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Assessing Beverage Vending Machine Options on a College Campus

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Abstract

Objective: To evaluate the availability, cost, and nutrient content of sugar-sweetened beverages (SSBs) on a Midwestern university campus in 2008 and 2012. **Design:** Retroactive data obtained on beverage vending machines from the library, student union, and two academic buildings from 2008 and 2012 were analyzed. Information collected included the type of beverage, brand name, product (container) size, price, and the number of slots in which the beverage appeared. A nutrient content analysis was made on sampled beverages. **Main Outcome Measures:** Number of different categories of beverages stocked in vending machines; change in costs of beverages (including bottled plain water) in 2008 and 2012; and nutrient content of these beverages. **Analysis:** Tests of analysis of variance (ANOVA) and Wilcoxon signed rank tests were used to test differences between availability and cost of beverages, respectively. All tests were two-tailed and an alpha level of 0.05 was used to determine statistical significance. **Results:** There was a significant interaction effect between year and assessed building, $F(2.4, 24.0) = 5.318$, $p = 0.009$. There was no significant difference in price of SSB ($p = 0.345$) and non-SSBs ($p = 0.276$) from 2008 to 2012. **Conclusions and Implications:** The college campus vending machine environment may encourage a greater consumption of empty-calorie products because of increased availability of SSBs.

Keywords: sugar-sweetened beverages, vending machines, college students, obesity

Introduction

The consumption of sugar-sweetened beverages (SSBs) has increased over the years and is a focus of current public health research and interventions.

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1,2 SSBs comprise sodas ('pop'), fruit drinks, sports drinks, low-calorie drinks, and other beverages such as sweetened tea and non-alcoholic wines/beverages.3 SSBs usually contain high amounts of added sugar, and the calories associated with these beverages typically have little influence on satiety.4,5 Increased consumption of SSBs leads to health concerns such as obesity, type II diabetes, poor nutrition, excess caffeine intake, and dental cavities. Purchasing SSBs from vending machines may be a convenient option to acquire the product, but the financial and health implications associated with it cannot be overlooked.

The treatment of obesity incurs both direct and indirect costs. Direct costs are those arising from treatment of the condition and include health services and laboratory and drug therapy. Indirect costs are the losses associated with having the condition and could come in the form of lost labor (absenteeism), higher insurance rates to employers, and lower wages to employees.6 Obesity is estimated to increase health care costs by 36% and medication costs by 77% compared with individuals with normal weight, and patients with obesity spend an average of approximately $395 per year for inpatient and ambulatory care.7

Increased SSB consumption is associated with decreased intake of milk and calcium.8 Low-fat and skim milk can be viewed as healthy alternatives to help reduce SSB consumption.9,10 Milk is a great source of energy and micronutrients such as calcium; vitamins A, D, and B12; and phosphorus, potassium, and magnesium.11 Calcium intake can be affected when milk is replaced with soft drinks or because of frequent eating out, skipped meals, insufficient knowledge of the health benefits of calcium, taste preferences, and lactose intolerance.12 Calcium is important for the formation of strong teeth and bones, blood clotting, neurotransmission, relaxation, and contraction of muscles as well as regulation of heartbeat.13 Adequate calcium in the body prevents osteoporosis (bone disease arising from malabsorption of calcium from diets). Vitamin A is associated with good vision, skin, and mucus membranes, and Vitamin D plays a role in calcium absorption by the body. Vitamin B12 is important for the regulation of metabolism, formation of red blood cells, and maintenance of the central nervous system. Potassium is responsible for muscle contraction and maintenance of normal blood pressure and reduces the risk of kidney stones and bone loss.14 Phosphorus contributes to the formation of bones and teeth, repair of cell tissues, production of adenosine tri-phosphate (ATP), synthesis of protein, and utilization of fats and carbohydrates. Magnesium helps with enzyme function, protein production, and energy transport.13

One striking difference between SSBs and milk is that the former contain added sugars (sugars or syrups added to beverages during processing), whereas the latter contains natural sugars.4,15 For an individual with an average daily calorie recommendation of 2,000 kcal, the daily maximum amount of calories associated with solid fats and added sugars is 258 kcal, or 13% of total calories, but this amount is likely to be exceeded with increased SSB consumption. Americans are currently consuming only about half (1.5 cups) of their daily dairy recommendation of 3 cups; the median daily intake of fluid milk and milk products for adult men and women in U.S. are 12.8 and 9.6 ounces, respectively.15 Milk consumption generally decreases with increasing age, especially during the transition from adolescence to young adulthood.16

Young adults (19-39 years) increased their soft drinks consumption from 4.1% in 1977 to 9.8% in 2001. Two factors contributing to this trend were an increased number of SSB consumers and increased portion sizes.17 In 1999 and 2009, the obesity rates for adult men and women in the United States were 27.5% and 33.4%, respectively; 35.7% of adults are currently obese.18 Thus, this increased obesity rates could be associated with the increased consumption of SSBs.

