Sayers, Margery

From:	Glenn Schneider <GSchneider@thehorizonfoundation.org>
Sent:	Monday, June 22, 2015 1:34 PM
To:	CouncilMail
Subject:	CB-17 Evidence Base for Vending Machine Price and Product Placement Strategies
Attachments:	IOM Priority for Nutrition Guidelines.pdf; Second-Year Results of an Obesity Prevention Program at The Dow Chemical Company_Goetzel 2010.pdf; The Association Between Worksite Physical Environment and Employee Nutrition, and Physical Activity Behavior_Alameida 2014.pdf; Impact of Individual and Worksite Environmental_Davy 2014.pdf; Food sold in school vending machines is associated with overall student dietary intake_Rovner 2011.pdf; Creating Healthy Food and Eating Environments_Story 2008.pdf; A pricing strategy to promote low-fat snack choices_French 1997.pdf; Pricing and Promotion Effects on Low-Fat Vending Snack Purchases_French 2001.pdf; Pricing and Availability Intervention in Vending Machines at Four Bus Garages_French 2010.pdf; Working With Community Partners to Implement and Evaluate the Chicago_Mason 2014.pdf; Managing Sales of Beverages in Schools to Preserve Profits_Brown 2009.pdf; Public Policy Versus Individual Rights in Childhood Obesity_Phillips 2011.pdf; Lessons Learned From a Healthful Vending_Lessard 2014.pdf; Competitive Food Initiatives in Schools and Overweight in Children_Fox 2010.pdf; Does food marketing need to make us fat_Chandon 2012.pdf; Does providing nutrition information at vending machines_Dingman 2015.pdf; Preferring the One in the Middle_Rodway 2012.pdf; A 2-Phase Labeling and Choice Architecture Intervention_Thorndike 2012.pdf; Does in-store marketing work_Chandon 2009.pdf

Dear Madam Chair and Members of the Council,

As a followup to the hearing and in anticipation of your worksession and potential vote, here is some more information about the importance and efficacy of pricing and placement strategies in vending healthier food and drink. This is only a small selection of the studies available. I can send more if you'd like.

One of the goals of this legislation is to incentivize healthier food and drink choices for county employees. The studies show that stocking vending machines with healthier items, placing the healthier items at eye-level, and giving consumers price discounts for healthier food and drinks (i.e., drinks in the case of CB 17-2015) can work to increase purchases of healthier items, maintain/increase overall vending machine revenue, and improve the health of the workforce.

Please let me know if you have any questions. I have attached the actual studies for your review.

Thanks,

Glenn
Glenn E. Schneider
Chief Program Officer

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A 2-Phase Labeling and Choice Architecture Intervention to Improve Healthy Food and Beverage Choices

Anne N. Thorndike, MD, MPH, Lillian Sonnenberg, DSc, RD, Jason Riis, PhD, Susan Barraclough, MS, RD, LDN, and Douglas E. Levy, PhD

Objectives. We assessed whether a 2-phase labeling and choice architecture intervention would increase sales of healthy food and beverages in a large hospital cafeteria.

Methods. Phase 1 was a 3-month color-coded labeling intervention (red=unhealthy, yellow=less healthy, green=healthy). Phase 2 added a 3-month choice architecture intervention that increased the visibility and convenience of some green items. We compared relative changes in 3-month sales from baseline to phase 1 and from phase 1 to phase 2.

Results. At baseline (977 793 items, including 199 513 beverages), 24.9% of sales were red and 42.2% were green. Sales of red items decreased in both phases ($P<.001$), and green items increased in phase 1 ($P<.001$). The largest changes occurred among beverages. Red beverages decreased 16.5% during phase 1 ($P<.001$) and further decreased 11.4% in phase 2 ($P<.001$). Green beverages increased 9.6% in phase 1 ($P<.001$) and further increased 4.0% in phase 2 ($P<.001$). Bottled water increased 25.8% during phase 2 ($P<.001$) but did not increase at 2 on-site comparison cafeterias ($P<.001$).

Conclusions. A color-coded labeling intervention improved sales of healthy items and was enhanced by a choice architecture intervention. (*Am J Public Health.* 2012;102:527–533. doi:10.2105/AJPH.2011.300391)

New public health strategies are needed to combat the rising prevalence of obesity. A major contributor to obesity is the consumption of energy-dense food purchased outside the home.[1,2] Interventions targeting the point of purchase have the potential to reduce obesity at the population level.[3–5]

Menu labeling with calories is a policy that has been gaining public and legislative support since 2006 and will soon be mandated as part of the Patient Protection and Affordable Health Care Act for restaurants and food vendors with more than 20 locations.[3,6–9] However, listing calorie information is effective only if consumers understand how to interpret it.[10] Previous research has demonstrated that the ability to correctly interpret nutrition information requires not only high literacy but also high numeracy skills.[11] Evidence for the effectiveness of calorie labeling has been equivocal,[12–18] and one study of a low-income, minority population in New York City found no effect of calorie labeling on food purchases.[17]

Information-based labeling policies were created with the assumption that, given calorie information, consumers will make a rational choice by choosing lower calorie options.[19,20] However, behavioral economists and psychologists have identified decision biases that explain why individuals often make choices, such as overeating, leading to poor health outcomes.[19,21] Patterns of behavior that may play a role in poor nutrition choices include individuals' tendency to stay with the usual or default option, to be motivated by actions with immediate benefit, and to be less motivated by actions with long-term benefit as well as limitations of self-control.[19,20] "Choice architecture" refers to the framing or presentation of choice options.[21] Strategies to change choice architecture by setting specific default choices have been successful in increasing individuals' retirement savings and organ donations.[22,23] One study demonstrated that changing the location of healthy sandwiches to the front page of a menu was more effective than was providing calories.[16]

We conducted a 2-phase food-labeling intervention that addressed low nutritional literacy and decision biases during 6 months in a large hospital cafeteria. Phase 1 was a simple color-coded labeling intervention of food and beverages. Phase 2 was a choice architecture intervention to increase visibility and convenience of healthy items in the cafeteria. We compared the change in sales of healthy and unhealthy items from baseline to phase 1 and from phase 1 to phase 2.

METHODS

The setting for this study was the main cafeteria at Massachusetts General Hospital in Boston between December 1, 2009 and September 1, 2010. The hospital has 1 main cafeteria and 4 smaller on-site cafeterias. The Massachusetts General Hospital Nutrition and Food Services operates all cafeterias. The main cafeteria is open 7 days a week from 6:30 a.m. to 8:00 p.m. The average number of transactions during each weekday is 6534, and the average sales during each weekday are $31 404. During the 2 years before we started the study, overall cafeteria sales did not vary by season (winter, spring, summer, or fall).

Intervention

After collecting baseline data for 3 months, we conducted a 2-phase intervention for 6 months. Phase 1 was a labeling intervention designed to inform cafeteria patrons about the relative healthiness of cafeteria items with a simple color-coded scheme. Phase 2 maintained the labeling and added a choice architecture intervention to increase the visibility and convenience of some healthy items.

Phase 1: labeling intervention. We designed a color-coded scheme to label all items red, yellow, or green on the basis of the United States Department of Agriculture's 2005 My Pyramid healthy eating recommendations.[24] The Massachusetts General Hospital staff nutritionists developed the food rating system in

this study. We rated packaged items on the basis of the nutrition information provided on the product label. We rated food prepared in the cafeteria on the basis of the individual ingredients for each of the recipes. We calculated the fat and calorie contents for the average portion size served to each individual. Before beginning the study, all the cafeteria cooks and servers were required to participate in an in-service seminar to reinforce the importance of consistency in measuring recipe ingredients and serving specified portion sizes to customers.

We categorized all food and beverages into 4 groups (food entree, food item, food condiment, or beverage) and rated them on 3 positive and 2 negative criteria. The 3 possible positive criteria for a food or beverage were (1) being a fruit or vegetable, (2) being a whole grain, or (3) having lean protein or low-fat dairy as the main component (defined as 1 of the first 3 ingredients by weight) of the item. Negative criteria were related to the saturated fat and caloric content of a food or beverage assuming a 2000-calorie per day diet with less than 10% of calories from saturated fat. We set an upper limit of 5 grams of saturated fat per food entree and 2 grams of saturated fat per food item, condiment, or beverage to account for 3 meals per day (each with ≤ 5 g of saturated fat) plus 5 grams of saturated fat for discretionary calories in snacks. For calories, we assumed 3 meals per day at 500 calories each and 500 discretionary calories. Therefore, the 2 possible negative criteria for a food or beverage were a (1) saturated fat content of 5 or more grams per entree or 2 or more grams per item, condiment, or beverage; and (2) caloric content of 500 or more kilocalories per entree, 200 or more kilocalories per item, or 100 or more kilocalories per condiment or beverage. For beverages, we considered each additional 100 kilocalories an additional negative criterion.

We categorized food and beverages that had more positive criteria than negative criteria as green. We categorized food and beverages that had positive criteria equal to negative criteria or that possessed only 1 negative criterion as yellow. We categorized food and beverages that had 2 negative criteria and no positive criteria as red. We rated items with no positive or negative criteria as yellow, except for diet beverages with zero calories, which we rated green. Red beverages included sugar-sweetened beverages with 200 or more kilocalories per container and whole milk dairy products with 100 or more kilocalories and 5 or more grams of saturated fat per container. Yellow beverages included sugar-sweetened beverages with less than 200 kilocalories per container. Fountain soda was not available in the cafeteria during the study, and therefore all cold beverages were sold in prepackaged cans, cartons, or bottles.

The labeling intervention began in March 2010. During 1 weekend, all food and beverages were labeled red, yellow, or green on the menu board located either directly over the individual food station, directly over the shelf where the food was located, or directly on the packaging. The labeling intervention was advertised as the Massachusetts General Hospital Choose Well, Eat Well program, and the

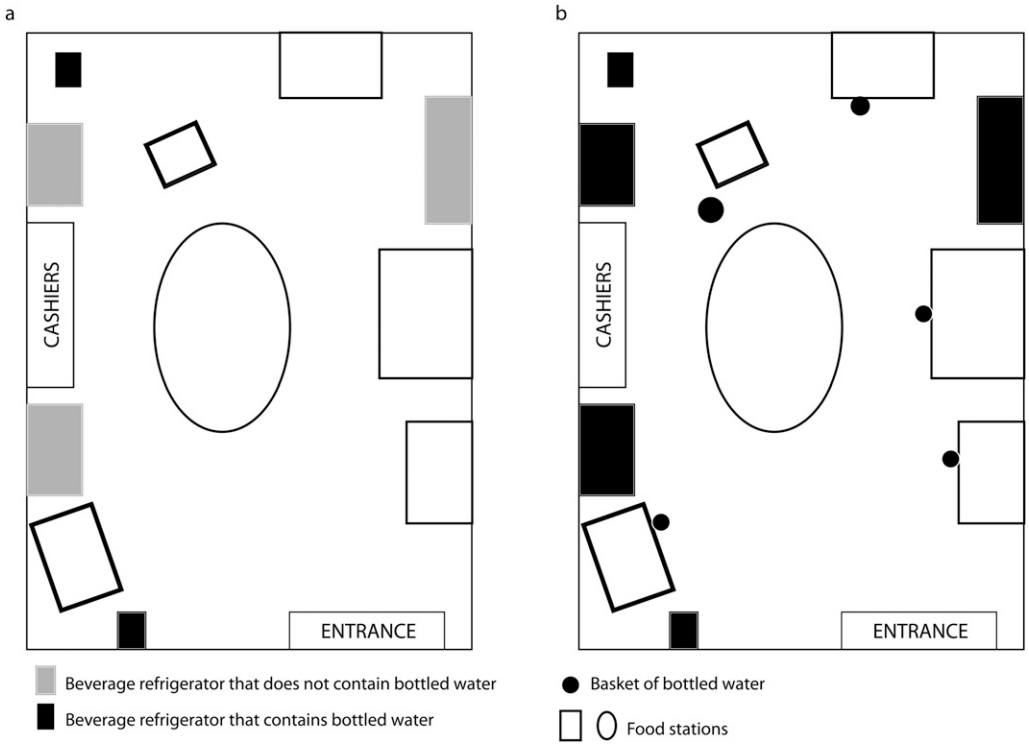


FIGURE 1—Location of bottled water for sale in the cafeteria during (a) baseline and phase 1, and (b) phase 2: a 2-phase labeling and choice architecture intervention; Massachusetts General Hospital, Boston; December 1, 2009–September 1, 2010.

message to cafeteria patrons focused on making a better choice. We posted new signage to describe the labeling on a wall in the cafeteria as well as on 2 large columns in the middle of the cafeteria. This signage highlighted that green meant "consume often," yellow meant "consume less often," and red meant "there is a better choice in green or yellow." Rather than tell patrons to stop for red items, we used a positive yet clear message to redirect patrons toward a better choice. During the first 2 weeks, a dietician was available in the cafeteria to answer questions about the labels. Throughout both phases 1 and 2, we supplied the cafeteria with pocket-sized pamphlets containing information about the labeling as well as the specific amount of calories and fat in all items.

Phase 2: Choice architecture intervention. In June 2010, we began the choice architecture intervention. We made the changes for this phase over a weekend and did not advertise them. The main target items for phase 2 were cold beverages, premade sandwiches, and chips. We chose cold beverages because they represented a large portion of cafeteria sales (20% of overall sales), and we hypothesized that location and convenience would influence beverage purchases. We also hypothesized that location and convenience would influence the sales of chips and premade sandwiches because cafeteria patrons who do not have a lot of time to spend in the cafeteria are likely to purchase these items.

We rearranged all 5 beverage refrigerators so that the green beverages (including water, diet beverages, and low-fat dairy products) were located at eye level and yellow and red beverages were located below eye level. We defined eye level as a height between 5 and 6 feet. During baseline and phase 1, bottled water was available in 2 refrigerators that were not centrally located in the cafeteria, similar to the cafeteria layout before the study started (Figure 1). During phase 2, we added bottled water to the other 3 beverage refrigerators and added 5 baskets of bottled water throughout the cafeteria near the food stations (Figure 1). We rearranged the premade sandwich refrigerator so that the green sandwiches were located at eye level and the yellow and red sandwiches were below or above eye level. Chips were located on 2 adjacent racks, and we placed the yellow chips on the higher eye level racks and the red chips on the bottom (no chips were rated green).

Data Collection and Measures

Before collecting any data, all 9 cafeteria cash registers were programmed to capture the information needed to identify an item as red, yellow, or green. Throughout the study, register data were exported daily. The 14 cashiers who worked in the cafeteria during the study were trained to enter the specific names of food and beverages (e.g., diet soda or regular soda rather than just "soda"), and then we categorized the item as red, yellow, or green once it was in the database. During the baseline phase, 10 anonymous shoppers made purchases in the cafeteria over the course of 9 weeks to validate the accuracy of data entry. The cashiers knew that they were being tested during this period but did not know when the testing would occur. Overall, during 9 weeks, the cashiers entered 847 out of 901 (94%) items correctly, and accuracy increased from 89% to 96% during the 9 weeks.

The primary outcome was change in sales of red and green items from baseline to phase 1 and from phase 1 to phase 2. Secondary outcomes were change in sales of cold beverages, premade sandwiches, and chips. For the primary outcome, we compared the proportion of total sales that were labeled red or green across all phases. As a secondary outcome, we compared the proportion of cold beverages sold that were labeled red, yellow, or green as well as the proportion that were diet soda, regular soda, and bottled water. We analyzed the proportions of premade sandwiches that were labeled red or green as well as the proportion of chips that were labeled red.

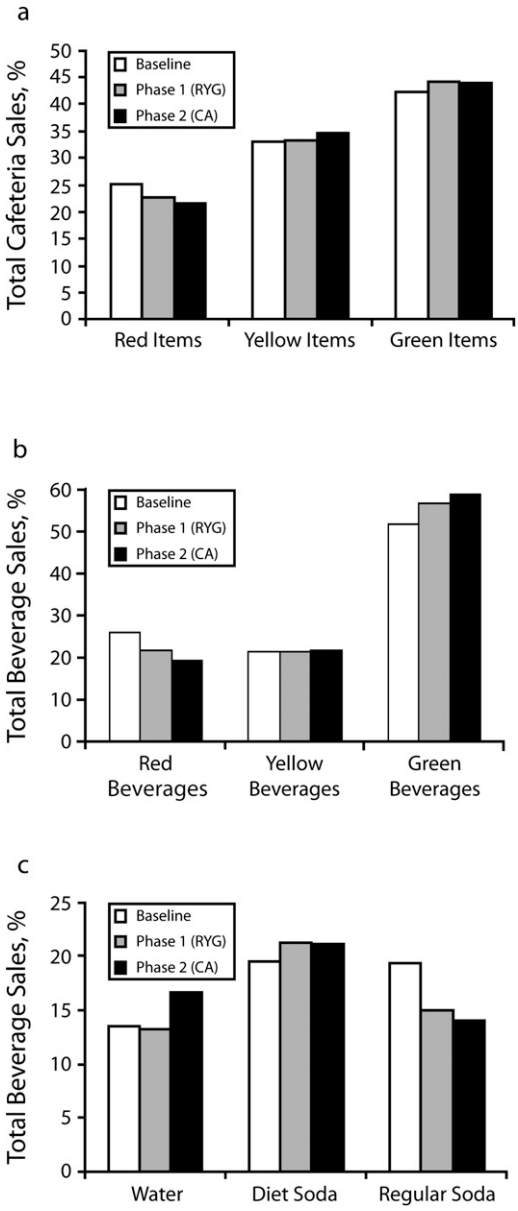
Analysis

We excluded data from weekends and holidays, including the week from December 24, 2009 to January 3, 2010. We also excluded data from May 1, 2010 to May 5, 2010 because of a "boil water" emergency in the city of Boston that affected cafeteria sales. The salad bar items were sold by weight. We assigned all salad bar purchases as green because the majority of the daily salad bar options were green (60%–67% green and 33%–36% yellow). We were unable to include 2.7% of items sold in the cafeteria in the analysis because we could not definitively identify them as red, yellow, or green through the cash registers. We calculated the statistical significance of changes from one phase to the next using logistic regression to

TABLE 1—Relative Change in Sales of Red, Yellow, and Green Cafeteria Items During the 2-Phase Intervention: A 2-Phase Labeling and Choice Architecture Intervention; Massachusetts General Hospital, Boston; December 1, 2009–September 1, 2010

Sale Item	Baseline,[a] %	Phase 1: Labeling,[b] Relative % Change in Sales From Baseline	Phase 2: Labeling + Choice Architecture,[c] Relative % Change in Sales From Phase 1
Total sales			
All red items	24.9	−9.2	−4.9
All yellow items	32.9	1.2	3.9
All green items	42.2	4.5	−0.5
Beverage sales			
All red beverages	26.1	−16.5	−11.4
All yellow beverages	21.6	−0.2	1.1
All green beverages	51.7	9.6	4.0
Diet soda	19.6	9.2	−0.8
Regular soda	19.5	−23.1	−5.9
Bottled water	13.6	−2.4	25.8

Note. $P < .001$ for all.
[a]For all items sold, n = 977 793; for all beverages sold n = 199 513.
[b]For all items sold, n = 988 734; for all beverages sold n = 202 098.
[c]For all items sold, n = 958 197; for all beverages sold n = 198 557.



Note. CA = choice architecture; RYG = red, yellow, green.

FIGURE 2—Proportion of red, yellow, and green items sold during baseline, phase 1 (labeling), and phase 2 (labeling + choice architecture): a 2-phase labeling and choice architecture intervention; Massachusetts General Hospital, Boston; December 1, 2009–September 1, 2010.

model the likelihood that an item was of a given type (e.g., green), controlling for day of the week and adjusting for clustering within phase.

Comparison Site Analysis

We compared sales of bottled water, premade sandwiches, and chips in the main cafeteria to 2 on-site cafeterias that did not have the labeling or choice architecture interventions. There were 1482 daily weekday transactions for the comparison sites. We were unable to compare other items because the comparison site cash registers were not programmed to collect these data. For these analyses, we used a difference-in-differences approach to calculate changes in purchases between subsequent phases at the intervention site after controlling for changes observed in the control sites. For example, the framework for the difference-in-differences analysis for bottled water during phase 2 was as follows: (the proportion of bottled water purchased in the cafeteria during phase 2 – the proportion of bottled water purchased in the cafeteria during phase 1) – (the proportion of bottled water purchased in the comparison sites during phase 2 – the proportion of bottled water purchased in the comparison sites during phase 1). We used logistic regression to calculate these quantities and the statistical significance of the changes using indicators for phase, an indicator for site, and phase by site interaction terms, all controlling for day of the week. A statistically significant interaction term indicated the change was associated with the intervention rather than existing trends in purchasing.

RESULTS

During the baseline period, there were 977 793 items sold in the cafeteria; 24.9% of sales were red, 32.9% were yellow, and 42.2% were green (Table 1). There were 199 513 cold beverages sold; 26.1% were red, 21.6% were yellow, and 51.7% were green.

Figure 2 shows the proportion of sales of items that were red, yellow, and green during the baseline period, phase 1 (labeling), and phase 2 (labeling + choice architecture). From baseline to phase 2, the sales of red items decreased and the sales of green items increased (for both, $P<.001$). Sales of bottled water and diet soda increased, and sales of regular soda decreased (for both, $P<.001$). Table 1 shows the relative changes in sales of red, yellow, and green items during the 2 intervention phases. During phase 1, sales of all red items decreased 9.2% ($P<.001$), and all red beverages decreased 16.5% ($P<.001$). During phase 2, sales of red items further decreased 4.9% ($P<.001$), and red beverages decreased 11.4% ($P<.001$). All green items increased 4.5% ($P<.001$) during phase 1, and green beverages increased 9.6% ($P<.001$). During phase 2, sales of all green items decreased 0.8% ($P<.001$) relative to phase 1,

TABLE 2—Change in Mean Number of Cold Beverages Sold in the Cafeteria Daily During the Intervention Compared With Baseline: A 2-Phase Labeling and Choice Architecture Intervention; Massachusetts General Hospital, Boston; December 1, 2009–September 1, 2010

Sale Item	Number Sold Daily During Baseline, Mean (SD)	Number Sold Daily During Phase 2, Mean (SD)	Change From Baseline to Phase 2
All beverages	3303 (180)	3255 (158)	–48
Red beverages	866 (85)	628 (56)	–238
Yellow beverages	718 (84)	709 (49)	–9
Green beverages	1719 (148)	1918 (105)	199
Diet soda	651 (54)	691 (48)	40
Regular soda	649 (103)	459 (46)	–190
Bottled water	452 (40)	544 (45)	92

but green beverages further increased 4.0% ($P<.001$).

To better understand beverage sales, we looked specifically at diet soda, regular soda, and bottled water. Diet soda sales increased 9.2% ($P<.001$) during phase 1 and then decreased 0.8% ($P<.001$) during phase 2 relative to phase 1 (Table 1). Regular soda sales decreased 23.1% ($P<.001$) during phase 1 and then decreased an additional 5.9% ($P<.001$) in phase 2. Although bottled water sales decreased 2.4% ($P<.001$) during phase 1, there was a large increase in sales of 25.8% ($P<.001$) during phase 2. Compared with baseline, the mean number of red beverages sold daily in phase 2 decreased by 238, and the mean number of green beverages increased by 199 (Table 2).

Table 3 shows the comparison of the sales of specific items targeted in the phase 2 intervention between the main cafeteria (intervention site) and 2 on-site comparison cafeterias. Bottled water, prepackaged sandwiches, and chips were sold at both the intervention and comparison cafeterias and were identifiable with available cash register data. Sales of bottled water increased significantly more in the intervention site than in the comparison sites during phase 2 (between-group absolute difference was 3.2%; $P<.001$). The sales of red sandwiches decreased more and the sales of green sandwiches increased more in the intervention site compared with the comparison sites, and the sales of chips labeled red decreased significantly more in the intervention site than in the comparison sites.

DISCUSSION

Our results demonstrate that a simple color-coded labeling intervention increased sales of healthy items and decreased sales of unhealthy items in a large hospital cafeteria. A choice architecture intervention that improved the visibility and convenience of healthy items further improved the effectiveness of labeling. By addressing low nutrition literacy and decision biases with our intervention, we saw significant improvements in food and beverage choices of cafeteria patrons over the 6-month period.

