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Adolescent Consumption of Sports and Energy Drinks: Linkages to Higher Physical Activity, Unhealthy Beverage Patterns, Cigarette Smoking, and Screen Media Use

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Abstract

Objective—To examine patterns of adolescent sports and energy drink (SED) consumption and identify behavioral correlates.

Design—Data were drawn from EAT 2010 (Eating and Activity in Teens), a population-based study.

Setting—Adolescents from 20 middle and high schools in Minneapolis/St. Paul, Minnesota completed classroom-administered surveys.

Participants—2,793 adolescents (53.2% girls) in grades 6–12.

Variables Measured—Beverage patterns; breakfast frequency; moderate-to-vigorous physical activity (MVPA); media use; sleep; and cigarette smoking.

Analysis—Linear and logistic regression models were used to estimate associations between health behaviors and SED consumption, adjusting for demographics.

Results—Over a third of adolescents consumed sports drinks and 14.7% consumed energy drinks at least once a week. Among boys and girls, both sports and energy drink consumption were related to higher video game use; sugar-sweetened beverage and fruit juice intake; and smoking ($P < 0.05$). Sports drink consumption was also significantly related to higher MVPA and organized sport participation for both genders ($P < 0.01$).

Conclusions and Implications—Although sports drink consumption was associated with higher MVPA, adolescents should be reminded of recommendations to consume these beverages

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only following vigorous, prolonged activity. There is also a need for future interventions designed to reduce SED consumption to address the clustering of unhealthy behaviors.

Keywords

Adolescents; Sports drinks; Energy drinks; Dietary intake; Physical activity; Sleep patterns

INTRODUCTION

Adolescent consumption of sugar-sweetened beverages is of concern because consumption is associated with increased risk for dental caries, excess weight gain, and poor diet quality.¹⁻⁴ Although recent evidence showed a decline from 1999 to 2008 in the prevalence of soft drink and fruit drink consumption among U.S. adolescents, sports and energy drink consumption tripled.⁵ Sports and energy drinks are considered sugar-sweetened beverages along with soft drinks and flavored juice drinks, but their ingredients and purported functions differ. Sports drinks are noncarbonated, flavored drinks which contain added sugars, minerals, and electrolytes to help replenish the body during vigorous exercise.⁶ Energy drinks contain high amounts of caffeine often coupled with other natural stimulants that enhance caffeine's effects, and may also contain vitamins, minerals, protein, and added sugars. Beverages marketed as energy drinks are purported to increase mental concentration as well as physical performance.⁶

The U.S. Food and Drug Administration considers energy drinks to be dietary supplements and they are not subject to food marketing or ingredient regulations.^{7, 8} Therefore, while the average caffeine content per fluid ounce for the top four selling soft drinks in the U.S. was 3.5 mg from 2002 to 2006, the average caffeine content for the four top selling energy drinks was 9.6 mg.⁸ Little information is available on the effects of the supplements or stimulants in energy drinks, especially among children and adolescents. The high caffeine content of energy drinks, as well as the high sugar and calorie content of many sports and energy drinks, has drawn much concern from health professionals as their consumption among adolescents has increased.⁹

In June 2011, the American Academy of Pediatrics (AAP) issued a report examining the marketing, ingredients, and possible negative effects of sports and energy drinks.⁹ They concluded that small amounts of sports drinks could be appropriate for young people participating in vigorous physical activity in hot, humid weather. However, for the average young athlete, sports drinks are unnecessary and could contribute to negative health outcomes, such as excess weight gain and tooth decay.⁹ In regards to energy drinks, the AAP concluded there is no benefit provided and, as these drinks create a risk for overstimulation of the nervous system, they should not be consumed by adolescents. Consumption of energy drinks by young people has resulted in cases of seizure, myocardial arrhythmia, and even death.⁷⁻¹⁰

Although soft drink and overall sugar-sweetened beverage consumption among adolescents has been well studied, few studies in adolescent populations have examined the consumption of sports and energy drinks or factors associated with their consumption. One study found that sports and fruit drink consumption were unrelated to weight status and associated with

higher levels of physical activity as well as consumption of milk, fruit and vegetables, but were also associated with negative health behaviors, such as higher consumption of energy-dense foods and sedentary behavior.¹¹ Additionally, a recent study found that sports and energy drink consumption were lower among Black and low-income adolescents.⁵ To the best of our knowledge, no study has specifically examined other factors that may be associated with sports and energy drink consumption among adolescents. To address this gap in the literature, and to inform public health efforts targeting consumption, the present study used data from a population-based survey to describe patterns of sports and energy drink consumption among adolescents, and to examine associations with dietary factors, physical activity, media use, hours of sleep, and cigarette smoking. These factors were selected for consideration based on their potential for modification to improve overall health if addressed as part of interventions targeting sports and energy drink consumption along with other risk behaviors.

