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Variation in access to sugar-sweetened beverages in vending machines across rural, town and urban high schools

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SUMMARY

Objectives—The 2010 Dietary Guidelines for Americans include reducing consumption of sugar-sweetened beverages. Among the many possible routes of access for youth, school vending machines provide ready availability of sugar-sweetened beverages. The purpose of this study was to determine variation in high school student access to sugar-sweetened beverages through vending machines by geographic location – urban, town or rural – and to offer an approach for analysing school vending machine content.

Study design—Cross-sectional observational study.

Methods—Between October 2007 and May 2008, trained coders recorded beverage vending machine content and machine-front advertising in 113 machines across 26 schools in New Hampshire and Vermont, USA.

Results—Compared with town schools, urban schools were significantly less likely to offer sugar-sweetened beverages ($P=0.002$). Rural schools also offered more sugar-sweetened beverages than urban schools, but this difference was not significant. Advertisements for sugar-sweetened beverages were highly prevalent in town schools.

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Ethical approval

Committee for the Protection of Human Subjects at Dartmouth College.

Competing interests

None declared.

Conclusions—High school students have ready access to sugar-sweetened beverages through their school vending machines. Town schools offer the highest risk of exposure; school vending machines located in towns offer up to twice as much access to sugar-sweetened beverages in both content and advertising compared with urban locations. Variation by geographic region suggests that healthier environments are possible and some schools can lead as inspirational role models.

Keywords

Adolescent; Sugar-sweetened beverage; School nutrition; Obesity; Policy

Introduction

The 2010 Dietary Guidelines for Americans include reducing consumption of sugar-sweetened beverages.¹ Research has demonstrated a compelling link between sugar-sweetened beverage consumption and obesity, particularly in youth.^{2–7} However, sugar-sweetened beverage consumption has been increasing.⁸ Among the many possible routes of access for youth, school vending machines provide ready availability of sugar-sweetened beverages. Youth spend most of their waking hours in the school environment, and at least one study has suggested that school may be a factor in youth consumption of sugar-sweetened beverages compared with home, stores, restaurants or friends.⁹ Students with access to sugar-sweetened beverages through their school vending machines are significantly more likely to consume them.^{10,11} Further, older students are at greater risk for the negative impact of sugar-sweetened beverage consumption – they are more likely to consume sugar-sweetened beverages than younger students, and consume an average of 170 kcal/day from sugar-sweetened beverages obtained in school⁹ – suggesting a need to examine access to sugar-sweetened beverages in the high school food environment.

By the time children reach adolescence and transition to increasingly greater independence, the school food environment offers significantly more a-la-carte and vending choices promoting calorically-dense and nutrient-poor options.¹² Therefore, the school food environment may be a risk factor for poor diets among high school students. High school students in rural areas may be at even greater risk, as youth living in rural settings are at increased risk for obesity, with estimates ranging from 25% to 50%.^{13,14} Students living in rural environments may be more heavily dependent on school food campus offerings due to having less access and availability of food compared with students living in more urban environments. Only a few studies investigating school food environments have included rural¹⁵ or urban¹⁶ schools, and none have compared school food environments across rural, town and urban locations within a geographic region.

While regulations exist for certain aspects of the school food environment, such as the federally funded USDA National School Lunch Program,¹⁷ vending machines are not regulated consistently in schools. In addition to content, another area to consider regarding school vending machines is youth exposure to advertising on the vending machines themselves. Research has shown a link between advertising and youth consumption of advertised foods,¹⁸ providing evidence for the concept that the school environment is an inappropriate place for students to be exposed to food advertising. Consistent with this idea, the American Academy of Pediatrics recommends prohibiting or extensively limiting all school-based advertising.¹⁹

Youth consumption of sugar-sweetened beverages is a public health concern. The Institute of Medicine (IOM) report on early childhood obesity prevention recommends that water should replace sugar-sweetened beverages, fruit juice and flavoured milk.²⁰ A growing number of organizations that serve children are moving towards an emphasis on water and

milk as ‘everyday drinks’, with other types of beverages, including juice, as a ‘sometimes’ option.²⁰ Since flavoured milk contains sugar, it would therefore be considered a ‘sometimes’ option. As an example of this movement to emphasize water and milk as daily choices, the Center for Science in the Public Interest launched a ‘Life’s sweeter with fewer sugary drinks’ campaign challenge.²¹

Studying vending machine content in schools presents an interesting challenge because of the unit of analysis. Schools vary in size, machine locations vary, the hours of access vary and the number of machines per school varies. The vending machines themselves also vary by number of slots. When comparing across schools, correlations within vending machines and within schools need to be considered. Also, reports of vending machine content can be unreliable if they are based on school staff reports of content, because vending machine ownership can vary within a school. For example, some machines are under the supervision of the school principal, or the food service or a school club. As such, even within the same school, the domain of the vending machine may vary.