Menu labeling with calories is a public health policy that has already been implemented in

TABLE 3—Change in Sales of Items Targeted During the Choice Architecture Intervention at the Intervention Site and Comparison Sites: A 2-Phase Labeling and Choice Architecture Intervention; Massachusetts General Hospital, Boston; December 1, 2009–September 1, 2010

		Phase 1: Labeling		Phase 2: Labeling + Choice Architecture	
Sale Item	Baseline Proportion of Sales,[a] %	Absolute Change in Sales From Baseline,%	Between-Group Difference, %	Absolute Change in Sales From Phase 1, %	Between-Group Difference
Bottled water					
Intervention site	13.6	–0.3	–1.1	3.4	3.2
Comparison sites	18.6	0.8		0.3	
Red sandwiches					
Intervention site	14.6	2.5	–0.3	–2.7	–0.7
Comparison sites	10.3	2.8		–2.0	
Green sandwiches					
Intervention site	24.0	0.5	1.9	7.5	4.3
Comparison sites	20.2	–1.4		3.2	
Red chips					
Intervention site	36.7	–0.8	–3.9	–5.2	–11.2
Comparison sites	77.4	3.1		6.1	

Note. $P<.001$ for all.
[a]Proportion of baseline sales for each type of item at the intervention or the control site (i.e., water is a proportion of all beverage sales, sandwiches are a proportion of all premade sandwich sales, and chips are a proportion of all chips sales).

some US cities and will soon be required by federal law.[8,9] The evidence for the effectiveness of this policy is unclear. Some studies suggest that consumers purchase slightly fewer calories with calorie labeling,[12–15] whereas others have shown no change in calories purchased.[12,16–18] Most studies rely on cross-sectional designs and register receipts, self-report, or direct observation.

Reading and understanding nutrition labels is a complex task.[10,11] Even highly literate consumers may have difficulty interpreting labels because of low numeracy skills.[11] Interpreting the meaning of caloric information on a menu requires an understanding of one's total caloric needs, an accurate estimation of a serving size, and adequate time at the point of purchase to consider and act on the information. Phase 1 of our intervention tested a simplified labeling scheme. Although this scheme provided the consumer with less precise information than does calorie labeling, it conveyed complex information in a way that could be easily understood and acted on immediately. The effectiveness of this system was most striking for beverage sales, with red beverages decreasing 16.5% and green beverages increasing 9.6%.

Any information-based labeling intervention, however, does not account for decision biases inherent in many individuals' health behaviors.[19,20] Phase 2 of our study tested whether changing the choice architecture by rearranging the presentation of the food or beverage options would increase healthier choices. The strongest example of the effectiveness of this intervention was the increase in bottled water purchases. During phase 1, bottled water remained in 2 refrigerators that were not centrally located in the cafeteria (Figure 1), and despite the green label, there was a slight decrease in sales. During phase 2, bottles of water were placed in every refrigerator in the cafeteria at eye level as well as in baskets near several of the food stations (Figure 1), and water sales increased 25.8%. By making water the default choice, the choice architecture reduced the likelihood that patrons would be tempted by sugared beverages that were less prominently displayed but still available for purchase.

The consumption of sugar-sweetened beverages in the United States has increased dramatically in recent decades, and there is strong epidemiologic evidence for the association between sugared beverages and poor health outcomes, including obesity, diabetes, and heart disease.[25–28] By phase 2, the cafeteria sold 238 fewer red beverages per day and 190 fewer regular sodas. Although our study does not examine individual-level data, significant changes in the beverage habits of employees who visit the cafeteria regularly could translate into health benefits over time.

A limitation of this study is that there was no control cafeteria. However, we were able to compare sales data for some items at 2 on-site cafeterias that had no intervention, and the changes in the intervention cafeteria were significantly different from those of the comparison cafeterias. We were not able to create a washout period after phase 2 to assess the effectiveness of a choice architecture–only intervention because the changes to the menu boards and displays in the cafeteria for the Choose Well, Eat Well program were designed as permanent changes to the cafeteria. Another limitation to this study is that we could not assess longitudinal change for individuals over time.

This study demonstrated the effectiveness of a labeling and choice architecture intervention in promoting healthy food and beverage choices in a large hospital cafeteria. Without changing the price or selection, we saw significant increases in healthy choices that were sustained over a 6-month period. Our results suggest that a simple information-based nutrition intervention is effective and is enhanced by an additional intervention that takes decision biases into account. In the future, these types of interventions could be integrated with menu calorie labeling to improve the reach and effectiveness of this policy. ■

About the Authors

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Contributors

A.N. Thorndike, L. Sonnenberg, J. Riis, and D.E. Levy were responsible for the study concept and design and for interpretation of the data. A.N. Thorndike drafted the article and obtained funding for the project. S. Barraclough and D.E. Levy were responsible for acquisition of the data. L. Sonnenberg was responsible for developing the food-labeling system in the cafeteria. D.E. Levy was responsible for statistical analyses. All authors contributed to critical revision of the article for important intellectual content.

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The results of the article were presented at the American Heart Association Nutrition, Physical Activity, and Metabolism and Cardiovascular Epidemiology and Prevention 2011 Scientific Sessions in Atlanta, Georgia, March 24, 2011.

Note. The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the National Center for Research Resources or the National Institutes of Health.

Human Participant Protection

The Partners Human Research Committee deemed this study exempt from institutional review board review per the regulations found at 45 CFR 46.101(b) (2), including observation of public behavior.

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A Pricing Strategy to Promote Low-Fat Snack Choices through Vending Machines

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ABSTRACT

Objectives. This study examined the role of price on purchases of low-fat snacks from vending machines.

Methods. Sales of low-fat and regular snacks were monitored in nine vending machines during a 4-week baseline, a 3-week intervention in which prices of low-fat snacks were reduced 50%, and 3 weeks postintervention.

Results. The proportion of low-fat snacks purchased was 25.7%, 45.8%, and 22.8% in the three periods, respectively. Total snack purchases did not vary by period.

Conclusions. Reducing relative prices may be effective in promoting lower-fat food choices in the population. Vending machines may be a feasible method for implementing such nutrition interventions. (*Am J Public Health.* 1997;87:849–851)

Introduction

There is general agreement that measures that would reduce the fat content of the diet in the population as a whole would be helpful in preventing or delaying the development of several chronic diseases.[1–4] An important question for public health policy, therefore, is how to encourage the population as a whole to make lower-fat food choices. To date, environmental intervention strategies to reduce the population prevalence of high-fat food consumption have focused primarily on improving consumer knowledge through mass media, school-based, and point-of-purchase education.[5–11] Such interventions have shown positive effects on nutrition knowledge, but changes in food-choice behaviors have been modest in magnitude, variable, and often short lived.

Environmental strategies designed to influence food choice through mechanisms of availability and cost rather than nutrition education have received less research attention.[5–14] Perhaps the most impressive of these studies in magnitude of effect was a recent cafeteria-based study that examined pricing and availability influences on food choice.[14] Prices of fruit and salad were reduced by 50%, and the number of fruit and salad items available was increased. Purchase of fruit and salad increased threefold during the 3-week intervention period. Given the magnitude of these effects, further exploration of the feasibility and efficacy of environmental interventions seems warranted. The present study examined the role of price on the purchase of low-fat snacks from vending machines. It was hypothesized that sales of low-fat snack foods would increase if prices were reduced relative to regular snack food prices.

Methods

The present study was conducted in a university setting over a 10-week period in collaboration with the university food and vending services. Nine vending machines at four locations were targeted for intervention. The study used a within-machine design with three time periods (baseline, low-price intervention, postintervention). The initial baseline period was 4 weeks; the low-price intervention, 3 weeks; and the postintervention, 3 weeks. Low-fat snacks were defined as those that contained 3 or fewer fat grams per package.[15] The proportion of low-fat products available averaged 24% of the total products sold in the machines, but varied by machine, ranging from 9% to 37%. Throughout the study, low-fat snacks were clearly identified for patrons by the placement of a bright orange price label beneath each low-fat item. In addition, a 5-by-7-inch bright orange sign placed on the panel glass of the vending machine indicated that orange-labeled products contained 3 grams of fat or less. The usual prices of the low-fat items were similar to those of comparable regular snacks. During the intervention, prices of the low-fat, orange-labeled items were reduced by 50%. Prices were labeled under each item. However, no promotional signage was used to call attention to the reduced prices. After the 3-week intervention period, prices were raised to preintervention baseline levels.

All analyses were conducted using SAS statistical software programs.[16] Sums were calculated for low-fat, regular, and total snacks for each week and each machine. SAS PROC MIXED was used to examine differences in the proportion of low-fat snacks purchased by experimental period. Location, machine, and weeks were treated as hierarchically nested random effects. In this study with four locations and three periods, there are 6 *df*

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TABLE 1—Mean Number of Snacks (SE) Sold from Vending Machines at a University, by Experimental Period and Snack Type

	Experimental Period					
	Baseline[a]		Low Price[b]		Postintervention[c]	
Snack Category	Mean	(SE)	Mean	(SE)	Mean	(SE)
Low-fat snacks, no.	106.6	(20.1)	241.8	(41.6)	74.7	(13.3)
Regular snacks, no.	354.8	(68.0)	266.1	(41.9)	339.9	(78.5)
Total snacks, no.	461.4	(80.7)	507.9	(79.1)	414.6	(85.1)
Low-fat snacks, %	25.7	(.51)	45.8	(.6)	22.8	(.71)

Note. Mean sum of products sold over four locations, nine machines and 10 weeks, by experimental period.
[a]Low-fat snacks were sold at usual price.
[b]Low-fat snacks were sold at 50% reduced price.
[c]Low-fat snacks were sold at usual price.

for estimating the appropriate error variance against which to assess period effects. A contrast was used to examine differences between the two baseline conditions combined and the low-price intervention.

Results

Table 1 shows the average number of items purchased summed over machines and weeks by snack category and experimental period. Across the entire 10-week period, the average number of snacks sold per machine per week was 142.6 (SD = 157.2) for low-fat snacks and 321.0 (SD = 319.7) for regular snacks. Low-fat snacks represented 31.6% and regular snacks 68.3% of total sales. At baseline, 106.6 low-fat items on average were sold per machine per week. During the intervention period, sales increased 150% to a mean of 241.8, and fell to 74.7 in the postintervention period. The percentage of low-fat snacks sold increased about 80% during the low-price intervention, from 25.7% to 45.8% of total sales. The percentage of low-fat snacks purchased returned to baseline levels (i.e., 22%) during the postintervention period. Results of the PROC MIXED analysis of the percentage of low-fat snacks showed a significant effect for experimental period ($F[2, 6] = 18.46$; $P < .002$). The contrast between the two baseline periods and the intervention period was also significant ($F[1,6] = 10.82$; $P < .01$). Sales of regular snacks declined modestly during the low-price intervention period (from 74.3% to 54.2%) and increased during the postintervention period (to 77.2%). The total number of snacks sold did not differ by experimental period. Although some between-location variability was present in the percentage of low-fat snack sales, the pattern of intervention effects was similar across the four locations.

Discussion

The results of the present study showed that without affecting overall sales volume, sales of low-fat snacks from vending machines increased significantly when prices were lowered and in the absence of a concurrent nutrition education intervention. These findings suggest that environmental approaches to promoting low-fat food choices, such as reducing their relative price, may hold promise for promoting lower-fat food purchase and consumption in the population as a whole.

Despite the lack of public health initiatives in this area, public health policies that promote lower-fat food choices may be favorably received by the public. For example, a community-based survey of 821 men and women found that requiring low-fat foods to be available in school cafeterias and eliminating high-fat food snacks from vending machines were among the most favorably evaluated public health policies.[17]

Future research is needed to address several issues related to the present research, including (1) cost-effectiveness, (2) target populations, (3) concurrent nutrition education programs, (4) definitions of healthy snacks, (5) impact on total dietary intake, and (6) duration of effects. The cost-effectiveness issue has implications for the feasibility of implementing pricing strategies to promote low-fat food choices in diverse settings, such as schools and work sites. In the present study, low-fat items were reduced in price by 50% and the price of high-fat items was not increased. While the sales volume of low-fat items increased, it was not enough to offset the reduced profit margin and resulted in a net revenue loss. However, smaller price reductions for low-fat items and simultaneous price increases for high-fat items could result in net revenue gains and a net profit for vendors. For example, if an identical shift in purchase patterns of 50-cent items were observed with a 50% price change achieved by reducing the prices of low-fat items to 35 cents and raising the prices of high fat items to 70 cents, the net profit per machine would be $156. (Pricing in the present study resulted in a decrease in profit per machine from $116 per week to $66 per week.)

Target population is a second issue regarding intervention effectiveness. Pricing strategies may be most effective with groups that have less disposable income, such as lower socioeconomic groups or adolescent populations. Third, the incremental effect of an educational point-of-purchase intervention is worth exploration in future research. Actively promoting low-fat choices with educational messages may enhance low-fat food choices in conjunction with price reductions. Fourth, additional research is warranted into the specific foods defined as healthy. In the present study, healthy foods were defined solely in terms of fat content. Thus, healthy choices included candy that was high in sugar, low in nutrients, and already selling at a high volume. Future research should examine whether pricing strategies are effective in increasing sales of less popular foods (e.g., fruits, vegetables, low-fat milk, or yogurt).

The impact on total dietary intake of environmental interventions such as the one described in the present study should be further evaluated through prospective tracking of individual dietary intake. A related issue is the duration of intervention effects. In the present study, food choices rapidly returned to preintervention levels after the usual prices were reinstated. Additional research is needed to explore the conditions under which changes in food choices are maintained for a longer duration.

In conclusion, environmental strategies may be useful in promoting low-fat eating patterns in the general population. Pricing strategies that make low-fat foods much less expensive are clearly effective in increasing choices of low-fat foods. The parameters and boundary conditions of these effects, such as subject popula-

tion, magnitude of pricing differential, and food types targeted, warrant further empirical evaluation. Such strategies have policy implications with respect to taxation and price supports for foods of differing fat content. □

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A Persistent Rise in Mortality among Injection Drug Users in Rome, 1980 through 1992

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ABSTRACT

Objectives. The purpose of the study was to analyze overall and cause-specific mortality among injection drug users in Rome.

Methods. A cohort of 4200 injection drug users was enrolled in drug treatment centers from 1980 through 1988 and followed up until December 1992.

Results. The age-adjusted mortality rate from all causes increased from 7.8/1000 person-years in 1985/86 to 27.7/1000 in 1991/92. The rise was mainly attributable to acquired immunodeficiency syndrome (AIDS), but mortality from overdose and other causes increased as well. The cumulative risk of death by the age of 40 was 29.3%.

Conclusions. The impact of AIDS deaths appears to be additional to a persistent increase of mortality for all other causes. (*Am J Public Health.* 1997;87:851–853)

Introduction

There is established evidence that injection drug users are at increased risk of death from several causes.[1] In a cohort study of injection drug users in Rome, we documented a large excess in mortality for all causes in the period 1980 through 1988, with a decrease in total mortality from 1980 to 1985 and a rise afterward.[2] The main cause of death was overdose. Acquired immunodeficiency syndrome (AIDS) accounted for 7.1% of all deaths, whereas in a cohort of drug injectors enrolled and followed up from 1984 to 1987 in New York City, AIDS accounted for 40% of all deaths.[3] Since the highest incidence of human immunodeficiency virus (HIV) infection among injection drug users occurred in Italy in 1986 and 1987,[4–6] we extended the follow-up of the same cohort to investigate whether the rise in mortality observed since 1985 was continuing and whether such an increase could be attributed to AIDS or to other causes as well.

Methods

The population under study and the methods have been described in detail previously.[2] Briefly, all injection drug users attending, from 1980 to 1988, the three largest drug treatment centers in Rome were enrolled and followed up as of December 31, 1992. Vital status was ascertained through the registry office of

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Creating Healthy Food and Eating Environments: Policy and Environmental Approaches

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Key Words

ecological framework, environmental and policy change, healthy eating environments

Abstract

Food and eating environments likely contribute to the increasing epidemic of obesity and chronic diseases, over and above individual factors such as knowledge, skills, and motivation. Environmental and policy interventions may be among the most effective strategies for creating population-wide improvements in eating. This review describes an ecological framework for conceptualizing the many food environments and conditions that influence food choices, with an emphasis on current knowledge regarding the home, child care, school, work site, retail store, and restaurant settings. Important issues of disparities in food access for low-income and minority groups and macrolevel issues are also reviewed. The status of measurement and evaluation of nutrition environments and the need for action to improve health are highlighted.

INTRODUCTION

Environment: everything outside the person, in contrast with individual or personal variables

Policies: laws, regulations, policymaking actions, or formal and informal rules established by government or formal organizations

Healthy eating: eating the types/amounts of foods/nutrients recommended in the *Dietary Guidelines for Americans* to promote health and a healthy weight

Ecological framework: emphasizes connections between people and their environment; views behavior as affecting and being affected by multiple levels of interacting influences

Substantial research clearly indicates that diet plays an important role in prevention of chronic diseases and obesity (96, 98, 106). Nutrition has come to the fore as one of the major modifiable determinants of chronic diseases (106). Changes in Americans' dietary and lifestyle patterns could produce substantial gains in the population's health (96). Specifically, increasing consumption of fruits and vegetables, whole grains, and calcium-rich foods, while reducing saturated fats, trans fats, sodium, added sugars, and excess calories and reducing obesity could dramatically improve Americans' health and well-being (98).

Major changes in our food system and food and eating environments over the past decades have been driven by technological advances; U.S. food and agricultural policies; and economic, social, and lifestyle changes. Food is now readily available and accessible in multiple settings throughout the day. More processed and convenience foods are available in larger portion sizes and at relatively low prices. Parents are working longer hours, there are fewer family meals, and more meals are eaten away from home (51). The school food environment is remarkably different than a few decades ago: High-calorie, low-nutrition foods are available in multiple venues throughout the school day (91). Food marketing aimed at children has drastically increased over the past 30 years (50). We have seen an exodus of grocery stores and an influx of fast-food outlets in low-income urban areas, which has contributed to the income and racial/ethnic disparities in access to healthy foods (66, 75). Collectively, these environmental changes have influenced what, where, and how much we eat and are believed to have played a substantial role in the current obesity epidemic (50, 51).

Individual behavior to make healthy choices can occur only in a supportive environment with accessible and affordable healthy food choices (97). This article presents an overview of food environments and strategies for creating healthy eating environments. A conceptual framework is presented first, followed by a description of key environmental factors organized by specific settings: home, child care, schools, work sites, retail food stores, restaurants, and broader macrolevel issues such as food and agriculture policy and food marketing. Issues of disparities in food access for low-income and minority groups are highlighted. The aim is to advance readers' understanding of how the environment influences food choices and to highlight promising intervention and policy strategies to promote population-wide healthy eating. Measurement and evaluation issues in conducting environmental and policy research and surveillance is also discussed.

AN ECOLOGICAL FRAMEWORK

Eating behavior is highly complex and results from the interplay of multiple influences across different contexts. An ecological approach is useful to guide research and intervention efforts related to eating behavior because of the emphasis on multilevel linkages, the relationships among the multiple factors that impact health and nutrition, and the focus on the connections between people and their environments (83, 88, 93). An ecological framework depicting the multiple influences on what people eat is shown in **Figure 1**. Individual-level factors related to food choices and eating behaviors include cognitions, behaviors, and biological and demographic factors. These individual factors can impact food choices through characteristics such as motivations, self-efficacy, outcome expectations, and behavioral capability. Environmental contexts related to eating behaviors include social environments, physical environments, and macro-level environments. The social environment includes interactions with family, friends, peers, and others in the community and may impact food choices through mechanisms such as role modeling, social support, and social norms. The physical environment includes the multiple settings where people eat or procure food such as the home, work sites,

schools, restaurants, and supermarkets. The physical settings within the community influence which foods are available to eat and impact barriers and opportunities that facilitate or hinder healthy eating. Macrolevel environmental factors play a more distal and indirect role but have a substantial and powerful effect on what people eat. Macro-level factors operating within the larger society include food marketing, social norms, food production and distribution systems, agriculture policies, and economic price structures. These four broad levels of influence (**Figure 1**)—individual, social environment, physical environment, and macrolevel environments—all interact, both directly and indirectly, to impact eating behaviors.

The study of environmental and policy influences on nutrition and eating behaviors is a new and growing science. Thus, there are few well-articulated theoretical models with related data to test the interactions among personal, social, and environmental factors. Little is known about the mechanisms and causal pathways by which specific environmental influences might interact with individual factors to influence eating behaviors (3, 11). Furthermore, little research has been done on which aspects of the food environment are more influential than others or about the most feasible and effective interventions and policies to improve food environments in various populations (3, 11, 59, 100). The field is also hampered by a lack of validated environmental measures (39). The challenge is to accelerate multilevel ecological research in this area. The following section addresses key issues in environmental settings and promising interventions and policies to improve population-level eating behaviors.

SETTINGS AND PLACES FOR HEALTHY EATING

Homes

National survey data indicate that Americans consume roughly two thirds (68%) of their total calories from foods prepared within the home (43). A variety of factors within the home environment have been associated with healthful dietary behaviors; among the strongest factors are availability and accessibility of healthy foods, the frequency of family meals, and parental intake and parenting practices (for children's diets). Both household food availability (foods present in the house) and accessibility (whether available foods are in a form or location that facilitates their consumption, such as fruit on the counter) have been positively associated with healthful dietary intake in youth (19, 42, 100). Neumark-Stzainer and colleagues (72) found that home availability and taste preferences were the two strongest correlates of fruit and vegetable intake among adolescents. Home availability was mediated by parental social support for healthy eating, family meals, and household food security. Even when taste preferences for fruits and vegetables were low, if fruits and vegetables were available in the home, intakes increased. Collectively, studies suggest that readily available and easily accessible healthful foods within the home are likely to enhance healthful dietary intake among youth and families.

Availability of soft drinks in the home has also been strongly associated with soft-drink consumption among children (42). A recent home-based environmental pilot study was conducted through weekly home deliveries of noncaloric beverages to displace sugar-sweetened beverages (SSBs) to reduce SSB consumption among adolescents, who were frequent consumers of SSB (23). The results of this relatively simple environmental intervention showed that SSB intake decreased in the intervention group, and investigators saw a significant body mass index (BMI) change among adolescents in the highest BMI tertile group.

Social-environmental influences within the home such as modeling of healthful dietary intake by parents and siblings, authoritative feeding style (i.e., high in limit setting but also high in nurturance), and more

Macro-Level Factors: These "upstream" policy and environmental factors work at the highest levels of influence and have impact at the population level

Environmental interventions: strategies that involve changing the physical surroundings, social climate, information availability, and/or organizational systems to promote behavior change

CACFP: Child and Adult Care Food Program

USDA: United States Department of Agriculture

frequent family meals may promote healthful food consumption among children and adolescents. Parental fruit and vegetable intake has been associated with fruit and vegetable intake among youth (18, 27, 44) and may be the strongest predictor of fruit and vegetable consumption among young children (18). A recent systematic review by van der Horst and colleagues (100) report an association between parent and child intake of fat, fruits, vegetables, and soft drinks.

Another factor that may influence children's dietary intake is parental feeding style and parenting practices. An authoritative feeding style has been positively associated with preschool children's intake of dairy and vegetables (73), and mother's authoritative parenting style is associated with adolescent intake of fruits and vegetables (63). Birch (5) found that parental practices such as restricting foods, pressuring children to eat, or using foods as rewards may inadvertently promote behaviors counter to their intentions. For example, parental pressure could result in decreased preference for certain foods, whereas food restriction could increase preferences for certain foods.

Frequency of family meals may also have a positive impact on healthful dietary intake among youth. Research suggests that family meal frequency may be positively associated with child and adolescent intake of several vitamins and minerals, fruits, vegetables, grains, and calcium-rich foods and fewer fried foods, SSBs, and saturated and trans fat (34, 71).

There have been relatively few home-based interventions to improve dietary intake. A recent comprehensive research review on interventions to reduce obesity and related chronic-disease risk factors in children and youth found that of the 147 studies included in the critical review only 4 interventions were implemented in the home (28). Thus environmental interventions targeting the home environment represent an area for further study.

Child Care

Child care facilities provide a valuable opportunity to promote healthy eating and energy balance in children. Although much has been written on creating healthy food environments in schools, surprisingly little has been written regarding child care settings. Research examining the nutritional quality of foods and beverages served in child care settings has been extremely limited, and the few studies suggest that nutritional quality needs to be improved (90). Furthermore, little intervention research has been done on changing the food environment. This is a missed opportunity because the majority of children under age five (60%) spend an average of 29 hours a week in some form of child care setting and 41% spend 35 or more hours per week (52).

