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Factors Associated with Low Water Intake among US High School Students—National Youth Physical Activity and Nutrition Study, 2010

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Abstract

Drinking plain water instead of sugar-sweetened beverages is one approach for reducing energy intake. Only a few studies have examined characteristics associated with plain water intake among US youth. The purpose of our cross-sectional study was to examine associations of demographic characteristics, weight status, dietary habits, and other behavior-related factors with plain water intake among a nationally representative sample of US high school students. The 2010 National Youth Physical Activity and Nutrition Study data for 11,049 students in grades 9 through 12 were used. Multivariable logistic regression analysis was used to calculate adjusted odds ratios (ORs) and 95% CIs for variables associated with low water intake (<3 times/day). Nationwide, 54% of high school students reported drinking water <3 times/day. Variables significantly associated with

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

a greater odds for low water intake were age ≤15 years (OR 1.1), consuming <2 glasses/day of milk (OR 1.5), nondiet soda ≥1 time/day (OR 1.6), other sugar-sweetened beverages ≥1 time/day (OR 1.4), fruits and 100% fruit juice <2 times/day (OR 1.7), vegetables <3 times/day (OR 2.3), eating at fast-food restaurants 1 to 2 days/week and ≥3 days/week (OR 1.3 and OR 1.4, respectively), and being physically active ≥60 minutes/ day on <5 days/week (OR 1.6). Being obese was significantly associated with reduced odds for low water intake (OR 0.7). The findings of these significant associations of low water intake with poor diet quality, frequent fast-food restaurant use, and physical inactivity may be used to tailor intervention efforts to increase plain water intake as a substitute for sugar-sweetened beverages and to promote healthy lifestyles.

Keywords

Drinking water; Dietary intake; Adolescents; Sugar-sweetened beverages; Television

Sugar-Sweetened Beverages (Ssbs) are the largest source of added sugar and an important contributor of energy in the diet of US youth.[1] Consumption of SSBs has been associated with obesity,[2–5] dental caries,[6] type 2 diabetes,[7] poor mental health,[8,9] poor academic grades,[10] and displacement of nutrient-rich foods.[11,12] In contrast, drinking plain water instead of SSBs is one approach for individuals trying to reduce dietary energy intake and thereby possibly benefit obesity prevention and control.[13–15] Hence, consuming water as part of a healthy diet (eg, one that contains fruits, vegetables, whole grains, low-fat/reduced fat dairy, and lean meats) can aid weight management[13–16] and, if substituted for SSB consumption, also possibly avert the adverse consequences associated with SSB intake such as dental caries,[6] and avoid risks from high levels of SSBs such as developing obesity[2–5] and type 2 diabetes.[7]

One approach for promoting water intake is to make free potable drinking water widely accessible in public facilities, including schools. For example, previous school-based intervention studies have shown that increasing access to drinking water in schools increased water intake among students[13,17] and in one study decreased their risk for obesity among students.[13] In fact, the US Department of Agriculture requires schools participating in the National School Lunch Program as of fall 2011 to make free potable water available to students where meals are served.[18]

The adequate intake (AI) level for water in any form (water, beverages other than water, and solid foods) was established by the Institute of Medicine as a guide for preventing adverse effects of dehydration rather than for decreasing risks for chronic diseases.[19] Specific AI levels vary by sex and age. For boys aged 14 to 18 years, the AI levels for total water are 3.3 L/day including 2.6 L (~11 c) as beverages. For girls aged 14 to 18 years, the AI levels for total water are 2.3 L/day including 1.8 L (~8 c) as beverages. People who are physically active or living in hot climates require even more water.[19] Based on the 2005–2008 National Health and Nutrition Examination Survey (NHANES), mean plain water intake (tap and bottled) among US youth (aged 12 to 19 years) was 3.6 c for boys and 3.1 c for girls.[20] Another study reported that plain water was most commonly consumed beverage among US

high school students and 72.4% reported drinking a bottle/glass of water at least one time per day.[21]

Despite the importance of drinking water as a healthful alternative for SSBs, plain water intake has received little research attention as an approach to improve diet quality. One study reported that plain water intake was inversely associated with intake of total sugars among youth aged 2 to 19 years,[22] suggestive of poor diet quality. That same study reported that mean plain water intake was significantly higher among boys, older age groups, youth with obesity, and physically active youth.[22] To inform the development of initiatives to promote water intake, our study examined whether low plain water intake is associated with other less healthful dietary and behavioral factors among US high school students. It was hypothesized that less healthful dietary habits and sedentary behaviors would be associated with low water intake.

