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Does the Sale of Sweetened Beverages at School Affect Children's Weight?

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Abstract

In response to the increase in children's weight in recent decades, many states, school districts, and schools in the United States have limited or eliminated the sale of sweetened beverages at school. These policies are promoted for their potential to reduce childhood overweight and obesity, but their effectiveness has not been evaluated. Using a large nationally representative longitudinal dataset, the Early Childhood Longitudinal Study-Kindergarten (ECLS-K), this study explores the relationship between children's access to sweetened beverages at school in 5th and 8th grade, their purchases and total consumption of these beverages, and their weight. We find almost no evidence that availability of sweetened beverages for sale at school leads to heavier weight or greater risk of overweight or obesity among children. We also find limited evidence that availability of sweetened beverages for sale at school leads to higher total consumption of these beverages.

Keywords

school; sweetened beverages; weight; BMI; obesity; overweight; USA; children

Introduction

The prevalence of obesity and overweight among American children is at an all-time high, with 19.6% of children ages 6 to 11 considered obese and another 15.9% considered overweight in 2007-08 (Ogden et al., 2010). Childhood obesity is associated with poorer physical and mental health and social wellbeing during childhood (Friedlander 2003; Must & Anderson 2003) as well as with adult obesity and increased risk of chronic disease later in life (Dietz, 1998; Thompson et al., 2007).

Several hypotheses have been proposed for the rapid increase in obesity among American children. These include less physical activity in schools; community designs that discourage walking and playing outside; larger portion sizes, especially of items of poor nutritional quality; increases in maternal employment; and families' increased reliance on restaurant and other prepared meals and snacks (Anderson & Butcher, 2006; Ebbeling et al., 2002;

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Patrick & Nicklas, 2005). Another possible cause of increased child obesity is the rise in consumption of sweetened beverages. In 1999–2004, elementary school children consumed 20% more calories from sugar-sweetened beverages than children of the same ages a decade earlier (Wang et al., 2008). Among school children, 56–85% consume at least one soft drink per day (Harrington, 2008), with higher consumption of these beverages among boys and among African Americans and Mexican Americans (Cullen et al., 2002; Forshee and Storey, 2003). A number of studies indicate that children who consume soft drinks and other sweetened beverages are more likely to be or to become obese (e.g., Bermudez and Gao, 2010; Blum, Jacobsen and Donnelly, 2005; LaRowe et al., 2010; Lim et al., 2009; Ludwig et al., 2001; Papandreou et al., 2010; Vartanian et al., 2007; Welsh et al., 2005). Not only are these beverages unhealthy because of their high glycemic load and paucity of essential nutrients, but they may also displace nutritious items, such as milk, from children's diets (Bermudez and Gao, 2010; Blum, Jacobsen and Donnelly, 2005; Finkelstein et al., 2004; Fox et al., 2005; Harrington, 2008).

This study examines the relationship between access to sweetened beverages at school, children's school-based purchases and their total consumption of these beverages, and their weight in 5th and 8th grade. From a public health standpoint, the role of sweetened beverages in obesity is much broader than the availability of sweetened beverages for sale in schools. However, school policies may be one of the easiest dimensions for policymakers to change. Legislation and school policies cannot prevent children from consuming these beverages entirely, but they can limit availability of sweetened beverages at school. Whether such restrictions actually reduce sweetened beverage consumption or instead merely divert it to other times and places is therefore an important question for policy. In addition, if such measures are intended to be among the main interventions for preventing childhood obesity, it is important to evaluate their effect on children's weight. This study examines these questions using data from the Early Childhood Longitudinal Study Kindergarten Class of 1998-99 (ECLS-K), the largest nationally-representative U.S. dataset of children with direct measurements of weight and height and multiple measures of sweetened beverage access and consumption.

Sweetened Beverages and the School Environment

There are several reasons to consider children's access to sweetened beverages in schools. School is a key social context in which children spend significant periods of time (Crosnoe & Muller, 2004) and in which many behaviours that can affect weight take place. In particular, school is an important source of food and beverages for children (Chaloupka & Johnston, 2007). It is also an ideal and convenient setting for health behaviour interventions (Plotnikoff et al., 2007).