The Child and Adult Care Food Program (CACFP), administered by the USDA (U.S. Department of Agriculture) through grants to state agencies, provides meals and snacks for nearly 2.1 million children in center-based care and almost 900,000 children in family child-care homes (80). The CACFP guidelines require that meals and snacks include a minimum number of age-appropriate servings from four food categories, but they do not require meals and snacks to meet any nutrient-based standards or be consistent with the Dietary Guidelines for Americans, nor do they prohibit offering foods or beverages that might be high-calorie, low-nutrition foods. There are no funding provisions or legislative requirements for nutrition education in the CACFP. To encourage healthier eating among children, CACFP regulations for meals and snacks for children two and older should be consistent with the Dietary Guidelines for Americans.

With the exception of the federal Head Start program, child care facilities are regulated by states, and state rules vary widely. Only 2 states require that meals and snacks follow the Dietary Guidelines for Americans, and only 15 states specify the percentage of

children's daily nutritional requirements to be provided per meal or per a given number of hours in care (90). Stronger state licensing requirements on nutrition quality of foods served and training for child care providers can help ensure healthier food environments. The current situation reflects an important missed opportunity to promote health.

Schools

The school food environment can have a large impact on children's and adolescents' dietary intake because up to two meals and snacks are eaten at school every day (91). Food at school is typically available through federally reimbursed school meals and "competitive foods," so called because they compete with the school meals program. Competitive foods are all foods and beverages sold outside of the federal meal programs and include vending machines, a la carte offerings in the cafeteria, snack bars, school stores, and fundraisers. Meals served in the National School Lunch Program and School Breakfast Program must meet federally defined nutrition standards and the Dietary Guidelines for Americans. However, federal requirements currently do little to limit the sale of competitive foods or to set school-wide nutrition standards. Competitive foods are widely available in schools; 9 out of 10 schools sell them (99) and the majority of offerings are high-fat or high-sugar foods and beverages (45, 99).

In response to growing concerns over obesity, attention has focused on the need to establish school nutrition standards and limit offerings of competitive foods. The Institute of Medicine (IOM) Report *Nutrition Standards for Healthy Schools* concluded that federally reimbursable school nutrition programs should be the main source of food at school and that competitive foods should be limited (49). The report set forth nutrition standards for competitive foods and recommended that if competitive foods are available, they should consist solely of fruits, vegetables, whole grains, and nonfat/low-fat dairy products to help children and adolescents develop healthful eating patterns.

In recent years, many states and local school districts have passed regulations or legislation on competitive foods (8), which are more restrictive than USDA regulations, although they differ greatly in the type and extent of restrictions. About half of all states (29) have adopted competitive school food and beverage policies, and almost all this activity has occurred in the past five years (49). Only 16 states require nutrition standards for competitive foods and beverages at school, and none has standards as strong as the IOM recommendations. The Center for Science in the Public Interest issued a report evaluating state competitive food policies and concluded that although changes are occurring at the state level, such changes are "fragmented, incremental and not happening quickly enough to reach all schools in a timely way. The nation has a patchwork of policies addressing the nutritional quality of school foods and beverages and the majority of states have weak polices" (15, p. 3). Congressional action to grant the USDA broader authority to regulate the content and sale of competitive foods and to require nutrition standards for all foods and beverages sold during the school day could improve children's health and nutrition.

A recent federal policy initiative that has implications for improving the school food environment requires school districts participating in the federally reimbursable school meal programs to establish local school wellness policies addressing nutrition and physical activity. Although the school wellness policies only went into effect at the beginning of the 2006–2007 school year, preliminary data show mixed results in terms of the implementation, compliance, and impact of the policies (1).

More support and regulatory action is needed by federal, state, and local authorities to strengthen and improve healthy eating and nutrition education in schools. At the federal level this could not only include stronger regulations for competitive foods in schools, but also expand the USDA fruit and

vegetable pilot program to improve fruit and vegetable intake among school children, especially among schools with a high proportion of low-income students. Other efforts to improve the quality of foods in schools could include farm-to-school programs, which link local farmers providing fresh locally grown produce to school food service cafeterias and school gardening programs. There is also a need for classroom nutrition education to complement changes in the school environment to increase students' skills for adopting healthy lifestyles.

After-School and Summer School Programs

After-school settings are important environments for the promotion of healthy eating. More than 6.5 million youth are in after-school programs such as schools, park and recreational centers, YMCAs, and Boys and Girls Clubs. African American and Hispanic children are more likely than other children to participate in after-school programs. More than half (55%) of high-poverty urban schools provide summer-school programs (95). These settings also reach millions of children through federal food assistance programs, such as the Afterschool Snack Program, which provides free snacks to children and adolescents, and the Summer Food Service Program, which provides meals and snacks to youth. Studies are needed to assess the nutritional quality of snack foods and beverages in these programs and intervention strategies to improve healthy eating in these programs.

After-school care programs in seven states (Delaware, Illinois, Michigan, Missouri, New York, Oregon, and Pennsylvania) were recently authorized by Congress to serve dinner in addition to snacks to children in areas where more than 50% of the children qualify for free or reduced price school meals (30). This means that some low-income children may consume three meals and a snack every weekday during the school year from federal food programs. This highlights the growing importance of the federal child nutrition programs in providing nutrition to children in low-income families and the need to ensure that the foods served through these programs are consistent with the Dietary Guidelines for Americans.

Work Sites

As schools are for children, work sites are ideal settings for reaching adults because 66% of U.S. adults are employed (12). The work site environment provides opportunities for both individual-level behavior changes and physical and social work site environmental change. Research suggests that nutrition behaviors can be positively influenced by work site health-promotion programs that include healthful modifications of the work site environment (4, 25, 86). Dietary intake has been positively influenced by environmental strategies such as increasing the availability and variety of healthful food options (54), reducing the price of healthful food in work site cafeterias (54) and vending machines (32), and sending tailored nutrition education email messages (7). A recent systematic review of work site health-promotion programs found that fruit, vegetable, and fat intake can be positively influenced by environmental strategies that include point-of-purchase labeling, promotional materials, expanded availability of healthy foods, and targeted food placement (25). A review of these programs found that most studies had small but significant decreases in dietary fat and increases in fruits and vegetables or fiber (31). Although the changes were modest, they may be meaningful from a population perspective.

Strengthening the social environment of the workplace may also be beneficial (4, 86). Involving employees in program planning and implementation and obtaining supervisory support and commitment from management are important for program sustainability (86). Priorities for future work site–based interventions include identifying and reducing

barriers to organizational and environmental change, addressing social contextual factors driving behaviors, and building expanded networks of community partnerships.

Retail Food Stores: Supermarkets and Small Grocery Stores

The presence of food stores, and the availability of healthful products in those stores, are important contributors to healthy eating patterns among neighborhood residents (41). Grocery stores play a major role in food purchasing: Households make an average of two visits to a supermarket per week, and average weekly household grocery expenses were $93 in 2006 (29). Several studies have found associations between access to supermarkets and healthier food intakes (16, 60, 66). For example, Morland et al. (66) found that fruit and vegetable intake increased with each additional supermarket in a census tract, and that increase was nearly three times as large for African Americans. Laraia et al. (60) found that pregnant women who lived more than four miles from a supermarket were significantly more likely to have poor diet quality, even after controlling for individual socioeconomic status and the availability of smaller grocery and convenience stores. Powell and others (76) found that increased access to chain supermarkets was associated with lower adolescent BMI and that greater availability of convenience stores was associated with higher BMI and overweight. Cheadle and others (16) found that the diets of neighborhood residents were healthier when the supermarkets in their neighborhoods offered more healthful products. However, a recent analysis found that both higher neighborhood density of small grocery stores and closer proximity to chain supermarkets were associated with higher BMI among women (101). More emerging research should shed light on the complexities of these relationships.

Among various types of retail stores that sell food, supermarkets offer the greatest variety of food at the lowest cost (29, 40). Low-income and minority neighborhoods have fewer chain supermarkets than do middle- and upper-income neighborhoods (67, 77, 107). A recent study linked availability of food store outlets in the United States across 28,050 zip codes to Census 2000 data (77). Low-income neighborhoods had fewer chain supermarkets with only 75% of stores available in middle-income neighborhoods. Data also showed large disparities by race in the availability of chain supermarkets even after controlling for differences in income, similar to those found in the Detroit area by Zenk and others (107). For example, the availability of chain supermarkets in African American neighborhoods was only 52% that of their counterpart white neighborhoods (77). The lack of availability of large supermarkets is of concern because large supermarkets tend to offer food at lower prices and provide a wider variety of and higher-quality food products than do small grocery stores (47, 75).

Lack of access to supermarkets is also a problem in some rural areas. Morton & Blanchard (68) examined the distribution of U.S. counties in which residents have low access to large food retailers (low access defined as living more than 10 miles from any supermarket or supercenter). They found that of all U.S. counties, 418 are food deserts and most of these had high poverty rates. The most affected rural counties were in the Great Plains and Rocky Mountain regions, the Deep South, the Appalachian region of Kentucky and West Virginia, and the western half of Texas. In rural America, it will take community action and public policy improvements to strengthen the capacity of rural grocery stores to provide nutritious high-quality and affordable foods.

Both large supermarkets and smaller groceries and food stores are important environments where environmental interventions may increase the availability of and access to healthier food choices (41). Point-of-choice nutrition information to help consumers identify healthier products can and has been tried in grocery store settings, with

mixed results but some notable successes (37, 41). In addition, interventions to increase availability, variety, and convenience; pricing; and promotional strategies have been found feasible and modest evidence has demonstrated their efficacy in influencing healthy eating behavior (41). Thus, retail food environments at both the community level (e.g., presence of supermarkets) and the consumer level (e.g., healthful, affordable foods in food stores) are promising venues for positive change (39).

Eating Out: Restaurants and Fast-Food Outlets

Americans are eating out more often and consuming more calories from away-from-home establishments than ever before. The National Restaurant Association estimates that sales will total $537 billion in 2007 for the 935,000 U.S. restaurants (70). The number of food establishments in the U.S. has nearly doubled in the past three decades (94). Today nearly half (47.9%) of all food expenditures are spent eating out, up from 34% in 1974 and nearly double from what it was in 1955 (70). Away-from-home foods tend to be more calorie dense and of poorer nutritional quality than foods prepared at home (43). Currently, Americans consume about 32% of their calories from food away from home (43). Whereas fast-food restaurant meals are typically high in calories and fat, foods consumed at full-service restaurants can be as high or higher in fat, cholesterol, and sodium (87). An observational study of 217 fast-food and sit-down restaurants in the Atlanta area found that it was not possible to choose a healthy main dish on the basis of readily available information in most restaurants (81). Studies have linked frequent eating out to higher caloric intake, weight gain, and obesity (9, 65, 74).

Trends toward large portion sizes in restaurants encourage over consumption because people consume more food and more calories when presented with large portions (102). Several restaurant items, such as soft drinks and desserts, are now served in portions that are two or more times larger than the standard serving size (53). It is not uncommon for restaurant entrees to contain one half to one day's worth of recommended calories (1100 to 2350 calories) (53). Most consumers may be unaware of the high levels of calories, fat, saturated fat, and sodium found in many menu items (13, 46) and may underestimate actual calorie content by as much as 50% (13).

Federal and state laws do not require restaurants to provide nutrition content information to consumers. Rather, the provision of nutritional information for menu items is voluntary and the information may appear on menus, Web sites, brochures, tray liners, food wrapper packages, or posters. One survey found that only 44% of the top 300 U.S. restaurant chains provided nutrition information for most of their standard menu items (104). Of the restaurants with nutrition information, 86% provided it on the company Web site, which requires Internet access and does not make the information available at the point of decision making.

In 2006, the Keystone Center, a nonprofit policy organization, released a report requested by FDA to develop recommendations on away-from-home foods (94). Among the recommendations were that food establishments should provide consumers with caloric information in a standard, easily accessible format and should increase the availability of low-calorie menu items. They also recommended that research should be conducted on how consumers use nutrition information for away-from-home foods, how this information affects caloric intake, and how nutrition information affects restaurant operators. Restaurant executives identify their most important priorities as growing sales and increasing profits, so they will only offer healthy food options if there is adequate consumer demand (38). Provision of nutritional information at the point of choice may increase customer awareness and stimulate demand for smaller portions and more healthful choices. Although there are several models for

changing environments and policies in restaurants to increase healthy eating, most have not been systematically evaluated (36). There is a need to disseminate promising strategies, increase public-private partnerships, and to study further the effects of policy and environmental changes including the provision of nutrition information in restaurant settings.

Legislation has been introduced in Congress and in more than a dozen state legislatures that would require chain restaurants and fast-food outlets to list calories and other nutrition information on their menus to make it easier for consumers to make more healthful food choices (105). To date, none of these measures have been enacted. On a local level, the New York City Board of Health passed a regulation to require some restaurants to post calorie information on menus or menu boards. In a surprising attempt to circumvent this requirement, several major chains took down their Web site–based nutrition information, suggesting the need for fewer loopholes in such laws. Also, cities such as New York and Philadelphia have recently passed bans or restrictions on trans fats in restaurants, which will go into effect in 2008.

Disparities in Food Access in Low-Income Communities

Inequalities in income underlie many health disparities in the United States. In general, population groups that suffer the worst health status, including nutritional health and obesity, are also those that have the highest poverty rates (96). Several studies have shown differential availability and affordability of healthy foods in low-income neighborhoods (2, 58, 62, 66, 67). Lack of access to affordable and healthy foods may be contributing to disparities in diet-related chronic diseases and obesity rates. (See section above on Retail Stores for background).

Among the important opportunities to reduce disparities are initiatives to encourage the development of grocery retail investments in low-income communities. A recent survey among urban and economic planners in 32 large cities found few activities to encourage any form of food retail in underserved areas, such as development of large supermarkets, farm stands, or assistance to neighborhood grocery businesses (75). Successful initiatives were characterized by political leadership at the highest levels and effective partnerships with community-based nonprofit organizations. Case studies showed supermarkets that had entered deprived inner-city neighborhoods experienced significant business and customer loyalty. Creative strategies by these stores included shuttle services, calculators on carts, services provided to immigrants and non-English speakers, automated teller machines, rooftop parking, and technology linking inventory to checkout data to facilitate efficient flow of high-demand products in limited spaces (75).

Other potential strategies to get healthy, local foods into low-income neighborhoods include fostering neighborhood farmers markets, cooperative food stores, community gardens; incorporating fresh produce and healthy foods into corner stores and convenience stores; having neighborhood churches and community centers purchase produce from local farmers to be sold to community members following church or community events; and having local community clinics and public health departments provide local produce to patients during clinic visits as part of a health-promotion initiative (61). We also need to find ways to have food banks and food shelves obtain fresh produce and healthy foods.

Federal, state, and local efforts and public-private partnerships are needed to create and facilitate new and expanded food systems programs to help underserved areas develop retail food markets and increase access to a healthy, affordable food supply. Because little research has been done on the most effective and promising programs in this area, more evaluation and intervention efforts are needed.

MACRO-LEVEL APPROACHES

U.S. Food and Agriculture Policies

The obesity crisis has focused attention on the role of federal agricultural policies on the U.S. food supply and how policies may impact public health and diet-related chronic diseases and obesity. Agricultural policies determine which crops the government will support. Government support influences which crops U.S. farmers produce, the prices of those crops, and subsequently, which products food processors, distributors, and retailers make available to consumers and at what market price (84). U.S. farm policies have contributed to the overproduction of certain crops, specifically commodity grain and oilseed crops (i.e., corn and soybeans), thereby creating artificially low prices, often below the cost of production (84). U.S. farm policy for commodity crops has made sugars and fats some of the most inexpensive food substances to produce and may have indirectly influenced food processors and manufacturers to expand their product lines to include more fats and sweeteners in their products (84, 85). High fructose corn syrup and hydrogenated vegetable oils (high in trans fats)—products that did not even exist a generation ago—are now prevalent in foods, likely owing to the availability of inexpensive corn and soybeans (84). Food companies can purchase these commodities at artificially cheap prices, contributing to the increased prevalence of added sugars and fats in our food supply. In the American food supply, per capita daily supply of added fats and oils increased 38% from 1970 to 2000, and added caloric sweeteners increased 20% during this time (78). In 2000, the average American consumed 152 pounds of sweeteners, which was equivalent to 52 teaspoons of added sugar per day of which 40% came from high fructose corn syrup (10). The current U.S. diet derives close to 50% of calories from added sugars and fats (78).

The low cost of cheap corn and soybeans and higher-priced fruits and vegetables are believed to be a direct consequence of U.S. agriculture policy over the past 30 years (69). Government support for grain and oilseed crops comes in many forms, from research dollars to infrastructure investments to subsidy payments that mitigate low prices (84). Healthy fruits, vegetables, and other specialty crops (i.e., nuts) receive little government support. This lack of government support may be reflected in the higher cost of fruits and vegetables. Between 1985 and 2000, fruits and vegetables led all other food categories in retail price increases, with price increases for fresh fruits and vegetables being much higher than those for processed products (78). For example, over this 15-year period the percent change in food price increases was 118% for fruits and vegetables and only 35% for fats and oils, 46% for sugars and sweets, and 20% for carbonated soft drinks (78). Although there may be a correlation between the drop in prices and expanding production of corn and soybeans, the increasing use of added fats and high-fructose corn syrup in processed foods, and the increase in obesity, these factors are complex and not well understood.

Current agricultural policies have helped make food environments less healthy for Americans. Farm and food policy should be aligned with national public health and nutrition goals. The key purpose of our food and farming policies should be to advance the health and well-being of Americans. Some of the same reforms that could make our farm policy healthier would also benefit family farmers (84). Every five to seven years there is an opportunity to change the system through the federal Farm Bill, which addresses agricultural production, food and nutrition assistance, rural development, renewable energy, conservation policies, and research.

The Farm Bill also reauthorizes some of the key domestic food and nutrition assistance programs including the Food Stamp Program, which serves 1 in 12 Americans, or nearly 24 million low-income people per month, more than half of whom are children (30). Currently, food-stamp recipients have

insufficient benefits to purchase the foods necessary for a healthy diet over the course of a month. We need to ensure that all Americans are able to access and afford healthy foods. Increasing access to healthier foods in food assistance programs could include expanding coupon programs that allow food assistance beneficiaries to purchase fruits and vegetables, whole grains, and other healthy foods at local farmers markets and other retail food outlets; expanding the programs that bring fresh local farm products into schools; and revising the commodity portion of the food assistance programs (84, 85). A shift toward healthier farm policies that would benefit the public's health also includes promoting local and regional sustainable food systems to increase access to healthier foods. Additionally, federal and state policies could facilitate increased institutional and agency procurement of local and regional agricultural food products, such as fruits and vegetables, by child care centers and schools, hospitals, food banks, senior centers, and prisons (26).

Economic and Pricing Issues

The cost of food is the second most important factor affecting food decisions, behind taste (35). Government regulations that affect price are consistent influences on the purchase of fresh fruits, vegetables, and meats (79). Drewnowski (21, 22) has hypothesized that the observed links between food supply trends and rising obesity rates are mediated by the economics of food choices. The current structure of food prices is that high-sugar and high-fat foods provide calories at the lowest cost (22). Thus individuals and families with limited resources may select energy-dense foods high in refined grains, added sugars, and fats as a way to save money. Fresh fruits and vegetables are more expensive on a per calorie basis than are fats and sugars. Little is known as to whether variations in food prices account for differences in diet quality or weight status. Sturm & Datar (92) merged data from the Early Childhood Longitudinal Study with metropolitan data on food prices and found that lower neighborhood prices for fruits and vegetables predicted lower gains in BMI in young children. Low-income families spend less on fruits and vegetables than do higher-income families (6). A 10% reduction in price for fruits and vegetables increases consumption by 7.2% (48). Thus, reducing the price of healthy food may increase intake.

It is surprising how little is known about whether healthier diets cost more. Recently, Jetter & Cassady (55) conducted a market-basket study in 25 stores in Los Angeles and Sacramento to compare the cost of a standard market basket [based on the USDA's Thrifty Food Plan (TFP)] to a market basket with healthier substitutes. For the two-week shopping list, the average TFP market-basket cost was $194 and the healthier market-basket plan was $230. The cost of the healthier basket was due to higher costs for whole grains, lean ground beef, and skinless poultry. This study suggests that the higher cost of healthier foods could be a deterrent to eating healthier among low-income consumers. More studies are needed on economic factors influencing eating behavior and the relationship between diet quality and food costs. This has important implications for strategies to modify the food environment, for national food policy, and for food assistance programs for low-income populations.

Food Marketing and Media Influences

Although multiple factors influence eating behaviors of youth, one potent force is food marketing. Today's youth live in a media-saturated environment. Over the past few decades, U.S. children and adolescents have increasingly been targeted with aggressive forms of food marketing and advertising practices (50, 89). Multiple techniques and channels are used to reach youth, beginning when they are toddlers, to foster brand loyalty and influence product purchase behavior. Recently

the Kaiser Family Foundation conducted the largest study on TV food advertising to children (57) and found that children ages 8–12 see the most food ads on TV, an average of 21 ads per day or more than 7600 per year. Most of the ads were for candy, snacks, sugared cereals, and fast foods; none of the 8854 ads reviewed marketed fruits and vegetables. Food marketing to children now extends beyond television, is widely prevalent on the Internet (56), and is expanding rapidly into a ubiquitous digital media culture of new techniques including cell phones, instant messaging, video games, and three-dimensional virtual worlds, often under the radar of parents (17).

The IOM Committee on Food Marketing to Children and Youth conducted a systematic review of the evidence and concluded that food and beverage marketing practices geared to children and youth are out of balance with recommended healthful diets and contribute to an environment that puts their health at risk (50). The report set forth recommendations to guide the development of effective marketing strategies that promote healthier food, beverages, and meals for children and youth. Among the major recommendations for the food, beverage, and restaurant industries was that industry should shift their advertising and marketing emphasis to healthier child- and youth-oriented foods and beverages. If voluntary efforts related to children's television programming are unsuccessful in shifting the emphasis away from high-calorie and low-nutrient foods and beverages to healthful foods and beverages, Congress should enact legislation mandating the shift. Advocacy and public health groups are also calling on the Federal Trade Commission, the Federal Communications Commission, and Congress to work together with industry to develop a new set of rules governing the marketing of food and beverages to children—rules that account for the full spectrum of advertising and marketing practices across all media and which apply to all children, including adolescents (17). Marketing efforts need to serve, rather than undermine, the health of children (17).

MEASUREMENT ISSUES

To make significant progress in the area of eating and nutrition environments, we need valid, reliable measures of nutrition environments and policies (39). Although there are an increasing number of reports of various dimensions of nutrition environments, there is no guidance in the literature on how best to measure nutrition environments in a comprehensive manner. Research on school food environments, neighborhood food environments (stores, restaurants), and state policies are illustrative of well-developed measurement tools and important needs in this area. This section provides examples of accomplishments and needs in the area of measurement of nutrition environments in schools, stores, and restaurant settings.

Schools

A number of measures of school food environments have been carefully developed, most often for use in intervention research. Large-scale studies of school food policies and environments have been conducted using surveys of school administrators and food service managers (20, 103). These data are limited by the usual concerns with self-report (bias, forgetting, etc.) and may also suffer from nonresponse bias. A state nutrition-environment policy classification system has recently been developed to track developments in 11 policy areas, among them school meal environments, reimbursable school meals, BMI screening, and competitive foods. This system is based on a social-ecological model and should enhance the surveillance opportunities for all 50 states and the District of Columbia (64).

Local and regional studies typically use a combination of data-collection methods, including surveys of food service managers,

observations and data-based inventories of foods available, observations/analysis of students' bag lunches, and food service sales data. Often the food availability and/or sales data are combined with nutritional information and subjected to nutrient analyses (33, 82). The measures are carefully designed and subjected to quality assurance, but few psychometric data are available. A key limitation of on-site measures is that the sales data are usually recorded manually rather than obtained from automated cash register systems. Details of the instruments and protocols used in peer-reviewed research have not been widely disseminated, most likely because the tools were developed in specific settings as part of larger intervention studies.

