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Multicontextual Correlates of Adolescent Sugar-Sweetened Beverage Intake

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1. Introduction

Sugar-sweetened beverages (SSB), such as regular soda, sports, and fruit drinks contribute about 10% of daily energy intake, and 250 kcal per day, among U.S. adolescents that consume these beverages.[1] SSBs also account for approximately 41% of added sugar intake across all age groups in the United States.[2] Ethnic minority adolescents, adolescents from lower income households, and adolescent males have particularly high SSB consumption.[1,3] SSB intake is of concern as added sugar intake is associated with weight gain, obesity, type 2 diabetes, cardiovascular disease, and dental cavities.[4] SSBs may also displace healthier beverages such as unflavored milk and water.[5,6] While SSB consumption has decreased in the past 12 years, consumption of SSBs remains high.[1] The 2015 Dietary Guidelines for Americans recommend limiting total added sugar intake to less than 10% of daily calories.[7] The American Heart Association recommends that adolescents consume fewer than 25 grams (100 calories or 6 teaspoons) of added sugars per day.[8] The accumulating evidence on the health consequences of added sugars has prompted national efforts to reduce SSB intake, especially among children, adolescents and young adults.[8]

Socioecological models of health behavior and previous research on adolescent eating behaviors highlight the multiple factors that may contribute to SSB consumption; however, few multilevel studies have focused on this behavior.[9,10] Previous studies have linked SSB intake to personal behaviors including fast food intake and sedentary behavior,[10,11] and to

the behavior of peers, through social modeling.[12] In addition, home/family factors may also influence an adolescent's SSB consumption. For example, parents may model the behavior by frequently consuming SSBs themselves, set limits on the amount of SSBs their children can consume, or restrict how many SSBs are available in the house. Previous research has linked both home availability of high calorie foods and the lack of food rules by parents to more consumption of high calorie beverages among children.[13]

Adolescent SSB intake has also been linked to school policy.[14] For example, school administrators that report having policies in place that restrict SSB availability is associated with lower SSB consumption by students.[15] School administrators can provide information on what health policies are in place and whether SSBs are available within the school. On the other hand, the use of Geographical Information Systems (GIS) as a tool to objectively capture the number of food outlets that adolescents are exposed to near their school or home can provide more information about how readily accessible SSBs might be to adolescents. Previous studies have linked greater proximity of food outlets to home and school to adolescent food purchasing and consumption, including of SSBs.[16,17] Finally, the content of media programming is another potentially important influence on SSB intake given that adolescents spend an average of three hours per day watching TV.[18] In order to develop successful multi-level approaches specific to reducing adolescent SSB intake, we need to better understand how risk and protective factors at each level contribute individually and collectively to adolescent SSB intake.

To our knowledge, previous research has not simultaneously examined correlates of SSB intake across personal, family/home, peer, school, neighborhood, and media contexts in a diverse sample of adolescents. This study combines survey data from adolescents, parents, and peers; school environment data reported by school personnel; GIS data; and a content analysis of favored TV shows to explore multicontextual correlates of SSB intake among an ethnically and socioeconomically diverse population-based sample of adolescents. This study aims to 1) identify the most important factors within the personal, family/home, peer, school, neighborhood, and media contexts associated with SSB intake, and 2) determine the overall and relative contributions of each context in explaining SSB intake. Findings will help to develop and appropriately target interventions to reduce the intake of SSB among adolescents from diverse socio-economic and ethnic/racial backgrounds.

2. Materials and Methods

2.1 Participants and Procedures

Data were drawn from EAT 2010 (Eating and Activity in Teens), a diverse population-based study of 2,793 adolescents attending 20 public middle and high schools in Minneapolis/St. Paul, Minnesota during 2009–2010.[19,20] Among adolescents present at survey administration, 96.3% had parental consent and chose to participate. The University of Minnesota's Institutional Review Board approved all study procedures. Participant mean age was 14.4 years (SD=2.0), with 46.1% in middle school and 53.9% in high school. Participants were equally divided by gender (46.8% boys, 53.2% girls). Approximately 71% qualified for free or reduced-price school meals. The ethnic/racial backgrounds of participants were as follows: 29.0% African American or Black, 19.9% Asian American,

18.9% white non-Hispanic, 16.9% Hispanic, 3.7% Native American, and 11.6% mixed or other.