The purpose of this study was to determine if high school student access to sugar-sweetened beverages through vending machines varies by geographic location (urban, town or rural). Both content and machine-front advertising of school vending machines were compared. The other aim of this work was to offer an approach to analysing vending machine content. It is hoped that this information will contribute to understanding the beverage vending landscape in schools, and will offer an approach to measuring a student source of calories and exposure to food industry advertising.

Methods

Sample

Observational data on school vending machine content were collected as part of a study to evaluate the role of schools and obesity in New Hampshire and Vermont. The study was approved by the Committee for the Protection of Human Subjects at Dartmouth College. Thirty-eight district-associated catchment schools in New Hampshire and Vermont were invited to participate in the assessments. Six schools refused to participate due to prior obligations or lack of interest. For this study, the analysis was limited to schools that included Grades 9–12 because vending machine policies vary across levels of elementary, middle and high school, with elementary schools being the most restrictive. The final sample for this study came from 26 schools.

Data collection

Between October 2007 and May 2008, trained coders counted the number of beverage vending machines and number of slots by beverage in each school. Coders also described the location of the machines (inside the cafeteria, in the hallway by the cafeteria, in the hallway by the gym, at an entrance to the building, in the main hallway); hours of access (any time the school building is open, when the school building is open except during one or more meals, only during meal times, only after school until the building closes, selected hours that do not fit into any of the other categories); and machine-front advertising. Coders described machine-front advertising by listing brand names. School characteristics, including geographic location (urban, town, rural), enrolment, and percentage eligibility for free or reduced-price lunches, were obtained from the National Center for Education Statistics (NCES).²² The NCES has 12 levels of urban-centric locale codes (city – large, midsize, small; suburb – large, midsize, small; town – fringe, distant, remote; rural – fringe, distant, remote). City and suburb were categorized as urban in this study.

Measures and variables

Beverages were considered to be sugar-sweetened if they were known to contain added sugar, except for milk which was contained in the milk category alone. Beverage classifications featured the following categories: sugar-sweetened beverages (regular soda, sports drinks, fruit drinks, non-diet iced teas, lemonade and other sweetened drinks), diet soda, other diet beverages, plain water/zero-calorie seltzer waters, flavoured/vitamin water, 100% juice (fruit juice, cider, vegetable juice), milk and other (milkshakes and soy/lactaid). Milk was classified in the following categories: plain skim/fat-free, plain 1%/low-fat, plain 2%/reduced-fat, plain whole, flavoured skim/fat-free, flavoured 1%/low-fat, flavoured 2%/reduced-fat, flavoured whole.

Data analysis

The unit of analysis was number of filled slots in the vending machines, controlling for school-level correlations and correlations among vending machines within each school using generalized estimating equations.²³ Logistic regressions were used in SAS Version 9.2 to obtain the estimated proportions by geographic location (urban, town, rural). To control for possible variation due to school resources, the models controlled for percentage eligibility for free or reduced-price lunches at each school. In addition, all models controlled for school-level correlations and school size. The Wald test was used to compare estimated proportions at the $P<0.05$ level for significance.

Results

Description of the sample

Most (76.9%, $n=20$) of the schools only served Grades 9–12. Two (7.7%) schools included Grades K–12, and four (15.4%) schools included Grades 7–12. The school enrolment was as follows: one school (3.8%) had fewer than 351 students, seven schools (26.9%) had 351–600 students, five schools (19.2%) had 601–950 students, and 13 schools (50.0%) had more than 950 students. Schools were located in geographic areas ranging from midsize city to remote rural. Almost one-third ($n=7$, 26.92%) of the schools were located in urban areas (cities or suburbs), one-third were located in rural locations ($n=8$, 30.77%), and the rest were located in towns ($n=11$, 42.31%). Schools that had students eligible for free or reduced-price lunches ranged from 0% (two schools) to 51.0% (mean 0.19, standard deviation 0.11). All schools had at least one vending machine (mean 4.3, range 1–11). Coders identified a total of 113 machines, of which most were located in the urban ($n=48$, 42.48%) and town ($n=45$, 39.82%) schools. Less than one-quarter ($n=20$, 17.0%) of the machines were located in the rural schools. The total number of beverage vending machine slots was similar to the overall vending machine distribution ($n=1708$, 41.82% in urban schools; $n=1592$, 38.98% in town schools; $n=784$, 19.20% in rural schools).