Neighborhood Food Environments: The Community Nutrition Environment

Key categories of food sources in neighborhoods include stores and restaurants. It is useful to distinguish where people get food and what type of food they can get within those establishments. The community nutrition environment is composed of the number, type, location, and accessibility of food outlets such as grocery stores, fast-food restaurants, and full-service restaurants. The consumer nutrition environment is what consumers encounter in and around places where they buy food, such as the availability, cost, and quality of healthful food choices (39). Community nutrition environment data are available from various commercial sources such as Dun & Bradstreet business lists (76, 77), as well as from county health or agriculture department food license lists, telephone books, and the Internet. Although national studies may rely on business lists, local and regional studies suggest that more complete and accurate enumeration of food-sale locations can be achieved using a combination of sources (40, 81) and supplemented with ground truthing by systematically walking or driving each street in a neighborhood.

Consumer Nutrition Environments in Stores

Some of the earliest published measures of availability of healthy foods in stores were reported nearly two decades ago by Cheadle and others (16), who calculated the percentage of shelf space used for healthy food options, such as low-fat milk, whole wheat bread, cheese, and lean meats. They found high inter-rater reliability (0.73 to 0.78) and test-retest reliability ranging from 0.44 to 1.00. These measures are theoretically robust but may be difficult to apply in contemporary grocery stores that are larger and more varied in layout than they were two decades ago. Horowitz and others (47) measured availability of five diabetic-recommended foods in grocery stores and reported excellent inter-rater reliability ranging from 0.94 to 1.00. Other published reports have been less clear about the rigor of their methods or did not report reliability of the measures.

Recently, the Nutrition Environment Measures Study developed observational measures of the nutrition environment within retail food stores (NEMS-S) to assess availability of healthy options, price, and quality for ten food categories (e.g., fruits) or indicator food items (e.g., ground beef), aligned with the U.S. Dietary Guidelines (40). Inter-rater reliability and test-retest reliability of availability were high: Inter-rater reliability kappas were 0.84 to 1.00, and test-retest reliabilities were 0.73 to 1.00. These measures are being disseminated through training workshops (**http://www.sph.emory.edu/NEMS**), and as of mid-2007, raters and trainers in 28 states have learned to use these tools and the NEMS-R restaurant measures.

Consumer Nutrition Environments in Restaurants

Research on the environment within restaurants is limited. Some recent advancements have been made in the measurement of food environments within restaurants, including

good interobserver reliability for availability of fruits and vegetables (24). Cassady and colleagues (14) developed a reliable restaurant menu checklist for use by community members, which assesses food preparation, number of healthful choices, and fruit/vegetable availability. However, this checklist did not assess the whole restaurant environment and was tested in only 14 family-style restaurants.

The NEMS-R observational measure for restaurants was recently developed to assess factors believed to contribute to food choices in restaurants, including availability of more healthy foods, facilitators and barriers to healthful eating, pricing, and signage/promotion of healthy and unhealthy foods. Inter-rater and test-retest reliability were assessed in 217 sit-down and fast-food restaurants in 4 neighborhoods, and inter-rater reliability was generally high, with most kappa values >.80 (range 0.27–0.97) and all percent agreement values >75% (77.6%–99.5%). Test-retest reliability was high, with most kappa values >.80 (0.46–1.0) and all percent agreement values >80% (80.4%–100%) (81). Like the NEMS-S store measure, it has been widely disseminated and continues to be adopted for research and community program use.

There is much more work to be done in designing and testing food-environment measures that are adoptable to a variety of locations. The options for self-reported measures include survey reports from individual consumers or residents (perceived reports) and reports from administrators or key informants (factual reports). Audit and observational tools also comprise a range of measurement methods: on-site observations, menu reviews, sales data, inventories, policy documentation, etc. Each type of method has pros and cons, and the relative advantages and disadvantages should be carefully considered when using or creating these measures for research and action projects. Developers and users of these measures will be challenged to be attentive to the nutritional meaningfulness of indicators, relevance and feasibility of measures, and potential for linking environmental and individual assessments in subsequent studies. A range of psychometrically sound measures are needed to obtain accurate and reliable estimates of the relation between nutrition environments and individuals' dietary intake, as well as to evaluate change in nutrition environments secondary to intervention.

CONCLUSIONS

Improving dietary and lifestyle patterns and reducing obesity will require a sustained public health effort, which addresses not only individual behaviors but also the environmental context and conditions in which people live and make choices. Individual behavior change is difficult to achieve without addressing the context in which people make decisions. Initial, significant steps are needed to make healthful food choices available, identifiable, and affordable to people of all races and income levels and in all types of geographic locations (e.g., urban, suburban, rural). Our ultimate goals should be to structure neighborhoods, homes, and institutional environments so that healthy behaviors are the optimal defaults.

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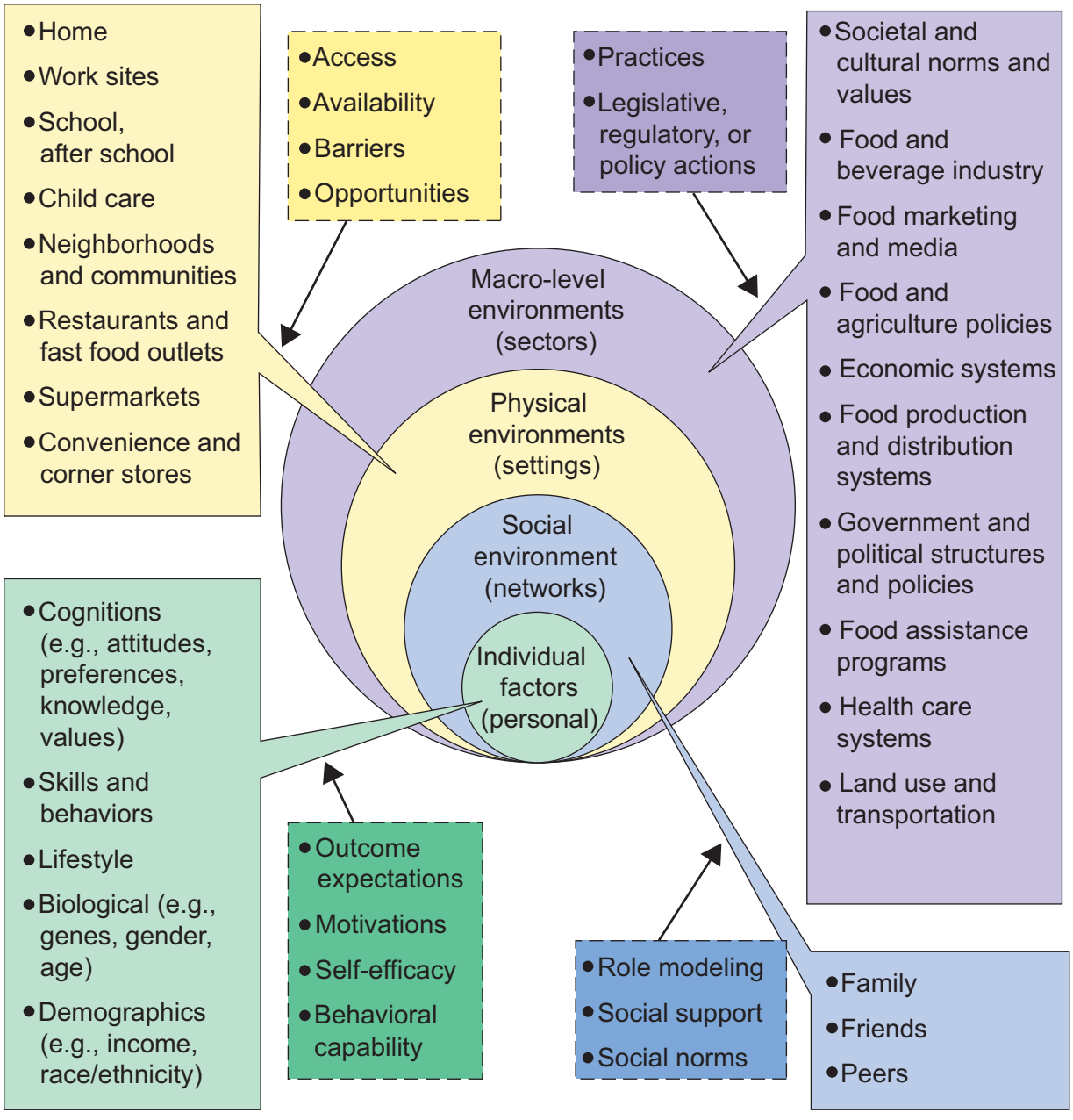

Figure 1

An ecological framework depicting the multiple influences on what people eat.

Annual Review of Public Health

Volume 29, 2008

Contents

Commentary

Public Health Accreditation: Progress on National Accountability
Hugh H. Tilson xv

Symposium: Climate Change and Health

Mitigating, Adapting, and Suffering: How Much of Each?
Kirk R. Smith xxiii

Ancillary Benefits for Climate Change Mitigation and Air Pollution Control in the World's Motor Vehicle Fleets
Michael P. Walsh 1

Co-Benefits of Climate Mitigation and Health Protection in Energy Systems: Scoping Methods
Kirk R. Smith and Evan Haigler 11

Health Impact Assessment of Global Climate Change: Expanding on Comparative Risk Assessment Approaches for Policy Making
Jonathan Patz, Diarmid Campbell-Lendrum, Holly Gibbs, and Rosalie Woodruff 27

Heat Stress and Public Health: A Critical Review
R. Sari Kovats and Shakoor Hajat 41

Preparing the U.S. Health Community for Climate Change
Richard Jackson and Kyra Naumoff Shields 57

Epidemiology and Biostatistics

Ecologic Studies Revisited
Jonathan Wakefield 75

Recent Declines in Chronic Disability in the Elderly U.S. Population: Risk Factors and Future Dynamics
Kenneth G. Manton 91

The Descriptive Epidemiology of Commonly Occurring Mental Disorders in the United States
Ronald C. Kessler and Philip S. Wang 115

The Women's Health Initiative: Lessons Learned
Ross L. Prentice and Garnet L. Anderson 131

U.S. Disparities in Health: Descriptions, Causes, and Mechanisms
Nancy E. Adler and David H. Rehkopf 235

Environmental and Occupational Health

Industrial Food Animal Production, Antimicrobial Resistance, and Human Health
Ellen K. Silbergeld, Jay Graham, and Lance B. Price 151

The Diffusion and Impact of Clean Indoor Air Laws
Michael P. Eriksen and Rebecca L. Cerak 171

Ancillary Benefits for Climate Change Mitigation and Air Pollution Control in the World's Motor Vehicle Fleets
Michael P. Walsh 1

Co-Benefits of Climate Mitigation and Health Protection in Energy Systems: Scoping Methods
Kirk R. Smith and Evan Haigler 11

Health Impact Assessment of Global Climate Change: Expanding on Comparative Risk Assessment Approaches for Policy Making
Jonathan Patz, Diarmid Campbell-Lendrum, Holly Gibbs, and Rosalie Woodruff 27

Heat Stress and Public Health: A Critical Review
R. Sari Kovats and Shakoor Hajat 41

Preparing the U.S. Health Community for Climate Change
Richard Jackson and Kyra Naumoff Shields 57

Protective Interventions to Prevent Aflatoxin-Induced Carcinogenesis in Developing Countries
John D. Groopman, Thomas W. Kensler, and Christopher P. Wild 187

Public Health Practice

Protective Interventions to Prevent Aflatoxin-Induced Carcinogenesis in Developing Countries
John D. Groopman, Thomas W. Kensler, and Christopher P. Wild 187

Regionalization of Local Public Health Systems in the Era of Preparedness
Howard K. Koh, Loris J. Elqura, Christine M. Judge, and Michael A. Stoto 205

The Effectiveness of Mass Communication to Change Public Behavior
Lorien C. Abroms and Edward W. Maibach 219

U.S. Disparities in Health: Descriptions, Causes, and Mechanisms
Nancy E. Adler and David H. Rehkopf 235

The Diffusion and Impact of Clean Indoor Air Laws
Michael P. Eriksen and Rebecca L. Cerak 171

Public Health Services and Cost-Effectiveness Analysis
H. David Banta and G. Ardine de Wit 383

Social Environment and Behavior

Creating Healthy Food and Eating Environments: Policy and Environmental Approaches
Mary Story, Karen M. Kaphingst, Ramona Robinson-O'Brien, and Karen Glanz 253

Why Is the Developed World Obese?
Sara Bleich, David Cutler, Christopher Murray, and Alyce Adams 273

Global Calorie Counting: A Fitting Exercise for Obese Societies
Shiriki K. Kumanyika 297

The Health and Cost Benefits of Work Site Health-Promotion Programs
Ron Z. Goetzel and Ronald J. Ozminkowski 303

The Value and Challenges of Participatory Research: Strengthening Its Practice
Margaret Cargo and Shawna L. Mercer 325

A Critical Review of Theory in Breast Cancer Screening Promotion across Cultures
Rena J. Pasick and Nancy J. Burke 351

The Effectiveness of Mass Communication to Change Public Behavior
Lorien C. Abroms and Edward W. Maibach 219

U.S. Disparities in Health: Descriptions, Causes, and Mechanisms
Nancy E. Adler and David H. Rehkopf 235

Health Services

A Critical Review of Theory in Breast Cancer Screening Promotion across Cultures
Rena J. Pasick and Nancy J. Burke 351

Nursing Home Safety: Current Issues and Barriers to Improvement
Andrea Gruneir and Vincent Mor 369

Public Health Services and Cost-Effectiveness Analysis
H. David Banta and G. Ardine de Wit 383

The Impact of Health Insurance on Health
Helen Levy and David Meltzer 399

The Role of Health Care Systems in Increased Tobacco Cessation
Susan J. Curry, Paula A. Keller, C. Tracy Orleans, and Michael C. Fiore 411

Indexes

Cumulative Index of Contributing Authors, Volumes 20–29 429

Cumulative Index of Chapter Titles, Volumes 20–29 434

Errata

An online log of corrections to *Annual Review of Public Health* articles may be found at http://publhealth.annualreviews.org/

Lead Article

NUTRITION REVIEWS 70 YEARS 1942-2012

Does food marketing need to make us fat? A review and solutions

Pierre Chandon and Brian Wansink

Food marketing is often singled out as the leading cause of the obesity epidemic. The present review examines current food marketing practices to determine how exactly they may be influencing food intake, and how food marketers could meet their business objectives while helping people eat healthier. Particular attention is paid to the insights provided by recently published studies in the areas of marketing and consumer research, and those insights are integrated with findings from studies in nutrition and related disciplines. The review begins with an examination of the multiple ways in which 1) food pricing strategies and 2) marketing communication (including branding and food claims) bias food consumption. It then describes the effects of newer and less conspicuous marketing actions, focusing on 3) packaging (including the effects of package design and package-based claims) and 4) the eating environment (including the availability, salience, and convenience of food). Throughout, this review underscores the promising opportunities that food manufacturers and retailers have to make profitable "win-win" adjustments to help consumers eat better.

INTRODUCTION

Biology and natural selection have created strong food preferences. Individuals around the world want easy access to a variety of tasty, convenient, inexpensive, and safe foods that can be eaten in large quantities. By catering to, and stimulating, these biological interests, food marketers have been accused of contributing to the growing problem of global obesity.[1–5] After all, the food industry (which includes food and beverage producers, as well as retailers, restaurants, and food services companies) employs savvy and creative marketers who have pioneered many of the tools of modern marketing.[6,7] At the same time, it is important to understand that the marketers and the executives who guide them are torn between satisfying the desires of various consumers, the demands of their shareholders, and the concerns of public health organizations, which largely perceive the food industry as the new tobacco industry (because both industries have used similar tactics, such as emphasizing personal responsibility, massive lobbying, pre-emptive self-regulation, etc.).[8,9] For these reasons, it is useful to review and integrate much of the overlooked evidence on how food marketing influences food intake and to examine how food marketers could continue to grow their profits without growing their customer's body mass index (BMI).

This review article examines and integrates the literature from marketing, consumer research, and related social science disciplines, which is not in the commonly referenced databases for health and medicine, such as PubMed, and is therefore often unknown to nutrition researchers. By incorporating this information, this review updates the existing reviews in the field,[10,11] which are rapidly becoming outdated given the breadth of more current research. For the purpose of this review, marketing is defined in accordance with the definition of the American Marketing Association as "the activity, set of institutions, and processes for creating, communicating,

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delivering, and exchanging offerings that have value for customers, clients, partners, and society at large." This article focuses on the direct effects of marketing activity under the direct control of food marketers, often referred to as the 4 Ps of "product," "price," "promotion," and "place." Specific focus is placed on the factors that influence how much consumers eat, and in particular, whether they overeat (which is defined as eating more than one realizes). Yet, it is important to remember that food/energy intake is not synonymous with weight gain, let alone obesity.[12] Because of this review's focus on marketing and food intake, many influencers of food intake that are not under the direct control of food marketers are excluded (e.g., physical activity, pro-social marketing, personal, cultural, and social norms about food, eating, dieting, incidental emotions, etc.).

Food marketers influence the volume of food consumption through four basic mechanisms that vary in their conspicuousness. 1) The short- and long-term price of food, as well as the type of pricing (e.g., a straight price cut or quantity discount), can influence how much people purchase and eventually consume. Pricing efforts are generally conspicuous and lead to deliberate decisions. 2) Marketing communications, including advertising, promotion, branding, nutrition, and health claims, can influence a consumer's expectations of the sensory and nonsensory benefits of the food. Marketing communications comprise the most recognized form of influence and the one most closely scrutinized by marketing and nonmarketing researchers. The influence of marketing communication can sometimes be as conspicuous as price changes, but consumers are not always aware of some of the newest forms of marketing communication (e.g., "advergaming," package design, or social media activities) and, even when they are aware of the persuasive intent behind these tools, they may not realize that their consumption decisions are being influenced. 3) The product itself, including its quality (composition, sensory properties, calorie density, and variety) and quantity (packaging and serving sizes) also influence in a variety of ways how much of the product consumers eat. This area has been frequently researched as marketing communication. 4) The eating environment, including the availability, salience, and convenience of food, can be altered by marketers. Compared to the breadth of the domain, this is the least frequently studied area, yet it is the one most likely to be driven by automatic, visceral effects outside the awareness and volitional control of consumers.

PRICING: HOW LONG- AND SHORT-TERM PRICE REDUCTIONS STIMULATE INTAKE

Some food products like milk, meats, fruits, and vegetables are often sold as commodities. With commodities, short-term prices are determined by supply and demand on world markets and long-term price changes are determined by efficiency gains in the production, transformation, and distribution of food rather than by marketers. The most notable change in this respect is the relative steep decline in the price of food over the last 50 years, particularly for branded, processed foods that are high in sugar and fat, and for ready-to-eat foods, which are prepared away from home.[13–17]

Yet most food products are *not* commodities; instead, they are branded products that are differentiated in the eyes of consumers thanks to the ways in which they are advertised, formulated, packaged, distributed, and so on. With these branded products, marketers can establish their own price depending on which consumer segment they wish to target. Advances in marketing segmentation have enabled companies to direct price cuts to only the most susceptible consumer segments, which increases their efficiency. Table 1 summarizes key findings about the effects of price on overeating, innovative solutions tested by marketers to mitigate its effects, and suggestions for using price to improve food consumption decisions.

Effects of long-term price changes

Econometric studies suggest that lower food prices have led to increased energy intake.[13–17] Even though the average price elasticity of food consumption is low (−0.78), it can be quite high in some categories (e.g., −1.15 for soft drinks) and for food prepared away from home. For example, one econometric study[18] using data from the 1984–1999 national Behavioral Risk Factor Surveillance System found that a 10% increase in prices at fast-food and full-service restaurants was associated with a 0.7% decrease in the obesity rate.

These conclusions are reinforced by the results of randomized controlled trials which demonstrate the causal effects of price changes. Longitudinal field experiments in cafeterias[19–21] have found that price changes above 25% significantly influence consumption of beverages or snacks, but also of fruit and vegetables, and they have stronger effects than nutrition labeling, which sometimes backfire because of negative taste inferences. One of the most thorough studies[22] also varied food budgets over time and found strong and comparable same-price elasticity in two studies for healthy (−1 and −1.7, respectively) and unhealthy (−0.9 and −2.1, respectively) foods. In contrast, the cross-price elasticities were four times smaller and only occurred when children had a very low budget, showing that children do not consider healthy foods to be a substitute for unhealthier ones.

The only exception to the rule that higher prices reduce consumption comes from a study showing that higher prices at an all-you-can-eat pizza restaurant led to

Table 1 **Pricing and consumer welfare.**

Findings indicating how pricing can negatively influence consumer choices and behavior	Examples of positive pricing initiatives by food companies to help consumers make healthy choices[a]	Win-win considerations for the future
Long-term price changes • Lower retail food prices lead to increased energy intake,[14,17–19,22,29] with the possible exception of all-you-can-eat buffets.[23] • Ready-to-eat foods high in sugar and fat have experienced the steepest price decline over the years.[13,16] • The price of food prepared away from home has declined significantly.[14,15] • Prices for vending machine items have declined while prices at full-service restaurants have increased.[15] • A 10% increase in fast-food prices is associated with a 0.7% decrease in obesity rate.[18] • Substantial price reductions in cafeterias significantly increase the consumption of snacks, fruits, and vegetables over time,[19,21] and in one situation substantial price increases reduced soft drink sales.[20] • Children with large budgets responded to an increase in the price of unhealthy food by buying less of the healthy food.[22] • Price is generally unrelated to the perceived quality of packaged food brands, except for ambiguous products like wine.[25,26]	• TGI Friday's: "Right Portion, Right Price" menu. • Au Bon Pain: bite-sized baked goods. • Applebee's: half-size portions for 70% of the price. • PepsiCo India: rural strategy to introduce new affordable beverages that target known regional health problems.[265] • Chili's: $20 dinner for two – each person gets an entree but they split an appetizer instead of getting one each. • Walmart: heavy promotion of fresh produce with frequent price deals.	• Reduce retail price of healthy food through more efficient production and distribution, e.g., lower spoilage with better packaging. • Provide quantity discounts through bulk packaging of fruits and vegetables like at membership warehouse clubs such as Sam's Club and Costco.
Temporary price changes • Temporary price reductions can increase energy intake.[28] • People accelerate consumption of products they believe were purchased at a lower price, even after the food has already been purchased.[27,29,30] • Quantity discounts lead to stockpiling, which accelerates consumption.[32] • Consumers prefer price discounts to bonus packs for "vice" foods but prefer bonus packs to price discounts for "virtue" foods.[35] • Price reductions mitigate guilt, increasing the incentive to buy unhealthy foods.[37]	• Chiquita: Banana Bites coupon distributed on its Chiquita Banana Facebook page • Family Tree Farms: produce sold in bulk with an attractive design on the crate • Wendy's: $1 off coupon for Wendy's Berry Almond Chicken Salad. • TGI Friday's: $5 deal for any sandwiches or salads for a limited time.	• Offer "free quantity" promotions for healthy food (e.g., larger packs, buy-one-get-one-free, etc.). • Give coupons or discounts on fruit and vegetables, such as $1 off salads; buy salad get a free small fry; buy one salad get another half off. • Use social media to promote healthy food choices.

[a] Information on specific company products and initiatives was obtained through the companies' websites on November 11, 2011. URLs can be obtained in the working paper written by the authors (with the same title) and available through SSRN.

higher consumption of pizza, probably because of the psychology of "sunk costs," which leads people to try to eat "their money's worth."[23] Interestingly, monetary (and normative) rewards do not seem to have any adverse effects on children's intrinsic motivation for the food.[24] In general, consumers appear to have learned that lower-priced foods are as hedonically satisfying as higher-priced foods, with the exception of a few categories, such as wine, for which determining good taste is ambiguous.[25] For example, in a recent study, Austrian consumers thought that price was unrelated to the quality of foods, which is not surprising given that the correlation between price and quality in that country was estimated by experts at only 0.07.[26]

Effects of temporary price promotions and quantity discounts

Until recently, it was believed that price promotions simply shifted sales across brands or across time. However, it has now become clear that temporary sales promotions can lead to a significant increase in consumption.[27,28] Probably the best evidence of this comes

from a randomized controlled field experiment involving 1,104 shoppers.[29] This study found that a 12.5% temporary price discount on healthier foods increased the purchase volume of these foods by 11% among the low-income consumers who received the coupons. The effect persisted even 6 months after the promotion had been stopped. In comparison, nutrition education and suggestions for substituting healthier food for less healthy food had no effect, whether alone or combined with the price discounts. However, the discounts on healthy food did not reduce purchases of unhealthy food.