METHODS

Sample and Survey Administration

Data were obtained from the 2010 National Youth Physical Activity and Nutrition Study (NYPANS).[23] This school-based survey conducted by the Centers for Disease Control and Prevention included information on physical activity, dietary practices, and behavioral determinants related to nutrition and physical activity. The study also included height and weight measurements taken by trained data collectors using a standard protocol. The study used a three-stage cluster sample design to create a nationally representative sample of students in grades 9 through 12 who attend public and private high schools in the 50 states and the District of Columbia. Student participation in the study was anonymous and voluntary, and local parental permission procedures were followed. NYPANS was approved by the study contractor's Institutional Review Board. This analysis was exempt from the Centers for Disease Control and Prevention Institutional Review Board process because it contained only publicly available de-identified data. Students completed a self-administered questionnaire in their classrooms during a regular class period during spring 2010. The school response rate was 82%, the student response rate was 88%, and the overall response rate was 73%. Data from 11,429 students were available for analysis after data editing.[23] In addition, for these cross-sectional analyses, 380 students (3.3%) with missing data on plain water intake were excluded. Of note, there were significant differences between students who were included in the study and those who were excluded for age and race/ethnicity, but not for sex and weight status. Students who were excluded from the study were more likely to be younger and non-Hispanic black.

Outcome Variable

The outcome of interest was plain water intake. Students were asked, "During the past 7 days, how many times did you drink a bottle or glass of plain water? Count tap, bottled, and unflavored sparkling water" The response options were as follows: "I did not drink plain water during the past 7 days," "1 to 3 times during the past 7 days," "4 to 6 times during the past 7 days," "1 time/day," "2 times/day," "3 times/day," and "4 or more times/day." For χ^2 tests, four mutually exclusive water intake categories were created; <1 time/day, 1 to 2

times/day, 3 times/day, and ≥4 times/day based on the data distribution. For logistic regression analysis, plain water intake was categorized as <3 times/day vs ≥3 times/day, based on previous studies conducted in youth.[20,22,24] For the purpose of our study, low water intake was defined as drinking a bottle/glass of plain water <3 times/day, which is lower than mean plain water intake (~3.4 c) reported based on NHANES data for adolescents.[20,22]

Exposure Variables

Mutually exclusive response categories were created for each exposure variable. Demographic variables included were age (≤15, 16, and ≥17 years), sex, and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other/multirace). Body mass index was calculated from measured weight and height and was categorized as underweight/ normal weight (<85th percentile for body mass index by age and sex), overweight (≥85th to <95th percentile), and obese (≥95th percentile) based on sex- and age-specific reference data from the 2000 growth charts.[25] Because a small percent of students were classified as underweight, these were combined with normal weight students. Dietary intake variables (reported consumption during the past 7 days) included were milk (<2 and ≥2 glasses/day), nondiet soda (<1 and ≥1 time/day), other SSBs such as lemonade, sweetened tea/coffee drinks, flavored milk, Snapple (Dr Pepper Snapple Group), or Sunny Delight (Procter & Gamble) (<1 and ≥1 time/day), nondiet sports drinks (<1 and ≥1 time/day), fruits including 100% fruit juice (<2 and ≥2 time/day), vegetables (<3 and ≥3 time/day), and eating at fast-food restaurants (0, 1 to2, and ≥3 days/week). Vegetable intake was derived from questions about eating green salad, potatoes (excluding french fries, fried potatoes, or potato chips), carrots, and other vegetables. Behavioral variables included were being physically active at least 60 minutes/day during the past 7 days (<5 and ≥5 days/week) and watching television on an average school day (≤2 and >2 hours/day). Cutpoints of aforementioned variables were chosen based on previous studies.[10,21,26] For television viewing cutpoint, the American Academy of Pediatrics guideline was used.[27] Unknown values or missing data regarding exposure variables ranged from 0.3% to 12% (weight status variable) and were excluded from analyses when the variable was used.