In response to the concern that sweetened beverages increase obesity risks among children, many schools, school districts, and states have implemented policies aimed at reducing or eliminating children's access to these beverages in school (Centers for Disease Control and Prevention, 2007; Fried & Nestle, 2002; O'Toole et al., 2007). Despite these efforts, there is little evidence on how availability of sweetened beverages for sale at school actually affects consumption of these beverages or children's weight. A cross-sectional analysis reported a positive relationship between access to sweetened beverages at school and whether a child consumed any sweetened beverages in the previous week (Fernandes, 2008). More broadly, several systematic reviews and meta-analyses of published research report positive associations between sweetened beverage consumption and weight (Hu & Malik, 2010; Ludwig et al., 2001; Malik et al., 2006; Malik et al., 2010; Vartanian et al., 2007; Welsh et al., 2005; Woodward-Lopez, Kao & Ritchie, 2010), while other systematic reviews and meta-analyses of published research have concluded that the association between sugar-

sweetened beverage consumption and body mass index (BMI) is weak and statistically insignificant (Bachman et al., 2006; Forshee et al., 2007; Gibson, 2008; Mattes et al., 2010; Pereira, 2006;), including among children (Forshee et al. 2008). Previous research has not used data from a large, nationally-representative sample to directly examine the effect of sweetened beverage access at school on weight. In addition, the relationship between children's access to sweetened beverages at school and their consumption of such beverages has not been investigated using longitudinal data, which is the preferred method for assessing relationships between dietary factors and obesity development (Gibson, 2008).

Figure 1 shows the pathway through which access to sweetened beverages at school is likely to affect children's weight. If sweetened beverages are available for sale at school, children may purchase them and presumably drink some or all of their purchases. Unless children reduce their consumption of sweetened beverages outside of school one-for-one with in-school consumption, their total consumption of sweetened beverages increases. These additional calories increase caloric intake relative to caloric expenditure, leading to increased weight.

Methods

Data source

The Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) was developed by the National Center for Education Statistics (NCES) of the United States Department of Education. It follows a nationally representative cohort of almost 20,000 children in the United States from kindergarten to 8th grade. Multistage probability sampling was used to select a nationally representative sample of children who were in kindergarten in 1998-99 and/or in 1st grade in 1999–2000. The primary sampling units were counties and groups of counties, with a 2nd stage selection of schools within the sampled PSUs (primary sampling units) and a 3rd stage unit of students within schools. Ethical approval received from Emory University review board.

The survey included interviews with parents, teachers and school administrators, direct anthropometric and cognitive assessments of the children, and child interviews (Tourangeau et al., 2006). The 5th and 8th grade waves included a food consumption questionnaire with 19 questions about food and drink consumption that children answered. The questions about sweetened beverages were developed by the United States Department of Agriculture (USDA) based on models from the Youth Risk Behavior Surveillance System (YRBSS) and California Children's Eating and Exercise Practices Survey (CalCHEEPS). In addition, school administrators completed a survey module on whether children could purchase certain products at the school, including sweetened beverages, during school hours. The sources of these questions are the same as those in the children's module (Tourangeau et al., 2005).

The anthropometric component of the ECLS-K consists of height and weight, each measured twice at each wave by trained assessors. Height was measured in inches to the nearest 0.25 inch using a Shorr Board, and weight was measured in pounds using a digital scale. This presents a significant advantage over other nationally representative studies, which collect self-reported or parent-reported weight and height, methods documented to be systematically biased (Bogaert et al., 2003).

This study focuses on children who participated in the 6th and 7th waves of data collection, when most were in 5th and 8th grade, respectively. Those waves were administered in the spring of 2004 and the spring of 2007. Most sample attrition from the original kindergarten sample resulted from random selection for non-sampling due to survey costs. That is,

children who moved to different schools before fifth grade were randomly selected for no follow-up (Tourangeau et al., 2006). Information from the school was collected at each wave for both children who moved and children who stayed at the same school. No substantial differences have been found between respondents and non-respondents, and non-response bias is addressed by the use of weights (Bose & West, 2006).

Data and variables

This study focuses on 3 parts of the pathway presented in figure 1. We first examine whether children's access to the sale of sweetened beverages at school is related to their total consumption of sweetened beverages. We then examine whether children's purchases of sweetened beverages at school are positively related to their total consumption of sweetened beverages. Finally, we examine how children's access to the sale of sweetened beverages at school, their purchases of such beverages at school, and their total consumption of sweetened beverages are each related to their weight.