Price deals can influence the speed of consumption even when the food has already been purchased (such as by another family member) and is, therefore, an irreversible sunk cost; this should not, in theory, influence consumption because the cost cannot be recovered, no matter when, or how quickly, the food is consumed. Nevertheless, studies have found that people accelerate the consumption of products perceived to have been purchased at a lower price.[30] This happens because a reduced past price is seen as an indication that the product will be discounted again in the future[31] or simply because the reduced sunk cost means that consumers feel they do not have to wait for a special occasion to consume the product perceived to be cheaper.[32]

Marketers also reduce the relative price of food by offering quantity discounts with larger package sizes or multi-unit packs, which is a powerful driver of supersizing.[33] Although there are exceptions, most studies found that quantity discounts generally lead to stockpiling and increased consumption, especially for overweight consumers.[27,34] One study found that during weeks in which multi-unit packages were purchased, consumption of orange juice increased by 100% and cookies by 92%, but there was no change in consumption of non-edible products.[32] The authors replicated this effect in a field experiment in which the quantity of food was randomly manipulated while keeping its price constant; they found that large purchase quantities influenced consumption by making the food salient in the pantry or fridge, and not just by reducing its price.

Beyond the degree of the incentive, the form of the promotion and the payment mechanism can also influence energy intake. One study suggests that consumers prefer price discounts to bonus packs for guilt-inducing "vice" foods, but preferred bonus packs to price discounts for "virtue" foods because it is easy to justify buying them in larger quantity.[35] By definition, "vices" are foods that are preferred when considering only the immediate consequences of consumption and holding delayed consequences fixed, whereas the opposite is true for "virtues."[36] The greater difficulty of justifying purchases of unhealthy foods also explains why they are more likely to be purchased when people pay for their grocery purchases via credit card than when they pay cash – a more painful form of payment which elicits a higher need for justification.[37] On the other hand, people are more likely to purchase and consume indulgent high-calorie ice-creams when paying cash than when paying with a credit card,[38] possibly because in this case they have the opposite goal of rewarding themselves.

Summary

Overall, all the studies reviewed here clearly show that pricing is one of the strongest – if not *the* strongest – marketing factors predicting increased energy intake and obesity, and this is why lower-income consumers are predominantly affected by these conditions. Conversely, the power of pricing means that it holds the key to many of the "win-win" solutions detailed in Table 1. However, price is not the only determinant of food choices and it cannot alone explain rising obesity rates.[18] Unlike price, which arguably influences consumption through deliberate processes that people are aware of, food communication influences food perceptions and preferences often beyond volitional control and sometimes outside conscious awareness.

PROMOTION: HOW MARKETING COMMUNICATION STIMULATES INTAKE

Advertising and promotions are one of the most visible and studied actions of food marketers. They include advertising, both on traditional media channels and on non-traditional non-media channels, such as online, in-store, in movies, television programs or games, sponsorship or organization of events, in the street, and so on. Food marketers also communicate in more indirect ways by branding the entire product category (e.g., the "Got Milk?" campaign), the ingredients (e.g., acai), and by making nutrition or health claims in their advertising or on their packages. These claims are distinct from the mandatory nutrition information about calories, nutrient levels, and serving sizes, whose effects are reviewed elsewhere.[39–44] Table 2 summarizes the effects of marketing communication and shows how they can also improve food choices.

Marketing communication informs people about product attributes, like the price or where it can be purchased. Marketing communication also increases awareness of the brand and food, which leads consumers, particularly children, to try fewer foods and to only search for brands they already know rather than the brand that would have the highest nutritional and hedonic qualities.[45–47] Moving beyond awareness, communication enhances a consumer's expectations of the sensory and non-sensory benefits (such as the social and symbolic

Table 2 **Marketing communications (promotion) and consumer welfare.**

Findings indicating how marketing communications can negatively influence consumer choices and behavior	Examples of positive marketing communications initiatives used by food companies to help consumers make healthier choices[a]	Win-win considerations for the future
Advertising and promotion effects • Food advertising represents one-third of television advertising in children's TV programs; children are exposed to 40,000 food ads a year.[8,52] • Most of the television advertising for food is for unhealthy foods that are high in fat, sodium, and added sugar; 72% is for candy, cereal, and fast food.[8,50] • Food marketers are increasingly relying on nontraditional, "non-media" communication, including Internet, games, social media, events, and product placement.[53] • Marketing works best on consumers without fully formed preferences and loyalty to their habitual food.[46] This includes some young consumers. • In some situations, banning television advertising in children's programming reduces consumption of sugared cereals and reduces fast-food consumption frequency.[62,63] • Children in closed environments with exposure to TV advertising for unhealthy foods are more likely to choose these products, especially obese children.[64,65] • Overall, television advertising (not just television viewing) has a causal (but small) influence on the food intake of children (though not on teens).[57,66–68]	• McDonald's: campaigns for its healthier smoothies and salads, fruit and maple oatmeal, and "choose apple dippers and we'll plant a tree". • Wendy's: website default kid's meal is a crispy chicken sandwich with apple slices and low-fat white milk. • A Bunch of Carrot Farmers: Fun, innovative advertising for produce, like the "Eat 'em' like junk food" campaign for baby carrots on YouTube. • Produce companies such as Chiquita and Sunkist: sweepstakes in which customers can win money and prizes for visiting their site. • Produce companies (e.g., Chiquita, Sunkist, Dole, Del Monte, and General Mills): many websites have sections filled with fun, easy recipes using the produce items the company sells. • Schools: emails to notify students of the healthy options in the dining hall each day. • Chiquita and Nintendo: cross-promotion of bananas and new Donkey Kong game.	• Increase messaging (in media and non-media outlets) for fruit and vegetables/salads. • Increase the online presence of produce on websites targeted at children. • Increase the use of social media and adver-gaming for healthy products. • Increase healthy eating in the media; in movies and TV shows portray characters eating healthily, especially in media geared towards children. • Co-brand healthy items with popular brands (that may not necessarily be known for being healthy).

value) associated with the purchase and consumption of a particular food. Even if it fails at changing the expected benefits of consumption, marketing communication can influence the importance of these benefits, for example, by making taste a more important goal than health. This may explain why nutrition ranks last in surveys of the drivers of food choices, after taste, cost, and convenience.[48,49]

Advertising and promotion effects

The food industry is among the top advertisers in the US media market. Children and adolescents are exposed to increasing levels of television advertising, mostly for nutritionally poor snacks, cereals, candies, and other food with a high fat, sodium, or added sugar content.[50–52] As with all consumer goods marketers, food marketers are diverting budgets from television, print, radio, or outdoor advertising to more recent forms of communication on new media (including web sites, all types of video games, social networks, product placement, point-of-purchase advertising, etc.) and through packaging, direct marketing, public relations, and event sponsorship.[53] The message communicated in these ads is that eating these foods is normal, fun, and socially rewarding.

Given how much food marketers spend on communication, and particularly television advertising, it is surprising that a link between television advertising and energy intake is still perceived to be controversial by some. Some researchers contend that television advertising only affects brand preferences and not overall energy intake, while others demand an extremely high bar before any conclusion can be drawn.[54–56] Part of the explanation for the duration of the controversy is that, unlike other factors, such as price or portion size changes, advertising

Table 2 **Continued**

Findings indicating how marketing communications can negatively influence consumer choices and behavior	Examples of positive marketing communications initiatives used by food companies to help consumers make healthier choices[a]	Win-win considerations for the future
Branding and labeling effects: food and ingredient branding; nutrition information; nutrition and health claims; health halos		
• The name and description of a food and its ingredients have a strong effect on expected and experienced taste and health perceptions, above and beyond the description of its ingredients/nutrition content.[71–75,81] • Packages with logos, licensed characters, or special colors can increase the appeal of food.[53,77,78] • Nutrient composition (such as fat content) and ingredients strongly influence health and taste expectations.[70,79] • Framing influences the effect of nutrient and ingredient composition. For example, food is perceived to be leaner when labeled "75% fat-free" rather than "25% fat."[36,80] • The physical characteristics of the packaging itself can influence consumption.[76] • Few people access the nutrition information available to them and, overall, such information does not have a strong effect on food intake.[40] • Many health claims are confusing or are misunderstood by consumers.[93] • Simple front-of-package health claims and guidelines are preferred by consumers, but they are also more likely to create unwanted health halos compared to more complete ones.[84–88] • Calorie information slightly improves food decisions overall, but only for consumers who care and when calorie counts are surprising.[41,99] • Although it can help reduce intake, serving size information is perceived by most as arbitrary and not an indicator of appropriate serving size.[89–91] • Health halos: when one aspect of the food is portrayed as healthy, consumers tend to categorize the entire food item as healthy, which leads them to underestimate its calories and to overeat.[89,96–99,106] • Consumers, especially dieters, expect the combination of healthy and unhealthy food to contain fewer calories than the unhealthy food alone.[100–102] • People expect they can eat more when marketing, nutrition, and health claims lead them to believe the target food is healthy.[89,96,103,104,107,108]	• Branding of entire product categories by commodity boards or individual businesses, such as milk (got milk?) or New Zealand-grown kiwifruit (Zespri) • Partnerships between entertainment companies and fruit companies to cross-promote products (e.g., Disney characters on fruit stickers, and promotion of the movie "Rio" along with Chiquita bananas). • Yoplait: calcium campaign promoting positive health outcomes. • Subway: Eat Fresh Live Green Initiative promoting healthy living based on sustainability. • Better front-of-package nutrition labeling. • American Beverage Association: Clear on Calories initiative, displaying calorie information on the front of the bottle and for the entire bottle (if below 20 oz), not per 8-oz serving. • Family Tree Farms: hosting Flavor Tech University, a comprehensive, hands-on training course for store-level produce personnel. • Campbell's: website that highlights the health benefits of its products.	• Rebrand healthy foods on non-health-related positive benefits that non-users and children can relate to, such as safety, sustainability, social justice, anti-consumerism and anti-globalization, animal protection, even energy independence, or national security.[264] • Co-brand and add licensed characters onto produce packaging. • Advertise produce websites on fruit stickers. • Label pre-packaged produce as "healthy" and highlight specific nutrients, such as iron. • Feature less clutter on packages to make them seem fresh and healthy. • Add descriptions to healthy foods. If the food is not packaged (like corn) add a label to it in the supermarket. • Add pictures to the front of healthy packaged food. • Leave out confusing or intimidating words. • Do not allow healthy products to touch unhealthy products.

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is a complex multi-dimensional intervention. Two campaigns can vary in their reach, frequency, scheduling, targeting, message strategy, and execution. In combination, this makes it difficult to conclusively estimate reliable effects using non-experimental real-world data.

Television viewing or television advertising? The correlation between television viewing and obesity is well established. Television viewing is associated with unhealthy snacking. Eating in front of the television also distracts, and therefore slows awareness of satiety.[57–59] Although television viewing also reduces calorie expenditures directly (by displacing physical activity) or indirectly (by advertising cars, games, and indoor toys that promote a sedentary lifestyle), studies suggest that the effects of television viewing on calorie expenditure are too weak to materially impact obesity.[57,60,61] Still, these studies cannot disentangle the effects of television *viewing* from the effects of television *advertising*.

One of the reasons it is difficult to estimate how television advertising influences energy intake is because there is very little natural variation in real-world exposure to television advertising for food, requiring one to make many statistical assumptions. In this context, probably the most convincing studies use real-world data from Québec's ban on television advertising aimed at children in French-speaking television networks. A first study[62] showed that the ban reduced the quantity of children's cereals in the homes of French-speaking children in Québec, but not for English-speaking children who continued to be exposed to the same amount of food advertising through US television stations. Another study[63] concluded that the Québec ban also significantly reduced fast-food consumption because French-speaking families in Québec with children eat less often in fast-food restaurants than English-speaking families with children, but no such difference are found between families without children or between French- and English-speaking families living in Ontario. These results are corroborated by other experimental studies in schools and summer camps, which showed that exposure to television advertising for unhealthy foods increased the likelihood that these foods would be chosen on a single consumption occasion as well as for longer time periods, and that the largest effects occurred among obese children.[64,65]

In summary, reviews of this literature suggest that food advertising moderately influences the diet of children (though not of teens). There is not, however, enough evidence to rule out alternative explanations regarding its effects on obesity itself.[57,66–68] It is also suggested that food advertising interacts with other marketing factors, such as price promotions, and with factors not directly under the control of marketers, such as social norms, to influence obesity to a degree which would be very hard to establish precisely.

Branding and labeling effects

Food and ingredient branding. Branding is the creation of names, symbols, characters, and slogans that help identify a product and create unique positive associations which differentiate it from the competition and create additional value in the consumer's mind.[69] The name of the food (brand name or generic category name) has a strong influence on how consumers' expectations of how tasty, filling, or fattening the food will be, which are often uncorrelated with reality.[70,71] Well-known brands, but also simple descriptions like "succulent," can influence taste expectations, consumption experience, and retrospective evaluations of the taste, and then lead to increased sales, especially for non-experts.[72–74] For example, a recent study[75] showed that branding the same food as a "salad special" versus "pasta special," or as "fruit chews" versus "candy chews" increased dieters' perceptions of the healthfulness or tastiness of the food as well as its actual consumption. Interestingly, name changes had no impact on non-dieters and disappeared when dieters were asked to consider the actual ingredients (versus the name), and when looking only at dieters with a high need for cognition. Consumers also form expectations about the product from any attribute associated with the product, from the presence of licensed or brand-owned character,[53] to the firmness of its container.[76]

Beyond the name of the food, communication about the nutrient composition and the presence (and number) of specific macro nutrients or ingredients (especially fat content, but also energy density, fiber, sugar content, unfamiliar long-worded ingredients, and so on) can strongly impact food expectations.[77–79] As with any communication, the framing of the information matters also for nutrition information. Food is perceived to be leaner and higher quality when labeled "75% fat-free" than "25% fat."[36,80] For example, vinegar improves the taste of beer, but only when it is described as a "special ingredient," not when it is described as vinegar, and only when the description is provided prior to the consumption.[81] This suggests that branding influences the interpretation of the sensory experience and does not just modify the retrospective interpretation of the experience. In fact, marketing descriptions of a milkshake as "indulgent" or "sensible" influences physiological satiation, as measured by gut peptide ghrelin.[82] Neuroimaging studies confirm that these marketing actions influence not just self-reported liking, but also its neural representations, suggesting that these effects are not merely influenced by social cues and that marketing actions modify how much people actually enjoy consuming the food.[25]

Health and nutrition claims. Although nutrition and health claims are regulated, the decision of whether or not

to use them rests with the food marketers. In past years, marketers have become increasingly likely to make heavy use of nutrition claims (including "low fat" or "rich in omega 3"), "structure-function" claims ("proteins are essential for growth"), health claims ("supports immunity"), vague unregulated claims or health sales (including "smart choice" or "good for you"), or the use of third-party ratings or endorsements (including "Kosher," "Halal," "organic," or the heart check mark of the American Heart Association). Some of these claims can improve brand evaluation and sales, although these effects are not universal and are influenced by comparisons with other foods in the same category and by how they influence taste expectations.[43,83]

Studies have shown that simpler, more prescriptive health claims, such as color-coded traffic lights, have stronger effects.[84,85] A field experiment found that simple color coding of cafeteria foods with a green, yellow, or red label (for "healthy," "less healthy," and "unhealthy" foods) improved sales of healthy items and reduced sales of unhealthy items.[86] Providing category benchmarks for each ingredient and nutrient (average or range) helps consumers process nutrition information, while summarizing information in a graphic format is particularly helpful for illiterate consumers.[87,88] Food marketers could also choose to provide information about recommended serving sizes (which is only mandatory in the United States). One study found that, although adding serving size information reduced granola intake for both overweight and normal-weight consumers, it had no impact if the granola was labeled as "low fat."[89] The same authors found that promoting smaller serving sizes did not influence intake or satiety ratings, especially among overweight people. This could be because most consumers think that the entire content of the package is the appropriate serving size and perceive USDA serving sizes as an arbitrary unit designed to allow a comparison of nutrition facts across products, rather than as a general guide to how much people should consume.[90,91]

Beyond evaluating whether health claims are scientifically true, an important question to examine is how they are understood by consumers. Recent reviews have identified many sources of confusion.[92–94] First, although the relationship between any nutrient and health is almost always curvilinear, consumers expect it to be monotonic ("more is better"). Second, consumers may not realize that they are already taking too much of a particular nutrient (e.g., protein intake in Western countries). Third, wording can be misleading; such as when "provides energy" is understood as "energizing." Finally, some claims are based on flimsy science, or they overstate research findings. For these reasons, health claims are likely to become even more regulated, and to be only allowed for general products as opposed to specific brands, for example.

Health halos. The branding and labeling of food often operate by relying on people's natural tendency to categorize food as intrinsically good or bad, healthy or unhealthy, regardless of how much is eaten.[95] When branding and labeling efforts emphasize one aspect of the food as healthy, it can lead to a "health halo," whereby people generalize that the food scores highly on all nutrition aspects, including weight gain.[96–98] In one study,[89] we found lower calorie estimations for granola than for M&Ms, a product with the same calorie density but considered less healthy than granola. The same study also found that labeling both products as "low fat" reduced calorie estimation and increased the amount that people served themselves or consumed, especially for people with a high body mass index. In another study,[96] we found evidence for health halos created by the name of a restaurant or the food available on a restaurant menu. For example, meals from the sandwich chain SUBWAY® were perceived to contain 21% fewer calories than same-calorie meals from McDonald's. These results were replicated with other foods and restaurant brands.[99]

Related studies showed that adding a healthy food to an unhealthy food could lead to calorie estimations that were lower than for the unhealthy food alone. For example, one study found that a hamburger alone was perceived to have 761 calories but the same hamburger and a salad was thought to have only 583 calories.[100] This "negative calorie" illusion created by adding a healthy food to an unhealthy food is particularly strong among people who are on a diet.[101] Different biases, or contrast effects, occur when people estimate calories sequentially instead of simultaneously.[102]

Overall, the finding that people expect that they can eat more, and do, when marketing actions lead the food to be categorized as healthy is robust and is replicated independently of people's BMI, gender, or restrained eating.[103,104] This boomerang effect seems to occur because people feel that they can eat more of the healthy food, or can eat more unhealthy, but tasty, food after choosing healthy food without guilt and without gaining weight.[96,105,106] In fact, simply considering the healthier option without actually consuming it, or forced choice of healthy food can be enough to allow some consumers to vicariously fulfill their nutrition goals, which makes them hungrier and entices them to choose the most indulgent food available.[107,108]

To fully understand the effects of health claims, however, we must look at their impact on choice and purchase and not just on consumption volume when they are freely provided. When examining purchases, the results are mixed. First, studies have shown that people generally expect food presented as "unhealthy" to taste better, and that these effects persist even after actual intake,[109] although another study found this only among

people who are not on a diet.[75] These results, coupled with the earlier findings that taste expectations are the strongest driver of food choices, imply that positioning food as healthy may not necessarily increase total energy consumption if the higher intake per consumption occasion is compensated by fewer consumption occasions (or fewer consumers).

The net effect of health claims probably depends on brand and individual characteristics, and is stronger for some claims than others. For example, differences in taste expectations about food, specifically when described as "low fat," as opposed to branded as "healthy" in general, have been found between men and women,[110] and mostly influence unfamiliar brands. It is also unlikely to influence foods strongly categorized as healthy or unhealthy. This could explain the null effect of some of the studies and some of the earlier opposite findings.[111,112] The negative association between health and taste is less pronounced in Europe, where people tend to associate "healthy" with freshness and higher quality, and thus sometimes healthier can be tastier.[113,114]

PRODUCT: HOW MARKETING STIMULATES INTAKE BY CHANGING THE FOOD ITSELF

Although marketing is most readily associated with communication and pricing, marketers are also closely involved with product development decisions. This includes making decisions about the "quality" of the food and also its "quantity." The effects of changes in the product on overeating are summarized in Table 3. This table also shows how some food marketers have found

Table 3 **Product and consumer welfare.**

Findings indicating how product changes can negatively influence consumer choices and behavior	Examples of positive product change initiatives used by food companies to help consumers make healthy choices[a]	Win-win considerations for the future
Food quality: sensory perceptions; macronutrient composition; calorie density; sensory variety; wanting vs. liking.		
• Increasing the amount of sugar, fat, and salt (up to a point) generally improves palatability and increases intake.[115,125,145] • Increasing the complexity of the sensory experience by adding different layers of flavors, more sensory cues, and more sensory stimuli improves palatability and increases consumption.[119–121,245] • Liquid and easy-to-eat fast-foods provide more calories than comparable solid "slow" foods of the same energy density.[122] • Colors can be more important than taste or brand information to discriminate foods.[72,123] • Adding ingredients reduces the perception that the food is natural while subtracting ingredients does not.[130] • Food marketers have responded to nutrition labeling laws by introducing healthier brand extensions; however, the nutritional quality of core brands has not improved beyond adding taste-neutral nutrients like vitamins.[131,132] • People tend to eat the same quantity of food, regardless of calorie density, relying on volume cues to tell them when they are full.[133,134,137,165] • Increased food variety both within and across meals increases consumption volume by reducing sensory-specific satiety.[138–140] • Beyond hedonic liking from sensory stimulation, food intake is influenced by reward salience and distraction.[145–148,150]	• Food companies have been able to reduce the amount of fat, sugar, and salt in many of their products without compromising the product's taste. • Danone: reduced the average sugar content of its products in Brazil from 13.9% in 2008 to 12.9% in 2010. • Danone: between 1981 and 2009 in Germany, it reduced fat by 63%, sugar by 25%, and calories by 36% in its "FruchtZwerge" products while keeping taste constant. • PepsiCo: added "better for you" products to its portfolio of "fun for you" products, including yoghurt.[266, 267] • McCain: offers Sweet Potato SuperFries as a healthier alternative to regular fries. • Burger King: offers flame-broiled chicken tenders and apple fries as new menu options. • Au Bon Pain: sells fruit salad as opposed to just one specific type of fruit. • McDonald's: has improved the taste and variety of their salads • McDonald's: Happy Meal will include apple slices and fewer fries.[268] • Family Tree Farms only sells its stone fruit when it is ripe, and often sacrifices cost for flavor.	• Develop foods that contain textures, ingredients, and nutrients that accelerate satiation (so that people stop eating faster) but extend satiety. • Companies can sell more fruit salad as opposed to just whole fruit; people eat more because of the variety and convenience. • More fast-food restaurants could start selling apple fries and other healthier alternatives to regular French fries. • Use multi-sensory displays to help people imagine what it will feel like to eat aromatic, soft, complex, visually appealing fruits. For example, pipe in the smell of fruit to a supermarket produce section. • Improve the desire for vegetables by teaching consumers how to prepare them well. • Help people become more sensitive to taste changes by giving them a better consumption vocabulary.

Table 3 **Continued**

Findings indicating how product changes can negatively influence consumer choices and behavior	Examples of positive product change initiatives used by food companies to help consumers make healthy choices[a]	Win-win considerations for the future
Food quantity: altering package and portion sizes; supersizing effects; size labeling		
• Product package and portion sizes have grown rapidly over the past decades and are now almost invariably larger than the USDA recommended serving sizes.[152–154,156] • Larger package sizes are typically more profitable for food marketers, especially if some consumers are willing to overpay small sizes that help them restrict how much they eat. They also benefit from a higher perceived economic and environmental value.[36,159] • With few exceptions (like bite-size portions),[176,177] larger portion and package sizes significantly increase consumption.[30,32,91,133,160–162,164,167,168,233] • Just observing someone else eating a large portion can increase intake, particularly if that person is not obese.[173–175,205] • People avoid ordering the largest and smallest drink sizes.[172] • Containers that attract more attention, and those with more pictures of the product or pictures on the bottom are perceived to contain more.[197–200] • Part of why larger portions make people eat more is because people underestimate how big they are.[184,188,189] • In general, people underestimate volume changes, especially when all three dimensions (height, width, and length) of packages or portions are changed.[183,191] • People take package size and even "virtual" partitions as a cue for appropriate serving size.[90,91,169,170] • Labeling products as "small" makes people eat more but think that they are eating less.[193,196]	• Wendy's: offers salads in half sizes. • Applebee's: offers under 550 calories and Weight Watchers menus. • Au Bon Pain: offers bite-size options. • Dairy Queen: offers a 7-oz mini Blizzard, which is 5 ounces smaller than its previously smallest size. • Smaller package sizes offered by some companies with no change in price. • Increasing availability of 100-calorie-pack products. • Increasing availability of mini-size of "fun-sized" products, such as candy bars, which are smaller than the regular-sized products. • Increasing availability of innovative, fun, eco-packaging with pre-determined portion sizes, such as those for nuts sold by Diamond Foods.	• Smart downsizing: reduce volume by elongating the packages (or at a minimum by reducing packages proportionally rather than just by reducing their height); this makes the size reduction less visible and increases preferences for smaller sizes. • Add a smaller size on the menu. Even if nobody chooses it, it will make other sizes look bigger and will lead people to choosing smaller sizes. • Use complex packages with displays of products on top to increase acceptance of smaller sizes. • Rebrand apple fries just like french fries: call the large size a medium, and so on. • Sell fruit and vegetables cut up and in large packages, meant for snacking. People will eat more of the fruit if it is in a large package.