Statistical Analysis

The unadjusted association of previously described characteristics with plain water intake was examined by χ^2 tests, and $P<0.05$ was used for statistical significance. Multivariable logistic regression models were used to estimate adjusted odds ratios (ORs) and 95% CIs for variables associated with low plain water intake (<3 times/day). All variables were included in the multivariable logistic regression model. This logistic regression model included data on 9,077 students who had complete information on all variables studied. Of note, there were no significant differences in age, sex, race/ethnicity, or weight status between students who were included in the logistic regression model and those who were not included in the logistic regression model. Sample weights were applied to all analyses to adjust for nonresponse. All statistical analyses were performed using Statistical Analysis Software (version 9.2, 2009, SAS Institute Inc) and incorporating appropriate procedures to account for the complex sample design.

RESULTS AND DISCUSSION

The final analytic sample was 11,049 students. Overall, 54% of students reported drinking a bottle or glass of plain water <3 times/day during the past 7 days. Based on χ^2 tests, plain water intake significantly differed by race/ethnicity, and all of the dietary habits and behavioral factors examined. For example, increased water intake was associated with increased intake of milk, sports drink, fruits, vegetables, physical activity, and decreased intake of nondiet soda, fast foods, and television watching (Table 1).

Based on multivariable logistic regression analysis, factors significantly associated with greater odds for low water intake were age ≤15 years (OR 1.1), consuming <2 glasses/day milk (OR 1.5), nondiet soda ≥1 time/day (OR 1.6), other SSBs ≥1 time/day (OR 1.4), fruits and 100% fruit juice <2 times/day (OR 1.7), vegetables <3 times/day (OR 2.3), eating at fast-food restaurants 1 to 2 days/week and ≥3 days/week (OR 1.3 and OR 1.4, respectively), and being physically active ≥60 minutes/ day on <5 days/week (OR 1.6). Being obese was significantly associated with reduced odds for low water intake (OR 0.7) (Table 2).

The prevalence of low water intake among adolescents was lower in our study (54%) compared with a previous study[24] that showed that 64% of Florida middle school students drank <3 glasses/day plain water. Discrepancies between studies could be due to differences in the populations studied, including the age of respondents. That is, our study used a nationally representative sample of high school students, whereas the Florida study used a state representative sample of middle school students.

In our study, race/ethnicity was significantly associated with plain water intake based on χ^2 tests, but was not significant based on the multivariable logistic regression analysis using non-Hispanic whites as the referent group and adjusting for the other variables. A study using NHANES data reported that there was no association between plain water intake and race/ethnicity among youth aged 2 to 19 years.[22] In contrast, the study among Florida middle school students found that Hispanics were significantly less likely to have low water intake than non-Hispanic whites.[24]

Although our study is cross-sectional and thus cannot address causality or directionality of association, the findings of a significant association between low water intake and high SSB intake may suggest that there is an opportunity to substitute plain water for SSBs. Consistent with the NHANES study cited above,[22] students with obesity in our study were 30% less likely to be low water consumers compared with normal/underweight students. Adolescents with obesity might try to limit energy intake from beverages by substituting plain water for SSBs. This tactic is supported by evidence from two studies that found that compared with students who were not trying to do anything about their weight, those who were trying to lose weight were less likely to drink SSBs.[10,28] Although there is limited evidence regarding whether water intake might facilitate weight management among youth, plain water may have an important role in decreasing energy intake and possibly preventing incidence of obesity.[14] For example, a school-based intervention to promote water consumption among elementary school students in Germany was conducted. In the intervention schools, water fountains were installed, plastic water bottles were given to each child, and classroom

lessons describing the water needs of the body and the water circuit in nature demonstrating the need for water consumption were provided. The control schools received no intervention. One year after the intervention, the OR for being overweight at follow-up was significantly reduced by 31% in the intervention schools compared with the control schools.[13]