METHODS

Study Design and Population

Data were drawn from EAT 2010 (Eating and Activity in Teens), a population-based study designed to examine dietary intake, physical activity, weight control behaviors, weight status, and factors associated with these outcomes in adolescents.^{12, 13} Surveys and anthropometric measures were completed by 2,793 adolescents during the 2009–2010 academic year. The study population includes adolescents from 20 public middle schools and high schools in the Minneapolis/St. Paul metropolitan area of Minnesota. Consideration was given to enrollment size and diversity as well as involvement in other research studies when recruiting school districts. Personnel at the participating schools reported no sports or energy drinks were available for purchase on school grounds. The mean age of the study population was 14.4 years (SD=2.0); 46.1% were in middle school (6th–8th grades) and 53.9% were in high school (9th–12th grades). Participants were equally divided by gender (46.8% boys, 53.2% girls). The racial/ethnic composition of the study population was diverse with 81.1% of participants reporting a background other than non-Hispanic white. In regards to socioeconomic status (SES), participants were distributed across five strata based primarily on parental educational attainment: 38.4% low SES, 21.3% low-middle SES, 16.9% middle SES, 12.4% upper-middle SES, and 7.3% high SES (3.7% did not report SES).

Trained research staff administered surveys and measured adolescents' height and weight during selected health, physical education, and science classes. Measurements were completed in a private area and surveys were administered following a standard protocol during two 50-minute class periods. Following survey completion, participants were given a \$10 gift card. All study procedures were approved by the University of Minnesota Institutional Review Board Human Subjects Committee and by the research boards of the participating school districts. Adolescents were given the opportunity to assent only if their parent/guardian did not refuse by returning a signed letter which explained the study purpose and procedures. Among adolescents at school on survey administration days, 96.3% had parental consent and chose to participate.

Survey Development and Measures

The EAT 2010 survey is a 235-item, self-report instrument designed to assess a range of factors of potential relevance to weight status and weight-related behaviors among adolescents. Survey development was guided by expert review and extensive pilot testing with adolescents.¹⁴ The estimates of measure test-retest reliability reported below were determined for a one-week period in a diverse sample of 129 middle school and high school students.

Sports and energy drink intake—Usual past year intake of sports and energy drinks was assessed on the EAT 2010 survey using two questions, which separately asked about the frequency of consuming each type of drink (response categories: never or less than once per month, 1–3 per month, 1 per week, 2–4 per week, 5–6 per week, 1 per day, 2 or more per day). Popular brand name examples were given for energy drinks (Red Bull, Full Throttle, and Rockstar) and sports drinks (Gatorade and Powerade). Regular consumption of sports and energy drinks was defined as at least one drink per week (test-retest agreement: 81.0% for sports drinks, 83.3% for energy drinks) based on the distribution of intake in the sample.

Physical activity and sport participation—Moderate-to-vigorous physical activity (MVPA) was measured by separately asking participants how many hours they spent doing strenuous and moderate activity in a typical week, with several examples of each level of activity provided.¹⁵ Response categories were none, less than ½ hour, ½–2 hours, 2 ½–4 hours, 4 ½–6 hours, and 6 or more hours (test-retest reliability for total MVPA: $r=0.73$). Sports participation was assessed by asking the number of sports teams the adolescent was involved with in the last year (test-retest reliability: $r=0.86$).¹⁶ This measure was dichotomized to represent none versus any sports team participation in the last year.