[a] Information on specific company products and initiatives was obtained through the companies' websites on November 11, 2011. URLs can be obtained in the working paper written by the authors (with the same title) and available through SSRN.

ways to mitigate these changes and provide avenues for further win-win strategies.

Product quality: effects of the composition, sensory, and nutritional properties of the food

In addition to being a source of nourishment, food is a source of hedonic pleasure and stimulation. Hence, it is not surprising that one of the primary goals of food marketing is to improve the palatability of the food. At a basic level, palatability generally increases energy intake because people in rich countries can choose to eat only what they like.[115] Although improving palatability and the sensory and nutritional properties of food are largely driven by advances in food science, marketing plays an important role because it helps incorporate the expressed and latent desires of consumers and, above all, the role of perception. For example, advances in market research can correct for the fact that some people may not like a given amount of sweetness simply because they are not as

sensitive to it as much as others or because they have a different interpretation of a scale label such as "extremely sweet."[116,117] This is particularly important because taste perception and preferences are not the same for people with a high and low BMI.[118]

Food composition. Flavor is a seamless combination of taste and predominately smell, but it is also enhanced by adding different layers of flavors; combining different forms (solid or liquid), textures, colors, or temperatures also influences flavor perceptions due to multisensory taste integration as well as consumers' expectations.[119–121] These factors can directly impact energy intake independent of their impact on flavor. People tend to consume more calories from liquid than from comparable solid foods of the same energy density because the lower bite effort and shorter sensory exposure postpone satiation.[122]

Because people associate certain colors with certain foods and flavors, food marketers have long used colors to improve taste expectations. For example, some colors, especially those with strong flavor expectations, can influence the perceived sweetness of food and play a very important role in helping consumers discriminate between different foods, sometimes bigger than the role played by taste or brand information.[72,123] Even advertisements that evoke multiple sensory experiences can enhance taste perceptions.[124]

Up to a certain level, adding sugar, fat, and salt, especially in combination, improves palatability, but does not increase the satiating power of the food in the same proportion.[125,126] Accordingly, food marketers have expanded the supply of food rich in fat or added sugar, such as sweetened beverages, which have accounted for a large proportion of the added supply of calories in recent decades.[127,128] Even though it is true that the percentage of calories consumed from fat has declined in the United States, this percentage decrease is the result of an increase in total energy intake; fat consumption itself has not decreased.[129] Interestingly, adding ingredients reduces the perception that the food is natural, which is an important criteria for food choices, whereas subtracting ingredients (e.g., skim milk) does not.[130]

Food marketers have changed the composition of foods not just to increase palatability but also to respond to public concerns about a particular ingredient or to regulatory changes. Surprisingly perhaps, responses to mandatory nutrition labeling have been mixed. One study suggested that the Nutrition Labeling and Education Act of 1990 led food marketers to improve the level of taste-neutral positive nutrients, such as vitamins, in their core brands (especially those with a weak nutritional profile) and to introduce healthier brand extensions with similar levels of positive nutrients but with lower levels of negative nutrients, especially in junk food categories.[131,132] However, despite these advances, the average nutritional quality of food products sold in grocery stores had actually worsened compared to pre-NLEA levels and compared to similar food products unregulated by the NLEA.[132] This is largely driven by established brands, which account for a large portion of people's diet (e.g., dinner food) and whose nutritional quality has slightly deteriorated. This may be because companies are afraid of reducing levels of negative nutrients (e.g., fat or sodium) in their flagship brands for fear that it may decrease flavor expectations and because companies prefer to compete on taste rather than on nutrition, which can now be more easily compared.

Calorie density and sensory variety. The biggest share of marketing budgets, and most new product introductions, tend to be for calorie-dense foods with a variety of flavors.[2] Unfortunately from a public health perspective, it is well established that calorie density – the number of calories per unit of food – increases energy intake over the short term, such as during an afternoon snack. This happens because people prefer calorie-dense food and tend to eat the same volume of food regardless of its calorie density.[133–135] One of the explanations for this finding is that, instead of paying attention to internal signals of satiation, they focus on external signals, which are often biased.[136] In one study, unsuspecting diners were served tomato soup in bowls that were refilled from tubing that ran under the table and up into the bottom of the bowls. People with varying BMI levels eating soup from these "bottomless" bowls ate 73% more soup than those eating from normal bowls, but these diners estimated that they ate only 4.8 calories more.[137]

It is well known that food variety, both within and across meals, increases consumption volume because it reduces sensory-specific satiety within a meal and it reduces monotony across meals.[138–140] The variety effect is independent of macronutrient content and energy density; it is also independent of individual characteristics such as gender, weight, and dietary restraints, and is only somewhat reduced with age. Research in marketing has focused on perceived (versus true) variety. It has shown that increasing the number of colors and the organization, duplication, and symmetry of an assortment can influence perceived variety, which then influences the perceived quantity of food and, ultimately, how much food is chosen.[141–144] Food marketers have explored many ways to increase perceived variety, including distraction, varying condiments, or giving people illusory choice over what they eat.[138]

Wanting versus liking. Despite the links between sensory stimulation, palatability, and consumption, the availability of tasty, highly palatable foods is neither a necessary

nor a sufficient cause of over-consumption.[145,146] While a highly satisfying meal can lead one person to not want to eat dessert, it can trigger the desire in another person. In fact, highly palatable food samples actually enhance subsequent consumption of similar foods and may prompt people to seek any other type of rewarding food.[147] Even then, people eat beyond the level at which their appetite is satisfied, which is why people eat and drink less when asked to focus on taste satisfaction.[148] Conversely, mental stimulation can create habituation. Simply imagining eating 30 pieces of cheese reduces consumption, increases satiation for the imagined food, and reduces subsequent wanting for the food, but not its hedonic liking.[149]

More generally, there is converging evidence that food decisions are influenced by motivational "wanting" – the salience or reinforcement value of eating – and not just by hedonic "liking" – the pleasure derived from sensory stimulation.[150,151] So although there is no doubt that marketing has played a role in developing more complex, palatable, and rewarding foods which people cannot easily resist or stop eating,[2] the hedonic effects of sensory properties are again just one of many drivers of energy intake.

Product quantity: altering package and serving sizes

Trends in serving and package sizes. With the exception of some specific foods that must be sold in standardized sizes (e.g., wine and liquor), most food and beverage manufacturers are free to choose the size and description (e.g., "medium" or "value" size) of the packages and servings that they sell. Product package and serving sizes have grown rapidly over the past decades and are now almost invariably larger than the USDA recommended serving sizes.[152–154] While this is a trend in much of the developed world, such "supersizing" is particularly common in the United States and has been identified as one reason why obesity has increased faster in the United States than in other developed countries.[155–157]

Larger package sizes almost always have lower unit prices (by volume or weight), except in the rare instances when there is more competition on the smaller sizes or when smaller sizes are used as loss leaders by retail stores.[158] Marketers can reduce the unit price of larger products and hence increase consumer value because of their lower packaging costs. More importantly, larger servings and packages provide greater absolute margins because the marginal cost of the extra food is often minimal compared to its perceived value for the consumer. For food retailers and restaurants with high fixed costs (such as high real estate, labor, or marketing costs), reducing serving sizes, and hence average consumer expenditure, would require a huge increase in traffic to break even – which is why the few restaurant chains that have tried this tactic have mostly stopped promoting these items or stopped offering them altogether. In fact, it can even be optimal for food marketers to price the incremental quantity below its marginal cost if their products are bought by two distinct consumer segments: one willing to pay more for smaller portion sizes that help them control their intake, and the other unconcerned about overeating and willing to buy larger quantities to obtain the lower unit price.[36,159] As a result, larger package sizes are typically more profitable for food marketers, and they benefit from a higher perceived economic and environmental value, a win-win in all aspects but convenience and consumption control.

Supersizing effects. There is considerable evidence that, with the exception of children under 3 years of age who still self-regulate naturally, larger package and serving sizes significantly increase consumption.[30,32,91,160–163] These studies have shown that the increased energy intake due to supersizing (as well as the decrease in energy intake due to downsizing) often reach a 30% change in calorie intake and are not followed by caloric compensation for up to 10 days.[164–166] Supersized servings can even increase the consumption of bad-tasting foods, such as stale 5- and even 14-day-old popcorn.[167,168]

Even "virtual" serving sizes can influence consumption. Simply adding unobtrusive partitions (e.g., colored papers in between the cookies inside the package or a red Pringle chip between every seven yellow ones in a tube) can reduce intake.[169,170] However, partitioning may only work when people pay attention to the partition. One study[171] found that 93% of the purchasers of a king-size pack containing two single-serving candy bars intended to consume both within one day, often because they had not noticed that smaller sizes of candy bars were available for purchase. This is consistent with earlier results indicating that people take package size as a cue for appropriate serving size.[90,91]

The effects of package size on consumption are strongly influenced by the range of the other sizes available and by the serving size chosen by other consumers. One study[172] found that people in hypothetical choice scenarios avoided the largest or smallest drink sizes. Such aversion to extremes causes consumers to choose larger size drinks when the smallest drink size is dropped or when a larger drink size is added to a set. Social modeling studies have shown that larger package and serving sizes can also have an indirect, passive, impact on energy intake, since people tend to imitate how much other people choose, particularly if the person that they have observed is not obese.[173–175]

There are important exceptions to this rule, however. Small units of products such as 100-calorie packs may increase consumption volume on one consumption

occasion more than regular-size packs for hedonic products and when people's self-regulatory concerns have been activated, or for restrained eaters.[176,177] These studies show that, unlike larger package sizes, small units "fly under the radar" and encourage lapses in self-control because the consumption of these small packages fails to activate healthy eating goals. However, these effects do not seem to hold for long periods, whereupon small sizes do lead to reduced calorie intake.[164,178]

One of the explanations for why large packages and servings increase consumption is the social norm that people should clean their plate.[153,179] However, this norm cannot explain why large packages also increase the pouring of inedible products such as shampoo, cooking oil, detergent, dog food, and plant food. Nor does it explain why large packages of M&Ms, chips, and spaghetti increase consumption in studies where even the smaller servings were too large to eat in one sitting.[30,163,180] Another explanation is that larger serving sizes are used as an indication of the "normal" or "appropriate" amount to consume. Even if people do not clean their plate or finish the package, the large size presented to them gives them the liberty to consume past the point where they might otherwise stop with a smaller but still unconstrained supply.[91] This explanation is consistent with the finding that supersized servings increase energy intake even when people eat in the dark.[181] Other studies have shown that people associate larger servings with higher status and that people are therefore more likely to supersize when they want to signal status, for example, when they are made to feel powerless.[182]

A final, and important, reason is that people are simply unaware of how large the supersized servings and packages are.[183,184] Information about food size, volume, or calorie content is not always easily available (such as in restaurants or at home once the food is no longer in its original packaging). Even in retail settings, where size information is available (on the front of the packages or on the shelf tags), few people read it, preferring to rely on visual estimations of the package's weight or volume to infer the amount of product that it contains.[185,186] Many studies have shown that people's perception of serving sizes is inelastic (it changes more slowly than it should).[187–191] On average, a 100% increase in serving size only looks like a 50–70% increase. As a result, whereas small servings tend to be accurately estimated, large servings are greatly underestimated.[188] These perceptual biases are very robust and even trained dieticians exhibit a strong diminishing sensitivity as the size of the meal increases. They are independent of the individual's BMI or interest in nutrition, and they have been replicated by other researchers across a variety of food categories.[99] Stated simply, meal size, not body size, explains serving size errors. People with a high BMI tend to underestimate their calorie intake more than people with a low BMI[192] because they tend to select larger meals, not because they are intrinsically worse (or biased) size estimators.[189]

Size labeling. The size labels used for food and beverages (such as "short" or "large" and also "biggie" or "petite") have acquired meanings among consumers, who are generally able to rank order them accurately.[193] In reality however, these labels mask huge discrepancies because a small size from one restaurant or brand can be larger than a medium size from another.[194] For example, McDonald's abandoned its supersize 42-oz beverages and 200-g fries, while other fast-food chains retained the serving size but simply renamed the "king" a "large."[51,195] These labels are important because they influence size perceptions, preferences, and actual consumption. One study[196] found that "labeling down" (labeling a large serving "medium") had a stronger impact on size perception than "labeling up" (labeling a small serving "large"). In addition, these authors found that smaller labels made people eat more but think that they eat less.

A few studies have shown that marketers can influence impressions of size by changing the visual representations on the package itself. Containers that attract more attention are perceived to contain more product.[197] Two recent studies[198,199] showed that people expected packages with pictures of the product on the bottom or on the right of the package to be heavier. Finally, simply showing more products on the packaging has been shown to increase size perception and consumption, especially when consumers are paying attention.[200] It is important to note that most of these studies were conducted in lab settings or in homes and not in in-store environments. Still, the key conclusion is that the quantity of food, and not just its quality, can have large effects on short-term intake and that consumers are largely unaware of these effects.

PLACE: HOW MARKETING CHANGES TO THE EATING ENVIRONMENT STIMULATE INTAKE

In the same way that food is more than nourishment, eating is more than food intake. It is a social activity, a cultural act, and a form of entertainment. Paradoxically, eating is also mostly a mindless habitual behavior that is strongly influenced by the environment, often without volitional input.[201,202] In this context, the most subtle and perhaps the most effective way marketing influences consumption is by altering the eating environment and making food accessible, salient, and convenient to consume. As for the other ways food marketing can influence overeating, Table 4 summarizes the key findings as well as existing and new solutions to reverse the effects of marketing changes to the eating environment.

Table 4 **Eating environment (place) and consumer welfare.**

Findings indicating how eating environment can negatively influence consumer choices and behavior	Examples of positive eating environment initiatives designed to help consumers make healthy food choices[a]	Win-win considerations for the future
Access, salience, and convenience • Food is now available everywhere, not just in grocery stores and restaurants, and this increased availability is a key driver of intake.[4,203,204] • The proximity to fast-food restaurants (but not full-service restaurants or grocery stores) predicts local childhood and adult obesity rates.[18,210–213] • A food's visibility and accessibility at home increases energy intake – food located away from the table or in opaque jars is consumed much more slowly.[32,205,216] • Just seeing or smelling food in the store can increase hunger and purchases.[47,48,217] • Salience can be internally generated, thinking about memories of soup led subjects to consume more soup later on.[220,222] • The visibility of food in the pantry or in the refrigerator influences the accuracy of inventory assessment and the likelihood of repurchasing it.[187] • Making healthy foods easier to find on restaurant menus and more convenient to grab in cafeterias increases consumption.[86,214,225] • Ease of preparation is a strong driver of intake.[4,32]	• Strong front-of-store produce displays in grocery stores ensure that fresh fruits and vegetables are the first thing customers see. • Positioning chocolate milk in school lunchrooms so it is less convenient to take. • New pre-packaged salads offer convenience while reducing safety risks. • Placing fruit in nice bowls in school cafeterias to attract attention. • Offering convenient, pre-sliced fruit and vegetables in supermarkets and school cafeterias. • Amusement parks offering healthier alternatives to popcorn and fries. • Volunteer initiatives, such as one in Philadelphia, where volunteers patrol streets to discourage kids from buying junk foods.[269] • Fast-food restaurants participating in the Kids Live Well program of the National Restaurant Association. • Making healthy food easy and convenient to eat with innovative vending machines.	• Restaurants should display fruits and vegetables or other healthy options near the entrance and slice and package them in an appealing way. • On dining tables at home or in restaurants, replace foods that are easy to eat, such as chips or bread, with food that is more time-consuming to eat, like peanuts. • Fast-food restaurants should display large, attractive pictures of their salads in the restaurant. • In restaurants where patrons take their beverage from a cooler, place water as the most accessible item, then the other healthy drinks, and put sugar-sweetened beverages in a more inconvenient spot. • In fast-food restaurants, make the salads very visible and put french fries in the back. • Routinely ask consumers if they want a smaller portion. • Instead of asking consumers if they want to supersize, ask if they want to add a salad or another healthy item that brings in more money. • Offer fruit or healthy snacks at the cash register as opposed to candy.
Shape and size of serving container • People use food serving containers as an external cue for how much they should eat.[163,179,201,227] • In the field, people tend to over-serve and overeat when using bigger plates because they make food quantities appear small.[231–233,235,236] • People over-pour into wide (vs. tall) glasses because they tend to focus on the height of the liquid and downplay its width.[228,229] • Because people underestimate three-dimensional volume changes, they pour more into conical containers than into cylindrical ones.[191]	• Many franchised restaurants in the United States (e.g., Friendly's, TGI Friday's, Applebee's) are selling enormous, supersized salads. • Ready-to-eat, prepackaged trays of sliced apples, carrots, and other healthy items are becoming increasingly available. • Tapas restaurants serving a variety of small dishes rather than large entrees are increasing in popularity. • "Small plate" restaurants serving more manageable portions that are "perfect for sharing" are becoming more popular.	• When serving a meal in a restaurant, use a big plate for the vegetable side dish, and use a small plate for starches and protein. • In restaurants, add fruits or vegetables to main entrees as garnishes to make the servings look bigger. • Serve the same size portions on smaller plates to reduce consumption and maintain satisfaction. • Use tall clear cups for drinks so people will think they're consuming more (especially with alcohol and sugary beverages). Conversely, use wide or conical glasses to serve water.

[a] Information on specific company products and initiatives was obtained through the companies' websites on November 11, 2011. URLs can be obtained in the working paper written by the authors (with the same title) and available through SSRN.

Access, salience, and convenience

Access. One of the biggest goals of food marketers is to facilitate access to food by making food easier to purchase, prepare, and consume. Obviously, food availability is a key factor since food that is not available cannot be consumed.[203] In addition, the sheer availability of a variety of palatable foods can derail the homeostatic system designed to regulate food intake.[2] For example, one study found that overweight men on a 3,000 calorie diet did not stick to their diet and consumed an average of 4,500 calories when given access to two free vending machines.[204] This pattern also holds for healthy foods.[205]

On a more general level, convenient, ready-to-eat food is now available in many developed countries almost anytime, anywhere. One can buy food not only in restaurants, grocery stores, and coffee bars, but also in gas stations, pharmacies, kiosks, places of work, schools, and in the hospital. We can also have food delivered almost immediately at home or elsewhere. Food which used to be bought in small family-owned stores is now bought in small or large outlets belonging to multi-national corporations with strong marketing skills and vast resources. Improvements in the marketing and distribution of food, as well as food policies such as subsidies of calorie-dense sugar and starch, explain why the total supply of calories has increased tremendously since the 1970s, reaching 3,900 kcal per person and per day in the United States and between 3,400 and 3,600 kcal in other wealthy countries; the exception to this pattern is Japan, where food supply is only 2,700 kcal and where, not coincidentally, obesity is almost nonexistent.[4]

It is true that the metabolism of obese people requires a higher calorie intake and hence that the increased supply of food is a consequence, and not just a cause, of rising obesity rates.[206] In addition, an increased part of the larger food supply is lost to waste and spoilage, although the estimates of how much is wasted vary between 25% and 40% of the food supply.[207,208] Still, the increased calorie supply cannot be attributed entirely to increasing food waste or to the higher energy requirements of heavier bodies. In fact, many prominent obesity researchers argue[4] that the rise in food energy supply is more than sufficient to explain the rise in obesity in the United States from the 1970s.

Access to food is greatly facilitated by the increased availability of ready-to-eat food prepared away from home, particularly in quick-service restaurants. Whereas spending on at-home food remained stable between 1982 and 2007, expenditure on away-from-home food in the United States increased by 16%, and now represents 49% of all food expenditures.[209] Econometric studies have suggested that the increased availability of fast food (but not full-service restaurants) is a strong predictor of local obesity trends.[18,210,211] Other studies show that proximity to grocery stores (but not to convenience stores) was associated with a lower BMI, possibly because grocery stores offer more healthful foods.[212] However, these findings were mitigated by a recent study[213] which showed that only the proximity to fast-food restaurant significantly influences BMI (particularly for women), whereas proximity to grocery stores or other restaurants does not seem to matter.

Salience. In today's cluttered stores and pantries, marketers know that availability, awareness, and even preferences are not sufficient to generate sales; food visibility must be maximized at the point of purchase and at the point of consumption. For example, eye-tracking studies[47,48] showed that simply increasing the number of facings on a supermarket shelf or placing familiar foods on top of the shelf (versus the bottom) increased the chances that these brands would be noticed, considered, and chosen. One study[214] found that making healthy foods easier to order at a fast-food restaurant by displaying them conspicuously on the menu led to a significant increase in sales. Displaying healthier food more conspicuously in cafeterias of school lunchrooms (by placing them on eye-level shelves and conveniently at various points in the cafeteria line) also increases their consumption.[86] Finally, another study conducted at a fast-food restaurant found that a stronger manipulation of salience, asking consumers whether they would like to downsize their side dishes, was accepted by one-third of consumers and was significantly more effective than calorie labeling.[215] Importantly, the smaller side dishes were not compensated by larger entrees.

The salience (or visibility) of food at home also increases energy intake. When jars of 30 chocolate candies were placed on the desks of secretaries, those in clear jars were consumed 46% more quickly than those in opaque jars.[216] Another study[32] showed that simply placing a food magnet on the refrigerator reminding people of food that they had bought in large quantities was enough to trigger consumption of ready-to-eat food. Spreading products in the pantry (versus stacking them) can increase people's awareness that the product is available and increase the likelihood of consumption.[187] The increased intake of visible foods occurs because their salience serves as a continuously tempting consumption reminder. While part of this may be cognitively based, part is also motivational. Simply seeing or smelling a food can increase reported hunger, devalue other goals, and stimulate salivation and consumption, even when sated.[147,217–219] Salience can also be generated by asking people to write a detailed description of the last time they ate soup or by asking them when they intend to eat.[220–222]

Convenience. One of the strongest trends in food marketing is the focus on improving the convenience of food preparation and consumption. For most people, with the exception of specific festive occasions, food preparation is a cost of inconvenience that consumers are increasingly less willing to pay.[223] Food marketers have responded to the preference for improved convenience by reducing preparation time and increasing the share of ready-to-eat food. Supporting the role of convenience, studies have shown that increased consumption is largely driven by increased consumption frequency rather than by increased consumption quantity per meal.[223] The same study showed that between 1978 and 1996 energy intake increased more for snacks (+101%) than for breakfast (+16%), lunch (+21%), and dinner (–37%). The gains were highest among married women who now spend less time preparing food at home. This may also explain why maternal employment is associated with childhood obesity.[224] Convenience also explains the success of "combo" meals at fast-food restaurants, which combine a sandwich, a side, and a beverage. In fact, one study[225] showed that consumers place a higher value on a "bundled" combo meal, even after controlling for the effect of price discounts, because they reduce transaction costs and increase the saliency of the "featured" items on the menu board.

Convenience also interacts with other factors such as serving size and salience. In one study,[32] we stockpiled people's pantries with either large or moderate quantities of eight different foods. We found that stockpiling increased consumption frequency but only for ready-to-eat products, and that this effect leveled off after the eighth day, even though plenty of food remained in stock. Interestingly, we found that stockpiling increased the quantity consumed per consumption occasion of both ready-to-eat and non-ready-to-eat foods throughout the entire two-week period. With ready-to-eat foods, this was due to the higher visibility because of stockpiling.