Few studies have examined possible associations between water intake and dietary or behavioral factors among US youth.[22,24] Although variables were slightly different than those used in our study, one such study also found that low water intake was significantly associated with numerous poor dietary habits, including low consumption of milk and 100% fruit juice, and high consumption of nondiet soda, fruit-flavored drinks/sports drinks, and fast foods among Florida middle school students.[24] In the NHANES study, plain water intake was inversely associated with intake of fluid from other beverages (eg, SSBs) and total sugar.[22] In our study, the strongest factor associated with low water intake was low vegetable intake. Of note, this association has not been well studied in the peer-reviewed literature. Results from NHANES showed that fiber intake was positively associated with plain water intake among US adolescents (aged 12 to 19 years).[22]

Regarding physical activity and sports participation, similar to findings from our study, the NHANES study[22] found that participation in physical activity was associated with higher water intake among US youth (aged 2 to 19 years), and Park and colleagues[24] reported that Florida adolescents who did not participate in team sports during the previous year were more likely to be low water consumers compared with those who participated in ≥3 team sports. It is not surprising that participation in physical activity and sports would lead to higher water consumption because of thirst and need for hydration. The American Academy of Pediatrics recommends that physically active adolescents drink plain water for their hydration with the exception of athletes with prolonged, vigorous sports or intense physical activity who may need more rapid replenishment of carbohydrates and/or electrolytes.[29] Furthermore, the American Academy of Pediatrics recommends that adolescents should avoid routine consumption of sports drinks and should never drink energy drinks.[29] In addition, consistent with findings from our study, the NHANES study[22] found that television viewing and computer use were not significantly associated with plain water intake.

The major strengths of our study are that it is based on a large, nationally representative sample with a relatively high response rate, and it had measured weight and height from which obesity status could be ascertained. However, our study is subject to limitations. First, NYPANS data are self-reported except for height and weight, and the extent of underreporting or overreporting of beverage consumption cannot be determined. Of note, the Centers for Disease Control and Prevention is currently analyzing NYPANS data to examine the extent to which the survey data on beverage consumption corresponds to 24-hour recall data among a subsample of students. A second limitation is that the associations are cross-sectional, and, as such, causality and directionality of these cannot be determined. Third, these data apply only to adolescents who attend school and, therefore, are not representative of all persons in this age group. However, in 2008, only about 4% of youth aged 16 to 17

years nationwide had not completed high school and were not enrolled in a high school program.[30]

CONCLUSIONS

More than half of high school students reported drinking a bottle or glass of plain water <3 times/day during the past 7 days. Factors significantly associated with greater odds for low plain water intake were being younger and having a low intake of milk, fruits (including 100% fruit juice), and vegetables, a high intake of nondiet soda and other SSBs, frequently dining at fast-food restaurants, and physical inactivity. Considering the possible adverse consequences of high SSB intake, efforts are needed to increase plain water intake among adolescents, specifically among low water consumers. One facilitator for this change is that as of May 2011, the US Department of Agriculture has put forth guidance for schools to provide plain drinking water during mealtime as part of the National School Lunch Program.[18] There is evidence that providing drinking water during mealtime can increase water access and intake.[17] In addition, we found several less healthful dietary and behavioral factors associated with low water intake. This may be useful for the development of health promotion initiatives, such as substituting plain water intake for less healthy beverages and making water easily accessible to students (eg, through water filling stations) to promote healthy lifestyles.

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Table 1

Characteristics of respondents and their associations with plain water intake[a] among US high school students, based on data from the National Physical Activity and Nutrition Study, 2010

