physical activity–related concussion due to greater participation in contact sports (eg, football).⁹ Larger head-to-body size ratio, weaker neck muscles, increased risk of posttraumatic seizures, and age-specific differences in cerebral blood flow and metabolism in the developing brain may also increase vulnerability of youth to concussion and the potential for a prolonged recovery.^{19,39,40} As such, the guidelines on sports- or physical activity–related concussion recommend a more conservative approach to management and return to sports for youth.^{11,15,32} Furthermore, all states and the District of Columbia have passed laws addressing sports- or physical activity–related concussion (often referred to as return-to-play laws) focused on youth athletes (high school age and under) that generally contain requirements on concussion education and medical clearance after a sports- or physical activity–related concussion. These laws were primarily created to reduce the risk for adverse health outcomes among youth athletes after a concussion, and research has suggested that schools are able to comply with these laws.⁴⁴

Self-report of a sports- or physical activity–related concussion may be associated with adverse health behaviors among high school students.^{12,27,28,34} For example, studies have found that self-reported sports- or physical activity–related concussion among high school students are associated with suicidality (ie, seriously considered attempting suicide, made a suicide plan, or attempted suicide),³⁴ substance use (ie, cigarette, alcohol, and marijuana use),¹² engagement in violence-related behaviors (ie, physical fighting and carrying of a weapon at school),²⁷ and cognitive and academic impairment.²⁸ Mantey et al³⁰ found an association between suicidality and sports- or physical activity–related concussion among middle school students. To our knowledge, there are no other published studies that have examined the association between sports- or physical activity–related concussion and adverse health behaviors among middle school students. Furthermore, it is unclear if middle

school students differ from high school students regarding associations between sports- or physical activity–related concussion and adverse health behaviors.

In 2019, 9 states administrated questions on their middle school and high school Youth Behavior Risk Surveys (YRBSs) on sports- or physical activity–related concussion, as well as adverse health behaviors. This study examined the prevalence of self-reported sports- or physical activity–related concussion (during the 12 months before the survey) among both middle school and high school students in these 9 states. In addition, this study explored whether sports- or physical activity–related concussion prevalence differed by demographics (sex, race/ethnicity), health behavior categories (participating in team sports, being physically active 5 or more days/week, performing well academically), and adverse health behaviors (tobacco use, vaping, physical fighting, suicidality) in these 9 states.

METHODS

Sample and Survey Administration

The YRBS is a system of surveys conducted at the national, state, territorial, tribal, and large urban school district levels. The YRBS is a biennial, school-based survey that monitors health risk behaviors and experiences primarily among high school students in grades 9 to 12. In some jurisdictions, middle school students in grades 6 to 8 also participate in the survey. Each jurisdiction uses an independent 2-stage cluster sample design to obtain representative samples of middle school or high school students in their jurisdiction. Student participation in the YRBS is anonymous and voluntary. After local parent permission requirements are met, students complete a self-administered pencil-and-paper questionnaire during a regular class period and record their responses on a computer-scannable answer sheet. The Centers for Disease Control and Prevention (CDC) institutional review board determined that CDC-funded state, tribal, territorial, and large urban school district YRBS activities are public health practice and not research; therefore, these YRBS activities are not bound by federal Department of Health and Human Services institutional review board regulations for the protection of human participants.

This study included middle school and high school YRBS data from the 9 states that included the same question about sports- or physical activity–related concussion. An additional 10 YRBS questions addressing student behaviors, of which 5 varied slightly in wording between the middle and high school questionnaires and reference periods (eg, “Have you ever had a drink of alcohol, other than a few sips?” [question in the middle school YRBS]; “During the past 30 days, on how many days did you have at least one drink of alcohol?” [question in the high school YRBS]), were assessed (Table 2). Across the 9 states in 2019, the school response rates for the middle school YRBSs ranged from 70% to 100%, the student response rates ranged from 76% to 89%, the overall response rates (computed as the number of participating schools/number of eligible sampled schools and the number of usable questionnaires/number of eligible students sampled in participating schools) ranged from 60% to 85%, and the unweighted sample sizes ranged from 1571 to 27,299 (Table 1). Across the 9 states, the school response rates for the high school YRBSs ranged from 83% to 100%, the student response rates ranged from 66% to 88%, the overall response rates ranged from 66% to 82%, and the unweighted sample sizes ranged from 1403

to 41,091. All jurisdictions include regular public school students in their sample; however, some jurisdictions include other types of schools (eg, charter, Bureau of Indian Education). Additional details regarding the YRBS methodology are described elsewhere.⁴