Shape and size of serving containers

About 70% of a person's caloric intake is consumed using serving aids such as bowls, plates, glasses, or utensils.[226] The size of bowls and plates obviously influences energy intake for the 54% of Americans who say that they "clean their plates" no matter how much food they find there.[227] This can influence energy intake simply because people (and not just those who clean their plates) rely on visual cues to terminate consumption. If a person decides to eat half a bowl of cereal, the size of the bowl will act as a perceptual cue that may influence how much is served and subsequently consumed. Unfortunately, many of these cues are misleading. A number of studies have shown that people in Western societies overestimate the height of a cylindrical object (such as a drinking glass) compared to its width.[228–230] For example, one of these studies found that the elongation caused people to unknowingly pour and drink 88% more juice or soft drink into a short, wide glass than into a tall, narrow one of the same volume.[229]

Another visual bias, the size-contrast or Delboeuf illusion, suggests that a given amount of product looks smaller on a larger plate than on a smaller plate.[231–233] A study showed that people who were given 24 oz. bowls of ice cream served and consumed about 20% more ice cream than those given 16 oz. bowls.[234] Larger serving containers increase consumption even when a constant amount of food is served on the bowl (versus people serving themselves).[30,163] On the other hand, other studies[235,236] found that using a smaller plate did not reduce energy intake in lab studies in which subjects were repeatedly eating the identical food in isolation.

Recent studies have started to link these results with work in psychophysics and to look at the interaction effects of size and shape on size perceptions and preferences.[237,238] An important finding has been that the lack of sensitivity to increasing sizes is even stronger when packages and servings increase in all three dimensions (height, width, and length) compared to when they only increase in one dimension.[191] This could explain why the effect is stronger for cups, glasses, and bowls (3D objects) than for plates (essentially 2D). The same authors have shown that because people underestimate volume changes that occur in three dimensions, they pour more beverage into conical containers (e.g., cocktail glasses where volume changes in three dimensions) than into cylindrical containers (where volume changes in one dimension). In addition, people's preference for supersizing is higher when products grow in one dimension. Although some studies have shown that part of these effects is mediated by attention,[180,197] other studies[190,239] suggest that they are mostly caused by people failing to compound the changes of multiple dimensions.

Atmospherics of the purchase and consumption environments

Retailers, restaurants, and food service companies can influence the ambient characteristics of the point of purchase and of the point of consumption (e.g., its temperature, lighting, odor, noise, and so on). Some atmospheric dimensions, such as temperature, have direct physiological effects. Studies have shown that people consume more energy when the ambient temperature is outside the thermo neutral zone, the range in which energy expenditure is not required for homeothermy.[240] For this reason, it has been argued that obesity could be linked to the reduction in the variability in ambient temperature

brought about by air conditioning.[241] For example, consumption increases more during prolonged cold temperatures than in hot temperatures because of the body's need to regulate its core temperature.[242]

Dimmed or soft lighting appears to influence consumption by lengthening eating duration and by increasing comfort and disinhibition. Harsh lighting makes people eat faster and reduces the time they stay in a restaurant, whereas soft or warm lighting (including candlelight) generally causes people to linger and likely enjoy an unplanned dessert or an extra drink.[243,244] Ambient odors can influence food consumption through taste enhancement or through suppression.[123,245] For example, one study[147] found that exposure to an appetizing odor increased soft drink consumption during movie-watching and that exposure to an offensive odor decreased consumption without people being aware of these effects.

The presence of background music is associated with higher food intake[246] and it is even linked with choice in supermarkets. In the context of restaurants, soft music generally encourages a slower rate of eating, longer meal duration, and higher consumption of both food and drinks.[247] When appealing music is played, individuals dine longer, feel more comfortable and disinhibited, and are more likely to order a dessert or another drink.[248] This is because when it improves affective responses (environmental affect, mood or arousal), background music reduces perception of time duration.[249] In contrast, when music or ambient noise is loud, fast, or discomforting, people tend to spend less time in a restaurant.[250] A recent meta-analysis found that music also influences shopping in a large range of retail contexts, that slower tempo, lower volume, and familiar music increase shopping duration, whereas loud, fast, disliked music increases perceived time duration.[251]

All of these findings highlight the role of distraction in influencing consumption or intake volume.[58] For example, one study found that eating while watching TV or eating with friends (but not with strangers) impaired the ability to self-monitor, decreased the attention given to the food itself, and led to higher energy intake.[59] Other studies found that eating while distracted reduced satiation and impaired memory of past consumption, which reduced the time until the next eating episode.[252] Indeed, amnesiac patients have been found to eat the same meal multiple times in a row if they are told that it is dinner time.[253,254] Distraction influences taste perception (e.g., reduces sensory-specific satiety) and increases subsequent consumption volume by emphasizing the affective (versus cognitive) drivers of taste. One study[255] found that distraction while sampling food increased enjoyment as well as the subsequent choice of the relative vice (chocolate cake) versus the relative virtue (fruit salad).

Although one of the least studied ways marketers can influence consumption, the impact of the eating environment is powerful and multifaceted – and often overlooked by consumers.[201,256] Overall, these studies show that consumption volume is influenced by the eating environment, by facilitating access to the food, increasing its salience and the convenience of its preparation, but also by modifying the shape and size of serving containers as well as temperature, brightness, ambient odors, and music.

CONCLUSION

The food manufacturing and retailing industries have evolved tremendously and now include numerous innovative and fast-growing organization that are either nonprofit or with strong concerns for public health and the environment.[257] However, the majority of the food eaten in developed countries is still manufactured and distributed by traditional for-profit, and often publicly listed, companies.[258] For-profit food marketers are not focused on making people fat but on making money. In a free market, for-profit food companies that are less profitable than their competitors are likely to end up being acquired by their rivals or to go bankrupt. In this context, the mission assigned to most food marketers is to understand what different consumer segments desire and to profitably offer it to them. In general, what many people want in the short term is tasty, inexpensive, varied, convenient, and healthy foods – roughly in that order of benefit importance. The marketer's mandate is to help identify and create foods that deliver these benefits better; to communicate these benefits; to profitably package, price, and distribute these foods; and to protect these innovations by branding the food so that it acquires unique and positive associations in the mind of consumers. In this respect, food marketers have been very successful and have pioneered many marketing innovations now used in other industries.

Yet, as this review has shown, the vast ingenuity and resources of food marketers have created a myriad of ways in which food marketing influences consumption volume and, hence, may promote obesity. Although television advertising has attracted the bulk of the attention of researchers, it is merely the tip of the iceberg. It is neither the most innovative nor the most powerful way food marketing works, and its importance is declining.

To summarize how food marketing has made us fat, it is most likely through increased access to continuously cheaper, bigger, and tastier calorie-dense food. Two contentions are also offered here: 1) Researchers have overestimated the impact that deliberate decision-making has on food intake. For this reason, the effects of nutrition information, health claims, and informational

advertising, have had a smaller impact than is believed. However, this probably does not apply to price and access to food, which are two important influencers of food intake that mostly operate through deliberate decision-making. 2) Researchers have underestimated the impact that peripheral factors and mindless habitual behavior have on food intake. For this reason, the effects of brand associations; calorie density and sensory complexity of food; the size and shape of portions, packages, and serving containers; and the convenience and salience of food stimuli in the eating environment. That is, the effects of the product and the place (the eating environment) have had a greater impact than believed.

Future research opportunities

Despite decades of work, what we presently know about how food marketing influences consumption is still dwarfed by what we do not know, creating many opportunities for impactful research and ensuring that no review will ever be complete and final. Yet, we should have realistic expectations regarding what research can do. This review shows that food marketing can influence consumption in many inter-related ways and that food consumption is governed by a complex set of dynamic interactions. In this context it is unlikely that any amount of research will be able to "prove" general statements such as "front-of-package health claims improve consumption decisions" because the magnitude and direction of the effects will depend on the implementation and will vary dynamically across consumer segments, consumption occasions, and the type of food studied.

One of the most important areas for future research, therefore, is to examine how the short-term effects reviewed here, which are often investigated only in single-consumption occasions in a lab, also hold when examined across time. Longer time horizons are particularly important because habituation and compensation can offset short-term effects. Ideally, these new studies would combine the best aspects of studies from 1) consumer research (including rich psychological insights and multi-method testing), 2) nutrition (including longitudinal designs, representative participants, biomarkers of calorie intake, and expenditures), and 3) health economics (including population-level interventions and analyses, and policy implications). As such, they would provide the necessary link between specific marketing actions, individual short-term food choices, and long-term population weight gain.

As shown in the tables, the factors leading people to eat more can also lead them to eat less, to promote consumption of healthier food, and more generally increase the importance people attach to health over taste, price, and convenience when making food decisions. For example, we have reviewed studies showing that consumption of healthy and unhealthy food responds similarly to price reductions,[22] that it is possible to incentivize children to prefer healthier food,[24] and that smart downsizing can lead people to prefer smaller servings.[191] In general, there is a wide range of profitable changes that businesses could make to help consumers eat better and eat less. What is important to understand is that these solutions need to fit both supply and demand in the food marketing value chain. In this respect, Tables 1–4 show that much of the leading thinking in this area of win-win approaches has been in food retailing, such as with supermarkets, cafeterias, and restaurants. Thanks to the longer time that consumers spend with food retailers, changes to their marketing have the highest potential to impact consumption.

Finally, it will be important to examine the interplay of marketing factors and cultural, social, and individual characteristics. Although obesity is a global problem, most of the studies reviewed here were conducted among North American consumers and often among undergraduate students. Yet, we know that culture, age, income, education, and a host of other socioeconomic factors influence food decisions. For example, there are important differences between how Americans, Europeans, and Asians approach food and eating. Beliefs that are taken for granted in a US context, for example, that unhealthy food is tastier or that external cues influence satiation, may not apply elsewhere.[113,114,136,259]

Policy implications

After reviewing the studies outlined here, one may question the effectiveness of the policy changes being suggested by regulators. It is beyond the scope of this paper to examine all the policy interventions designed to fight obesity, and we need to be mindful of the many factors mentioned in the introduction that influence food decisions that are not under the control of food marketers. What this review underscores is that many such changes will come with either modest results or unanticipated results due to how consumers and companies respond. Consider mandatory nutrition information. As a rule, mandatory information disclosure has the intended effect when there is a consensus among consumers about the valence of the information. This occurs when an attribute (like trans-fats, or fibers) is universally seen as negative or positive. However, mandatory disclosure may backfire if the information is about attributes that are not uniformly valued – like calories, salt, fat, or sugar content – which are seen by some as a signal of rich taste. In this case, companies may actually choose to compete on less transparent attributes like taste and to target taste-conscious consumers.[132]

By highlighting the effects of unobtrusive environmental factors on energy intake, the findings in this review support the current "small steps" approach to obesity prevention.[260] This approach recognizes that obesity is not a moral weakness but a normal response to the changing environment. As such, it stands in contrast with traditional public health efforts that have focused on providing science-based nutrition information and have exhorted people through didactic and sometimes moralizing appeals to change their dietary habits. A small steps approach focuses on adopting smaller, more sustainable goals. It recognizes that self-control is a limited and often absent resource and focuses less on persuasion and more on benevolent interventions that "nudge" consumers into making slightly better but repeated food choices without thinking about it.[261] This is done mostly by altering the eating environment, for example, by substituting calorie-dense drinks, like soft drinks, with water or diet soft drink in cafeterias, surreptitiously improving food composition, indirectly promoting smaller packages on menus (by eliminating quantity discounts and adding an extra small size to the range), storing tempting food out of reach and healthier alternatives within reach, using smaller cups and bowls, and pre-plating food instead of using family-style service. The small steps approach is not designed to achieve major weight loss among the obese but to prevent obesity for the 90% of the population that is gradually becoming fat by eating 60–100 calories too many per day.[262,263] It should be paired with smarter public education campaigns to rebrand health by associating it with stronger identity-based appeals, such as sustainability, animal welfare, or even national security.[264]

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Declaration of interest.

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Original Article

Does providing nutrition information at vending machines reduce calories per item sold?

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Abstract In 2010, the United States (US) enacted a restaurant menu labeling law. The law also applied to vending machine companies selling food. Research suggested that providing nutrition information on menus in restaurants might reduce the number of calories purchased. We tested the effect of providing nutrition information and 'healthy' designations to consumers where vending machines were located in college residence halls. We conducted our study at one university in Southeast US (October–November 2012). We randomly assigned 18 vending machines locations (residence halls) to an intervention or control group. For the intervention we posted nutrition information, interpretive signage, and sent a promotional email to residents of the hall. For the control group we did nothing. We tracked sales over 4 weeks before and 4 weeks after we introduced the intervention. Our intervention did not change what the residents bought. We recommend additional research about providing nutrition information where vending machines are located, including testing formats used to present information.
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Introduction

An increase in the number of meals and snacks purchased away from home (in restaurants, vending machines) often high in calories, saturated fat, and sugar, has been temporally associated with increased obesity in the United States (US) and elsewhere.[1] Wikipedia describes *vending machine* as 'a machine that dispenses items such as snacks, beverages,

alcohol, cigarettes, lottery tickets, cologne, consumer products … to customers automatically, after the customer inserts currency or credit into the machine' (see en.wikipedia.org/wiki/Vending_machine). Traditional vending machine snacks – chips, candy, and pastry – are associated with 20 per cent of the excess calories Americans consume,[2] and vending machines account for 5 per cent of away from home food and beverage sales.[2] Federal nutrition information in US legislation included in the 2010 Patient Protection and Affordable Care Act requires restaurants and large vending machine companies to make nutrition information available at the point of purchase, before purchase.[3] Nutrition information policies, such as this law, intend to limit or prevent diseases related to food consumption by reducing the calories Americans consume away from home.[1]

Evidence on nutrition information provided where vending machines are located is limited and contradictory.[4–6] Wilbur *et al* [5] found that sales of snacks with 140 or fewer calories increased when their proportion in a vending machine space increased, but labels calling attention to low calorie items had no effect. By contrast, Hoerr and Louden[4] found that when they increased the proportion of snacks that met certain nutrition criteria, overall vending machine sales declined. When they added special labels indicating the products nutrition content, total sales moved upward, but not to the original baseline. The increase in sales was for items they considered less nutritious. When Larson-Brown[7] added nutrition labels to snacks, the sales of snacks that had more protein, calcium, thiamine, vitamin C, and iron (nutrients believed, at the time, to be lacking in the American diet) increased, but so did sales of snacks that had lower amounts of these micronutrients. It is possible that the different years these studies were conducted could explain some of the apparently contradictory findings.

In two more recent studies,[6,8] French and colleagues found that labels by themselves had minimal or no impact on vending machine purchases, while price had a substantial impact when it was used to promote purchase of low fat snacks. They also found that a label *plus* promotion of low fat snacking increased sales of low fat snacks by about 8 per cent, whereas the nutrition label alone had no effect.

Although studies of vending machine sales suggest that a change in availability or price will lead buyers to choose lower fat or lower calorie snacks, the US federal legislation requires only that owners of vending machines provide nutrition information. It encourages rather than requires education and promotion. The legislation is intended to reduce

the calories purchased but research has not yet assessed the impact on calories purchased.

A separate body of research on nutrition information labels might guide choice of label type.[9–12] The US Institute of Medicine (IOM) recommended a standardized assessment of calories, saturated fat, added sugar, and sodium content be used to develop simple, *interpretive labels*.[12] An interpretive label guides the customer by showing whether or not the noted item (sugar or sodium) is considered to be high or low for a usual diet. The IOM notes that interpretive labels help consumers make choices that align with dietary guidance (a diet low in calories, saturated fat, sugar, and sodium).[12]

As the law requires that vending machine operators provide nutrition information but the evidence about its efficacy is unclear, we undertook an intervention study. We investigated whether a multicomponent nutrition intervention – nutrition information, interpretive label, and promotional health communication – would lead consumers to choose lower calorie snacks that contained less salt, sugar, and saturated fat. We tested how this multicomponent intervention would impact the behavior of college students.

Research suggests that college students are at risk for weight gain due to snacking and access to vending machines.[13,14] One study[14] showed that 76 per cent of college students reported snacking from vending machines at least once a day, and many college campuses have vending machines in academic buildings and residence halls.

We tested the effect of an intervention package that included nutritional information, item labels, and promotion/education. We focused on two separate outcomes measures: the average calories sold per snack, and the proportion of snacks that contained fewer calories and less saturated fat, sugar, and sodium than the usual snacks. (We refer to these as *Better Choice* snacks.)

We hypothesized that our intervention would decrease the average calories per snack item sold and increase in the proportion of *Better Choice* snacks sold.

Methods

Study sample

We studied vending machine sales from 21 machines located in 22 residence halls that housed 4128 students at a southeastern university in

the US. Each residence hall had only one snack vending machine, but one set of residence halls with a connecting hallway shared a vending machine. At the end of our study, we had gathered usable sales data from 18 machines. Sixty-seven per cent of students living in these 18 residence halls were female, average age 19. Fifty-seven per cent were in their first year, and 91 per cent were residents of North Carolina. All of the residence halls housed both men and women. (The university institutional review board reviewed and approved our study materials and procedures.)

Intervention

We affixed a poster board adjacent to each vending machine. It listed the *Nutrition Facts Panel* (as required on packaged food in the US) for each product in that vending machine. We also highlighted five products in the machine that met certain per package nutrition criteria (less than 200 calories, 2 g or less of saturated fat, 0 g of trans fat, 7 g or less of sugar, and less than 300 mg of sodium per package). We used these criteria (similar to those recommended by the IOM[12]) to define the snack as a *Better Choice* compared with other snacks within the machine. We placed a sticker with the letters BC inside the machine next to these snacks.

We placed the Nutrition Facts Panel labels, a BC symbol, and the criteria on the posters. In an email from the first author to all residents of the 'intervention' halls, we explained the *Better Choice* criteria. University and nutritionists in the community reviewed the *Better Choice* criteria and the email message for accuracy. We did not provide information or send the promotional email to residents in the control residence halls. We believe that sales reflect residents' behavior, as entry to the residence halls required a key or code.

Procedure

Before the collection of any sales data, the vendor stocked the machines and agreed to keep the items consistent and in the same slots throughout the 8-week study. For each machine, the vendor provided a sheet that listed each snack name and its location inside that machine. We assessed the nutrient content from the Nutrition Facts Panel for each item. Seventeen of the machines contained 35 snack items and 1 machine contained 40.

At the start of Week 5, we placed the nutrition posters in frames adjacent to the intervention machines. A note on the machine directed

the customers' attention to the poster. On the same day that we placed the poster and note, we sent the students in those residence halls an email communication about the *Better Choice* criteria. It also announced the availability of nutrition information near the machines. We collected data from 2 October to 27 November 2012. During this time, the campus closed for a few days to observe the Thanksgiving Holiday and sales were lower across all of the machines.

The vendor provided us with sales data on the number of each snack item sold per machine for the 8 continuous weeks. During routine service visits, the vendor representative using a handheld computerized device counted the number of each item sold. If the electronic device failed, the representative conducted and entered a manual count. This occurred three times during this study, once in a control machine and once each in two intervention machines.

During the 8-week experiment, we conducted one intervention fidelity check of a randomly selected group of 11 machines. We did this to confirm that the snack items continued to match the posters. Our fidelity check found that one snack item had changed and we revised that particular poster. Otherwise, the posters accurately reflected the machine content and nutrient disclosures throughout the first 6 weeks of the study. Changes in snack items occurred in all but one machine during the last 2 weeks of data collection (3–12 snacks changed within a given machine when the vendor chose to replace some of the snack items. However, we confirmed that the replacement items were of similar caloric content and the number of *Better Choice* items did not change.) The director of *Residence Life* (an adult staff person responsible for the buildings) confirmed that the posters remained intact and in place during the intervention phase.

At the end of the data collection period, we emailed a link inviting students to participate in a supplemental survey. We sent it to all students living in the original 22 residence halls. We used the survey to complete a second fidelity check: Did those sent the original email communication receive it? Did they see the information at the vending machine?

Research design

We used a 2 (time)×2 (condition) experimental design to test the effect of our intervention. We collected data throughout a 4-week baseline period (pre-intervention). There was no nutrition information given. We also collected data throughout a 4-week post-intervention period during

which we posted information and placed labels for the intervention machines. We used simple random sampling to assign the vending machines to intervention or control.

Analysis

From the sales data, we calculated the average calories per snack sold and the proportion of *Better Choice* snacks sold. For analysis, we chose summary measures (pre-intervention average for each machine and post-intervention average for each machine). Frison and Pocock consider them the best way to capture differences between groups before and after an intervention.[15] Summary measures were necessary because the vending machine data were not all collected weekly (see below). We analyzed the dependent variables separately, using Repeated Measures ANOVA; one within-subject factor (for example, pre- versus post-intervention) and one between-subject factor (intervention versus control). Our data met the assumptions of normality. We used Ver. 20 IBM/SPSS software for our analysis.[16]

When we met with the vendor to retrieve the sales data, we learned that not all machines were serviced weekly. We reviewed the available sales data and learned which machines had data for both the 4-week pre-intervention period and the 4-week post-intervention period. We excluded 3 machines that had only post-intervention data, leaving us with our sample of 18. The 18 machines had at least one set of sales data in the pre-intervention weeks, but 7 had missing data for Week 4. The next available data point – Week 5 – would include sales from one pre-intervention week. Where there were missing data for Week 4, the end of the pre-intervention period, but data for Week 5, sales in Week 5 for that machine would include products sold during both a pre-intervention and a post-intervention week. To prevent confounding in these particular cases, we used the next available data point in the post-intervention period and all those that followed (for example, Weeks 6–8).

Results

The residence halls with the final 18 machines (9 intervention, 9 control) housed 3850 students. More males (34.8 versus 30.4 per cent) and more first year students (63.1 versus 47.1 per cent) lived in the intervention halls, but the differences were not statistically significant. We included

sex and year of school as covariates in our models. We present the adjusted numbers.

The average calories (standard deviation (SD)) per snack sold across the 9 intervention machines for the 4 weeks of pre-intervention sales was 252 (24) and for the 4 weeks of post-intervention sales, the average was 251 (21). The average calories (SD) per snack sold across the 9 control machines at the pre-intervention time point was 217(55) and at post-intervention the average was 225(56) (Figure 1). Available snacks ranged in calories from 100 to 470 per package.

The per cent (and SD) of *Better Choice* snacks sold across the intervention machines at pre-intervention was 6.17 per cent (2.72 per cent) and at post-intervention, it was 6.92 per cent (1.14 per cent). The per cent of *Better Choice* snacks sold across the control machines at pre-intervention was 8.24 per cent (3.56) and at post-intervention, the per cent was 6.60 per cent (2.66) (Figure 2). The changes from pre-intervention to post-intervention were not statistically significant ($P>0.05$).

We did not find a significant interaction between intervention period and intervention versus control for the average number of calories sold per snack ($F_{(1,14)}=0.51$, $P=0.49$, $\eta p^2=0.04$). Nor did we find a significant interaction between intervention period and intervention and control for the proportion of *Better Choice* snacks sold ($F_{(1,14)}=1.64$, $P=0.22$, $\eta p^2=0.11$). See Table 1 for tests of effects.

Forty-five per cent of the students responding to our post-study survey lived in the intervention residence halls. Of these 670 students, only 16 per cent recalled getting the email health communication ($n=106$). Of them only 63 per cent ($n=67$) said that they had read the email. Thus only 10 per cent who responded to the survey had read the email sent to them.

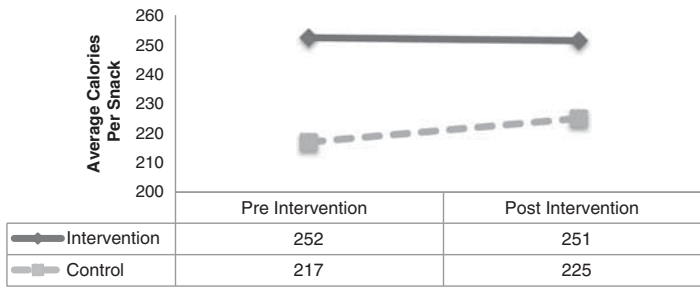
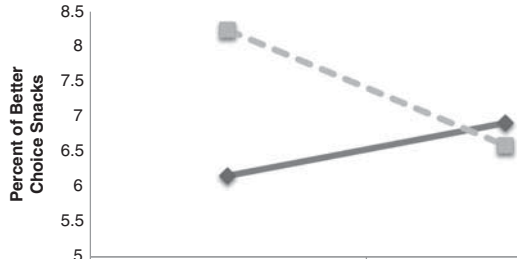


Figure 1: Average calories per snack sold at pre- and post-intervention.
$P>0.05$.



	Pre Intervention	Post Intervention
Intervention	6.17	6.92
Control	8.24	6.60

Figure 2: Percent of *Better Choice* snacks sold at pre- and post-intervention. $P>0.05$.