According to French et al.19, more studies are needed to explore the reasons for increased SSBs consumption among youth. The aim of this study was to evaluate the availability, cost, and nutrient content of SSBs on Midwestern University campus in 2008 and 2012. We posed the following research questions: 1) How is the campus environment shaping SSBs consumption? 2) Was there a change in cost of SSBs in vending machines from 2008 to 2012? 3) How does the nutrient content of these SSBs compare with that of milk (skim and low-fat)?

Methodology

To assess the campus SSB vending machine environment, four buildings on the selected campus were chosen in 2008 and 2012; the library, the student union, and two academic buildings (academic bldg. I and II). The criterion used in selection was the most frequented buildings on campus. For each building, the most frequented beverage vending machines on the first floor were assessed, but if vending machines were absent on the first floor, another floor was used.

This project did not apply for IRB approval because no human subjects were involved during the environmental assessment.

Vending machines were of two types: one in which contents could be viewed through a glass window (VM1) and one that displayed buttons representing beverage choices (VM2). The total number of slots available was 45 for VM1 and 9 for VM2. For each vending machine, evaluators collected data on the name/flavor, brand name, product (container) size, price, and the number of slots in which the beverage appeared. For VM1, the number of slots represented actual counts of beverages in the various slots, whereas for VM2, the number of slots was the number of buttons available for each beverage choice.

The nutrient content of the sampled beverages and milk (low-fat and skim) were compared by tabulation. Values of the various nutrients were obtained from the respective product websites, Food-A-Pedia (for fruit and energy drinks), and the United State Department of Agriculture (USDA) National Nutrient Database for Standard Reference (for milk). This comparison was made to emphasize skim and low-fat milk as a healthful alternative to SSBs. The availability and cost of bottled water were also assessed for this same reason.

Data Analyses

Descriptive statistics (frequency, means and percentages) were used to summarize the availability and cost of the various types of beverages in each building. The average price per 8 ounces of each category of beverage was estimated from their unit prices.

In comparing the availability (frequency) of all categories of beverages, year and buildings were considered as independent variables whereas price and frequency were dependent variables. For variables that were normally distributed, a paired sample t-test or analysis of variance (ANOVA) was used to test differences in means, and Wilcoxon signed rank test was used to test differences between variables that violated normality assumption for parametric tests. All statistical analyses were performed using SPSS software version 19 (2010, IBM Company). All tests were two-tailed and an alpha level of 0.05 was used to determine statistical significance.

Results

Variety of Beverages in Assessed Buildings

In total, 11 categories (types) of beverages were assessed in all four buildings for both years (Table 1) – regular sodas (sweetened, carbonated beverages, e.g. Pepsi, Dr. Pepper, Mug Root beer, Sierra Mist); diet sodas (unsweetened, no calorie carbonated beverages, e.g. Diet Pepsi, Diet Dr. Pepper); water (including plain and non-caloric flavored bottled water); enhanced water [water, to which some nutrients (e.g. vitamins) have been added]; energy drinks (including Starbucks Doubleshot Energy coffee); sports drinks; coffee; sweetened tea; unsweetened tea; 100% fruit juice; and fruit drinks. Beverages were further sub-classified as SSBs [sugar-sweetened carbonated soda (pop), fruit drinks (including fruit punch, other non-soda SSBs, and enhanced water), energy drinks, sports drinks, sweetened teas and sugar-sweetened specialty coffee drinks] and non-SSBs [diet sodas, water (including non-caloric flavored water), unsweetened teas and 100% fruit juices].

Only the academic bldg. II and library offered water in their vending machines in 2008 and the library was the only building that offered 100% fruit juice. In 2012, the library offered only energy drinks while the student union offered fruit drinks, regular and diet soda.

