



## Healthier vending machines in a university setting: Effective and financially sustainable

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### 1. Introduction

Vending machines are a pervasive part of the American food environment and have often been overlooked in efforts to improve diet quality and weight status. Each year, vending machines in the United States sell approximately \$10 billion in snacks and candies and \$24 billion in cold drinks. (Census of the Industry, 2014, 2014) The snacks and beverages sold in vending machines tend to be low in nutritional value and high in calories, fat, salt, and sugar (Browne, Friedman, & Wootan, 2014; Byrd-Bredbenner et al., 2012), and therefore foods and beverages sold in vending machines are increasingly being scrutinized and addressed by federal policies. (“Public Law 108–265 - Child Nutrition and WIC Reauthorization Act of 2004,” n.d., “Nutrition Standards for Foods in Schools,” n.d., “A Guide to Smart Snacks in School,” 2016; Food and Drug Administration, HHS, 2014) Private institutions and local

governments have also recently begun to implement voluntary policies and programs to encourage healthier purchasing from vending machines. Strategies have generally included increasing the number of healthy items available, changing prices, and promoting healthy choices through posters, machine branding, and stickers that identify healthier items (Grech & Allman-Farinelli, 2015; Hua & Ickovics, 2016; Matthews & Horacek, 2015). Healthy vending programs have been implemented in a variety of settings including hospitals (Gorton, Carter, Cvjetan, & Ni Mhurchu, 2010), city parks (Mason, 2014), public buildings, (Centers for Disease Control and Prevention, n.d.) worksites (French et al., 2001; Wilbur, Zifferblatt, Pinsky, & Zifferblatt, 1981) and college campuses (Dingman, Schulz, Wyrick, Bibeau, & Gupta, 2015; French, Jeffery, Story, Hannan, & Snyder, 1997; Hua et al., 2017; Stöckli, Stämpfli, Messner, & Brunner, 2016). However, institutional concerns about losing revenue are commonly reported as a significant barrier in voluntarily implementing a healthier vending program (Terry-McElrath, Hood, Colabianchi, O'Malley, & Johnston, 2014), and the reliance on vending machine revenue is an important consideration for a sustainable healthy vending program (Grech & Allman-Farinelli, 2015; Hua & Ickovics, 2016).

College is an important transitional period for many adolescents, with newfound independence in food and lifestyle choices. Unfortunately, the average college food environment generally does not promote healthful eating, which has been associated with excessive weight gain in college students, particularly during their first year (Smith-Jackson & Reel, 2012; Vella-Zarb & Elgar, 2010, 2009). However, college can also be seen as an opportunity to support adolescents in establishing positive eating habits that promote their long-term health. Providing and encouraging healthier vending options is one way to foster a health-promoting food environment for students, faculty and staff.

There have been relatively few evaluations of healthier vending initiatives on college campuses, and the results of these studies are mixed. Reducing the price of healthier items significantly increased the number of healthier items sold for French and colleagues

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(French et al., 1997), but not for Hua and colleagues (Hua et al., 2017), however for both studies price reductions resulted in revenue loss. Promotion strategies have also had mixed effects in the university setting. Brown and colleagues (Brown, Flint, & Fuqua, 2014) found that classifying all vending items with a red-yellow-green sticker system resulted in increased purchasing of healthier (green) items, and Stöckli and colleagues (Stöckli et al., 2016) found that even non-food-related imagery could prime vending machine customers to purchase healthier products. However, providing nutritional information on a poster was not effective in changing consumer behavior in other university based studies (Dingman et al., 2015; Hoerr & Loudon, 1993). Hua and colleagues found that promotional signs alone had a small but positive impact on sales volume, but that these effects were significantly higher when paired with either machines fully-stocked with healthier items or machines which have reduced the price of healthier items (Hua et al., 2017).

These results suggest there is still significant work to be done in bringing healthy vending to college campuses, however the mixed results of these studies may not be surprising in the broader context of the literature. Many of these studies are small in scale, intervening on fewer than ten machines and generally analyzing two weeks to a month's worth of sales data, which are common challenges and short-comings in healthy vending research (Hua & Ickovics, 2016; Matthews & Horacek, 2015). Several studies do not consider proportion of healthier items and revenue simultaneously, which complicates comparisons across studies (Matthews & Horacek, 2015). It is also unclear what proportion of university vending machine customers would be amenable to the influence of choice-architecture in vending machines, or if healthier vending machines simply attract a new customer base (Grech & Allman-Farinelli, 2015). Lastly, several studies make note that interventions could be implemented with higher fidelity and healthier vending policies could be more sustainable with more engagement with the university's vending operators.