2.2 Data Collection and Measures

EAT 2010 collected data on adolescents' personal and environmental characteristics using adolescent and parent surveys, friendship nominations that link to friends' surveys, qualitative media content analysis and GIS. Dietary data were collected from adolescents using a semi-quantitative food frequency questionnaire (FFQ).[21,22] Conceptually relevant measures used to assess adolescents' personal and environmental characteristics are described in Table 1.

2.2.1 Adolescent Assessments—Adolescents completed a classroom-based survey and FFQ. The Youth and Adolescent FFQ was used to assess the study outcome, usual daily servings of sugar-sweetened beverage intake.[21,22] The validity and reliability of the Youth and Adolescent FFQ have been examined and found to be within acceptable ranges for dietary assessment.[22,23] A daily serving of SSB was defined as the equivalent of one glass, bottle, or can of non-diet soda or fruit drink (i.e., not juice; including iced tea, lemonade, Kool-Aid®). Responses to the FFQ were excluded for 123 participants that reported a biologically implausible level of total energy intake (<400kcal/day or >7000 kcal/day).[24,25]

The EAT 2010 adolescent survey was developed to assess constructs of relevance to adolescent weight-related health based on social cognitive theory and an ecological perspective;[19,20] expert review; and extensive piloting with adolescents including test-retest reliability testing. Sociodemographic characteristics were also assessed on the EAT 2010 survey. Adolescents reported their age, gender and race/ethnicity; Socioeconomic status was determined primarily using the higher education level of either parent.[26]

2.2.2 Parent Survey—All parents/caregivers of adolescent participants were also asked to respond to a mail or telephone survey.[27] When two parents responded, only data from the adolescent's primary parent were used to ensure the most accurate information on usual home environment. Primary parent status was based on an algorithm that prioritized amount of time living with that parent, being the biological or adoptive parent, and mothers. Measures are described in Table 1.

2.2.3. Friendship Nominations—As part of the EAT 2010 survey, adolescents nominated up to six of their closest friends within their school by selecting friends' identification numbers from a comprehensive school list.[28] The average number of nominations per adolescent was two friends. A generic code number was used to nominate friends outside of their school. Data provided by each nominated friend on his or her own EAT 2010 survey were linked back to the nominator. All nominated friends were used, regardless of friendship reciprocity, to examine eating behaviors among peers of adolescent participants (Table 1).

2.2.4 School Personnel Surveys—At each participating school, surveys were completed by an administrator to report on policies and practices of relevance to weight-

related health, and by food service professionals to report on school food availability and policies (Table 1). All participating personnel were instructed to respond in regard to the 2009–2010 academic year and encouraged to confer with others at their school if they were unsure of policies or practices.

2.2.5. Media Coding—Adolescents identified their three favorite shows on the EAT 2010 survey. Three episodes of the 25 most popular shows were randomly selected from the 2010 season (accessed via online services such as network websites, Netflix) and were content analyzed for various weight-related aspects including the number of times that SSB appeared during the show (Table 1). Coding was done in two waves by three coders for the first 10 shows and then by two coders for the remaining 15 shows, with one original coder training the two new coders to ensure consistency in applying the instrument. Additional details of the coding procedure have previously been described.[29,30] SSB portrayals on each show were linked back to adolescent participants who reported the show as a favorite.

2.2.6. GIS Data Sources—GIS data sources were used to examine food access within residential and school neighborhoods (Table 1). Network buffer distances of 1200 m to 1600 m were selected for examining access to fast-food restaurants and convenience stores in residential neighborhoods, as prior research has found that adolescents perceive an easy walking distance to be about 15 min and the average participant in this study was not of driving age.[31] For the school neighborhood assessment, smaller network buffers of 800 m were selected to better capture food access within a distance that might be easily traveled by students during the school day. ArcGIS Version 9.3.1 (Esri, 2009, Redlands, CA) was used for geocoding each adolescent's home and school address, and GIS variables were defined following previously published protocols.[32,33] Restaurant and convenience store locations were identified using GIS land use data from commercial databases accessed through Esri Business Analyst (2010).

2.3 Statistical Analysis

Mixed effects linear regression models accounting for clustering of adolescents within schools were used to identify correlates of adolescent SSB intake. First, each personal, family, peer, school, neighborhood, and media variable was modeled separately to examine individual associations with SSB intake controlling for age, gender, race/ethnicity and socioeconomic status. Next, a mutually adjusted model that simultaneously included all independent variables and covariates was modeled to examine the independent and relative associations of each variable with SSB intake. Blocks of variables related to each contextual level were also modeled to determine the variation explained by each context (e.g. a model with only home/family variables indicates the variability in SSB intake explained by the home/family context).

