Dietary and Activity Correlates of Sugar-Sweetened Beverage Consumption Among Adolescents

WHAT'S KNOWN ON THIS SUBJECT: SSBs are known to displace milk consumption, and 1 study revealed that SSB consumption reduces fruit intake and increases calorie intake. Some studies have revealed increases in television-watching. Multiple behavioral correlates of SSB consumption have not been reported.

WHAT THIS STUDY ADDS: This study examined associations of multiple dietary and activity behaviors with SSB consumption in the same cohort and revealed that these associations vary with the type of SSB. Consumption of flavored and sports beverages coexists with several healthy behaviors.

abstract

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OBJECTIVE: To examine the dietary and activity correlates of sugar-sweetened beverage consumption by children in middle and high school.

METHODS: Data were obtained from a cross-sectional survey of 15 283 children in middle and high schools in Texas. Consumption of sodas and noncarbonated flavored and sports beverages (FSBs) were examined separately for their associations with the level of (1) unhealthy food (fried meats, French fries, desserts) consumption, (2) healthy food (vegetables, fruit, and milk) consumption, (3) physical activity including usual vigorous physical activity and participation in organized physical activity, and (4) sedentary activity, including hours spent watching television, using the computer, and playing video games.

RESULTS: For both genders, consumption of soda and FSBs was systematically associated with a number of unhealthy dietary practices and with sedentary behaviors. However, consumption of FSBs showed significant positive graded associations with several healthy dietary practices and level of physical activity, whereas soda consumption showed no such associations with healthy behaviors.

CONCLUSIONS: Consumption of FSBs coexists with healthy dietary and physical activity behaviors, which suggests popular misperception of these beverages as being consistent with a healthy lifestyle. Assessment and obesity-prevention efforts that target sugar-sweetened beverages need to distinguish between FSBs and sodas. *Pediatrics* 2010; 126:e754–e761

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KEY WORDS

soft drinks, correlation, dietary habits, physical activity, population-based studies

ABBREVIATIONS

SSB—sugar-sweetened beverage
SPAN—School Physical Activity and Nutrition
FSB—flavored and sports beverage

www.pediatrics.org/cgi/doi/10.1542/peds.2010-1229

doi:10.1542/peds.2010-1229

Accepted for publication Jun 28, 2010

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

Despite recent reports of a possible slowdown in the obesity epidemic, the obesity burden in the United States remains a troubling public health issue.[1,2] Currently, nearly 17% of children and adolescents (ages 2–19) in the United States are at the ≥95th percentile of the 2000 Centers for Disease Control and Prevention BMI-for-age growth charts.[2] These trends have spurred intensive efforts to identify effective strategies for preventing weight gain among adolescents. Consistent with the multifactorial nature of obesity causation,[3] these interventions encompass a variety of dietary and activity behaviors that are believed to affect energy balance and, hence, weight gain.[4–8]

One target behavior of interest for interventions is the consumption of sugar-sweetened beverages (SSBs). Although sodas (carbonated beverages) are usually seen as the primary SSB, the category also includes sports drinks and a large number of colas and fruit-flavored beverages that are not carbonated but nevertheless contain large amounts of added sugar. The consumption of both types of SSBs by children has increased dramatically in the past few decades. Between 1977 and 1998, the prevalence of daily SSB consumption among children aged 11 to 18 years nearly tripled,[9] whereas the amount of SSB intake per day in this population more than doubled.[10] Adolescents now derive 10% to 15% of their total caloric intake from the consumption of SSBs.[11] Because these increases have occurred concomitantly with rising levels of childhood overweight and obesity across the population, several scholars have theorized that SSB consumption may be an important driver of the obesity epidemic.[12,13] The results of several individual-level cross-sectional and cohort studies have confirmed an association between soft drink consumption and BMI or weight gain.[14,15]

Nevertheless, only a small number of interventions have explicitly targeted SSB consumption as a primary outcome.[16] SSB interventions that have been successful tend to be characterized by environmental alterations such as home delivery of noncaloric beverages to displace SSBs[17] or the installation of water fountains in schools.[18] There is a need to develop more feasible behaviorally based interventions. An important knowledge gap in this regard is the absence of information regarding the behavioral context of SSB consumption among adolescents. Little is known about the dietary and activity correlates of SSB consumption and whether these behavioral correlates are similar across different categories of SSBs in this age-group. Several studies have revealed that SSBs displace milk consumption,[19,20] and 1 small study revealed reduced fruit consumption and increased calorie consumption associated with high levels of SSB consumption[21]; apart from these data, little is known about foods that are either complementary to or negatively associated with SSB consumption. Similarly, there have been few studies examining if SSB consumption is associated with specific patterns of physical and/or sedentary activity. Knowledge of dietary and activity correlates, and how they differ across broad subgroups of beverages, is clearly relevant in informing the design of broad-based behavioral interventions that target SSB consumption among adolescents.