Our measures of children's access to the sale of sweetened beverages at school are based on children's and school administrators' reports. In the food consumption questionnaire, children were asked the following questions about sweetened beverages:

- "In your school, can kids buy Soda pop (EXAMPLES Coke, Pepsi, Mountain Dew), sports drinks (EXAMPLE Gatorade), or fruit drinks that are not 100% fruit juice (EXAMPLES Kool-Aid, Hi-C, Fruitopia, Fruitworks) in the school?" Children answered yes or no.
- Children who answered yes then were asked, "During the last week that you were in school, how many times did you buy soda pop, sports drinks, or fruit drinks at school?" Children answered none, 1–2 times during the last week in school, 3–4 times during the last week in school, 1 time per day, 2 times per day, 3 times per day, or 4 or more times per day.
- All children, irrespective of availability of sweetened beverages for sale at school, were asked, "During the past 7 days, how many times did you drink Soda pop (EXAMPLES Coke, Pepsi, Mountain Dew), sports drinks (EXAMPLE Gatorade), or fruit drinks that are not 100% fruit juice (EXAMPLES Kool-Aid, Hi-C, Fruitopia, Fruitworks)?" Children answered none, 1–3 times, 4–6 times, 1 time per day, 2 times per day, 3 times per day, or 4 or more times per day.

In addition, an administrator at the school attended by each child was asked:

- "Can students purchase, either from vending machines, school store, canteen, snack bar or a la carte items from the cafeteria during school hours Soda pop, sports drinks, or fruit juice that are not 100% juice?" Administrators answered yes or no.

Based on the responses to these questions, we created 2 dichotomous measures of children's access to the sale of sweetened beverages at school. These variables were, respectively, equal to 1 if the administrator reported that children were able to purchase sweetened beverages at the school or if the child reported that children were able to purchase sweetened beverages at the school. We believe that administrator reports are the most reliable source, but we also examine children's reports for a comprehensive perspective. Disagreement between student and administrator may arise from the fact that administrators were asked specifically about sales during school hours. We also created several measures of access based on agreement between the administrator and the child or between children at the same school, and those models yielded results consistent with those shown here (available upon request).

We created three measures of children's purchases of sweetened beverages at school during the last school week. The first is a dichotomous variable equal to 1 if a child reported purchasing any sweetened beverages at school. The second is a dichotomous variable equal to 1 if a child reported purchasing at least 1 beverage per day at school. The third is a linear variable that measures a child's reported total purchases at school. We used the mean value for categories (e.g., 1–3 times per week was coded as 2 purchases) and multiplied daily purchases by 5. Purchases equal 0 if the child reported that sweetened beverages were not for sale at school. The results are robust to setting purchases equal to 0 if the administrator reported no access.

We created three measures of children's total consumption of sweetened beverages during the last week. The ECLS-K question combines consumption of drinks purchased at school with all other consumption. In our analysis, the first measure is a dichotomous variable equal to 1 if a child reported drinking any sweetened beverages. The second is a dichotomous variable equal to 1 if a child reported drinking at least 1 beverage per day. The third is a linear variable that measures a child's reported total consumption. We again used the mean value for categories, and we multiplied daily consumption by 7. We look at multiple measures of purchases and consumption in order to get a comprehensive picture of children's behaviour. Although the linear measures are more important from a policy perspective, the "any" and "daily" measures are useful if some children do not accurately report purchases or consumption.

Finally, we created three measures of children's weight. BMI varies by age and sex in childhood because of changes in body proportions related to growth and maturation, so age- and sex-specific BMI z-scores or percentiles are generally used instead of BMI (Johnson-Taylor & Everhart, 2006). We used the age- and sex-specific 2000 CDC Growth Reference for Children to calculate children's BMI z-score. These z-scores are our first measure of children's weight. We also categorized children as normal weight, overweight, or obese according to international cutoff points recommended by the Childhood Obesity Working Group of the International Obesity Taskforce (Cole et al., 2000). We then created two dichotomous variables, one indicating whether a child is overweight or obese and the second whether a child is obese.