Overall access

Half (55.8%, $n=63$) of the machines were located inside the cafeteria. The other school beverage vending machine locations were: in the main hallway (16.8%, $n=19$), the hallway by the cafeteria (15.0%, $n=17$), the hallway by the gym (11.5%, $n=13$), and in the entrance to the building (0.9%, $n=1$). Most vending machines (76.1%, $n=86$) were accessible any time the school building was open. Others were only available during meal times (11.5%, $n=13$), when the school building was open except during one or more meals (4.4%, $n=5$), only after school until the building closes (1.8%, $n=2$), or other hours that did not fit into those categories (6.2%, $n=7$).

Vending machine content

The most common beverages in the vending machines were flavoured water (34.8% of filled slots), sugar-sweetened beverages (23.6% of filled slots) and plain water (21.8% of filled slots). Less common beverages were 100% juice (8.1% of filled slots), milk (4.6% of filled slots), diet soda (3.0% of filled slots), other diet beverages (1.0% of filled slots) and other beverages (0.9% of filled slots). Only three vending machines contained soda, which were included in the sugar-sweetened beverage category.

Most of the milk offered in the vending machines was 1% flavoured milk (92.2%). The other types of milk available were 2% flavoured (4.2%), 1% plain (2.4%) and flavoured skim milk (1.2%). None of the vending machines contained skim, plain 2%, plain whole or flavoured whole milk.

Sugar-sweetened beverages were most prevalent in town schools (Table 1). Compared with town schools, urban schools were significantly less likely to offer sugar-sweetened beverages ($P=0.002$). Rural schools also offered more sugar-sweetened beverages than urban schools, but this difference was not significant. Flavoured water was significantly more likely to be offered in urban schools ($P<0.001$) compared with town schools. Plain water was significantly more likely to be offered in urban schools compared with town ($P=0.0128$) and rural ($P<0.0001$) schools. Comparisons for 100% juice were not significant. Milk was significantly more likely to be offered in rural schools compared with town schools ($P=0.003$). Diet soda was only offered in town schools, and other beverages were only offered in urban schools.

Machine-front advertising

Every school had at least one vending machine with a machine-front advertisement. Most (83.2%, $n=94$) vending machines featured advertisements; of these, two machines had two advertisements and 92 machines had one advertisement. The most common machine-front advertisements featured Dasani® waters (63.8%, $n=60$) (Coca-Cola Company, Atlanta, GA, USA); bottled water brands were featured in 69.1% ($n=65$) of all advertisements. Advertisements for brands featuring sugar-sweetened beverages, including Snapple® (Dr Pepper Snapple Bottling Group, Dallas, TX, USA), Powerade® (Coca-Cola Company), Gatorade® (PepsiCo, Purchase, New York, NY, USA), Coca-Cola® (Coca-Cola Company), Pepsi® (PepsiCo) and Mystic® (Dr Pepper Snapple Bottling Group), appeared on almost one-third of the vending machines (27.7%, $n=26$). Four machines had advertisements for milk (4.3%, $n=4$).

Advertisements for sugar-sweetened beverages were also most common in town schools (Table 2). Compared with town schools, urban schools were significantly less likely to have advertisements for sugar-sweetened beverages ($P=0.018$), although this difference did not hold following Bonferroni's correction for multiple comparisons. Rural schools also had more advertisements for sugar-sweetened beverages than urban schools, but this difference was not significant. Comparisons for advertisements depicting milk and water were not significant.

Percentage eligibility for free or reduced-price lunches was not significant in any of the analyses; it did not predict the proportion of beverages in the vending machines.

Discussion

Sugar-sweetened beverages were widely available in school vending machines, appearing and advertised most often in schools located in towns and rural areas compared with urban locations. The most common beverage in school vending machines was flavoured water.