Media use—Participants indicated the average number of leisure-time hours they spent playing video games (Xbox[®]/PlayStation[®]/other electronic games played when sitting) and watching television (TV), DVDs or videos separately for both weekdays and weekend days.^{17, 18} Response categories for each question were 0 hours, ½ hour, 1 hour, 2 hours, 3 hours, 4 hours, and 5 or more hours; these responses were scored 0, 0.5, 1, 2, 3, 4, and 6 hours to create continuous variables representing total weekly hours of use (test-retest reliability: $r=0.84$ for video games, $r=0.67$ for TV/DVDs/videos).

Sleep—Sleep habits were assessed using measures drawn from a previously validated questionnaire.¹⁹ Participants were asked when they usually go to bed and get out of bed separately for weekdays and weekend days. Average weekday and weekend day sleep duration were calculated from the times provided.²⁰ Overall average daily sleep duration was calculated as (weekday duration *5/7) + (weekend day duration*2/7).

Cigarette smoking—Smoking status was determined from reported cigarette use during the past year (non-smoker=never used; ever smoker=used at least a few times). Test-retest agreement for this measure was high (92.9%).

Breakfast frequency and other beverage intake—To assess breakfast consumption, adolescents were asked: “During the past week, how many days did you eat breakfast?” Five response options ranged from never to every day (test-retest reliability: $r=0.76$). Dietary intake of sugar-sweetened soft drinks, fruit drinks, 100% fruit juice, and milk were assessed with the semi-quantitative, 149-item Youth and Adolescent Food Frequency Questionnaire. A beverage serving was defined as the equivalent of one glass or can. The validity and reliability of this tool have been previously examined and found to be within acceptable ranges for dietary assessment.^{21, 22}

Weight status—Height and weight measurements were completed using standardized procedures. Body mass index (BMI) was calculated and sex- and age-specific percentiles were determined using reference data from the Centers for Disease Control and Prevention growth tables.²³ Percentiles were used to classify respondents as overweight (85th to <95th) or obese (>95th).

Demographics—Grade level, race/ethnicity, and SES were assessed by self-report. Classification tree methodology was used to generate five categories of SES.²⁴ The prime determinant of SES was the higher education level of either parent. Subsidiary variables were student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.

Statistical Analysis

All analyses were conducted using the Statistical Analysis System (version 9.3, 2011, SAS Institute Inc., Cary, NC) and stratified by adolescent gender. Descriptive statistics were first calculated to examine patterns of sports and energy drink consumption. The χ^2 statistic was used to identify differences in consumption according to demographic characteristics and weight status. Linear and logistic regression models that included a random effect to account for clustering within schools were used to estimate associations between health behaviors and regular sports and energy drink consumption, while adjusting for grade level, SES, and race/ethnicity. One set of models included frequency of sports drink consumption as the independent variable and each health behavior of interest (i.e., moderate-to-vigorous physical activity, sport participation, media use, dietary intake, breakfast frequency, sleep, and cigarette use) was included in a separate model as the dependent variable. A second set of models likewise included frequency of energy drink consumption as the independent variable to examine associations with each dependent health behavior variable. The overall F value for each model examined was statistically significant at the $P<0.05$ level. To estimate the total variance in health behaviors explained by consumption of sports and energy drinks along with all of the covariates considered here, nonhierarchical models were further examined that included school identifier as a covariate rather than as a random effect. Nonhierarchical models with sports drink consumption as the independent variable explained 4–19% of variance in health behaviors and the nonhierarchical models with energy drink consumption as the independent variable explained 4–18% of variance in health behaviors. A 95% confidence level was used to interpret the statistical significance of probability tests. Whenever the dependent variable exhibited positive skewness, such testing was carried out under the square root transformation.

RESULTS

Frequency of Consumption and Associations with Demographic Characteristics

Overall, sports and energy drinks were consumed regularly (at least once per week) by 37.9% and 14.7% of the adolescent sample, respectively. Regular consumption of sports drinks among boys was 44.9% and 31.6% among girls ($P<0.001$). For energy drinks, regular consumption was 17.1% among boys and 12.5% among girls ($P<0.001$). There was a moderate to low correspondence between intake of sports and energy drinks, with 10.6% of adolescents regularly consuming both sports and energy drinks, 26.8% regularly consuming sports drinks but not energy drinks, and 3.6% consuming energy drinks but not sports drinks. Consumption of sports drinks was highest among boys and girls who reported their race/ethnicity was Black or mixed/other (Table 1). However, similar differences by race/ethnicity in energy drink consumption were statistically significant only among girls.