### 1.1. Purpose

The goal of this intervention was to test the feasibility of increasing the proportion of healthier products purchased at vending machines on a large university campus, without losing revenue. We also aimed to better understand our university's vending machine customer base, in particular whether they approach the machine with a specific intention of what to buy. We hypothesized that through choice-architecture strategies we could increase the proportion of healthier products purchased without significant changes in revenue, and customers who approach a vending machine without the intention to purchase a specific product – referred to in this paper as “undecided customers” – would be more amenable to a choice-architecture intervention and have a greater likelihood of purchasing a healthier product. The intervention was part of a larger interdisciplinary effort by the university, called the Healthy Campus Initiative, to promote healthy choices among students, faculty and staff, and was designed in collaboration with leadership from the campus Housing and Hospitality, which operates all vending machines on campus.

## 2. Material and methods

### 2.1. Intervention

Healthier vending machine products were identified through a three-step process. First, we reviewed criteria for healthier vending machine products published by various government agencies and vending industry organizations. We adopted the Los Angeles

County Department of Public Health's criteria of a healthier item which includes: not containing more than 250 Calories, 35% calories from fat, 10% calories from saturated fat, 35% sugar by weight and 360 mg of sodium for the contents of the entire package. (“Policy # 3.155. County of Los Angeles Vending Machine Nutrition Policy,” n.d.) Second, we developed a database of all relevant nutritional information for all products sold in university vending machines, and used the criteria to identify which products classified as healthier. Third, university nutritionists reviewed all products and their initial classification. At their recommendation, products that met initial nutrition criteria were reclassified if they contained corn syrup or other added sugar as one of the first three ingredients, any trans fats, or were fried. In addition, unsalted nut and seed products that did not meet the initial nutritional criteria because of their high caloric and fat content were reclassified as healthier products. This classification is consistent with a recent opinion that criteria for healthfulness should be based in well-established nutritional guidelines, but also individualized (Matthews & Horacek, 2015). A list of products as healthier choices and their nutrition information are available from the authors on request.

Intervention machines were purposefully sampled to ensure a sufficient number of high-usage machines across campus, as has been done in other university-based vending studies (Brown et al., 2014; French et al., 1997; Hoerr & Loudon, 1993). Intervention machines were branded with a large Healthy Campus Initiative sticker, which included a web address for more information regarding the intervention and nutritional criteria for healthier products. Healthier products were each identified with “Eat Well” stickers. Basic choice architecture principles (Johnson et al., 2012; Thorndike, Sonnenberg, Riis, Barraclough, & Levy, 2012) were used to reorganize items in the machines. Healthier products were placed in cohesive groups for visual impact. Large healthier product were arranged in dedicated rows placed at eye level and accounted for 25%–45% of all large snack products. Small healthier products accounted for at least a third of all small snack products. In contrast, comparison machines maintained their original inventory of healthier and other products.

For all vending machines, the price of popular candy bars was raised from \$1.00 to \$1.25, regardless of experimental condition. All intervention machines were converted over a two-day period just prior to the start of the fall academic quarter in September 2013.

### 2.2. Vending machine measures

Data were collected during the months of October and November 2013. Monthly machine-level sales reports were generated to measure revenue, profit, number of total products sold, and number of healthier products sold. To evaluate potential impact on financial performance, sales reports were generated for these same intervention and comparison machines during the same period in 2012.

### 2.3. Customer measures

A point-of-purchase survey of 100 vending machine customers was conducted immediately after the purchaser made their purchase to better understand individual-level purchasing behavior. In addition to questions regarding demographics, university affiliation, and typical frequency of vending machine purchasing, customers were asked: “Did you come to the vending machine just now to specifically purchase [item purchased]?”. Customers who replied “no” were considered to be “undecided customers”.

## 2.4. Sample

The evaluation focused on typical snack food vending machines; refrigerated, beverage, and snack/beverage combination machines were not eligible. Similarly, machines previously dedicated entirely to organic or wholesome options ( $n = 3$ ) were excluded as they were not viewed as representative of a typical vending machine. Of 97 eligible vending machines, 36 (37%) were converted into pilot intervention machines and 61 (63%) were in the comparison group. Revenue and profit data were available for 95 (98%) and 96 (99%) machines in 2012 and 2013, respectively. In 2013, 93 (96%) machines had reliable data on the quantity of healthier products sold. Analyses were restricted to machines with no missing data, resulting in a final analytic sample of 89 machines (92%), including 34 intervention machines (94%) and 55 comparison machines (90%).

Surveys were administered to a convenience sample of vending machine customers, stratified by month and machine intervention status. One hundred point of purchase customer surveys were conducted (response rate = 91%).