Characteristic	All respondents	Plain Water Intake during the Past 7 d				*P* value[b]
		<1 Time/d	1–2 Times/d	3 Times/d	≥4 Times/d	
	%[c] ± standard error					
Total sample (N=11,049)[d]	100	27.6±1.2	26.3±0.8	15.5±0.7	30.6±1.1	—
Age (n=10,973)						
≤15 y	35.3±0.7	28.8±1.4	25.8±1.0	15.8±0.8	29.5±1.3	0.55
16 y	26.4±0.6	25.6±1.6	26.4±1.7	16.0±1.5	32.0±2.1	
≥17 y	38.2±0.7	27.9±1.4	26.5±1.1	15.0±1.0	30.6±1.1	
Sex (n=10,994)						
Female	49.6±0.9	28.2±1.6	26.9±1.1	15.3±1.0	29.6±1.0	0.43
Male	50.4±0.9	27.1±1.2	25.6±1.0	15.8±0.8	31.6±1.5	
Race/ethnicity (n=10,831)						
White, non-Hispanic	58.3±3.1	24.3±1.3	29.0±1.1	16.9±1.0	29.9±1.5	<0.0001
Black, non-Hispanic	14.5±1.7	36.5±1.4	20.2±1.2	11.9±0.9	31.4±1.3	
Hispanic or Latino	18.7±2.2	30.8±1.8	24.6±1.0	14.9±0.9	29.7±1.8	
Other/multirace, non-Hispanic[e]	8.5±0.8	27.5±3.6	21.8±2.6	14.9±1.6	35.7±2.2	
Weight status[f] (n=9,704)						
Underweight/normal weight	63.2±1.2	28.5±1.2	27.1±1.0	15.5±1.1	29.0±1.6	0.11
Overweight	17.7±0.5	25.8±1.6	26.8±1.6	16.2±1.2	31.2±1.3	
Obese	19.1±0.9	26.0±2.2	24.3±1.7	14.5±1.3	35.2±2.2	
Milk (n=11,017)						
<2 glasses/d	74.2±1.3	31.7±1.3	26.3±0.9	14.6±0.7	27.4±1.2	<0.0001
≥2 glasses/d	25.8±1.3	15.8±1.4	26.4±1.2	18.4±1.3	39.4±1.9	
Nondiet soda (n=11,007)						
<1 time/d	75.7±1.2	24.9±1.2	26.1±1.0	16.5±0.8	32.5±1.1	<0.0001
≥1 time/d	24.3±1.2	35.8±1.3	27.0±1.2	12.7±1.1	24.6±1.7	
Other SSBs[g] (n=10,996)						

Characteristic	All respondents	Plain Water Intake during the Past 7 d				*P* value[b]
		<1 Time/d	1–2 Times/d	3 Times/d	≥4 Times/d	
<1 time/d	83.2±0.8	27.7±1.3	25.4±0.9	16.3±0.8	30.7±1.3	0.002
≥1 time/d	16.8±0.8	27.0±1.7	30.8±1.6	12.2±1.1	30.0±1.4	
Nondiet sports drinks (n=11,011)						
<1 time/d	83.9±0.7	29.1±1.4	26.0±0.9	15.5±0.8	29.4±1.2	<0.0001
≥1 time/d	16.1±0.7	19.7±1.0	27.9±1.4	15.8±1.1	36.6±1.7	
Fruits including 100% fruit juice (n=10,980)						
<2 times/d	59.1±0.8	34.6±1.4	27.4±1.0	14.8±0.8	23.3±1.4	<0.0001
≥2 times/d	40.9±0.8	17.3±1.0	24.8±1.0	16.7±1.0	41.1±1.2	
Vegetables[h] (n=10,922)						
<3 times/d	81.5±0.6	30.5±1.2	28.2±1.0	15.0±0.7	26.3±1.1	<0.0001
≥3 times/d	18.5±0.6	14.5±1.3	18.2±1.7	18.0±1.5	49.3±2.2	
Eat at fast-food restaurants (n=10,741)						
0 days/wk	25.2±1.6	19.7±1.5	25.9±1.3	16.9±1.6	37.6±1.6	<0.0001
1–2 days/wk	43.9±1.2	27.8±1.2	27.4±1.0	16.3±0.8	28.5±1.0	
≥3 days/wk	31.0±1.3	33.4±1.5	25.6±1.0	13.6±0.9	27.3±1.8	
Physically active ≥60 min/d during previous 7 d (n=10,933)						
<5 days/wk	52.1±1.1	33.0±1.4	27.4±1.0	14.1±0.8	25.5±1.3	<0.0001
≥5 days/wk	47.9±1.1	21.4±1.2	25.1±1.3	17.3±0.9	36.3±1.4	
Television watching on average school day (n=11,001)						
≤2 hours/d	71.9±1.3	25.0±1.3	27.1±1.0	16.8±0.9	31.0±1.3	<0.0001
>2 hours/d	28.1±1.3	34.0±1.1	24.1±1.0	12.4±0.8	29.5±1.0	

[a] The question asked was, “During the past 7 days, how many times did you drink a bottle or glass of plain water? Count tap, bottled, and unflavored sparkling water.”