Sports Drink Consumption and Health Behaviors

Regular sports drink consumption was associated with measures of physical activity, media use, other beverage intake, and cigarette smoking (Table 2). For both genders, regular sports drink consumption was associated with higher MVPA, greater likelihood of past-year participation in an organized sport, and higher video game use. Among boys, regular sports drink consumption was also significantly associated with higher TV viewing; boys who regularly consumed sports drinks spent about one additional hour per week watching TV compared to boys who consumed sports drinks less than once per week. In regards to dietary behaviors, among both genders there was a significant positive association between regular sports drink consumption and daily consumption of sugar-sweetened soft drinks, fruit drinks, and 100% fruit juice. Additionally, there was a significant association between regular sports drink consumption and ever having smoked cigarettes for both genders.

Energy Drink Consumption and Health Behaviors

Regular energy drink consumption was similarly associated with measures of media use, other beverage intake, and cigarette use but was unrelated to measures of physical activity (Table 3). For both genders, regular energy drink consumption was positively associated with weekly video game use. As an example, in a usual week, boys who regularly consumed energy drinks spent approximately four additional hours playing video games compared to those who consumed energy drinks less than once per week (Table 3). Among the dietary factors examined, for both genders, there was a significant association between regular energy drink consumption and higher daily intake of sugar-sweetened soft drinks, fruit drinks, and 100% fruit juice. For girls only, there was also a significant association between regular energy drink consumption and lower frequency of breakfast. Additionally, there was a significant positive association between having ever smoked cigarettes and regular energy drink consumption for both genders.

DISCUSSION

The results of this study indicate that at least weekly consumption of both sports and energy drinks among adolescents is significantly associated with higher consumption of other

sugar-sweetened beverages, cigarette smoking, and screen media use. The observed associations between consumption of sports and energy drinks and these unhealthy behaviors are troubling since they may indicate a clustering of problem behaviors among some adolescents. Given these findings, evidence of increasing advertising of sports and energy drinks to youth is particularly concerning. One study found that exposure to TV advertisements for energy drinks increased 23% among children and 20% among adolescents from 2008 to 2010.²⁵ Research has further indicated that sports and energy drinks are disproportionately targeted to Black youth; in a media exposure study, Black children and adolescents were exposed to over twice as many advertisements for sports and energy drinks in 2010 as white youth after adjusting for TV viewing time.²⁵ Based on the results of this media exposure research and the current study, there is a need for advocacy efforts to limit advertising to all racial/ethnic groups of adolescents and complement public health interventions that directly target sports and energy drink consumption. Recently, energy drink companies have hired lobbyists to fight the U.S. Food and Drug Administration investigation into the safety of their products, signaling an even greater need for public health advocacy in this area.²⁶

In addition to unhealthy behaviors, sports drink consumption was also significantly associated with higher levels of MVPA. These results may reflect evidence demonstrating that sports drinks are heavily marketed to adolescent athletes.^{25, 27} The majority of advertisements for sports and energy drinks directed towards adolescents depict these drinks as “hip or cool”, promoting optimal fitness, or having beneficial nutrients.²⁵ For example, the Gatorade Company and the National Athletic Trainers’ Association recently partnered to establish National Recovery Day and promote the consumption of fluids with sodium (i.e., sports drinks) before, during, and after exercise.²⁷ The campaign messages promoting consumption of sports drinks were widely disseminated to athletes of all ages despite contradiction with the AAP recommendations for adolescent use of sports drinks, which emphasize they are not necessary for the average adolescent athlete.^{9, 27, 28} Thus, exposure to advertisements for sports drinks may lead adolescents to believe these beverages are beneficial for activities that do not involve vigorous and prolonged exertion.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Although this study used a comprehensive survey with reliable measures to examine characteristics associated with sports and energy drink consumption among adolescents, not all survey measures were validated and additional research is needed to address certain limitations. Single items were used to separately assess overall intake of sports and energy drinks for the current study, but there are numerous types of these drinks on the market that vary considerably in nutritional composition (e.g., low or no sugar beverages). Due to the cross-sectional design, we were unable to establish temporality. In addition, while the sample was large and diverse, the results may not apply to other adolescent populations with higher levels of sports and energy drink consumption for whom there may be larger associations with adverse health-related outcomes. Future studies should incorporate longitudinal designs when feasible and examine additional factors of relevance to consumption (e.g., stress, substance use) as well as reasons for observed associations using validated measures in other population-based samples. Given the finding that electronic