Measures

Respondents were asked their sex (female or male) and their race and ethnicity. Students were classified into 4 racial/ethnic categories: White, non-Hispanic (“White”); Black, non-Hispanic (“Black”); Hispanic or Latino of any race (“Hispanic”); and other or multiple races. The numbers of students in the other or multiple racial/ethnic groups were too small for meaningful analysis; therefore, those data are not presented, although they remain in the analytic sample.

The primary outcome of interest for this analysis was self-reported sports- or physical activity–related concussion during the 12 months before the survey. The middle and high school YRBS questionnaires provided the following definition of concussion: “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 students were asked, “During the past 12 months, how many times did you have a concussion from playing a sport or being physically active?” Response options were “0 times,” “1 time,” “2 times,” “3 times,” and “4 or more times.” Data are presented as 1 times and 2 times.

The questions used in this analysis covered the following topics: sports team participation (0 teams vs 1 teams), physical activity level (physically active at least 60 minutes each day for 5 days vs 0–4 days), alcohol use, participation in a physical fight, suicidality (seriously considered attempting suicide, made a suicide plan [yes vs no], and attempted suicide [0 times vs 1 times]), and academic grades (mostly As or Bs vs mostly Cs, Ds, or Fs). Students were also asked if they have ever tried cigarette smoking and ever used an electronic vapor product (Table 2).

Analysis

A weight based on student sex, race/ethnicity, and grade was applied to each record to adjust for school and student nonresponse. The prevalence of having had a sports- or physical activity–related concussion was computed overall by sex and race/ethnicity and by each of the aforementioned student behaviors. Missing data were not imputed. To account for the complex sample design and weighting, SAS-callable SUDAAN Version 11.0.1 (Research Triangle Institute) was used to conduct all statistical analyses. Chi-square tests were used to examine differences in sports- or physical activity–related concussion prevalence within a school level and across school levels. Differences within and across schools were only examined among questions that were worded the same, including academic grades, sports- or physical activity–related concussion, played on a sports team, were physically active 5 or more days/week, ever tried cigarette smoking, and ever used an electronic vapor product. For the remaining 5 questions, differences were only examined within a school level. Estimates were considered statistically significant when $P < .05$. To ensure data from Maryland and Vermont were not driving the study findings because of their large sample

sizes, we conducted a sensitivity test by removing data from those 2 states and rerunning the statistical tests. Conclusions from the significance testing without those 2 states did not change; therefore, all states were included in the sample, and those overall findings are presented.

RESULTS

Prevalence of Self-Reported Sports- or Physical Activity–related Concussion by School Level and State

Overall, 18.2% of middle school students and 14.3% of high school students self-reported 1 sports- or physical activity–related concussions during the previous 12 months. This ranged from 16.0% in Pennsylvania to 21.5% in New Mexico among middle school students and 13.1% in Pennsylvania to 19.5% in New Mexico among high school students (Table 3). Overall, 9.1% of middle school students and 6.2% of high school students self-reported 2 sports- or physical activity–related concussions during the previous 12 months, with a range from 6.6% in Vermont to 11.3% in New Mexico among middle school students and 4.5% in Pennsylvania to 9.5% in New Mexico among high school students.

Prevalence of Sports- or Physical Activity–Related Concussions Among Middle and High School Students by Sex, Race, and Academic Grades

Male students had a higher prevalence of 1 self-reported sports- or physical activity–related concussions compared with female students in both middle and high school (Table 4). Also, among both female and male students, the prevalence of having 1 sports- or physical activity–related concussions was higher among middle school students than among high school students. Among all racial/ethnic groups, middle school students had a higher prevalence of 1 self-reported sports- or physical activity–related concussions compared with high school students. White middle and high school students had a lower prevalence compared with Black and Hispanic middle and high school students. The prevalence of 1 sports- or physical activity–related concussions was higher among middle and high school students who described their grades as mostly Cs, Ds, or Fs compared with students who described their grades as mostly As or Bs.