In addition, differences by gender were examined by running separate, stratified models for boys and girls. Associations between independent variables and SSB consumption in stratified models (data not shown) remained largely unchanged from combined models (where boys and girls were included in one model). The combined models were retained for the present analysis given that no meaningful differences were observed between the

combined models and those run separately for boys and girls, and because stratified models further increase the number of statistical comparisons made, reducing power and increasing the chance of spurious findings.

Normality of residuals and correlation between independent variables were examined and found not to violate analytic assumptions. Model results are presented as standardized beta coefficients, standard errors and p-values. The amount of variance explained is presented as the adjusted R^2 for the full mutually adjusted model and for models examining contextually relevant blocks of variables. P-values were adjusted for multiple comparisons using the Bonferroni corrected cut point for this analysis of $p < 0.003$.

There was a varying amount of missing data for variables across data sources (adolescent survey: 0–11%, parent/caregiver survey: 15–21%, friendship nominations/survey: 40–44%, school personnel surveys: 0–2%, GIS data sources: 2–10%, content analysis of TV shows: 45%). To account for potential bias of missing data, multiple imputation was used under the assumption of missingness at random and multivariate normality. Twenty imputed datasets were generated and combined using Rubin's rule for variance.[34] Multiple imputation was previously used with EAT 2010 data and adequately accommodates missingness up to 50%. [34,35] All analyses were conducted in 2016 using SAS (version 9.4, 2013; SAS Institute).

3. Results

Among the overall study population, average daily consumption of SSB was less than one serving (mean $\pm$ standard deviation = 0.82 ± 0.94 ; range = 0–4.7). Daily servings of non-juice fruit drinks were higher (0.47 ± 0.64) than that of regular soda (0.35 ± 0.53) ($p < .001$; $t = 8.51$).

3.1 Individual associations between multicontextual factors and adolescent SSB intake

Individual regression analyses were used to examine how factors from each context were related to adolescent SSB intake, controlling for sociodemographic variables (Table 2). At the personal level, fast food intake and hours of screen time were associated with greater SSB intake, while the use of healthy weight control behaviors and more hours of sleep were associated with lower SSB consumption. Within the home/family environment, more meals spent watching TV, home availability of soda, and having parents who consume more fast food and SSBs were associated with greater adolescent SSB intake. In contrast, greater frequency of having milk served with dinner, parental concern for healthy eating, and parent role modeling of milk consumption were associated with lower adolescent SSB consumption.

Within the peer environment, greater consumption of SSB by peers was associated with greater SSB intake, while having peers who think healthy eating is important was associated with lower adolescent SSB consumption. None of the school, neighborhood or media factors examined here were significantly associated with adolescent SSB intake. Overall, associations across all contexts were small. The strongest associations were observed between SSB intake and fast food consumption ($\beta = 0.21$) and home soda availability ($\beta = 0.27$).

3.2 Mutually adjusted associations between multicontextual factors and adolescent SSB intake

A mutually adjusted model, adjusting for the influence of sociodemographic variables and all other variables, was used to examine the relative influence of factors across contexts (Table 2). In the full model, study variables accounted for approximately 24% of the variance in SSB intake. When examined by block of variables, the personal and home/family contexts accounted for the greatest amount of variance in SSB intake, 13% and 16%, respectively.

Variables that continued to be significantly associated with higher adolescent SSB intake in mutually adjusted models included fast food intake, screen time, home soda availability, and parent's own SSB intake (Table 2). Similarly, variables that continued to be associated with lower adolescent SSB intake included use of healthy weight control behaviors and having milk frequently served with dinner.

4. Discussion

Factors across multiple contexts were associated with SSB intake among an ethnically and socioeconomically diverse sample of adolescents and may be potential targets for interventions aimed at reducing adolescent SSB intake. The proximal factors of personal behaviors and the home/family environment characteristics were most strongly associated with adolescent SSB intake, while the more distal characteristics of school, neighborhood and media contexts did not appear to play a strong role in SSB intake. Further, the contribution of any one variable in this study was small (based on effect sizes). However, many small influences together may produce meaningful effects on behavior as we found that multicontextual variables accounted for almost a quarter of the variance in adolescent SSB intake.