The primary purpose of this study was to examine the dietary and activity correlates of SSB consumption among adolescents. Data for the study were obtained from the School Physical Activity and Nutrition (SPAN) surveys conducted by the University of Texas School of Public Health and funded by the Texas Department of State Health Services in the state of Texas in 2004–2005.[22] The size of the data set ($n = 15\,283$), the substantial representation of key racial and ethnic categories, and the age groups represented (8th and 11th grade) all make these data particularly suited to these analyses.

We hypothesized that SSB consumption co-occurs with specific dietary and activity behaviors for children at these ages such that the extent of each of these behaviors would vary systematically across levels of SSB consumption. We further presumed that these behaviors vary according to gender, because a number of studies have revealed gender differences in the level of SSB consumption as well as in possibly associated dietary behaviors.[23–25] Finally, we hypothesized that the behavioral correlates of SSB consumption vary with the type of SSB consumed, specifically, regular sodas and flavored and sports beverages (FSBs), because of differences in how consumers perceive these 2 categories. The analysis was limited to 8th- and 11th-grade children, because younger children typically have lower control over the acquisition of beverages or the context of beverage consumption.

METHODS

The SPAN project is a surveillance system designed to monitor childhood obesity and related behaviors in schoolchildren at the state level. The cross-sectional study design used a stratified, multistage probability sampling scheme to obtain data and was designed to be representative at the state level and by 3 major ethnic groups: black, Hispanic, and white/other. Questionnaires were used to collect self-reported data on students' eating behaviors on the previous day by using a food-

frequency-questionnaire approach. Usual physical activity and sedentary activity were assessed through self-report. Versions of these questionnaires have been evaluated for reproducibility and validity.[26] The sampling frame for the 2004–2005 SPAN survey included 87% of children in Texas public schools. In all, 160 secondary schools were sampled. Additional details of the SPAN study design are available elsewhere.[22] Analyses for this article were limited to 15 283 8th- and 11th-grade students represented in the 2004–2005 SPAN survey data, the most recent year for which complete statewide data are available. Approval for the SPAN study was obtained from the University of Texas Health Science Center at Houston Committee for the Protection of Human Subjects as well as the Texas Department of State Health Services institutional review board and participating school districts.

Sugar-Sweetened Beverages

SSBs are drinks that contain added caloric sweeteners such as sugar or high-fructose corn syrup.[13] The definition includes a large variety of both carbonated and noncarbonated drinks and excludes 100% fruit juice. Consistent with our hypothesis that sodas are perceived as a beverage type distinct from sports drinks and flavored beverages, we operationalized SSB consumption as 3 distinct measures: consumption of regular (not diet) sodas; consumption of noncarbonated FSBs; and consumption of any SSB (obtained as the sum of responses for regular soda and FSBs). The question relating to soda consumption was asked as, "Yesterday, how many times did you drink any regular (not diet) sodas or soft drinks?" The wording for the question for FSB was, "Yesterday, how many times did you drink any punch, Kool-Aid, sports drinks, or other fruit-flavored drinks? Do not count 100% fruit juice." Responses to each of these measures, obtained as the number of servings consumed on the previous day, were available in 1 of 4 ordinal categories: none, 1, 2, and ≥3. Both categorical and continuous specifications of beverage consumption were used in the analyses. Prevalence of SSB consumption and the amount of beverage consumed were derived from these measures. Consumption of 100% fruit juice was also examined for its associations with the behavioral measures of interest, because fruit juice has been linked to adiposity in some studies.[27]

Dietary Measures

Dietary correlates were drawn from 22 detailed questions included on the 2004–2005 SPAN survey, which referenced specific marker foods or food groups. As in the beverage questions, these questions pertained to the number of times the food was consumed on the previous day, and responses ranged from none (0) to ≥3. For the analysis of dietary behaviors, items were examined singly or in combination to yield a set of healthy and unhealthy foods/food groups, as well as alternative beverage choices. The unhealthy food groups examined included (*a*) fried meats (obtained as a sum of 2 related items: hamburgers and related meats, and fried meats), (*b*) fried snacks (a single item that referenced French fries, chips, and other savory chip-type snacks), and (*c*) desserts, obtained as the sum of 3 items (frozen desserts, cakes, and chocolate/candy). Healthy food and beverage groups included (*a*) fruit, (*b*) vegetables, and (*c*) milk. Each of the individual food item scores ranged from 0 to 3, except for fried meats (0–6) and desserts (0–9). Means of items for each category of SSB consumption, as well as for SSB consumption overall, were estimated from adjusted regression models.