Prevalence of Sports- or Physical Activity–Related Concussions Among Middle and High School Students by Selected Health Risk Behaviors

Among both middle school and high school students, the prevalence of 1 sports- or physical activity–related concussions was higher among students who played on a sports team, were physically active 5 or more days/week, had ever tried cigarette smoking, had ever used an electronic vapor product, had seriously considered attempting suicide, had made a suicide plan, and had attempted suicide compared with those who had not engaged in those behaviors. The prevalence of sports- or physical activity–related concussion was consistently higher among middle school students than high school students across sex, race/ethnicity, and adverse health behaviors. Although the prevalence of 1 sports- or physical activity–related concussions was higher among middle school students who had not played on a sports team than high school students who had not played on a sports team, the prevalence of

sports- or physical activity–related concussion was not significantly different across school levels among those who had played on a sports team.

DISCUSSION

This analysis found that a higher percentage of middle school students compared with high school students self-reported 1 sports- or physical activity–related concussions, which is consistent with previous studies on concussion prevalence.^{22,30} Among middle school students who drank alcohol, ever tried cigarette smoking, and ever used an electronic vapor product, the prevalence of self-reported sports- or physical activity–related concussion was higher than among high school students who engaged in those behaviors. The findings from this study, as well as previous studies on high school students, suggest that middle school and high school students with a history of concussion warrant further attention and study as at-risk populations. Health care providers may consider screening students for adverse health behaviors during preparticipation examinations and concussion evaluations. As the data from this study are based on a cross-sectional survey, it is unclear whether self-reported adverse health behaviors were present before or after a sports- or physical activity–related concussion. Future studies are needed to explore causality.

It is unclear from the findings in this study whether the higher prevalence of self-reported sports-self-reported sports- or physical activity–related concussion among middle students was driven primarily by a greater susceptibility to brain injury due to neurobiological factors,¹ differing reporting behaviors between middle and high school students,⁴⁷ or other factors that may affect concussion rates (eg, participation in team sports and physical activity,¹³ exposure to multiple sources of concussion education,⁴¹ and social ecological factors^{23,42}). Future studies could explore these factors and inform concussion safety interventions for middle school students.

State laws that address concussion in sports have been shown to increase concussion knowledge and access to education.^{5,7,26} These laws are also associated with increases in concussion rates, likely due to improved awareness of concussion and care-seeking behaviors after their implementation.^{38,48,49} Not all state concussion in sports laws are the same. This may be one contributing factor to the variation in the prevalence of sports- or physical activity–related concussion reported among middle school and high school students across the 9 states examined. New Mexico had the highest percentage of both middle school and high school students who self-reported 1 sports- and physical activity–related concussions. In 2017, New Mexico’s law was updated to include additional requirements related to concussion education and return-to-sports management.³⁷ New Mexico’s law states that before sports participation, student athletes must confirm completion of an educational training on concussion and receipt of concussion information that includes the importance of reporting a possible concussion by alerting medical professionals. Furthermore, under New Mexico’s law, student athletes with a concussion are not permitted to return to sports participation for at least 240 hours after the injury. In comparison, laws in other states in this study do not designate a required minimum time frame that athletes must refrain from returning to sports participation.³⁷ In addition, except for Hawaii, which also requires student athletes to complete educational training on concussion,²⁰ concussion

in sports laws for the other states examined in this study only require parents and athletes to acknowledge receipt and/or sign a concussion information sheet. Future studies that investigate whether some components or requirements in state concussion in sport laws improve concussion reporting by student athletes may be beneficial to inform policy efforts.