The regression models control for child, household, and school characteristics that may be related to weight. The child-specific variables include sex, age in years, and race/ethnicity (non-Hispanic black, Hispanic, Asian or Pacific Islander, American Indian, and multiracial, with non-Hispanic white as the omitted category). A dichotomous variable equal to 1 for children who changed schools since the last wave was included since movers experienced multiple school environments. Because more active children may burn more calories and drink more than less active children, the regressions included a dichotomous variable equal to 1 for children who were active at least 20 minutes per day, according to the parent's report in the 5^{th} grade. In robustness checks, we also controlled for the other nutrition indicators collected in the ECLS-K: consumption of milk, juice, sweets, salty snacks, salad, potatoes, carrots, other vegetables, fruit, and fast food. The household characteristics include controls for 4 of 5 socioeconomic status (SES) quintiles created internally by the ECLS-K based on parents' occupational prestige, income, and education. Because the family environment is expected to affect both children's consumption patterns and their weight, we include dichotomous variables equal to 1 if a family ate dinner together 6 or 7 nights per week, if there were other children in the household, and if the mother worked full time. The school variables are controls for 3 of 4 Census regions, 3 of 4 school types (Catholic, private other religion, and private non-religious, with public as the omitted category), 2 of 3 urban status settings, 4 of 5 categories for percent minority students, and a linear variable for the percentage of children at the school eligible for free lunch.

Our sample includes all children with valid information in both the 5th and 8th grade waves of the survey on the availability of sweetened beverages for sale at school by both child and administrator, consumption of sweetened beverages, BMI, age, and sex. This results in a sample of 6,128 children. We used the dummy variable adjustment method to retain the small number of children with missing data on control variables. This method involves including, for each variable with missing values, a dummy variable equal to 1 if an individual has a missing value for that variable and setting the variable itself equal to an arbitrary constant. Observations are weighted using the child-parent weights for the 6th and 7th survey wave panel, which accounts for attrition and non-response. The empirical methods correct for the complex sample design of the ECLS-K using the svy command in Stata 11.

Analytic Methods

We estimate logit (for dichotomous outcomes) and linear regression models (for continuous outcomes) of the relationship between availability of sweetened beverages for sale at school, purchases, consumption, and weight. We estimate 3 versions of each specification: 5th grade only, 8th grade only, and pooled data with individual fixed effects. The last version includes a dichotomous variable equal to 1 in wave 7 to control for any changes over time common to the sample. Our preferred specification throughout is the individual fixed effects model because it controls for unobservable child-specific factors that do not change over time, including those that are correlated with observed characteristics, and characteristics that were set before the 5th grade wave, such as birthweight and early childhood nutrition. Because the fixed effects specifications only include children who had a change in the dependent variable when estimating nonlinear (logit) models, the sample sizes are reduced considerably for some outcomes. We also performed multi-level models with child and school levels for all specifications, and the results are available in an on-line appendix. All regressions control for the individual, household, and school characteristics listed above. For the nonlinear models, we present logit coefficients and discuss the magnitude of the marginal effects below.

We first examine the relationship between availability of sweetened beverages for sale at school and children's beverage consumption. We use logit models to examine whether children consumed any sweetened beverages and whether they consumed them at least daily and we use linear models to examine children's total weekly consumption of sweetened beverages. We then turn to the relationship between children's purchases of sweetened beverages at school and children's total consumption of sweetened beverages. Using logit models, we examine first whether children's purchases of sweetened beverages at school are associated with the likelihood that they consumed any sweetened beverages at all. We then examine whether children's purchases of any or daily sweetened beverages at school are associated with the likelihood that they consumed sweetened beverages daily. Finally, we use linear models to estimate whether children's purchases of sweetened beverages at school at all, daily, or in total are associated with their total consumption of sweetened beverages.

Finally, we turn to children's weight. The first step was to examine whether the availability of sweetened beverages for sale at school as reported by administrators or by children is related to children's weight. We then examine the relationship between total purchases at school and weight and finally whether children's total consumption of sweetened beverages is related to their weight. We use linear models to look at BMI z-scores and logit models to look at the likelihood that children are overweight or obese, or just obese.

Before discussing the regression results, we discuss descriptive statistics from the ECLS-K data.

Descriptive statistics

Table 1 provides descriptive statistics for the key variables. About 31% of administrators reported that sweetened beverages were available at school during school hours in the 5th grade, and 42% in the 8th grade. About 41% of children reported that sweetened beverages were available at school in the 5th grade, and 63% in the 8th grade. Children thus reported greater availability of sweetened beverages for sale than did administrators. One reason for this difference may be that children were asked about availability at school while administrators were asked about availability at school during school hours, so children may have had access to vending machines or canteens before or after school. Regardless, according to both administrator and child reports, a substantial proportion of children could buy sweetened beverages at school, and that access increased between 5th and 8th grade. The latter likely reflects most children's transition to middle school.