Activity Measures

Physical activity and sedentary behaviors were examined for their association with SSB consumption. Physical activity measures included (*a*) the number of days in the previous week that the student engaged in vigorous physical activity, (*b*) whether the student opts for physical education class, and (*c*) whether the student participates in any organized physical activity, including participating in a sports team. The 3 sedentary measures included typical daily hours spent watching television, typical hours per day spent on the computer, and typical hours per day playing video games. As in the case of dietary items, means for these measures were estimated across categories of SSB consumption.

Sociodemographic Data

Demographic data included gender; grade (8th or 11th); language spoken at home (English or non-English); a school-level socioeconomic status variable, defined as the proportion of enrolled students who were eligible for free or reduced-price meals or were otherwise classified as economically disadvantaged; and self-identified race/ethnicity, collapsed into 3 major categories of interest (black, Hispanic, or all other races, mostly white). BMI measures were also used.

Statistical Analyses

We first examined how the consumption of soda, FSBs, and total SSBs was distributed according to gender and across categories of potential confounders including race/ethnicity, socioeconomic status, grade level, and BMI. Means, SEs, and proportions of beverage consumption in

each demographic category were estimated. Next, in multivariate analyses, we estimated the degree of various dietary and activity behaviors across categories of beverage consumption for each of the beverage categories of interest by using linear regression models. Adjustment variables included race/ethnicity, grade, percentage who were economically disadvantaged, BMI, and language spoken at home. The *P* value for linear trend across increasing categories of beverage consumption was estimated for each outcome by using identical regression models but with a continuous specification for the main beverage variable. All regression models were stratified according to gender. In another set of analyses we similarly examined the associations of dietary and activity behaviors with 100% fruit juice consumption. A level of .05 was established a priori as the threshold for statistical significance. All estimates and statistical tests took into account sampling stratification and clustering and the sample weights used by the survey. Estimates were obtained by using Stata 11.0 (Stata Corp, College Station, TX).

RESULTS

Detailed demographics of the sample are presented according to gender in Table 1. The final sample consisted of 7573 boys and 7748 girls. Fifty-eight percent of the children were in the 8th grade ($n = 8827$). The racial/ethnic makeup of the sample was 42.9% Hispanic and 11.4% black, and most of the remaining 45.7% were white. Approximately 22% of the children reported that English was not the language used at home/with parents. Distributions of grade, race/ethnicity, language spoken at home, and economic disadvantage were comparable across the genders. The mean age of the sample was nearly 15 years (SD: 1.6). Twenty-two percent of the boys were obese (BMI $\geq$ 30), and 17% of the girls in the sample were obese. Sixty-two percent of the sample was of normal weight (BMI $<$ 25). Across schools, the percentage of economically disadvantaged students was ~50%.

Sociodemographic Characteristics and Amount of SSB Consumption

Table 1 also lists the mean number of times SSBs were consumed (on the basis of self-reported previous-day consumption) across sociodemographic characteristics within gender and SSB categories. Among boys, the average number of times soda was consumed daily increased from 8th to 11th grade, whereas the number of times FSBs were consumed remained steady. In contrast, among girls, soda consumption remained steady from 8th to 11th grade, and FSB consumption declined substantially. Marked differences in average consumption were also present across racial/ethnic categories. Black children of both genders had lower soda consumption but considerably higher FSB consumption than either Hispanic or white/other children. Among boys, children who reported that English is not the primary

TABLE 1 Mean Number of Times That Sodas and FSBs Were Consumed Daily (Based on Previous-Day Consumption) Among 8th- and 11th-Grade Students Across Sociodemographic Characteristics and BMI Categories, According to Gender: SPAN 2004–2005