Not surprisingly, this study found that the prevalence of self-reported sports- or physical activity–related concussion was higher among middle school and high school students who were physically active 5 or more days/week compared with those students who were not. Recent studies of concussion seen in health care settings found that concussions among youth are most likely to occur during organized sports activities, especially for youth who are high school age or at school.^{18,50} Within the school setting, concussions are most common when a student is participating in physical education class.⁵⁰ Consistent with previous studies, this study found a higher prevalence of sports- or physical activity–related concussion among boys compared with girls.^{9,43} YRBS does not include questions about the types of sports or activities in which students engage; however, it could be that one reason for a higher rate of sports- or physical activity–related concussion among male students is greater participation in contact sports (such as football) among boys.⁵⁰

Consistent with previous studies,^{9,13,43} this study found that Black and Hispanic students were more likely to self-report having had a sports- or physical activity–related concussion. Future studies may investigate if these differences hold when accounting for underlying differences in physical activity and sports team participation. For example, previous research has pointed to less access to noncontact sport options,²⁵ socioeconomic factors (eg, lack of private health insurance),⁸ and less concussion awareness and access to concussion education^{3,24,45} as potential explanations for higher rates of concussion among Black and Hispanic youth as compared with White youth. Importantly, Black and Hispanic youth may be less likely to receive concussion care and more likely to experience delays in care in an emergency department.^{29,46,51}

Limitations

The findings in this report are subject to several limitations. First, these data are based on self-report by students in 9 states and are not generalizable to other states. Use of self-reported measures can be subject to reporting and recall bias due to social desirability. Second, none of the variables examined were confirmed via health care provider diagnosis or medical record review. As such, there may be some over- or underreporting of concussions. Third, these data apply only to middle school and high school students who attend school and are not representative of all youth in this age group or in other age groups. In 2017, approximately 2% of youth aged 7 to 13 years and 4% of high school–aged youth (aged 14–17 years) were not enrolled in school.²¹ Fourth, continuing to play sports or being physically active with a concussion that is symptomatic increases the risk for a subsequent, more serious concussion. YRBS data showed that 9.1% of middle school students and 6.2% of high school students reported 2 sports- or physical activity–related concussions during the previous 12 months, but YRBS data do not allow for determining the proportion of these injuries that might have been related to a previous concussion that had not fully healed. Fifth, it is not known what proportion of concussions occurred during

team sports participation versus other types of physical activity. Thus, it was not possible to examine specific mechanisms of concussions by activity type—limiting the potential to inform prevention efforts. Sixth, the data are from a cross-sectional survey; thus, it is unclear whether self-reported adverse health behaviors were present before or after a sports- or physical activity–related concussion. Longitudinal data are needed to establish temporality related to the relationship observed between sports- or physical activity–related concussion and adverse health behaviors. Finally, the extent of underreporting or overreporting of behaviors examined in this study cannot be determined, although in general, YRBS survey questions demonstrate good test-retest reliability.²⁸ Although self-report introduces the possibility of recall bias and misclassification of sports-related concussions, another study showed that self-report is a valid method of collecting data on sports- or physical activity–related concussion and traumatic brain injury.¹⁶

CONCLUSION

This study found that 18.2% of middle school students and 14.3% of high school students in 9 states self-reported 1 sports- or physical activity–related concussions during the 12 months before the survey. In both groups, the prevalence of sports- or physical activity–related concussion was higher among students who used tobacco and engaged in suicidal thoughts and attempts than among those students who did not. Furthermore, the prevalence of sports- or physical activity–related concussion was consistently higher among middle school students than high school students across sex, race/ethnicity, and adverse health behaviors. These findings, as well as those of previous studies, suggest that middle and high school students with a history of concussion warrant further attention and study as at-risk populations for adverse behaviors. Health care providers may consider screening students for adverse health behaviors during preparticipation examinations and concussion evaluations.

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Unweighted Sample Size, Response Rate, and Type of Sampled Schools—Middle and High School Youth Risk Behavior Surveys in 9 States, 2019

TABLE 1

State	Middle School				High School				Types of Schools	Overall RR, ^a %	Types of Schools
	Sample No.	School RR, %	Student RR, %	Overall RR, ^a %	Sample No.	School RR, %	Student RR, %	Overall RR, ^a %			
Total	65,978				86,288						
Florida	5177	91	76	69	5703	98	66	66	66	Public, charter	Public, charter
Hawaii	6591	97	84	82	5879	100	77	77	77	Public	Public
Maryland	27,299	99	84	83	41,091	100	80	80	80	Public, charter	Public, charter, vocational
New Mexico	4841	81	80	65	7603	95	76	73	73	Public, charter	Public, charter
North Dakota	2346	95	88	83	2045	94	88	82	82	Public, Bureau of Indian Education	Public, alternative, Bureau of Indian Education
Pennsylvania	2497	70	87	60	2338	83	83	69	69	Public, charter	Public, charter, vocational
Rhode Island	1571	76	89	68	1613	84	79	66	66	Public, charter, alternative	Public, charter, alternative, vocational
Vermont	13,998	100	85	85	18,613	99	74	73	73	Public, charter	Public, charter
West Virginia	1658	94	86	81	1403	89	82	73	73	Public	Public

^aOverall response rate (RR) is computed as (number of participating schools/number of eligible sampled schools) * (number of usable questionnaires/number of eligible students sampled in participating schools), rounded to the nearest integer.