## 2.5. Analysis

Analyses of sales data, including total sales volume, revenue and profit, were conducted at the machine level. Because data from both months of the intervention were not statistically different, data were aggregated for 2012 and for 2013. Revenue and profit were reported in dollars and log-transformed for analysis. Paired *t*-tests were used to determine differences in both revenue and profit between 2012 and 2013 for comparison machines and intervention machines. Negative binomial regression models were used to test whether the number of healthier products relative to total number of products sold was different between comparison machines and intervention machines during the intervention. Point of purchase survey data were analyzed descriptively, and chi-square tests were used to compare responses between customers at intervention and comparison machines.

This study was certified exempt by the university's Institutional Review Board. All analyses were conducted in Stata 13.1 (StataCorp, College Station, TX), and used a two-tailed significance threshold of 0.05.

## 3. Results

During the two-month intervention period, 21.3% of products purchased from the typical intervention machine were healthier choices, compared to 1.3% of purchases from comparison machines (Table 1). In regression models controlling for each machines total sales volume, this difference was found to be an incidence rate ratio (IRR) of 8.73 ( $p < 0.001$ ). Additionally, the intervention machines'

revenue during the intervention period was not compromised compared to the previous year ( $t_{88} = 0.63$ ,  $p > 0.05$ ). Profits from the intervention machines were found to have significantly increased from the previous year ( $t_{33} = 2.42$ ,  $p < 0.05$ ). For comparison machines, there were no significant differences in revenue ( $t_{55} = 0.12$ ,  $p > 0.05$ ) or profit ( $t_{54} = 1.44$ ,  $p > 0.05$ ) between the intervention period and the previous year.

Table 2 reports responses from surveys conducted at intervention and comparison vending machines. Overall, 83% of survey respondents were students, and the typical respondent purchased an item from a vending machine once a week (IQR = 2 to 8 items per month). The majority (63%) of respondents were "undecided customers"—reporting they did not approach the vending machine to purchase a specific product. Undecided customers who purchased from an intervention machine were significantly more likely to purchase a healthier product than undecided customers who purchased from a comparison machine (50% vs. 10%,  $p < 0.01$ ). There was no difference in the number of undecided customers between comparison and intervention machines (65% vs. 62%,  $p > 0.05$ ). The effect of the vending machine intervention on the purchase of healthier items by undecided customers persisted after controlling for customer demographics including age, sex, race/ethnicity and university affiliation, as well as whether the product was intended as a snack or meal.

## 4. Discussion

In a university setting, the redesign of vending machines using principles of choice architecture and point-of-purchase labeling resulted in much higher rates of healthier products purchased without compromising financial performance. The expected count of healthier items purchased from an intervention machine is 8 times higher than that of a comparison machine, and undecided customers who purchased from intervention machines were significantly more likely to buy a healthier product than undecided customers who purchased from comparison machines. This suggests that our intervention has the capacity to increase sales of healthier items. To our knowledge, this study evaluated sales data from a larger number of vending machines than any previous evaluation of healthier vending machines in a university setting, contributing to the growing evidence that healthy vending policies can support healthier eating choices on university campuses. These results are encouraging, and the intervention serves as an example for large institutions considering making similar changes to their food environments.

Concerns that healthier vending initiatives could lose money is a commonly cited barrier to broader implementation (Grech & Allman-Farinelli, 2015; Terry-McElrath et al., 2014). As such, this project placed particular importance on developing a meaningful collaboration between the research team and the university's

**Table 1**  
Machine-level descriptive sales statistics for university vending machines by intervention status\*.

	Comparison machines (n = 55)		Intervention machines (n = 34)		All machines (n = 89)	
	Fall 2012	Fall 2013	Fall 2012	Fall 2013	Fall 2012	Fall 2013
Items Sold						
Total	812	609	1553	1715	1182	964
Healthier products	N/A	7	N/A	397	N/A	45
% healthier products	N/A	1.6%	N/A	21.3%	N/A	4.6%
Revenue						
Total	\$801.65	\$648.36	\$1554.50	\$1739.63	\$1140.30	\$1107.05
Per item	\$0.99	\$1.08	\$1.00	\$1.07	\$0.99	\$1.08

\*Median values presented.  
N/A, not available.