Sociodemographic Characteristic	Boys				Girls			
	n (%)	Regular Sodas, Mean (SE)	FSBs, Mean (SE)	Any SSB, Mean (SE)	*n* (%)	Regular Sodas, Mean (SE)	FSBs, Mean (SE)	Any SSB, Mean (SE)
Total[a]	7535	1.04 (0.05)	1.00 (0.05)	1.78 (0.05)	7748	0.85 (0.04)	0.75 (0.04)	1.46 (0.04)
Grade								
8th	4328 (57)	0.97 (0.06)	1.01 (0.06)	1.73 (0.06)	4499 (58)	0.85 (0.06)	0.82 (0.05)	1.50 (0.06)
11th	3207 (43)	1.13 (0.07)	0.99 (0.06)	1.85 (0.07)	3249 (42)	0.84 (0.06)	0.66 (0.04)	1.40 (0.06)
Race/ethnicity								
Black	795 (11)	0.82 (0.10)	1.42 (0.08)	1.92 (0.09)	947 (12)	0.70 (0.07)	1.21 (0.07)	1.69 (0.07)
Hispanic	3128 (42)	1.05 (0.04)	0.97 (0.03)	1.80 (0.04)	3430 (44)	0.99 (0.05)	0.70 (0.05)	1.52 (0.05)
White/other	3612 (48)	1.10 (0.09)	0.91 (0.08)	1.72 (0.1)	3371 (44)	0.78 (0.06)	0.64 (0.05)	1.33 (0.06)
Language spoken at home								
Not English	1624 (22)	0.95 (0.05)	0.86 (0.06)	1.64 (0.06)	1688 (22)	1.01 (0.07)	0.78 (0.04)	1.58 (0.06)
English	5826 (77)	1.07 (0.06)	1.05 (0.05)	1.82 (0.06)	5957 (77)	0.80 (0.04)	0.74 (0.04)	1.42 (0.05)
Economic disadvantage tertiles								
Lowest tertile	2394 (32)	1.00 (0.11)	0.92 (0.08)	1.69 (0.1)	2371 (31)	0.72 (0.06)	0.64 (0.04)	1.26 (0.06)
Middle tertile	2591 (34)	1.11 (0.07)	1.06 (0.05)	1.88 (0.06)	2683 (35)	0.88 (0.05)	0.73 (0.05)	1.50 (0.05)
Upper tertile	2550 (34)	1.01 (0.05)	1.03 (0.08)	1.77 (0.06)	2694 (35)	0.96 (0.09)	0.89 (0.07)	1.63 (0.06)
BMI categories[b]								
Normal	4540 (60)	1.09 (0.07)	1.03 (0.06)	1.82 (0.07)	4977 (64)	0.90 (0.05)	0.75 (0.04)	1.49 (0.06)
Overweight	1286 (17)	0.94 (0.06)	0.90 (0.09)	1.69 (0.11)	1471 (19)	0.72 (0.07)	0.79 (0.07)	1.41 (0.09)
Obese	1709 (23)	0.97 (0.06)	0.99 (0.07)	1.73 (0.09)	1300 (17)	0.74 (0.06)	0.71 (0.05)	1.36 (0.08)

[a] Classification of BMI categories: normal, <85th percentile; overweight, 85th to 95th percentile; obese, ≥95th percentile; this classification follows World Health Organization guidelines.
[b] Sample sizes were not weighted. Estimated means and SEs take into account the complex sampling scheme and survey weights.

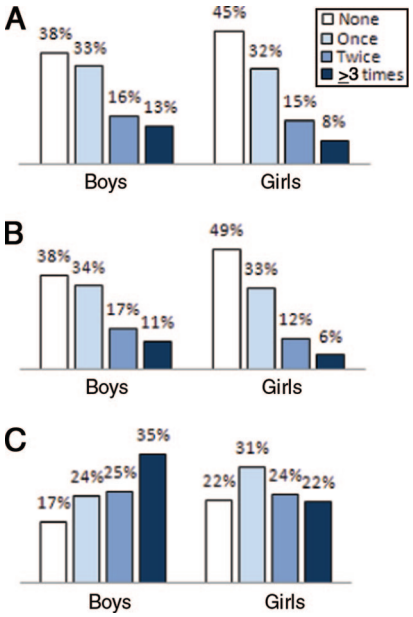

FIGURE 1
Number of times that soda (A), FSBs (B), and SSBs (C) were consumed on the previous day, according to gender. Data are from the 2004–2005 SPAN survey.

language used at home had lower soda and FSB consumption than children for whom English is the primary language at home. The reverse is true among girls. Soda and FSB consumption increased with economic disadvantage among girls. Soda or FSB consumption showed no patterning according to BMI level.