The total number of sweetened beverages (SSBs) ranged from 3 to 11 in 2008 and 6 to 16 in 2012. The highest number of sweetened beverages was observed in the library in 2008 (n=11) and in academic bldg. I in 2012 (n=16). For the student union, the number of beverages in 2008 and 2012 were fairly stable; the highest number of regular soda was found in the student union in 2008 (50%) and 2012 (55.5%). Generally, the higher the total number of slots, the greater the variety of beverages (SSBs and non-SSBs) in the vending machines. Results from a factorial ANOVA showed no significant main effect of year [$F(1, 10) = 0.510$, $p = 0.492$] and assessed building [$F(1.50, 14.97) = 0.432$, $p = 0.600$] on the availability of beverages. However, there was a significant interaction effect between year and assessed building, $F(2.4, 24.0) = 5.318$, $p = 0.009$. This indicates that the assessed buildings had different effects on available beverages depending on the year that the assessment was performed. Contrasts (repeated) were performed to identify these effects.

This revealed a significant interaction when comparing academic building II to the library [$F(1,10) = 7.742$, $p = 0.019$, $r = 0.66$]. There were non-significant interactions when comparing academic building I to II [$F(1,10) = 0.025$, $p = 0.878$, $r = 0.04$] and the library to the student union [$F(1,10) = 3.929$, $p = 0.076$, $r = 0.53$]. However, these contrasts yielded small to medium effect sizes (r).

Sizes and Prices of Beverages Available in Vending Machines

Only sweetened tea and 100% fruit juice had different package sizes in both years. In 2012, the size of sweetened tea also increased from 16 oz. in 2008 to 20 oz. in 2012. In 2012, 100% fruit juice was available as both 15 and 20 oz., however, 20 oz. was dominant.

The average price of a beverage (including water) ranged from $ 0.40 to $1.47/8 ounces in 2008 and from $0.50 to $1.33/8 ounces in 2012 (Table 2). In 2012, the price of SSBs increased by 25-38% with the exception of specialty coffee and sweetened teas, which decreased by 10 and 7%, respectively. Soda and bottled water cost the least, and specialty coffee cost the most. However, results from a Wilcoxon signed-rank test showed no significant difference in price/8 oz. of SSBs from 2008 (Mdn = 0.61) to 2012 (Mdn = 0.59), $Z = -0.944$, $p = 0.345$, $r = -0.27$. Similarly, there was no significant difference in price/8 oz. of non-SSBs from 2008 (Mdn = 0.40) to 2012 (Mdn = 0.50), $Z = -1.089$, $p = 0.276$, $r = -0.44$.

Nutrient Content of Available Beverages

The sugar content of SSBs ranged from 21 to 31 g/8 ounces, whereas the average sugar content of milk (irrespective of its fat content) was 12.58 g/8 ounces (Table 3).The nutrient content of milk is considerably higher than the other beverages. Fruit and energy drinks have relatively higher calcium content than carbonated beverages, but their calcium content is much lower than that of milk. Specialty coffee has almost the same calcium content as low-fat and skim milk but lacks vitamins A and D, phosphorus, and magnesium. Compared with the other sweetened beverages, specialty coffee has the highest amount of fat (2.52 g). None of the SSBs contain vitamins A and D. Compared with low-fat and skim milk, specialty coffee has the highest amount of calories (151.6 kcal).

Discussion

In the present study, we evaluated the availability, cost, and nutrient content of SSBs to understand why their consumption is favored over healthy beverages such as milk and bottled water, particularly among college students.

In 2008, both academic buildings I and II had the VM2 type of vending machine, so they recorded the least variety of regular (non-diet) SSBs. In 2012, however, these two buildings recorded the highest number and variety of beverages. This may be because a floor other than the one assessed in these buildings in 2008 was assessed in 2012. It is possible that the vending machines in these buildings were also upgraded to the VM1 type due to an increased demand for regular SSBs by college students. A reverse trend was observed in the library, where the vending machine changed from a VM1 to VM2 type. This could be related to the placement of a restaurant in the 24-hour study area. The student union had a fairly constant beverage variety in both years, perhaps because of the presence of a food court as well as other food service points in the building.