Children's average purchases of sweetened beverages rose as availability of those beverages for sale at school increased from 5th to 8th grade. About 13% of 5th graders reported purchasing at least 1 sweetened beverage at school in the last week, as did 25% of 8th graders. Among those reporting access at school, 31% of 5th graders and 40% of 8th graders reported purchasing at least 1 sweetened beverage at school in the last school week (not shown in the table). The average number of purchases per week increased markedly between 5th and 8th grade, but very few children reported purchasing at least 1 beverage a day in either wave.

In spite of increased access to sweetened beverages at school and increased school purchases, children's average consumption of sweetened beverages did not rise between 5th and 8th grade. About 84% of 5th graders reported drinking any sweetened beverages in the last week, a fraction that was virtually identical in 8th grade. Similarly, the proportion of children who reported drinking at least one sweetened beverage per day did not increase between 5th and 8th grade. Reported average weekly consumption actually fell between 5th and 8th grade.

Comparing the measures of school purchases and consumption, it is clear that school purchases are a small component of sweetened beverage consumption. School purchases can account for only about 7% of consumption in 5th grade and 16% in 8th grade. Furthermore, the descriptive statistics suggest that school purchases replaced sweetened beverages from elsewhere; as children moved from 5th to 8th grade, their school purchases increased but their total consumption did not.

In terms of children's weight, the average BMI z-score was about 0.7 in both 5th and 8th grades, meaning that the average child was heavier than the reference population mean. Almost 40% of children were overweight or obese and 16% obese in both survey waves, with little change across survey waves.

Results

Turning to the regression results, we find limited evidence that availability of sweetened beverages for sale at school affected children's consumption of those beverages. Looking first at any consumption in the last week (table 2, panel A, row 1), there is no significant relationship between whether the school administrator reported that sweetened beverages were available for sale and children's consumption in any of the 3 specifications. Using children's reports instead (row 2), availability of sweetened beverages for sale at school is significantly positively associated with whether a child drank any sweetened beverages in the previous week in the 8th grade but not the 5th grade or the fixed effects model.

While the likelihood of consuming sweetened beverages at all may increase with availability at school, we do not observe any evidence of an increase in daily consumption or in total consumption. Panel B of table 2 reports the associations between school availability and daily consumption. None of the results indicates a significant relationship between availability of sweetened beverages for sale at school and whether children drank sweetened beverages daily. The results for total consumption in panel C similarly do not point to a significant positive relationship between availability of sweetened beverages for sale at school and children's total consumption of those beverages.

If school availability had relatively little effect on consumption, does that mean that children were not buying and drinking sweetened beverages at school? Table 3 indicates that this is not the case. Regardless of whether we look at any consumption, daily consumption, or total consumption, children who bought sweetened beverages at school appear to have drunk more sweetened beverages in total than did children who did not have access to these beverages for sale at school. Our results indicate that children who purchased any sweetened beverages at school were more likely to drink such beverages every day (panel B) and to have drunk more beverages in the last week (panel C), particularly in the cross-sectional specifications.

It may seem obvious that children who purchased more drinks at school consumed more: purchasing at least one beverage entails drinking at least one beverage, and purchasing beverages daily entails drinking them daily. Nevertheless, it could be the case that children prefer to drink a certain number of sweetened beverages and their total consumption is independent of total purchases at school. For each drink at school, children might consume one fewer drink outside of school, which would be called displacement. Our results show some displacement, but they indicate that school-based purchases did boost total consumption. For each additional drink purchased at school, a child's total consumption increased by almost one-third of a drink in 5^{th} grade (panel C, bottom row, column 1), and by almost two-thirds of a drink in 8^{th} grade (column 2). The fixed effects specification, while statistically insignificant, suggests almost complete displacement (column 3).

Our final step is to examine children's weight. We first look at the link between availability of sweetened beverages for sale at school and weight. Given that availability appears to have little effect on total consumption, it also should have little effect on children's weight. Indeed, our estimates do not indicate a positive significant relationship between availability at school and weight. As shown in the first row of each panel in table 4, there is no significant relationship between administrator reports of availability and children's BMI z-score, likelihood of being overweight or obese, or likelihood of being obese. The second row of each panel similarly shows no evidence of a positive significant relationship between child reports of availability and the 3 measures of children's weight.