Prevalence and Level of Beverage Consumption According to Gender and Type of SSB

The prevalence of SSB consumption (defined here as the proportion of students who reported any consumption of SSBs on the previous day) and level of consumption varied according to gender and according to type of SSB (Fig 1). Boys reported both higher prevalence and higher levels of consumption of soda and of FSBs; 62% of the boys reported that they drank regular soda 1 or more times, and a similar proportion reported that they drank FSBs 1 or more times the previous day, compared with the 55% and 51%, respectively, reported by girls. The prevalence of consumption of any SSB was substantially larger for both boys and girls (83% and 78%, respectively), which suggests that consumption of sodas and consumption of FSBs seem to be independent behaviors and, therefore, additive across categories. Large proportions of both boys and girls (35% and 22%, respectively) reported consuming some SSBs ≥3 times per day.

TABLE 2 Association of Level of SSB Consumption With Healthy and Unhealthy Diet Measures

	Unhealthy Meats	French Fries	Desserts	Vegetables	Whole Fruit	Milk
Boys						
Soda, mean times consumed/d						
0	1.32	0.75	1.13	0.89	0.83	1.48
1	1.36	0.99	1.31	0.93	0.75	1.33
2	1.52	0.95	1.39	0.76	0.72	1.27
≥3	1.89	1.27	2.08	0.75	0.75	1.18
P for trend	.000 ↑	.000 ↑	.000 ↑	.053	.374	.013 ↓
FSBs, mean times consumed/d						
0	1.29	0.79	1.04	0.79	0.64	1.35
1	1.42	0.93	1.36	0.92	0.74	1.38
2	1.63	1.04	1.53	0.77	0.89	1.24
≥3	1.74	1.23	2.15	1.05	1.20	1.49
P for trend	.001 ↑	.000 ↑	.000 ↑	.150	.000 ↑	.731
Any SSB, mean times consumed/d						
0	1.15	0.67	0.88	0.86	0.78	1.48
1	1.33	0.76	1.14	0.83	0.71	1.39
2	1.39	0.95	1.20	0.99	0.68	1.38
≥3	1.67	1.15	1.82	0.79	0.89	1.26
P for trend	.000 ↑	.000 ↑	.000 ↑	.612	.105	.222
Girls						
Soda, mean times consumed/d						
0	1.08	0.80	1.20	0.94	0.90	1.10
1	1.24	0.90	1.30	0.66	0.62	0.97
2	1.41	1.18	1.66	0.52	0.70	0.87
≥3	1.68	1.32	1.83	0.54	0.80	0.97
P for trend	.000 ↑	.000 ↑	.000 ↑	.000 ↓	.010 ↓	.003 ↓
FSBs, mean times consumed/d						
0	1.18	0.82	1.15	0.70	0.74	1.00
1	1.20	0.93	1.39	0.78	0.72	0.95
2	1.28	1.14	1.57	0.87	0.93	1.14
≥3	1.63	1.37	2.38	0.92	1.00	1.28
P for trend	.021 ↑	.000 ↑	.000 ↑	.039 ↑	.040 ↑	.044 ↑
Any SSB, mean times consumed/d						
0	1.10	0.72	1.15	0.85	0.88	1.12
1	1.10	0.84	1.16	0.80	0.79	0.96
2	1.29	0.95	1.33	0.76	0.63	1.02
≥3	1.48	1.24	1.87	0.60	0.79	0.97
P for trend	.000 ↑	.000 ↑	.000 ↑	.015 ↓	.103	.185

Estimates were obtained from linear regression models that estimated the mean number of times each food group was consumed daily, according to ordered levels of SSB consumption. All models were adjusted for grade, race/ethnicity, language spoken at home, and socioeconomic status and are stratified according to gender. For the models, we took into account the complex sampling design of the study and survey weights. *P* for linear trend was obtained from regression models that used a continuous specification of the beverage variable. Arrows are used to indicate the direction of significant ($P \leq .05$) trends.