Variable Names and Question Wording—Middle and High School Youth Risk Behavior Surveys in 9 States, 2019

TABLE 2

Variable Name	Question	
	Middle School	High School
Academic grades	During the past 12 months, how would you describe your grades in school?	During the past 12 months, how would you describe your grades in school?
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?	During the past 12 months, how many times did you have a concussion from playing a sport or being physically active?
Played on a sports team	During the past 12 months, on how many sports teams did you play? (Count any teams any teams run by your school or community groups.)	During the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)
Were physically active 5 or more days/week	During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)	During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)
Ever tried cigarette smoking	Have you ever tried cigarette smoking, even one or two puffs?	Have you ever tried cigarette smoking, even one or two puffs?
Ever used an electronic vapor product	Have you ever used an electronic vapor product?	Have you ever used an electronic vapor product?
Drank alcohol	Have you ever had a drink of alcohol, other than a few sips?	During the past 30 days, on how many days did you have at least one drink of alcohol?
Were in a physical fight	Have you ever been in a physical fight?	During the past 12 months, how many times were you in a physical fight?
Seriously considered attempting suicide	Have you ever seriously thought about killing yourself?	During the past 12 months, did you ever seriously consider attempting suicide?
Made a suicide plan	Have you ever made a plan about how you would kill yourself?	During the past 12 months, did you make a plan about how you would attempt suicide?
Attempted suicide	Have you ever tried to kill yourself?	During the past 12 months, how many times did you actually attempt suicide?

TABLE 3

Prevalence of Middle and High School Students Who Self-Reported a Sports- or Physical Activity–related Concussion During the Past 12 Months—Middle and High School Youth Risk Behavior Surveys in 9 States, 2019

State	Middle School, % (95% CI)	High School, % (95% CI)
Self-reported 1 sports- or physical activity–related concussions		
Total	18.2 ^a (17.4–19.0)	14.3 (13.5–15.1)
Florida	19.4 (18.0–20.8)	13.3 (12.0–14.7)
Hawaii	17.7 (15.8–19.6)	15.9 (14.3–17.6)
Maryland	16.8 (16.1–17.6)	16.5 (15.6–17.3)
New Mexico	21.5 (19.7–23.3)	19.5 (18.0–21.1)
North Dakota	17.0 (15.5–18.7)	16.2 (14.4–18.1)
Pennsylvania	16.0 (14.1–18.0)	13.1 (11.5–14.9)
Rhode Island	16.4 (13.5–19.7)	16.3 (14.1–18.7)
Vermont	18.7 (17.9–19.5)	17.6 (16.8–18.5)
West Virginia	19.8 (17.7–22.1)	15.8 (13.6–18.3)
Self-reported 2 sports- or physical activity–related concussions		
Total	9.1 ^a (8.5–9.8)	6.2 (5.7–6.7)
Florida	10.5 (9.3–11.8)	6.5 (5.7–7.5)
Hawaii	8.6 (7.2–10.2)	6.5 (5.4–7.9)
Maryland	8.2 (7.6–8.9)	7.3 (6.7–8.0)
New Mexico	11.3 (10.0–12.9)	9.5 (8.6–10.6)
North Dakota	6.8 (5.8–8.0)	5.4 (4.4–6.7)
Pennsylvania	7.0 (5.9–8.4)	4.5 (3.6–5.7)
Rhode Island	8.6 (6.5–11.5)	7.0 (5.4–9.1)
Vermont	6.6 (6.1–7.1)	6.6 (6.0–7.2)
West Virginia	9.1 (7.4–11.0)	5.7 (4.5–7.3)

^aPrevalence among those in middle school was significantly higher than among those in high school, based on chi-square test ($P < .05$).