That the academic buildings offered more types of beverages in 2012 could mean that many students spent time in these buildings and were likely to purchase drinks from the vending machines as they studied. This may be a reason why there were more energy drinks than other beverage types in 2012. Energy drinks and specialty coffees contain stimulants (e.g., caffeine) and most college students consume them to cure sleep deprivation, boost energy and to improve cognitive function while studying or working on school projects.20

The high availability of SSBs in vending machines in this study conforms to earlier studies in which vending machine purchases were found to be linked to SSB purchase and consumption.21,22 These findings are also consistent with that of Kassem et al.23, who established a direct link between the availability of regular soft drinks and their consumption by students. Thus, by increasing the availability and package sizes of SSBs, the academic buildings may indirectly be promoting an increase in empty calories consumption. Although this increased demand for SSBs is a positive thing for the manufacturer, the high added sugar and low nutrient contents of these beverages are a cause for concern.

The low calcium content of SSBs, for instance, poses a risk for osteoporosis to college students, especially those who lack bone mass reserves.24 Overconsumption of SSBs has also been associated with low fluid milk, 100% fruit juice, and whole fruit consumption but high consumption of foods rich in solid fats and added sugars.25

Since the price of SSBs and non-SSBs did not differ much, more students may purchase the former than the latter because price and taste are two important factors that determine beverage choice.26 Although the cost of soda and bottled water were the same for both years, assessed vending machines appeared to stock more of the former than the latter. Sodas are normally in higher demand than water. It could be argued that even if a small bottle or can of soda costs as much as a larger bottle of water, it would be better to buy the soda because it is sweet and may provide temporary satiety. Providing healthful beverage options, such as skim and low-fat milk, in vending machines may help influence positive dietary behavior change, especially among college students.21

The nutrient content analysis showed that SSBs are less nutritious than milk (skim/ low-fat) because they lack or have negligible amounts of nutrients such as protein, calcium, vitamins A and D, phosphorus, and magnesium. Some of the sampled SSBs (specialty coffee, fruit, and energy drinks) possibly contained some amount of micronutrients, such as calcium and vitamins A and D, and may have been fortified; however, the absorption and bioavailability of these nutrients, especially calcium, may be lower than that of milk due to the presence of inhibitors. For instance, coffee and energy drinks contain caffeine, an excess consumption of which decreases magnesium and calcium absorption. A balance of calcium, phosphorus, potassium, and sodium chloride in body cells ensures optimal relaxation of vascular muscles and enzyme activation.27 Phosphoric acid is used in soft drinks' production, especially cola-containing ones, for flavor and acidification. Phosphorus and calcium are both mineral components of the human bone23, and calcium incorporation into bone is dependent on phosphorus.28 Thus, an imbalance in their concentrations in the body would lead to bone loss and decreased bone mass, further leading to risk for fractures23.

The sugars present in milk, unlike those in SSBs, are from natural sources and thus do not produce extra (empty) calories.

Sugar-sweetened carbonated beverages and fruit drinks account for approximately 37% and 11%, respectively, of the added sugars in the American diet29. Excess consumption of these empty calories consequently leads to excess body weight and displaces vitamins and minerals from the diet30,23.

Even though multi-vitamin/minerals supplementation may provide an individual with these lacking micronutrients, they may cause adverse effects in cases where the micronutrients' Tolerable Upper Intake levels are exceeded.13 The bioavailability of calcium in milk products and mineral supplements are quite similar, but the absorbability of calcium from milk is more efficient because milk lacks inhibitors such as oxalates (in supplements) and phytates (in some plant foods). For this reason, milk is an important food source, especially for post-menopausal women, the elderly, and children.28

Implications for Research and Practice

According to the 2010 Dietary Guidelines for Americans, Americans are encouraged to reduce their intake of calories from added sugars, which are commonly found in SSBs13 (USDA, 2010). Results from this study show that vending machines make these beverages readily available to students. Though insignificant, the differences in the availability of beverage types in the assessed buildings imply that more SSBs, rather than non-SSBs, are available in vending machines on college campuses. Due to this increase in availability of SSBs, the college campus vending machine environment may encourage a greater consumption of these empty-calorie products. Milk could serve as a healthy substitute for SSBs because it contains essential micronutrients and naturally occurring sugar.

Excessive consumption of empty calories increases the risk of overweight and obesity. Health risks associated with obesity include diabetes, cardiovascular diseases, asthma, some cancers, sleep apnea, osteoporosis, and other joint disorders, and treating these health conditions affects financial resources. Besides medical expenses, wages also could be affected due to job absenteeism or decreased work productivity, thus resulting in decreased income. Excessive consumption of energy drinks may result in caffeine intoxication and dependence, experiencing jolt and crash episodes, heart palpitations and headaches.31, 20 Consumers must therefore consider the financial and health costs associated with consuming excess SSBs.