Personal behaviors explained 13% of the variance in SSB intake. Both fast food intake and screen time have previously been linked to SSB consumption among adolescents.¹⁰[10] This is not surprising given that sugary drinks accompany most “combo meals” at fast food restaurants, and that television viewing exposes adolescents to advertisements for sugary drinks and may be a time when adolescents snack on sugary drinks.[36,37] On the other hand, SSB exposure in favorite TV shows was not associated with SSB consumption. It is possible that advertising during commercials or clustering of behaviors (TV watching while drinking soda) was driving behavior more than the TV show content or that the measurement of TV show content did not adequately capture exposure. Engagement in healthy weight control behaviors (scale that includes reporting drinking less soda to manage weight) was associated with lower SSB intake suggesting that adolescents were generally successful in their behavioral intentions. In addition, more hours of sleep was associated with lower SSB intake in individual models, and has previously been found to be associated with healthier diets and lower weight status.[38] The behavioral factors identified in this study warrant further investigation in longitudinal and intervention studies as a means to reduce SSB intake.

The home environment explained the greatest amount of variance in SSB intake at 16%. Although adolescents are growing in their independence from family, these results suggest that parents still have an important role to play in influencing their adolescents' eating behaviors. The strongest association was between the availability of soda in the home and adolescent consumption, and this aligns with previous studies.[13,39] This association may reflect adolescents' purchasing of these beverages themselves, or requesting that their parents purchase them; however, parents can help to influence their adolescent's food choices by overseeing what is purchased and limiting the availability of SSBs in the home. Serving milk with dinner is another parental strategy supported by the findings. The present study did not distinguish between serving different types of milk (e.g. white milk versus chocolate milk), however, serving unflavored milk may displace the consumption of other types of drinks that are high in sugar, including SSBs.[5,6] Making sure that parents are aware that they have a key role to play in supporting their adolescent's dietary choices may be an important tool for parents and should be encouraged by health care professionals and considered when designing interventions and programs.

Few and small associations were found between peer factors and adolescent SSB intake. In individual models, small positive associations were found with peers' SSB intake and small negative associations with peers' attitudes towards healthy eating. These associations are in the expected direction, but did not continue to be significant accounting for other contexts. This finding is aligned with previous research showing that adolescents and their nominated peers have similar diets when not controlling for other contexts.[12] Parents may exert a greater influence on adolescent SSB intake than peers, despite the importance of peers in social development,[40] and the many opportunities for eating with peers at school and social activities.

School and neighborhood factors did not appear to play a strong role in SSB intake. A previous study in Minneapolis-St. Paul found a positive association between home proximity to food and non-food retail facilities and adolescent SSB intake, but found no associations with the school neighborhood environment or with other dietary intake variables (e.g., energy or fruit & vegetable intake).[16] School and neighborhood environments are difficult to measure precisely and associations are difficult to detect in cross-sectional studies and studies in small versus large geographical areas (where policies and neighborhood characteristics may vary to a greater extent).[41] Details about adolescents' transit mode and routes to school and home may help to determine the impact of neighborhood environments on dietary behaviors. For example, those who drive longer distances to school or are travelling to after-school activities may access food outlets outside their immediate home or school neighborhoods. Additionally, null associations with school policy variables may be explained by limited variation; all the school districts in this study had strong wellness policies and it is increasingly common for schools to have policies that restrict SSBs during the school day. Further research is needed to determine the role of schools and neighborhoods in influencing SSB intake and to examine these multicontextual influences of SSB intake longitudinally.

Strengths of this study include the large number of contextual variables examined and the population-based nature of the ethnically and socioeconomically diverse sample. In addition,

measures assessing the neighborhood environment and media exposure were assessed objectively (GIS and content analysis of TV shows), while school environment data were assessed by school personnel, and parental and peer data from parents and peers directly. Although we studied a wide array of variables, many measures were brief in order to minimize participant burden and may have led to imprecise measurement and null findings. In addition, the measure of SSB used in this study did not include beverages such as sports drinks, energy drinks or flavored milks, beverages that are on the rise, commonly sold in schools and at convenience stores, and very high in added sugar.[1] The unexplained variation in the present study is likely the result of imprecise measurement of study variables, and also unmeasured variables such as personal factors that influence taste preferences and decision-making, economic factors including food prices, and additional aspects of the social and physical environment. For example, the parent-child relationship and social media use were not examined but may be important factors influencing SSB intake.[42,43] Finally, the cross-sectional nature of this study limits our understanding of the direction of relationships.