**Table 2**  
Vending machine customer survey results.

	All Machines (n = 100)	Comparison Machines (n = 48)	Intervention Machines (n = 52)
	n (%)	n (%)	n (%)
Undecided customer	63	31 (49.2)	32 (50.8)
Purchased item classification*			
Healthier product	76	6 (12.5)	18 (34.6)
Conventional product	24	42 (87.5)	34 (65.4)
Purchases per month** (IQR)	4 (2–8)	6 (3–12)	4 (2–8)
Reason for purchase			
Snack	91	43 (89.6)	48 (92.3)
Meal	4	3 (6.3)	1 (1.9)
Both	5	2 (4.2)	3 (5.8)
University affiliation			
Student	83	41 (85.4)	42 (80.8)
Staff	15	7 (14.6)	8 (15.4)
Faculty	1	0	1 (1.9)
Missing	1	0	1 (1.9)
Student housing type			
On campus	46 (56.1)	22 (53.7)	24 (57.1)
Off campus	36 (43.9)	18 (43.9)	18 (42.9)
Missing	1 (1.2)	1 (2.4)	0
Sex			
Male	46	22 (45.8)	24 (46.2)
Female	53	26 (54.2)	27 (51.9)
Missing	1	0	1 (1.9)
Race/ethnicity*			
Latino	21	8 (16.7)	13 (25.0)
Non-Latino White	38	21 (43.8)	17 (32.7)
Non-Latino Black	15	7 (14.6)	8 (15.4)
Non-Latino Asian	16	4 (8.3)	12 (23.1)
Non-Latino other race(s)	8	7 (14.6)	1 (1.9)
Missing	2	1 (2.1)	1 (1.9)
Age* (IQR)	20 (19–26)	20 (19–23)	20 (19–26)

\*p < 0.05.

\*\*Median value presented.

IQR, interquartile range.

Department of Housing and Hospitality, which operates the campus vending machines, and collected robust sales data campus-wide. This partnership ensured that our outcomes would be meaningful and feasible to institutions and vending machine operators, which must work together to implement and sustain healthy vending changes. The sales data in this study, which include 4 months of sales volume, revenue and profit for 89 machines, provide a strong business case that vending sales meet the twin goals of promoting health and financially sound. It is noteworthy that in contrast to similar university-based interventions, we chose to increase the price of unhealthy items as opposed to reducing the price of healthier items. It may be that this pricing strategy helped keep intervention machines financially solvent, which may inform future interventions, and warrants further research.

Results from the point-of-purchase surveys are in line with other published results, and offer new insight on the typical vending machine customers on our campus. The majority of our vending machine customers were students, followed by staff, in line with the make-up of the university population and similar to trends previously reported (Caruso, Klein, & Kaye, 2014). We found that the majority of customers approached the vending machine without intending to buy a particular product, which has not been previously assessed. We hypothesized these customers, who we have referred to as “undecided” customers, would be more likely to be affected by interventions than a customer who approached a machine with the intention of purchasing a particular candy bar, chips, or other item. Indeed, we found undecided customers were far more likely to purchase a healthier item from an intervention machine (50%) compared to from a comparison machine (10%), and only 5% of all surveyed customers approached the machine

intending to purchase an item which happened to be classified as healthier (results not shown). This finding suggests a sizeable portion of customers approach the machine with an open mind and can be influenced by interventions that promote healthier vending choices.

For other institutions interested in improving the nutritional quality of vending machine offerings, we recommend Robles (Robles, Wood, Kimmons, & Kuo, 2013) as an excellent resource regarding the steps involved in developing and implementing written institutional policies for food procurement, including vending machine operations. Similar to our experience, these steps focus on identifying evidence-based nutritional criteria early, engaging all stakeholders, and developing an evaluation plan to chart progress and identify areas for improvement.

There are limitations to this study. This pilot intervention was conducted on a single university campus, and thus results may not be generalizable to other settings. Ideally, intervention machines would be randomly selected, however a purposeful sample was pursued instead to ensure a sufficient number of high-volume machines were included in the intervention sample. To address this constraint, we conducted analysis by the matched pre- and post-intervention design.

A strength of this study was its use of a multi-disciplinary partnership, which ensured the intervention was based in science and policy while being operationally feasible. Research team members from the Department of Housing and Hospitality anticipated introducing differential pricing between intervention and comparison machines would be operationally difficult and compromise the intervention's fidelity. They also suggested increasing the price of popular candy bars as opposed to reducing the price of healthier products would create a similar financial

incentive to other healthy vending studies, but would better protect their financial bottom line. As a result, the price of popular candy bars were raised for all campus machines. This precludes us from considering the impact of price changes on sales as part of the broader intervention, however we can conclude that the price increase was not associated with a reduction in sales campus-wide. It also suggests a new pricing strategy could be used in university-based vending interventions to enhance sales of healthful food items.

## 5. Conclusion

As vending machines are increasingly being recognized as part of the broader food environment, governments and institutions are looking to implement healthier vending policies. In addition to an actionable set of recommendations, such as nutrition criteria, methodologically robust evaluations of real-world case studies are needed to demonstrate these policies are effective, feasible, and financially sustainable. The findings of this study suggest that health-promoting interventions can influence vending machine consumers without compromising revenue or profit. We encourage institutional leaders to use this study as an opportunity to engage public health and business partners to lend their respective expertise in establishing healthy and viable food environments.

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