There also is little evidence of a link between children's purchases of sweetened beverages at school and their weight. The third row of each panel in table 4 shows the results for purchases. Only one of the estimated coefficients indicates a significant positive relationship, which is for the likelihood of being obese in the 5^{th} grade sample. None of the 8^{th} grade cross-section or fixed effects panel data models indicates a significant relationship between purchases and children's weight. In other results (not shown), we also do not find that purchasing sweetened beverages at all at school or buying them daily is positively related to children's weight.

Turning to the link between total consumption of sweetened beverages and children's weight, we do not find evidence that sweetened beverages affected children's weight. When the outcome is BMI z-scores (table 4, panel A, fourth row), the results do not indicate a

positive significant relationship between children's consumption of sweetened beverages and their weight; there is a negative relationship in the 5th grade sample. Children's consumption of sweetened beverages is not related to the likelihood that they were overweight or obese (panel B) or the likelihood that they were obese (panel C). In results not shown here, we also do not find evidence that drinking sweetened beverages at all or drinking them daily is positively related to children's weight.

Discussion

This study showed that, in a nationally representative longitudinal sample, there is little evidence that children who had access to sweetened beverages for sale at school drank more sweetened beverages, though children's purchases of sweetened beverages at school were positively associated with their total consumption of such beverages. The findings suggest that availability of sweetened beverages for sale at school may affect the extensive margin—whether children consume them at all—but not the intensive margin—how many sweetened beverages the average child consumes. This pattern can result if children who do and do not consume sweetened beverages are, in essence, different groups of children. Our results suggest that some children who are not allowed to drink sweetened beverages at home buy them at school if they are available for sale there, but the average child's consumption is not affected by whether sweetened beverages are available for sale at school. The logit models of any consumption capture the marginal child, who perhaps is not allowed to drink sweetened beverages at home, while the linear models of total consumption capture the average child, who is allowed to do so. Another reason why school access had relatively little effect on total consumption is that most sweetened beverage consumption occurred outside of school. Fifth graders drank an average of 5.7 sweetened beverages per week, but only 0.4 of those were at school. Purchases at school almost doubled in the 8th grade, but average total sweetened beverage consumption did not increase. Sweetened beverage consumption increased less than one-for-one with school purchases, indicating that beverages at school partially displace beverages outside of school. Most of the results indicate that children's weight is not significantly positively related to access to sweetened beverages at school, their purchases of those drinks at school, or their total consumption of sweetened beverages.

Our results are robust to alternative specifications, including multi-level specifications with children nested within schools. They are robust to controlling for the other indicators of food and drink consumption collected in the ECLS-K. This includes consumption of milk, juice, sweets, salty snacks, salad, potatoes, carrots, other vegetables, fruit, and fast food. The findings also are robust to using an alternative reference population in calculating BMI z-scores, the World Health Organization's age and sex-specific growth reference for school-aged children (World Health Organization, 2007). The results also are robust to alternative measures of access at school, such as access indicated by both the child and the school administrator or by majority of children interviewed at the school. The consumption and weight results are robust to looking only at children who purchased sweetened beverages at school or those who did not, suggesting that the relationship between sweetened beverage consumption and weight is not significantly different for the two groups.

Although we use both child and administrator reports on availability of sweetened beverages for sale in school, information on children's own purchases and consumption is only available from children's reports. Children may have not understood what beverages they were being asked about and may not have known, for example, which juice drinks are not 100% juice. Children were not specifically asked to exclude diet drinks from their reports, so it is possible that some children included diet drinks in their reports of availability and consumption of sugar-sweetened beverages. Although this could introduce bias into the

results, we do not expect systematic bias, with children of different weights more or less likely to misunderstand the questions. The study may suffer from systematic bias if obese children are more likely to purposefully under-report the availability of sweetened beverages for sale at school. These concerns motivated us to look at multiple measures. The fact that results based on children's and administrators' reports are, in general, consistent with each other gives further confidence in the results. We did find that children's and administrators' reports did not always agree, with a tendency for more children to report access than administrators. We expect that school administrators have a clearer understanding of the question asked and that they were more likely to have answered the question correctly.