5. Conclusions

Factors associated with higher adolescent SSB intake included fast food intake, TV viewing, watching TV during meals, home soda availability, parent modeling of fast food intake, and parent and peer modeling of SSB consumption. Factors associated with lower adolescent SSB intake included engaging in healthy weight control behaviors, more sleep, having milk served with dinner, parental concern for healthy eating, parent modeling of milk consumption, and having peers who believe healthy eating is important. An in depth look at correlates within each level of the socioecological model that identifies similarities and/or differences across sociodemographic groups, will help to develop and tailor interventions aimed at reducing adolescent SSB consumption. Findings from the present study provide support for the importance of multicontextual interventions when dealing with complex health behaviors such as adolescent SSB consumption. Particular attention to adolescents' health behaviors while also involving parents to make changes to the home environment may be most helpful for promoting low SSB consumption.

Abbreviations:

EAT 2010	Eating and Activity in Teens Study
FFQ	Food frequency questionnaire
GIS	Geographic Information System
SES	Socioeconomic status
SSB	Sugar-sweetened beverages

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Table 1.

Measures used to assess personal, home/family, peer, school, neighborhood, and media environments

Variable	Source ^a	Description
Personal Characteristics		
Weight concerns	Teen	2-item scale. I think a lot about being thinner; I am worried about gaining weight. <i>Strongly disagree, somewhat disagree, somewhat agree, strongly agree</i> (Cronbach's $\alpha=0.83$, test-retest $r=0.77$)
Identity as a picky eater	Teen	I am a picky eater. <i>Strongly disagree, somewhat disagree, somewhat agree, strongly agree</i> (test-retest $r=0.75$)
Cost barriers to healthy eating	Teen	Eating healthy just costs too much. <i>Strongly disagree, somewhat disagree, somewhat agree, strongly agree</i> (test-retest $r=0.58$)
Meal skipping	Teen	During the past week, how many days did you eat breakfast? During the past week, how many days did you eat lunch? During the past week, how many days did you eat dinner? <i>Never, 1–2 times, 3–4 times, 5–6 times, every day</i> (test-retest $r=0.47–0.76$). If participants indicated eating any meal fewer than 5 days per week they were classified as skipping meals in a binary variable.
Fast food intake	Teen	Past month frequency of eating at the following five types of restaurants (including take-out and delivery): Traditional “burger-and-fries” fast food restaurant, Mexican fast food restaurant, fried chicken restaurant, sandwich or sub shop, pizza places. <i>Never/rarely, 1–3 times/month, 1–2 times/week, 3–4 times/week, 5–6 times, 1+ times per day</i> (test-retest $r=0.49$). Scored as 0 to 28 times per month; Total meals per month was trimmed at 90 to resolve unrealistic responses.
Screen time	Teen	Total weekday/weekend hours in free time spent: watching TV/DVDs/Videos; using a computer (not for homework); using Xbox/play station/other electronic games that you play when sitting? <i>0, 1/2 hour, 1 hour, 2 hours, 3 hours, 4 hours, 5+ hours</i> (test-retest $r=0.86$). Hours spent in each behavior were summed to get the total weekly hours of screen time. Range=0–126
Healthy weight control behaviors	Teen	6-item scale. Past year engagement in the following six behaviors in order to lose weight or keep from gaining weight: exercise, ate more fruits and vegetables, ate less high-fat foods, ate less sweets, drank less soda pop, watched my portion sizes. <i>Never, Rarely, Sometimes, On a regular basis</i> (Cronbach's $\alpha=0.88$, test-retest $r=0.71$).
Involvement in meal preparation	Teen	In the past week, how many times did you help make dinner or supper for your family? <i>Never, 1–2 times, 3–4 times, 5–6 times, 7 times</i> (test-retest $r=0.61$). Responses were recoded as <i>0, 1, 5, 3, 5, 5, 5 and 7</i> hours respectively to be analyzed as a continuous variable.
Sleep	Teen	Average hours per night averaged across weekday and weekend days. On an average weekday (Monday-Friday)/weekend day (Saturday or Sunday) what time do you go to bed (to go to sleep)? What time do you get out of bed (to start your day)? Range=4–16
Home/Family Environment		
Meals while watching TV	Teen	In my family, we often watch TV while eating dinner. <i>Strongly disagree, somewhat disagree, somewhat agree, strongly agree</i> (test-retest $r=0.66$)
Home soda availability	Teen	Soda pop is available in my home. <i>Never, sometimes, usually, always</i> (test-retest $r=0.58$)
Household food insecurity	Teen	5-item scale. E.g., The food that we bought just didn't last, and we didn't have money to get more. <i>Often true, sometimes true, never true</i> . Higher scores indicate more household food insecurity. (percent agreement=90%)
Parental pressure to eat	Parent	4-item subscale of the Child-Feeding Questionnaire. E.g., My child should always eat all of the food on his/her plate. <i>Disagree, slightly disagree, slightly agree, agree</i> (Cronbach's $\alpha=0.70$)
Parental restriction of unhealthy food	Parent	6-item subscale of the Child-Feeding Questionnaire. E.g., I intentionally keep some foods out of my child's reach. <i>Disagree, slightly disagree, slightly agree, agree</i> (Cronbach's $\alpha=0.86$)
Parent fast food intake	Parent	In the past week, how often did you eat something from a fast food restaurant, such as McDonald's, Burger King, Domino's, or similar places? (pizza counts). <i>Never, 1–2 times, 3–4 times, 5–6 times, 7 times, more than 7 times</i> (test-retest $r=0.55$). Values of <i>0, 1, 5, 3, 5, 5, 5, 7, and 8</i> were assigned to the responses to analyze this as a continuous variable with units count per week.