Plain water appeared least often in rural schools. Juice (100% juice) and milk were offered, but infrequently, and the milk was predominantly 1% flavoured milk.

Soda rarely appeared in the schools, suggesting that policies addressing school beverage vending machine content can effect change. One possible explanation for the high prevalence of sugar-sweetened beverages in the school vending machines is the misperception that sports drinks are healthy beverages. Concurrent with the new dietary guidelines for healthy eating, some school administrators, staff, students and parents may benefit from awareness of which beverages contain added sugars. In addition to the ease of access of sugar-sweetened beverages being contrary to national guidelines, the ready availability and marketing of sugar-sweetened beverages in the schools overall is a concern because sugar-sweetened beverage consumption is associated with child obesity,^{5,6} and sugar-sweetened carbonated beverages provide approximately 37% of added sugars in American diets.²⁴ On average, a 12-ounce (354.88 ml) serving of a sugar-sweetened beverage has 75–150 calories. Sugar-sweetened beverages provide a quick means of excessive weight gain; most contain fructose, which signals to the body a lack of satiety and increased appetite.^{25,26} In addition, sugar-sweetened beverage consumption displaces the consumption of water, milk and other needed nutrients.^{27,28}

This approach to analysing vending machine content included the use of trained coders (rather than relying on school personnel), taking into consideration access points within the school and hours of access by machine. The authors also controlled for school-level correlations and correlations among vending machines within each school, as well as school size. This final approach reflects many, many months of consideration; it is hoped that this documentation of the recommended final approach can serve as a launch pad for others looking to conduct this work on a larger scale.

In retrospect, some things that were not done would benefit future studies. Data on container size were not collected in this study, and it was therefore not possible to assess exact calorie content. Also, specific information about type of flavoured water was not collected, so it was not possible to make comparisons between water types and their nutrient content. No information was available on how often each type of drink was replaced, or whether the empty slots represented items that were sold out. This study was also limited to beverage vending machine content; it did not include food. However, beverage intake in itself is associated with obesity risk,³ yet many children, parents and other caregivers still do not appreciate the magnitude of its role in daily caloric intake. This study was limited to New Hampshire and Vermont schools; future studies should examine if these differences exist in other parts of the country. Larger studies should also compare school wellness policies with beverage vending machine content to determine if differences exist across states. Finally, the authors suggest that photographs of vending machines should be taken to aid in post-coding and to tell a visual story.

Vending machines are a means to offer sustenance when other means are unavailable. However, guidelines exist which can help schools offer healthy vending as the default option. The IOM offers a set of guiding principles for healthy eating in schools.²⁹ They organize foods into a tier system (Tier 1 and 2) that describes recommended school standards. Healthier vending options include plain water, 100% juice, low-fat and non-fat plain milk, and lactose-free and soy beverages. Sugar-sweetened beverages fall outside of the standard. They recommend that sports drinks, which are sugar-sweetened beverages, should be consumed under the guidance of a coach, and that water should be free to students throughout the day.

The high prevalence of bottled water in the vending machines may be an indicator of schools' efforts to promote healthier vending. However, the IOM recommends that water should be free and available to students at all hours of the day, either in the form of bottled water or through water fountains. Future studies should examine students' access to water fountains in the schools to ensure that they are not being replaced by vending machines. Water fountains enable water to be free and accessible to students at any time. Bottled water, in addition to costing students money, putting students with fewer resources at a disadvantage, is associated with multiple controversial environmental and health issues, including: groundwater extraction for bottled water,^{30–32} generation of plastic waste,³³ and exposure to leaching of phthalates from plastic bottles.³⁴ Future studies are needed to determine the prevalence and safety of current drinking water fountains in schools.

Advertisements for sugar-sweetened beverages were found most often in town and rural school locations. These exposures may put students in town and rural areas at a greater disadvantage compared with students in urban areas. Food advertisements have been linked with increased requests, preferences, selection and/or consumption of advertised foods.^{18,35} Further, the American Academy of Pediatrics has stated that 'pediatricians should work with parents, schools, community groups, and others to ban or severely curtail school-based advertising in all forms'.¹⁹ Future studies should examine why content and advertisements may vary in rural and town vs urban environments. It is possible that compared with more populated urban areas, rural and town areas offer a less saturated market for the beverage industry.