gaming was relevant for both sports and energy drink consumption, it will be particularly important for studies to develop measures for investigating specific linkages to various gaming platforms (e.g., mobile devices, video game consoles). Research should also evaluate intervention designs that encourage appropriate hydration among adolescents, in particular water consumption, and target linkages between sports and energy drink use and other unhealthy behaviors.

In conclusion, the findings of this study and other research indicate sports and energy drink consumption are prevalent among adolescents.^{5, 10} National data indicate 12% of adolescents consume a sports or energy drink on a given day.⁵ Though the national prevalence of consuming other sugar-sweetened beverages such as soft drinks (51%) and fruit drinks (23%) remains much higher among adolescents, consumption of sports and energy drinks is increasing and the potential for serious consequences when energy drinks are consumed in combination with alcohol justify the need for public health concern.^{5, 10} While sports drink consumption was found to be associated with higher levels of MVPA, it is unlikely that consumption only followed vigorous, prolonged activity as recommended by the AAP and both sports and energy drink consumption were also associated with several unhealthy behaviors.⁹ These findings suggest that future sugar-sweetened beverage interventions should consider targeting the clustering of unhealthy behaviors among some adolescents, such as smoking, high screen media use, and breakfast skipping. Nutrition professionals, pediatricians, coaches, and teachers can also make an impact through continued public health advocacy focusing on the marketing and availability of sports and energy drink products to youth. Further, these professionals can work to educate youth and parents about the potential consequences associated with consumption of sports and energy drinks and encourage healthy hydration habits.

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Table 1

Demographic variables and frequency of sports and energy drink consumption among adolescent boys (n=1307) and girls (n=1486)

Characteristic	Sports Drink Intake 1 or more per week (%)		Energy Drink Intake 1 or more per week (%)	
	Boys	Girls	Boys	Girls
Race/ethnicity				
White	37.4	20.5	15.8	8.6
Black	52.8	36.3	19.1	15.5
Hispanic	44.9	32.8	13.8	12.8
Asian	35.0	27.3	15.1	8.8
Mixed/other	55.0	38.4	22.3	15.6
<i>P</i> value	<0.001	<0.001	0.14	0.01
Socioeconomic Status				
Low	45.6	30.1	18.3	12.6
Middle-Low	48.8	37.3	17.3	12.8
Middle	42.5	30.5	16.7	13.7
Middle-High	46.7	27.1	12.6	8.4
High	38.1	26.1	15.0	12.5
<i>P</i> value	0.33	0.10	0.52	0.58
BMI Category				
Not overweight	43.5	31.1	17.8	11.7
Overweight	46.0	31.9	16.9	10.7
Obese	46.5	32.0	14.8	16.6
<i>P</i> value	0.60	0.95	0.50	0.06
Grade Level				
Middle School	43.9	33.8	16.4	13.8
High School	45.7	29.7	17.9	11.4
<i>P</i> value	0.52	0.09	0.50	0.17

Note: *P* values represent overall testing by sex for independence of demographic categorization and weekly sport or energy drink consumption using the χ^2 test.

Table 2

Sports drink consumption frequency and health behaviors among adolescent boys and girls^a