Variable	Source ^a	Description
Parent sugar-sweetened beverage intake	Parent	Thinking back over the past week, how often did you drink sugar-sweetened beverages (e.g., regular soda, pop, Kool-Aid)? <i>Less than once per week, 1 drink per week, 2–4 drinks per week, 5–6 drinks per week, 1 per day, 2 or more per day</i> (test-retest $r=0.66$). Values of 0, 1, 3, 5, 7, and 14 were assigned to the responses to analyze this as a continuous variable as frequency per week.
Milk is served with dinner	Teen	Milk is served at meals in my home: <i>never, sometimes, usually, always</i> (test-retest $r=0.78$).
Frequency of family meals	Parent	During the past week, how many times did all, or most, of your family living in your household eat a meal together? <i>never, 1–2 times, 3–4 times, 5–6 times, 7 times, more than 7 times</i> (test-retest $r=0.63$). Values of 0, 1, 5, 3, 5, 5, 7, and 8 were assigned to the responses to analyze this as a continuous variable with units count per week.
Encouragement for healthy eating	Teen	Averaged across both parents. My mother/father encourages me to eat healthy foods. <i>Not at all, a little bit, somewhat, very much</i> (test-retest mother $r=0.47$, father $r=0.66$)
Parent role modeling of milk	Teen	Averaged across both parents. My mother/father drinks milk at dinner. <i>Never, rarely, sometimes, on a regular basis</i> (test-retest mother $r=0.71$, father $r=0.68$)
Peer Environment		
Peer fast food intake	Peer	Same item as teen. Fast food frequency was average of nominated friends' responses.
Peer sugar-sweetened beverage intake	Peer	Mean servings per day derived from FFQ. Average of nominated friends' responses was calculated
Peer attitudes about healthy eating	Teen	Many of my friends think it is important to eat healthy foods like fruits and vegetables. <i>Not at all, a little bit, somewhat, very much, I don't know.</i>
School Environment		
Fast-food restaurant and convenience store presence in 800m	GIS	Commercial databases were used along with NAICS codes to identify restaurants and convenience stores, including gas stations, within network buffers. Both chain names and 18 key words (e.g., take out, fried, pizza) were used to identify fast-food restaurants.
Availability of competitive foods	Food Service	2-item scale. Are there any vending machines in your school that are available to students before or during the school day? <i>Yes, No</i> . Does your school offer a la carte options at lunch? <i>Yes, No</i> . Scored as 0 for no to both, 1 for yes to one and 2 for yes to both.
Corporate sponsorship	Admin	School reports any partnering with food/beverage companies when asked about 6 categories (restaurant nights, sponsorships, contests, scholarships, support for athletics, or other; <i>yes/no</i>)
School commitment to promotion of healthy eating	Admin	In your opinion, to what extent has your school made a serious/real effort to promote healthy food and beverage habits among students? <i>Not at all, to a little extent, to some extent, to a great extent, to a very great extent</i>
School health or nutrition council	Food Service	Does your school have a health or nutrition advisory council made up of school staff, students, and parents that provide input about the types of foods available at school? <i>Yes, No</i>
Neighborhood Environment		
Fast-food restaurant presence in 1200m	GIS	Commercial databases were used along with NAICS codes to identify restaurants and both chain names and 18 key words (e.g., take out, fried, pizza) were used to identify fast-food restaurants within network buffers
Fast-food restaurant density in 1600m	GIS	Dichotomized to reflect if 5 or more fast food restaurants present within network buffers
Convenience store presence in 1200m	GIS	Commercial databases were used along with NAICS codes to identify convenience stores, including gas stations, within network buffers
Convenience store density in 1600m	GIS	Dichotomized to reflect if 5 or more convenience stores present within network buffers
Media Environment		
SSB in favorite shows	Media	The average number of times that sugar-sweetened beverages appeared in teens' three favorite shows.