Schools have the potential to model a healthy food environment for students and school employees. Unlike significant barriers to improving school nutrition such as removing frialators, changing vending machine content does not require the machines themselves to be moved, disconnected or mechanically modified, unless a change is needed to offer refrigerated milk. Some of the arguments against healthier vending include concerns about revenue loss and the need for higher refrigeration levels for milk. Studies have shown that healthier substitutes do not translate to a loss in profits; in fact, some gain revenue.³⁶ Aside from water, milk is a potentially healthier substitute for sugar-sweetened beverages. Regarding the issue of refrigeration, ultra-pasteurized milk in aseptic cartons – which are prevalent in Europe – do not need refrigeration and have a longer shelf life (i.e. 4 months). Referred to as 'shelf milk', it tastes like regular milk and comes in individual serving sizes. It is available in skim, low-fat and flavoured forms. Given that local dairy farms are highly accessible in New Hampshire and Vermont, this option is suboptimal for recommendations to support local business and Farm to School programmes,³⁷ but it could offer the trade-off solution to address areas with limited refrigeration, and may be a feasible solution for areas with limited access to local dairy farms.

Some promising advances have been made in improving the healthfulness of the school food environment, as exemplified by implementation of policies evaluated in California³⁸ and Connecticut.³⁹ However, in terms of competitive foods offered in schools, the healthfulness of vending machine content lags behind other avenues, such as school stores.³⁸ Barriers to offering more healthful food may be due to lack of awareness of healthful alternatives, as well as lack of awareness of what is truly healthful in the face of a multitude of food marketing claims.⁴⁰ Given that school leaders have expressed a strong interest in developing effective school wellness policies,⁴¹ the current climate seems ripe for offering resources to educate school leadership about healthy options for school beverage vending.

The 2010 Dietary Guidelines for Americans recommend limiting consumption of sugar-sweetened beverages. However, high school students have ready access to sugar-sweetened beverages through their school vending machines. Town schools offer the highest risk of

exposure; school vending machines located in town areas offer up to twice as much access to sugar-sweetened beverages compared with urban locations. When taking into consideration the overall school environment, school administrators and staff should be aware that vending machines are a potent source of student access to not just energy-dense, low-nutrient calories but also to advertising. Variation by geographic region suggests that healthier environments are possible and some schools can lead as inspirational role models.

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Table 1

Filled vending machine slots by school geographic location (estimated proportions).^a

	Urban Column % (n=1708)	Town Column % (n=1592)	Rural Column % (n=784)
Sugar-sweetened beverages ^b	12.69	28.90	24.99
100% juice	8.25	5.60	7.11
Milk ^c	4.29	1.69	5.81
Plain water ^d	23.78	16.83	12.33
Flavoured water ^e	40.54	22.79	30.76
Other diet beverages ^f	0.34	0.64	2.80

^aThe estimated proportions are obtained by logistic regressions controlling for school level correlations, free or reduced-price lunches, and school size. Significant differences across rows are indicated by superscripts described below and bold text.

^bUrban is significantly different from town by Wald test ($P=0.002$).

^cTown is significantly different from rural by Wald test ($P=0.003$).

^dUrban is significantly different from both town ($p=0.012$) and rural ($P<0.0001$) by Wald test.

^eUrban is significantly different from town by Wald test ($P<0.0001$).

^fUrban is significantly different from rural by Wald test ($P=0.049$).

Columns do not add to 100% due to empty slots in the vending machines.

Using Bonferroni's correction for multiple comparisons, the significance level is $0.05/6=0.0083$ as there are six outcomes. The differences between urban and rural for sugar-sweetened beverages, milk, plain water and flavoured water remained significant following use of Bonferroni's correction.

Table 2

Vending machine front advertisement beverage category by school geographic location (estimated proportions).^a

	Urban Column % (n=38)	Town Column % (n=40)	Rural Column % (n=18)
Advertisements for milk	10.94	1.76	2.97
Advertisements for water	79.78	58.85	61.03
Advertisements for sugar-sweetened beverages ^b	11.60	40.11	33.12

^aThe estimated proportions are obtained by logistic regressions controlling for school level correlations, free or reduced-price lunches, and school size.

^bUrban is significantly different from town by Wald test ($P=0.018$). This significant difference did not hold following Bonferroni's correction for multiple comparisons.

Columns do not add to 100% due to rounding.