Dietary Behaviors Associated With Beverage Consumption

Associations of "unhealthy" foods (meats, fried snacks, desserts) with sodas, FSBs, and overall SSBs were unequivocally positive for boys and girls (Table 2). Consumption of each of these items increased significantly with the level of consumption of these categories of SSBs. With the "healthy foods" (vegetables and fruit), the pic-

ture is not as clear-cut and varied with the type of SSB. Thus, vegetable and fruit consumption increased with the level of FSB consumption but decreased with the level of soda consumption. These trends are apparent with both boys and girls and are statistically significant in the case of girls. It is interesting to note that these opposite associations with sodas and FSBs resulted in an apparent lack of association with the composite SSB variable. Apparent displacement of milk by soda consumption was seen in both boys and girls, but FSB consumption, in contrast, was positively associated with milk consumption. In general, the results suggest that soda consumption is associated with lower consumption of healthy foods, but FSB consumption increases concomitantly with the consumption of healthy foods, especially among girls.

Physical Activity and Sedentary Behaviors Associated With Beverage Consumption

Again, it is evident from results of the analysis that soda and FSB consumption relate differently to physical and sedentary activities (Table 3). Each of the 3 physical activity indexes examined (amount of vigorous physical activity, participation in school physical education classes, and participation in organized sports activity) decreased with level of soda consumption and increased with level of FSB consumption, especially among boys. Positive associations with FSB consumption are repeated among girls, but not the negative associations with soda consumption. Finally, each of the 3 sedentary measures (hours spent watching television, using the computer, and playing video games) increased in general with both soda consumption and FSB consumption among both girls and boys, although the associations tended to be significant mostly with soda consumption.

TABLE 3 Association of Level of SSB Consumption With Physical and Sedentary Activity

	Days of Vigorous Physical Activity	Opts for Physical Education Class	Any Organized Physical Activity	Hours Watching Television	Hours on Computer	Hours Playing Video Games
Boys						
Soda, mean times consumed/d						
0	4.90	0.68	0.75	2.47	1.30	1.37
1	4.33	0.66	0.75	2.64	1.30	1.58
2	4.28	0.59	0.66	2.77	1.57	1.84
≥3	4.48	0.64	0.63	3.25	1.47	2.02
P for trend	.008 ↓	.096	.008 ↓	.000 ↑	.015 ↑	.000 ↑
FSBs, mean times consumed/d						
0	4.38	0.60	0.64	2.69	1.36	1.60
1	4.43	0.68	0.79	2.56	1.28	1.55
2	4.80	0.68	0.71	2.67	1.49	1.43
≥3	5.18	0.71	0.77	2.97	1.47	1.99
P for trend	.005 ↑	.006 ↑	.044 ↑	.148	.362	.220
Any SSB, mean times consumed/d						
0	4.81	0.62	0.68	2.38	1.34	1.36
1	4.39	0.64	0.71	2.66	1.23	1.55
2	4.47	0.66	0.75	2.51	1.25	1.41
≥3	4.60	0.67	0.71	2.94	1.56	1.88
P for trend	.816	.219	.616	.000 ↑	.019 ↑	.000 ↑
Girls						
Soda, mean times consumed/d						
0	3.94	0.56	0.72	2.39	1.11	0.26
1	3.55	0.50	0.69	2.67	1.45	0.34
2	3.50	0.52	0.60	2.93	1.54	0.34
≥3	3.33	0.52	0.55	3.30	1.50	0.55
P for trend	.002 ↓	.400	.001 ↓	.000 ↑	.000 ↑	.003 ↑
FSBs, mean times consumed/d						
0	3.58	0.51	0.65	2.54	1.28	0.28
1	3.75	0.53	0.72	2.67	1.38	0.32
2	3.93	0.55	0.69	2.66	1.16	0.25
≥3	4.09	0.65	0.71	3.25	1.60	0.79
P for trend	.067	.062	.093 ↑	.007 ↑	.389	.005 ↑
Any SSB, mean times consumed/d						
0	4.02	0.56	0.75	2.33	1.20	0.21
1	3.50	0.50	0.62	2.52	1.17	0.30
2	3.70	0.53	0.73	2.67	1.41	0.35
≥3	3.68	0.55	0.65	3.08	1.56	0.42
P for trend	.307	.818	.354	.000 ↑	.005 ↑	.000 ↑

Estimates were obtained from linear regression models that estimated the level of physical and sedentary activity for ordered levels of SSB consumption. All models were adjusted for grade, race/ethnicity, language spoken at home, and socioeconomic status and are stratified according to gender. For the models, we took into account the complex sampling design of the study. *P* for linear trend is obtained from regression models that use a continuous specification of the beverage variable. Arrows are used to indicate the direction of significant ($P \leq .05$) trends.