[b] χ^2 tests were used for each variable to examine differences across categories.

[c] Because of rounding, weighted percentages may not add up to 100%.

[d] Unweighted sample size.

[e] Includes non-Hispanic American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or multirace.

[f] Measured weight and height were used to calculate body mass index. Underweight/normal weight was defined as body mass index <85th percentile for sex and age; overweight was defined as body mass index ≥85th to <95th percentile; and obese was defined as body mass index ≥95th percentile.

[g] SSBs=sugar-sweetened beverages. Other SSBs include lemonade, sweetened tea/coffee drinks, flavored milk, Snapple (Dr Pepper Snapple Group), or Sunny Delight (Procter & Gamble).

[h] Vegetables include green salad, potatoes (excluding french fries, fried potatoes, or potato chips), carrots, or other vegetables.

Table 2

Odds ratios (ORs) for variables associated with low plain water intake[a] (<3 times/d) among US high school students, based on data from the National Physical Activity and Nutrition Study, 2010[b]

Characteristic	Adjusted OR	95% CI
Age (y)		
≤15	1.1[c]	1.04, 1.26
16	1.0	0.82, 1.13
≥17	Referent group	
Sex		
Female	1.0	0.87, 1.15
Male	Referent group	
Race/ethnicity		
White, non-Hispanic	Referent group	
Black, non-Hispanic	1.0	0.79, 1.21
Hispanic or Latino	1.0	0.84, 1.24
Other/multirace, non-Hispanic	0.9	0.65, 1.19
Weight status[d]		
Underweight/normal weight	Referent group	
Overweight	0.9	0.72, 1.01
Obese	0.7[c]	0.58, 0.93
Milk		
<2 glasses/d	1.5[c]	1.21, 1.76
≥2 glasses/d	Referent group	
Nondiet soda		
<1 time/d	Referent group	
≥1 time/d	1.6[c]	1.40, 1.92
Other SSBs[e]		
<1 time/d	Referent group	
≥1 time/d	1.4[c]	1.11, 1.65
Nondiet sports drinks		
<1 time/d	Referent group	
≥1 time/d	0.9	0.72, 1.12
Fruits including 100% fruit juice		
<2 times/d	1.7[c]	1.46, 2.01
≥2 times/d	Referent group	
Vegetables[f]		
<3 times/d	2.3[c]	1.92, 2.78
≥3 times/d	Referent group	
Eat at fast-food restaurants		
0 days/wk	Referent group	

Characteristic	Adjusted OR	95% CI
1–2 days/wk	1.3[c]	1.12, 1.55
≥3 days/wk	1.4[c]	1.22, 1.63
Physically active ≥ 60 min/d during previous 7 d		
<5 days/wk	1.6[c]	1.35, 1.81
≥5 days/wk	Referent group	
Television watching on average school day		
≤2 hours/d	Referent group	
>2 hours/d	1.1	0.93, 1.18

[a] The question asked was, “During the past 7 days, how many times did you drink a bottle or glass of plain water? Count tap, bottled, and unflavored sparkling water.”

[b] The multivariable logistic regression model included all variables of study and is based on a sample of 9,077 students without missing data. Reference category included students who drank plain water ≥3 times/d.

[c] Significant finding based on the 95% CI (ie, the CI does not include 1).

[d] Measured weight and height were used to calculate body mass index. Underweight/normal weight was defined as body mass index <85th percentile; overweight was defined as body mass index ≥85th to <95th percentile; and obesity was defined as body mass index ≤95th percentile.

[e] SSB=Sugar-sweetened beverage. Other SSBs include lemonade, sweetened tea/coffee drinks, flavored milk, Snapple (Dr Pepper Snapple Group), or Sunny Delight (Procter & Gamble).

[f] Vegetables include green salad, potatoes (excluding french fries, fried potatoes, or potato chips), carrots, or other vegetables.