	Boys' Sports Drink Intake			Girls' Sports Drink Intake		
	Less than 1 per week Mean (95% CI)	1 or more per week Mean (95% CI)	P	Less than 1 per week Mean (95% CI)	1 or more per week Mean (95% CI)	P
Physical Activity						
Moderate-to-vigorous activity (hours/week)	4.9 (4.0–5.7)	6.9 (6.3–7.5)	0.003	3.9 (3.1–4.6)	4.9 (4.0–5.7)	0.004
Sport participation (%)	56 (52–60)	76 (72–80)	0.003	48 (44–52)	66 (61–71)	0.004
Media Use						
Video games (hours/week)	15.2 (12.6–17.7)	18.4 (16.0–20.7)	0.008	6.1 (4.5–7.7)	7.8 (5.9–9.7)	0.02
TV viewing (hours/week)	18.2 (16.5–19.8)	19.2 (17.6–20.7)	0.03	17.3 (15.4–19.2)	17.6 (15.5–19.6)	0.60
Dietary Factors						
Sugared soda (servings/day)	.37 (.26–.49)	.55 (.46–.63)	<0.001	.46 (.39–.52)	.59 (.52–.66)	0.02
Fruit drinks (servings/day)	.50 (.35–0.64)	.66 (.52–.79)	0.002	.59 (.47–.70)	.78 (.62–.93)	0.003
Fruit juice (servings/day)	.56 (.32–.83)	.81 (.57–1.0)	0.005	.92 (.64–1.2)	1.3 (1.0–1.5)	0.005
Milk (servings/day)	1.4 (1.1–1.7)	1.6 (1.1–1.9)	0.46	1.3 (1.1–1.4)	1.4 (1.1–1.6)	0.42
Breakfast (frequency/week)	4.7 (4.2–5.2)	4.5 (3.9–5.2)	0.30	3.8 (3.2–4.3)	3.6 (3.0–4.2)	0.20
Other Behaviors						
Sleep (mean hours per day)	9.3 (8.9–9.7)	9.2 (8.8–9.6)	0.21	9.6 (9.3–9.9)	9.4 (9.0–9.7)	0.01
Ever smoked cigarettes (%)	7.1 (5.1–9.1)	13.5 (10.5–16.5)	0.02	7.4 (5.4–9.4)	13.7 (11.1–16.2)	0.02

^a All tests controlled for race/ethnicity, grade, and socioeconomic status.

Table 3
Energy drink consumption frequency and health behaviors among adolescent boys and girls^a

	Boys' Energy Drink Intake			Girls' Energy Drink Intake		
	Less than 1 per week Mean (95% CI)	1 or more per week Mean (95% CI)	P	Less than 1 per week Mean (95% CI)	1 or more per week Mean (95% CI)	P
Physical Activity						
Moderate-to-vigorous activity (hours/week)	5.7 (4.9–6.5)	6.4 (5.7–7.0)	0.31	4.3 (3.5–5.0)	4.5 (3.4–5.7)	0.28
Sport participation (%)	63 (57–66)	70 (64–76)	0.08	53 (50–56)	61 (52–70)	0.10
Media Use						
Video games (hours/week)	16.2 (13.7–18.6)	20.5 (18.2–22.8)	0.005	6.5 (4.7–8.2)	8.9 (6.6–11.2)	0.003
TV viewing (hours/week)	18.5 (17.1–19.9)	19.7 (17.9–21.6)	0.19	17.0 (15.0–19.0)	18.3 (15.5–21.1)	0.46
Dietary Factors						
Sugared soda (servings/day)	.42 (.33–.51)	.70 (.52–.87)	0.01	.61 (.41–.83)	.86 (.62–.85)	0.001
Fruit drinks (servings/day)	.57 (.44–.70)	.72 (.55–.88)	0.03	.47 (.49–.72)	.74 (.70–1.0)	0.002
Fruit juice (servings/day)	.65 (.38–.92)	.90 (.55–1.2)	0.03	.98 (.74–1.2)	1.2 (.94–1.5)	0.04
Milk (servings/day)	1.5 (1.1–1.8)	1.5 (1.1–2.0)	0.70	1.4 (1.2–1.5)	1.3 (1.0–1.5)	0.45
Breakfast (frequency/week)	4.6 (4.0–5.2)	4.4 (3.8–5.0)	0.28	3.8 (3.2–4.3)	3.2 (2.5–3.7)	0.01
Other Behaviors						
Sleep (mean hours per day)	9.3 (8.9–9.7)	9.0 (8.6–9.4)	0.10	9.5 (9.2–9.8)	9.3 (8.9–9.6)	0.06
Ever smoked cigarettes (%)	8.7 (6.7–10.7)	19.7 (14.6–24.7)	0.005	7.8 (6.1–9.5)	21.8 (15.8–27.8)	0.01

^a All tests controlled for race/ethnicity, grade, and socioeconomic status.