SSB, sugar sweetened beverage intake; GIS, geographical information systems, FFQ, food frequency questionnaire, NAICS, North American Industrial Classification System

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Teen (Adolescent Survey), Parent (Parent Survey), Peer (Link to identified peers', Adolescent Survey), Admin (survey completed by school administrator), Food Service (survey completed by school food service personnel)', GIS (GIS linking to school and home neighborhood), Media (content analysis of adolescent identified favored TV shows)

Table 2.
Multicontextual factors associated with adolescent sugar-sweetened beverage intake

	Individual Models		Mutually-adjusted Model			
	β	(SE)	p -value	β	(SE)	p -value
Personal Characteristics						
Weight concerns	-0.04	(0.02)	0.012	-0.01	(0.02)	0.594
Identity as a picky eater	0.04	(0.02)	0.042	0	(0.02)	0.875
Cost barriers to healthy eating	-0.03	(0.02)	0.118	-0.03	(0.02)	0.031
Meal skipping	0.04	(0.02)	0.033	0.01	(0.02)	0.390
Fast food intake	0.21	(0.02)	<0.001	0.12	(0.02)	<0.001
Screen time	0.19	(0.02)	<0.001	0.09	(0.02)	<0.001
Healthy weight control behaviors	-0.12	(0.02)	<0.001	-0.08	(0.02)	<0.001
Involvement in meal preparation	-0.02	(0.02)	0.366	0	(0.02)	0.969
Sleep	-0.07	(0.02)	<0.001	-0.03	(0.02)	0.097
Adjusted R ²	0.13					
Home/family Environment						
Meals while watching TV	0.13	(0.02)	<0.001	0.04	(0.02)	0.009
Home soda availability	0.27	(0.02)	<0.001	0.18	(0.02)	<0.001
Household food insecurity	0.03	(0.02)	0.145	0.01	(0.02)	0.529
Parental pressure to eat	0	(0.02)	0.936	-0.01	(0.02)	0.586
Parental restriction of unhealthy food	0	(0.02)	0.980	0.02	(0.02)	0.277
Parent fast food intake	0.09	(0.02)	<0.001	0.01	(0.02)	0.678
Parent sugar-sweetened beverage intake	0.14	(0.02)	<0.001	0.08	(0.02)	<0.001
Milk is served with dinner	-0.09	(0.02)	<0.001	-0.06	(0.02)	0.001
Frequency of family meals	-0.04	(0.02)	0.029	-0.02	(0.02)	0.180
Encouragement for healthy eating	-0.07	(0.02)	<0.001	0	(0.02)	0.804
Parent role modeling of milk	-0.06	(0.02)	0.002	0	(0.02)	0.881
Adjusted R ²	0.16					
Peer Environment						
Peer sugar-sweetened beverage intake	0.06	(0.02)	0.002	0.03	(0.02)	0.093
Peer fast food intake	0.04	(0.02)	0.035	0.01	(0.02)	0.626

β , standardized regression coefficient; SE, standard error

All individual and mutually adjusted mixed-effects models control for age, race, gender and socioeconomic status and account for clustering of students within schools

Sociodemographics accounted for 6% of the variance in SSB intake (adjusted $R^2=0.06$)

Boldface indicates statistical significant at $p < .003$ (Bonferroni adjusted p-value of significance)