Providing healthful beverages, such as skim and low-fat milk, and bottled plain water, in vending machines may help decrease future health costs associated with obesity as well as the consumption of empty calories on college campuses.

This study has shown that the availability of SSBs in vending machines increased from 2008 to 2012, but a major limitation to this study is the lack of information on how often the vending machines were stocked to ascertain whether the stocking of these beverages translates into their consumption by students. Secondly, the sample size of 4 buildings was too small to observe statistically significant differences. Despite these limitations, findings from this study showed observable differences in the availability of beverages in assessed buildings. Thus, further research is needed to explore the SSB consumption patterns of college students to understand how availability of beverages in vending machines affects students' consumption habits.

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Table 1. Variety of Beverages in Assessed Vending Machines, 2008 and 2012

	2008					2012				
Beverage Type	**Academic I**	**Academic II**	**Library**	**Union**	**Total**	**Academic I**	**Academic II**	**Library**	**Union**	**Total**
Regular soda	3	3	0	6	12	4	0	0	5	9
Diet Soda	4	2	0	1	7	1	0	0	1	2
Water	0	1	3	0	4	1	1	0	0	2
Enhanced water	0	0	2	0	2	0	2	0	0	2
Energy dinks	0	0	5	0	5	6	5	7	0	18
Sports drinks	0	0	0	0	0	2	5	0	0	7
Coffee	0	0	2	0	2	0	1	0	0	1
Sweetened teas	0	0	2	0	2	3	1	0	0	4
Unsweetened teas	0	0	2	0	2	0	0	0	0	0
100% Fruit juice	0	0	3	0	3	2	2	0	0	4
Fruit drinks	0	0	0	1	1	1	1	0	1	3
Total	7	6	19	8	40	20	18	7	7	52
Mean ± SEM	0.64±1.0.43	0.55±0.31	1.73±0.49	0.73±0.54		1.82±0.57	1.64±0.54	0.64±64	0.64±0.45	
95% Confidence Interval	(-0.33, 1.60)	(-0.15, 1.24)	(0.64, 2.81)	(-0.48, 1.93)		(0.55, 3.09)	(0.42, 2.85)	(-0.78, 2.05)	(-0.37, 1.64)	

Table 2: Availability of Beverages in Assessed Vending Machines, 2008 and 2012

Beverage type	Price / 8 oz.	
	2008	2012
SSB		
Regular soda	0.40	0.50
Enhanced water	0.60	0.60
Energy drink	1.00	1.25
Specialty coffee	1.47	1.33
Sweetened teas	0.62	0.58
Fruit drink	0.40	0.55
Mean ±SD	0.75 ± 0.42	0.80 ± 0.38
Non-SSB		
Diet soda	0.40	0.50
Water	0.40	0.50
100% Fruit juice	0.66	0.60
Mean ±SD	0.49 ± 0.15	0.53 ± 0.06

Table 3. Nutrient Content Analysis of Milk and Sugar-sweetened Beverages

Nutrients per 8 oz.	Milk		Fruit drink	Carbonated beverage				Energy drink	Specialty coffee (Starbucks Mocha Frappuccino)
	Skim	Low-fat (1%)		Dr. Pepper	Pepsi	Sierra Mist	Mountain Dew		
Calories (kcal)	83.00	102.00	114.00	100.00	100.00	100.00	110.00	110.84	151.57
Total fat (g)	0.20	2.37	0.00	0.00	0.00	0.00	0.00	0.00	2.52
Sugar (g)	12.47	12.69	28.00	25.60	28.00	25.00	31.00	25.06	26.10
Protein (g)	8.26	8.22	0.00	0.00	0.00	0.00	0.00	0.96	5.89
Calcium (mg)	299.00	305.00	20.00	0.00	0.00	0.00	0.00	32.00	200.00
Vitamin D (μg)	2.90	2.90	0.00	0.00	0.00	0.00	0.00	~	0.00
Vitamin A, RAE (μg)	149.45	141.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phosphorus (mg)	247.00	232.00	7.00	25.00	25.00	0.00	0.00	41.00	0.00
Magnesium (mg)	27.00	27.00	7.00	0.00	0.00	0.00	0.00	7.42	0.00