Endogeneity bias is a potential concern. For example, if schools with heavier children were more likely to ban sales of sweetened beverages, then any positive relationship between availability and weight would be underestimated. A few of our findings indicate a negative relationship between sweetened beverage consumption and weight; these may be driven by endogeneity if heavier children purposely drank—or reported drinking—fewer sweetened beverages than other children because of their weight. However, the fact that most of the models give consistent null results for the relationships between availability, consumption, and weight makes it less likely that endogeneity bias underlies the null results. In addition, our use of fixed effects addresses endogeneity arising from time-invariant unobservable individual characteristics, although not endogeneity arising from time-varying unobservable variables.

The study offers several strengths. The data are from a large, nationally representative longitudinal dataset. This is the only nationally representative dataset to collect direct measures of weight and height for children of these ages; others rely on self- or parent reports. The longitudinal nature of the data allows us to include individual fixed effects, which control for much of the unobserved heterogeneity that confounds cross-sectional analyses. The ECLS-K is also the only study of this scale to collect information on school access to sweetened beverages from both students and school administrators.

Sweetened beverages may be detrimental to children's health, and the implications of children's access to them in schools need to be well understood. This study suggests that, on average, access to sweetened beverages at school is not significantly associated with BMI or obesity among 5th and 8th graders. It is important that future studies distinguish between different types of sweetened beverages to determine whether some are detrimental while others are not. It is also important to determine whether children understand questions about sweetened beverages and whether they can distinguish such beverages from non-caloric or other drinks. Finally, since we did find a net increase in consumption when children purchased sweetened beverages at school, other health problems that may be associated with sweetened beverages, such as diabetes, cardiovascular disease, and dental cavities, should not be overlooked as policymakers and schools consider whether to allow children to have access to sweetened beverages at school. Although school restrictions may seem like a promising policy tool against obesity, the results of the cross-sectional and longitudinal models estimated here using a large, nationally-representative dataset do not indicate that they have great impact on the prevalence of childhood obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Provides limited evidence that US children with access to sweetened beverages at school consume more of those beverages.
- Does not indicate that children who can or do buy sweetened beverages at school are heavier than other children.
- Finds limited ability of restrictions on sweetened beverages in schools to reduce sweetened beverage consumption or obesity

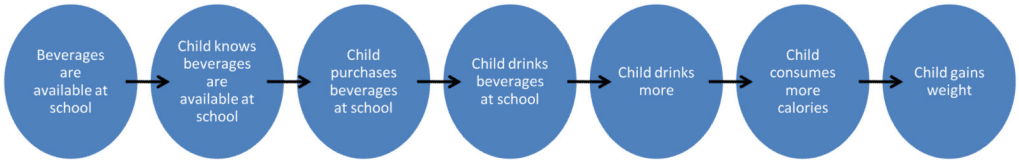

Figure 1.
Hypothesized Pathway between School Availability and Children's Weight

Table 1

Descriptive Statistics of Access to Sweetened Beverages at School, Children's Purchases and Consumption of Sweetened Beverages and Children's Weight in the United States, by Grade, N=6,128

	5th Grade		8th Grade	
	Mean or %	**SE**	**Mean or %**	**SE**
Sweetened beverages available for sale at school				
Administrator reports available (%)	30.5	1.7	42.1	2.5
Child reports available (%)	41.1	1.5	62.8	1.6
Children's purchases of sweetened beverages at school				
Purchase at least once in last school week (%)	12.9	1.0	25.3	1.0
Purchase at least daily in last school week (%)	2.4	0.4	4.7	0.4
Purchases in last school week	0.40	0.06	0.78	0.05
Children's consumption of sweetened beverages				
Consume at least once in last week (%)	83.7	0.8	84.8	0.8
Consume at least daily in last week (%)	29.1	0.9	26.8	1.0
Consumption in last week	5.7	0.2	5.0	0.2
Children's weight				
BMI z-score	0.69	0.03	0.70	0.02
Overweight or obese (%)	39.5	1.4	37.1	1.0
Obese (%)	15.7	0.8	15.6	0.8

Note: Sample means and standard errors are weighted. The measures of purchases are equal to 0 for children who reported that sweetened beverages were not available for sale at school. 5th grade corresponds to wave 6 of the ECLS-K and 8th grade to wave 7; a small number of children are in other grades.