In additional analyses we examined the associations of these behaviors with 100% fruit juice consumption (results not shown). Correlates of 100% fruit juice consumption were similar to those seen with FSB consumption; fruit juice consumption showed positive associations with physical activity measures and healthy food consumption, as well as with unhealthy food practices and sedentary behavior.

DISCUSSION

In this cross-sectional analysis, we examined the dietary and activity correlates of SSB consumption among girls and boys from a population-based sample of 8th- and 11th-grade children in Texas. The analysis included an examination of the prevalence and levels of consumption of 2 major types of SSB (regular sodas and FSBs), according to gender and across various sociodemographic characteristics.

Several findings are noteworthy. First, when total SSBs (both regular sodas and FSBs) were considered, the prevalence of SSB consumption among these children was high: 28% of children consumed ≥3 SSBs per day. Second, the amount of SSB consumption varied according to sociodemographic characteristics as well as according to type of SSB. Third, the study is the first, to our knowledge, to demonstrate pronounced and consistent associations of a variety of dietary and activity behaviors with the level of SSB consumption. Fourth, these associations varied substantially and systematically according to the type of beverage considered.

The high level of consumption of SSBs among adolescents has generated considerable concern because of its potential to increase weight gain. It has been estimated that daily consumption of just 1 12-oz can of soda or other SSB could lead to as much as a 15-lb weight gain in 1 year.[28] In light of this figure, our findings relating to the high prevalence and level of soda and other SSB consumption among 8th- and 11th-grade children are troubling. Approximately 10% of these children reported consuming ≥3 sodas on the previous day. Average consumption of SSBs across all children is ~1.6 servings per day; this is likely an underestimate, because the questions related to consumption were top-coded at 3 and did not include other beverages such as energy drinks or sweetened milk drinks, which frequently contain high levels of sugar.

The findings related to differences in level of consumption according to sociodemographic category have important implications for the development of interventions. Boys consumed higher levels of SSBs than girls, and soda consumption in particular increased with grade level among boys. Black children consumed soda at lower levels than Hispanic or white children, but their level of FSB consumption was substantially higher. Soda consumption increased with economic disadvantage among girls but less so among boys. Different patterns of SSB consumption among different demographic subgroups, especially across racial/ethnic categories, can and should be accommodated in efforts to tailor interventions.

Our most important findings relate to the difference in behavioral correlates of FSB and soda consumption. Both soda consumption and FSB consumption were positively associated with various unhealthy dietary practices and sedentary behaviors, which suggests that these practices may be universal in the adolescent population. However, there was clear divergence between the 2 categories of SSBs with regard to the consumption of healthy items such as milk, fruit, and vegetables; FSBs showed a positive association, and sodas showed a negative association. Similarly, physical activity increased with the level of FSB consumption but decreased with the level of soda consumption. The most likely explanation for these findings is that FSBs have been successfully marketed as beverages consistent with a healthy lifestyle, to set them apart from sodas. Often, these beverages contain a minimal percentage of fruit juice or, more commonly, contain artificial fruit flavors, which conveys the impression that the drink is more healthful than it actually is. This may explain our finding that the behavioral correlates of FSB consumption are similar to those of fruit juice consumption while remaining distinct from the correlates of soda consumption. Thus, it is apparent that consumers differentiate between sodas and the FSBs. This product differentiation between sodas and FSBs has not been made by public health advocates and scholars, who have focused instead on the fact that all these beverages are sugar-sweetened.[13,15,29] Although this approach is consistent from a physiologic point of view, our findings clearly underscore its inadequacy as a paradigm for informing analyses as well as the development of interventions. Analyses that examine SSBs as a single category mask the differential behavioral associations with categories of SSBs. Recognition of the different behavioral contexts of different categories of SSBs needs to be an important input in intervention design, as well as in assessment of SSB consumption.

This study does have limitations. The associations are cross-sectional and provide no information on the direction of causality. Our instruments for measuring both beverage consumption and behavioral correlates were blunt, given that there were only 4 response categories for most items and that the measures were derived from self-report. Despite adjustment for several covariates, there may have been some residual confounding from unmeasured variables. Nevertheless, it is unlikely that the findings are an artifact, given the large size of the data set and the similarity of the results across conceptually consistent categories. In conclusion, we have described novel findings relating to the behavioral correlates of SSB consumption that may be important for intervention design.

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