Prevalence of 1 Self-Reported Sports- or Physical Activity–Related Concussions Among Middle and High School Students, by Selected Demographics and Behaviors—Middle and High School Youth Risk Behavior Surveys in 9 States, 2019^a

TABLE 4

Characteristic	Middle School, % (95% CI)	High School, % (95% CI)	P Value ^b
Sex			
Male	20.8 ^c (19.7–21.8)	16.5 ^c (15.5–17.6)	<.001
Female	15.4 (14.4–16.4)	11.8 (11.0–12.8)	<.001
Race			
White, non-Hispanic	15.2 ^d (14.3–16.3)	13.2 ^d (12.2–14.3)	.005
Black, non-Hispanic	20.9 (18.9–23.1)	16.1 (14.1–18.3)	.001
Hispanic	21.1 (19.7–22.6)	15.1 (13.8–16.6)	<.001
Academic grades			
A/B	15.5 ^e (14.7–16.4)	12.5 ^e (11.7–13.3)	<.001
C/D/F	25.4 (23.8–27.0)	19.1 (17.6–20.6)	<.001
Played on a sports team			
Yes	21.6 ^f (20.4–22.8)	20.0 ^f (18.5–21.7)	.125
No	13.4 (12.4–14.4)	6.7 (5.9–7.5)	<.001
Were physically active 5 or more days/week			
Yes	19.1 ^f (18.1–20.1)	16.7 ^f (15.7–17.8)	<.001
No	17.0 (15.9–18.2)	12.3 (11.5–13.1)	<.001
Ever tried cigarette smoking			
Yes	29.9 ^f (27.6–32.4)	19.9 ^f (18.0–22.0)	<.001
No	16.5 (15.7–17.3)	11.6 (10.8–12.5)	<.001
Ever used an electronic vapor product			
Yes	26.6 ^f (24.8–28.5)	18.2 ^f (16.9–19.5)	<.001
No	15.5 (14.7–16.4)	10.7 (9.9–11.6)	<.001
Drank alcohol			
Yes	25.6 ^f (23.9–27.3)	11.3 ^g (10.6–12.1)	NA ^h

Characteristic	Middle School, % (95% CI)	High School, % (95% CI)	P Value ^b
No	15.3 (14.4–16.2)	15.0 (13.3–16.8)	
Were in a physical fight			
Yes	24.1 ^f (22.8–25.5)	10.7 ^g (9.9–11.6)	NA ^h
No	11.8 (10.8–13.0)	19.2 (16.6–22.0)	
Seriously considered attempting suicide			
Yes	22.4 ^f (20.6–24.3)	17.8 ^f (16.1–19.7)	NA ^h
No	16.8 (16.0–17.7)	13.2 (12.4–14.1)	
Made a suicide plan			
Yes	22.3 ^f (20.2–24.6)	19.7 ^f (17.7–21.9)	NA ^h
No	17.3 (16.6–18.1)	13.3 (12.5–14.1)	
Attempted suicide			
Yes	27.0 ^f (24.1–30.0)	24.5 ^f (21.2–28.0)	NA ^h
No	17.2 (16.4–18.0)	11.6 (10.8–12.4)	

^aFlorida, Hawaii, Maryland, New Mexico, North Dakota, Pennsylvania, Rhode Island, Vermont, and West Virginia. NA, not applicable.

^bChi-square tests were used to compare differences between middle and high school prevalence when the questions on the middle and high school questionnaires were identical. Tests are marked not applicable when the wording differed by school level.

^cPrevalence among boys was significantly higher than among girls, based on a chi-square test ($P < .05$).

^dPrevalence among White students was significantly lower than among Black and Hispanic students, based on a chi-square test ($P < .05$).

^ePrevalence among those who had A/B was significantly lower than among those who had C/D/F, based on a chi-square test ($P < .05$).

^fPrevalence among those who responded yes was significantly higher than among those who responded no, based on a chi-square test ($P < .05$).

^gPrevalence among those who responded yes was significantly lower than among those who responded no, based on a chi-square test ($P < .05$).

^hTests were only performed when the questions on the middle and high school questionnaires were identical.