Table 2

Estimated Relationships between Reported Availability of Sweetened Beverages for Sale at School and Children's Consumption of Sweetened Beverages

	5th Grade	8th Grade	Fixed Effects
A. Logit model for any consumption in last week			
Administrator report	−.189 (.141)	.043 (.121)	−.379 (.306)
Child report	.081 (.133)	.293* (.124)	.453 (.308)
N	6128	6128	2722
B. Logit model for daily consumption in last week			
Administrator report	−.134 (.099)	.097 (.094)	−.118 (.222)
Child report	−.155 (.092)	.050 (.104)	.002 (.247)
N	6128	6128	3798
C: Linear model for total consumption in last week			
Administrator report	−.481 (.379)	.298 (.288)	−.198 (.296)
Child report	−.712* (.341)	.088 (.265)	−.258 (.341)
N	6128	6128	12256

* $p < 0.05$;

** $p < 0.01$. Standard errors in parentheses.

Note: Shown are estimated coefficients from logit or linear models as indicated. "Administrator report" indicates that the administrator's report of availability is used, and "child report" means that the child's report of availability is used. Each coefficient and standard error pair is from 1 regression, for a total of 18 models in the table. The fixed effects regressions have 2 observations per child.

Table 3

Estimated Relationships between Children's Purchases of Sweetened Beverages at School and Their Total Consumption of Sweetened Beverages

	5th Grade	8th Grade	Fixed Effects
A: Logit model for any consumption in last week			
Purchased at all at school	1.027** (.232)	.818** (.190)	1.225** (.381)
N	6128	6128	2722
B. Logit model for daily consumption in last week			
Purchased at all at school	.180 (.119)	.420** (.103)	.461 (.309)
Purchased daily at school	1.108** (.333)	1.960** (.190)	1.053** (.519)
N	6128	6128	3798
C: Linear model for total consumption in last week			
Purchased at all at school	.539 (.435)	1.396** (.326)	.135 (.480)
Purchased daily at school	4.198** (1.483)	6.500** (.894)	2.073 (1.083)
Total purchases at school	.302* (.126)	.628** (.069)	.087 (.163)
N	6128	6128	12256

* $p < 0.05$;

** $p < 0.01$. Standard errors in parentheses.

Note: Shown are estimated coefficients from logit or linear models as indicated. All measures of purchases equal 0 if the child reports that sweetened beverages are not available for sale at school. Each coefficient and standard error pair is from 1 regression, for a total of 18 models in the table. The fixed effects regressions have 2 observations per child.

Table 4

Estimated Relationships between Reported Availability of Sweetened Beverages for Sale at School, Purchases at School, Consumption, and Children's Weight

	5th Grade	8th Grade	Fixed Effects
A: Linear model for BMI z-score			
Administrator reports available at school	.012 (.051)	−.029 (.044)	.002 (.017)
Child reports available at school	.015 (.038)	.034 (.039)	.001 (.018)
Total purchases at school	.018 (.013)	−.007 (.008)	.002 (.004)
Total consumption	−.006* (.003)	−.005 (.004)	−.001 (.002)
N	6128	6128	12256
B: Logit model for overweight or obese			
Administrator reports available at school	−.072 (.102)	−.030 (.101)	−.003 (.316)
Child reports available at school	−.019 (.089)	−.032 (.081)	−.261 (.357)
Total purchases at school	.017 (.027)	−.018 (.022)	.111 (.057)
Total consumption	−.009 (.005)	−.005 (.007)	.001 (.019)
N	6128	6128	1682
C: Logit model for obese			
Administrator reports available at school	.126 (.146)	−.081 (.132)	−.434 (.439)
Child reports available at school	.029 (.128)	.022 (.118)	−1.200** (.453)
Total purchases at school	.073** (.028)	−.041 (.031)	.025 (.085)
Total consumption	−.010 (.006)	−.001 (.011)	−.029 (.039)
N	6128	6128	908

* $p < 0.05$;

** $p < 0.01$. Standard errors in parentheses.

Note: Shown are estimated coefficients from logit or linear models as indicated. Total purchases equal 0 if the child reports sweetened beverages are not available for sale at school. Each coefficient and standard error pair is from 1 regression, for a total of 36 models in the table. The fixed effects regressions have 2 observations per child.