Table 1: *F*-tests for main effects and interactions

	$F_{(1,14)}$	P	ηp^{2a}
Average calories per snack			
Time	0.211	0.65	0.02
Condition	1.93	0.19	0.12
Time×condition	0.505	0.49	0.04
Proportion of Better Choice			
Time	2.12	0.17	0.13
Condition	0.568	0.46	0.04
Time×condition	1.64	0.22	0.11

[a]Partial η^2 is a measure of effect size.

Fifty-six per cent of students living in the intervention halls ($n=364$) said that they noticed the on-site nutrition information, but 60 per cent ($n=192$) of them said it did not influence their purchasing decisions. (The *n* for each question varied slightly due to missing responses.)

Discussion

We did not find support for our hypothesis that a multicomponent intervention including nutrition information, an interpretive label, and a health communication/promotional message would reduce average calories per snack item purchased and an increase in the purchase of snacks with a *Better Choice* label.

Our intervention combined three strategies that had shown promise in previous research (that is, information, label, promotion).[4–8] We tailored

our promotional component and delivered it directly, following the suggestion of French *et al* to use promotion outside of the vending setting with media (for example, through email).[8] We also used an interpretive label, as suggested by the IOM.[12] We were not, however, allowed to place the label directly on the product package.

There are several possible explanations for our findings. Our implementation of the intervention may have been compromised, as the three components we used, might be effective strategies for changing behavior if delivered at full dose and with fidelity. Survey responses from students in the intervention halls suggest that our promotional message did not work as intended. Very few students recalled receiving the message and an even smaller percentage reported reading it. In future studies, it might help to use recurring promotions, delivered multimodally (for example, email, university Web pages, on site posters, social media, text messages).

We attached the BC (*Better Choice*) symbol to the machine, where it may have been overlooked. Ideally, this interpretive label would be on the snack pack itself, where it is more likely to be seen and taken into consideration. Lastly, it is possible that there was a cross over effect. If students in the control halls were exposed to the intervention, they might have changed their purchasing behavior.

Personal characteristics of the residents may have influenced purchasing behavior. We randomly assigned machines with the intent of creating two groups that would differ only in exposure to the intervention. We controlled for potential differences in year of school and sex, but the groups may have differed in a characteristic that we did not measure, such as including more public health or nutrition students.

Changes in the snacks in machines during the last 2 weeks of the study period could also have influenced our results. Ideally, the machines would have been the same in every respect for the entire 8 weeks except information introduced at Week 5. Possibly the new snacks introduced at Week 7 were more or less popular than those they replaced, influencing sales. Our follow-up analysis using the average of Weeks 5 and 6 as the post-measure did not produce different results.

Lastly, the three components used in this study may change behavior and a longer study with a larger sample might have detected the effect.

College students are more likely to consider taste than health (for example, calorie content) when choosing snacks[13] and females are more likely to choose lower calorie items than males[17]. The effects of providing nutrition labels at the vending machine site would be small

and moderated by sex. The intervention might work in a different population and setting, such as employees at a worksite. Of five previous studies[4–8] that attempted to change behavior at vending machines, only two[4,7] were conducted at universities and none assessed behavior in residence halls.

Policy Questions

Is there (i) a more effective way to display information than is currently proposed by law or, (ii) would a non-information strategy work better to change behavior for this population? Most college-aged students are age 18–29, the group recently found to be the least likely to use nutrition information as it is currently available.[18]

First, could a different format for providing the nutrition information be more effective? Traditional vending machine snacks come in packages similar to those in grocery stores. Comprehensive studies on packaged foods conducted in the US,[12] the United Kingdom[19] and Australia[20] found that consumers respond better to simple, interpretive labels.[21] The Multiple Traffic Light (MTL) label placed on the front of the package is well known and effective.[22] Each selected nutrient (for example, sugar, salt) is highlighted in a circle that is red, green, or amber; similar to the order of a traffic light. Front of Pack systems (that include a total calories declaration) might allow a vending machine customer to scan all product nutrition information rapidly, something our study was not able to accomplish. The MLT label has a second attribute. It can trigger a health appraisal, as the color red is often associated with danger.[23] As we do not know of any studies that have examined the traffic light approach with college students and snacks from vending machines, we believe it is a fruitful area for future research. This type of nutrition label is not popular with the food industry. If the food industry changes its behavior, as suggested by Robbins and Nestle,[24] and reformulates its snacks to be lower in calories, saturated fats, and sugar, the application of traffic light labels may highlight their efforts. In reformulating snacks and using interpretive labels, the food industry becomes part of the solution.

Second, we acknowledge that non-information strategies might work better to change behavior at vending machines, especially in combination with interpretive labels. Studies, including university field studies, that manipulated the availability of lower calorie snacks or the price of more nutritious snacks or both, in addition to placing a nutrition label

on them, led to an increase as intended in the sale of targeted snacks.[5,6] To us this seems too controlling as national policy, but this type of restriction may be feasible at the state, local, or organizational level, if not preempted by the national law. In fact, in worksites, schools, and recreation centers, these strategies are recommended and used more often than information disclosures (see, for example, the County of San Diego Parks and Recreation Healthy Vending Policy, King County Healthy Vending Guidelines). Here again, the food industry can benefit from reformulating their snacks. When organizations adopt 'healthier' policies, they promote reformulation because criteria exist for sales in machines; organizational policy incentivizes manufacturers to change so they may sell their products in the organizations' vending machines.

In conclusion, our small, exploratory study did not find that providing and promoting nutrition information led to a significant decrease in calories per snack purchased or a significant increase in the purchase of snacks with a *Better Choice* label. It is possible that replication using careful fidelity checks, revision of the label and promotion components, and separate analysis for males and females would have confirmed our hypothesis. It is also possible that an alternative label would be a more effective information approach or that the information approach in general is inferior to less popular, but more effective pricing and availability strategies. As the law currently requires the disclosure of nutrition information, we suggest that future research also assess the use of MLT labels. In addition, we encourage food manufacturers to reformulate their products so vending machine snacks will have a better nutrient profile.

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Original article

Food Sold in School Vending Machines Is Associated With Overall Student Dietary Intake

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See Editorial p. 3

A B S T R A C T

Purpose: To examine the association between food sold in school vending machines and the dietary behaviors of students.
Methods: The 2005–2006 U.S. Health Behavior in School-aged Children survey was administered to 6th to 10th graders and school administrators. Dietary intake in students was estimated with a brief food frequency measure. School administrators completed questions regarding food sold in vending machines. For each food intake behavior, a multilevel regression analysis modeled students (level 1) nested within schools (level 2), with the corresponding food sold in vending machines as the main predictor. Control variables included gender, grade, family affluence, and school poverty index. Analyses were conducted separately for 6th to 8th and 9th–10th grades.
Results: In all, 83% of the schools (152 schools; 5,930 students) had vending machines that primarily sold food of minimal nutritional values (soft drinks, chips, and sweets). In younger grades, availability of fruit and/or vegetables and chocolate and/or sweets was positively related to the corresponding food intake, with vending machine content and school poverty index providing an explanation for 70.6% of between-school variation in fruit and/or vegetable consumption and 71.7% in sweets consumption. Among the older grades, there was no significant effect of food available in vending machines on reported consumption of those food.
Conclusion: Vending machines are widely available in public schools in the United States. In younger grades, school vending machines were either positively or negatively related to the diets of the students, depending on what was sold in them. Schools are in a powerful position to influence the diets of children; therefore, attention to the food sold at school is necessary to try to improve their diets.

Food choices and eating habits of children are affected by a variety of individual and environmental factors [1]. The school environment is one important influence that plays a significant role in teaching and modeling eating behaviors to children [2]. With demonstrated inadequacies in the diets of children [3–5] and the rising rates of overweight children in the United States [6], the school food environment is a potentially modifiable factor that has received attention in recent years [7].

Students have a wide variety of eating options and opportunities at school, and food and beverages consumed during the school day contribute toward a significant portion of the daily nutrient intake of children [2]. The three main sources of food and beverages consumed in schools include federally-reimbursable U.S. Department of Agriculture (USDA) school nutrition programs (the National School Lunch Program [NSLP] and the School Breakfast

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Program [SBP]); food and beverages sold in a la carte lines, snack bars, school stores, vending machines, or during school activities (e.g., fundraisers, classroom parties); and food brought from home [7]. Food and beverages sold in schools outside of the NSLP or SBP are referred to as "competitive food." In contrast to NSLP or SBP meals, competitive food is not required to follow any federal nutrition guidelines and are frequently food of Minimal Nutritional Value (FMNV), defined as "those that provide low amounts per portion of specified nutrients (e.g., soft drinks, candy, chips)" [8]. Competitive food is widely available in middle and high schools in the United States; vending machines are the most common provider of these food, with 82% of middle schools and 97% of high schools having vendin machines [9]. There have been recent measures to try to improve the school food environment. In the Child Nutrition and Woman, Infants, and Children (WIC) Reauthorization Act of 2004 (Public Law 108–265), the U.S. Congress established a new requirement that all school districts with a federally-funded school meals program develop and implement wellness policies that address nutrition and physical activity by the start of the 2006–2007 school year. However, it was left to the schools to determine specifically what would be addressed in their wellness policies and how they would implement those policies.

Although it is well-documented that most schools in the United States sell FMNV [9], few studies have examined the association between food sold in schools and student outcomes. In the Teens Eating for Energy and Nutrition at School study comprising middle-school students from Minnesota, a la carte food availability was negatively associated with fruit and fruit and/or vegetable consumption and positively associated with total and saturated fat intake [10]. In addition, having vending machines in schools was negatively associated with fruit consumption. Another study comprising 8th graders (n = 3,088) from the Teens Eating for Energy and Nutrition at School study examined the relationship between body mass index and school-wide food practices (e.g., allowing snacks in the hallways, using food as incentives) [11]. For every additional unhealthy food practice that was permitted in the school, body mass index of the students increased by 10%. Recently, a study of 9,151 students from 64 middle schools in Washington state found that sugar-sweetened beverage exposure at school significantly predicted total sugar-sweetened beverage exposure consumption (β = .157, $p < .001$) [12]. Although these studies provide important data, they were each conducted in a single geographic location and included children in a limited age range. More recent data on the availability and consumption of competitive food in 287 public schools (grades one through 12) in the United States from the third School Nutrition Dietary Assessment Study [13] indicated that competitive food was available in 73% of elementary schools, 97% of middle schools, and 100% of high schools. In addition, 40% of children consumed one or more competitive food daily and consumption was highest in high school students. Although the third School Nutrition Dietary Assessment Study provides important descriptive national data on the school food environment, to date, no national study has examined the relationship of competitive food available in schools to school-level variation in the overall dietary intake in students.

The aim of the current study was to examine the association between food sold in school vending machines and the dietary intake in students. Data were collected as part of the 2005–2006 U.S. Health Behavior in School-aged Children (HBSC) survey. It was hypothesized that food and beverages available in school vending machines would positively relate to the corresponding food intake in students.

Methods

Study population

HBSC is a cross-national research study involving 41 countries [14]. The study conducted in the United States was designed to provide a national probability sample of students in grades six through 10, with an over-sampling of minorities (Hispanics and African Americans) large enough to provide accurate population estimates [15]. A sample of public, religious, and other private schools was derived from the Quality Education Data's list of schools in the United States. The sample design is a two-stage cluster of classes stratified by grade within nine Census regions of the United States.

Student surveys were conducted in school classrooms during the school year of 2005–2006. Surveys regarding school policies were completed by school administrators; 33% were completed by the principal, 27% by an assistant or vice principal, 8% by another administrator, and 32% by school staff designated by the principal. Passive or active consent was obtained from parents and students according to school district policy, and participant responses were kept anonymous. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development approved the study.

Student measures

Measures were obtained from standard self-completion questionnaires, which included questions on personal and social resources, health-related behaviors, health outcomes, and demographics.

Dietary intake. As part of a brief food frequency questionnaire (FFQ), participants were asked how many times a week they usually consumed fruit, vegetables, sweets (chocolates and candy), soft drinks, and chips. Consumption of french fries was asked as a separate question and was not included in the vegetable category. The response options for the items were coded as 1–7 for "never," "less than once a week," "once a week," "2–4 days a week," "5–6 days a week," "once a day, every day" and "every day, more than once." This FFQ was previously validated in a sample of Belgian children participating in the HBSC study [16]. In that study, test–retest reliability of the FFQ was conducted and consumption frequencies were compared with a 24-hour food behavior checklist (FBC) and a 7-day food diary. Reliability (weighted kappa values between test and retest) ranged from .43 to .70, percentage agreement from 37% to 87%, and Spearman correlations from .52 to .82. Relative validity, comparison of the FBC with the percentage of respondents who should have consumed the food items on a random day, computed from the FFQ, showed good agreement between the FFQ and the FBC for most items. Results from that validation study indicated that the HBSC FFQ had sufficient reliability and validity to rank intake rates of the children on the basis of food items. To correspond with the school administrator survey, in which the variable of fruit and/or vegetables offered by vending machine was measured as a single item, the mean fruit and vegeta-

ble intake for each student was calculated and used as a single outcome variable.

Sociodemographic characteristics. Students were questioned about their gender (male, female), grade, race and/or ethnicity (Hispanic/Latino, non Hispanic black, nonHispanic white, others), and family affluence. The Family Affluence Scale (FAS) was the sum of four items assessing number of family-owned cars, vacations in the past year, home computers, and whether the respondent had his or her own bedroom. Previous research has indicated that the scale has good content validity and external reliability and may be a more reliable affluence indicator as compared with parent education or occupation, when reviewed by adolescents [17,18]. Scores ranged from 4 to 13, with higher value indicating higher level of family affluence.

School measures

Vending machines. School administrators were asked whether students could purchase snacks or beverages from a school vending machine. In cases where they answered "yes," they were asked whether students could buy the following items from the vending machines: (1) fruit and/or vegetables, (2) chocolates and/or other candies, (3) soft drinks, and (4) non–low-fat salty snacks. Each vending machine variable was coded as a binary variable (yes, no).

School poverty index. The school poverty index was determined by the percentage of students who fell below the 2005 federal government poverty guidelines [19].

Statistical analyses

A separate model was used for consumption of each food, with the corresponding food provided by school vending machine as the main predictor. Control variables included in the models were gender, grade, and family affluence (student-level), as well as school poverty index (school-level). Because of the hierarchical structure of the data with students (level 1) nested within schools (level 2), multilevel regression models were applied to account for the possible intraschool correlation. To estimate how well the school-level variables (i.e., vending machine and poverty variables) provided explanations for between-school variation in student dietary behaviors, the intraclass correlation coefficient (ICC) was calculated and compared with the ICC in a reduced model (without these school-level variables). A decline in the ICC indicates that the between-school differences in student dietary behavior have been reduced by the inclusion of the two school-level explanatory variables.

Analyses were conducted separately for younger (6–8) and older (9 and 10) grades because previous studies reported differences in vending machine availability among grades [13]. Descriptive statistics were conducted using SAS (version 9) survey procedures to take into account the sampling design and weights [20]. Multilevel analyses were conducted with Mplus (version 5) to account for other complex survey features, including stratification and weighting [21]. This statistical approach has the advantage of being able to adjust for all three complex survey data features (stratification, clustering, and weighting) in the HBSC study to obtain unbiased estimates and their corresponding standard errors.

Results

Data were collected from students in 222 public schools and five private schools. In all, 85% (n = 9,016) of the eligible students participated in the HBSC study. The current analyses were limited to only the public schools (n = 222 schools; 8,743 students) because poverty index information was not available for the private schools. A total of 30 schools (13.5%) were excluded because they did not complete the administrative survey. Of the 192 schools with completed surveys, nine did not provide information regarding vending machine or school poverty (4.7%). From the remaining 183 schools, 107 of the 7,255 students were missing data on gender, grade, or FAS (1.5%). Of the 183 schools, 152 (83.1%) had vending machines (5,930 students). The percentages of schools with vending machines were 69.8%, 81.1%, 80.9%, 98.2%, and 98.3% for grades six through 10, respectively. The difference between the prevalence of vending machines between schools with older grades (9 and 10) and younger grades (6–8) was statistically significant (76.0% vs. 98.3%, χ^2 statistics = 14.5, $p < .001$). Subsequent analyses were restricted to the 152 schools with vending machines (5,930 students).

Table 1 reports the student and school characteristics for younger and older grades separately. food and beverages sold in vending machines were frequently FMNV (soft drinks, 76.8% for younger grades and 93.2% for older grades; chips, 56.8% for younger grades and 79.9% for older grades; sweets, 44.2% for younger grades and 78.0% for older grades) and less commonly healthy food (fruit and/or vegetables, 36.8% for younger grades and 47.5% for older grades).

Table 2 presents data on descriptive statistics of the dietary behavior of students, by gender, grade, race, and vending machine availability. For example, a mean of 4.66 for fruit and/or vegetables intake among younger students represented a response between 2–4 days a week and 5–6 days a week.

Multilevel regression analyses

Estimates of regression coefficients in the multilevel regression analyses are presented in Table 3.

Student-level variables. In the younger age group, there was a significant gender difference in sweet consumption; females reported consuming sweets more frequently as compared with males ($\beta = .369$, $p < .001$). FAS also had a significant effect on fruit and/or vegetable intake, with students reporting higher FAS consuming more fruit and/or vegetables ($\beta = .096$, $p < .05$).

In the older age group, females reported less frequent soft drink consumption as compared with males ($\beta = -.419$, $p < .001$). Tenth graders ate chips less frequently when compared with ninth graders ($\beta = -.407$, $p < .001$). Higher FAS was associated with more frequent fruit and/or vegetable consumption ($\beta = .056$, $p < .05$) and less frequent soft drink consumption ($\beta = -.109$, $p < .001$).

School-level variables

School poverty. In both younger and older grades, school poverty was negatively associated with fruit and/or vegetable consumption, and positively related to consumption of soft drinks and chips. In the younger grades, school poverty was also positively related to intake of sweets.

Table 1
Characteristics of students and public schools with vending machines from the 2005–2006 Health Behavior in School-aged Children Survey

Category/variable	Younger grades (6–8)			Older grades (9–10)		
	n	Percent	Mean (*SE*)	n	Percent	Mean (*SE*)
Student-level						
Total number of students	3,692			2,238		
Gender						
Male	1,761	48.7%		1,117	49.8%	
Female	1,931	51.3%		1,121	50.2%	
Grade						
Grade 6	1,299	28.9%				
Grade 7	1,215	37.9%				
Grade 8	1,178	33.2%				
Grade 9				1,079	51.0%	
Grade 10				1,159	49.0%	
Race						
White	1,566	42.2%		1,113	46.2%	
African	783	15.8%		474	19.4%	
Hispanic	848	25.7%		447	24.5%	
Other	470	16.3%		201	9.9%	
FAS			9.78 (.14)			9.78 (.13)
School-level						
Total number of schools	95[a]			59[a]		
School poverty			40.1 (23.4)			36.2 (23.4)
Vending machine						
Fruit	35	36.8%		28	47.5%	
Sweet	42	44.2%		46	78.0%	
Soft drinks	73	76.8%		55	93.2%	
Chips	54	56.8%		47	79.9%	

[a] Two schools were selected for both younger grades and older grades in the 2005–2006 HBSC survey.

School vending machine. In the younger grades, availability of food in school vending machines had a significant influence on consumption of both fruit and/or vegetables ($\beta = .243$, $p < .05$) and sweets ($\beta = .344$, $p < .01$), that is, students from schools that sold fruit and/or vegetables in the vending machines consumed more fruit and/or vegetables when compared with those from schools in which vending machines did not offer fruit and/or vegetables. Similarly, students from schools selling sweets in the vending machines consumed more sweets as compared with those from schools in which sweets were not offered in the vending machines. There was no significant effect of food available in vending machines on reported consumption of those food in students in older grades.

Intraclass correlation coefficients

The amount of within-school and between-school variation in each of the four student dietary behaviors and ICCs are reported in Table 4. To examine how well the school-level variables provided explanations for between-school variations of student dietary behaviors, ICCs were compared with those in the models without between-school variables (the reduced model in Table 4). The percentage of decrease in ICC was also reported for each dietary behavior. In the younger grades, the percentages of between-school variation explained by vending machine and school poverty variables were 71%, 72%, 31%, and 28% for student dietary intake of fruit and/or vegetables, sweets, soft drinks, and chips, respectively. In the older grades, the two school-level variables provided explanation for 89% of between-school variation in fruit and/or vegetables, 42% in soft drinks, and 25% in chips, but effectively none of the between-school variance for sweets.

Discussion

Vending machines are widely available in public schools throughout the United States and primarily sell FMNV, including soft drinks, chips, and sweets [7,13,22,23]. Among the public schools that participated in the 2005–2006 HBSC survey, 83% had vending machines and soft drinks were the most common item found in them. Schools with older grades were more likely to have vending machines as compared with those with younger grades, which is consistent with previous surveys [9,23].

In this study, the relationship of food sold in school vending machines to the overall consumption of those food differed by grade. In younger grades, students from schools that sold fruit and/or vegetables in vending machines consumed more fruit and/or vegetables when compared with those from schools in which vending machines did not offer fruit and/or vegetables. Similarly, students from schools that sold sweets in the vending machines consumed more sweets when compared with those from schools in which sweets were not offered in the vending machines. In older grades, there was no significant effect of food available in vending machines on reported consumption of those food. This finding was not anticipated. Among the older grades, the great majority of schools had vending machines selling these items. It is not known how the small number of schools in which these food were not sold in vending machines may have differed in ways not measured by this study. The difference in effect by grade may be related to differences in parental control of food choices, which is most likely to be greater for younger children. Therefore, when younger students have access to different food in school vending machines it gives them an opportunity to make their own decisions about what they consume. Another possible explanation for this finding is that FMNV might be more readily

Table 2
Descriptive statistics of the dietary behavior of students (n = 5,930)

Categories	Fruit and/or vegetables		Sweets		Soft drinks		Chips	
	M[a]	*SE*[b]	*M*	*SE*	*M*	*SE*	*M*	*SE*
Grades 6–8 (n = 3,692)								
Total	4.66	.06	4.37	.05	4.38	.07	4.26	.07
Gender								
Male	4.67	.06	4.21	.07	4.50	.08	4.28	.07
Female	4.66	.08	4.52	.07	4.26	.09	4.24	.09
Grade								
Grade 6	4.77	.13	4.27	.10	4.28	.16	4.31	.12
Grade 7	4.67	.08	4.39	.07	4.35	.08	4.22	.10
Grade 8	4.56	.06	4.44	.09	4.50	.12	4.26	.11
Race								
White	4.84	.07	4.27	.06	4.19	.11	3.92	.06
African	4.51	.06	4.92	.10	4.88	.10	5.10	.10
Hispanic	4.44	.08	4.13	.08	4.36	.07	4.27	.09
Other	4.71	.13	4.53	.10	4.46	.12	4.35	.12
Vending machine								
No	4.57	.07	4.30	.05	4.27	.15	4.08	.07
Yes	4.84	.08	4.47	.10	4.42	.08	4.39	.06
Grades 9–10 (n = 2,238)								
Total	4.41	.05	4.47	.06	4.42	.08	4.00	.09
Gender								
Male	4.37	.06	4.27	.09	4.60	.09	4.02	.09
Female	4.44	.06	4.67	.11	4.25	.10	3.98	.12
Grade								
Grade 9	4.34	.06	4.56	.08	4.47	.08	4.17	.09
Grade 10	4.48	.07	4.37	.08	4.38	.11	3.82	.12
Race								
White	4.57	.05	4.41	.08	4.18	.11	3.62	.07
African	4.15	.07	5.17	.07	5.06	.11	4.97	.15
Hispanic	4.09	.09	4.12	.10	4.59	.09	4.08	.11
Other	4.95	4.95	4.19	4.19	3.88	3.88	3.64	3.64
Vending machine								
No	4.35	.08	4.47	.12	4.24	.24	4.13	.25
Yes	4.45	.07	4.47	.08	4.44	.08	3.95	.11

[a] Scales of response categories are as follows: 1 = never, 2 = less than once a week, 3 = once a week, 4 = 2–4 days a week, 5 = 5–6 days a week, 6 = once daily, and 7 = more than once daily.
[b] SE = standard error of the mean: Analyses of the complex survey data gave the standard error of the mean.

available to the older youth in other venues at school (e.g., school stores, snack bars, and a la carte sales), and therefore intake is less likely to be associated with vending machine availability. Also, teenagers typically have greater access to food outside of school, such as purchases made in convenience stores or fast food restaurants; therefore, vending machines may contribute toward only a smaller proportion of their daily intake as compared with that of younger children.

This study provides a unique contribution, using multilevel analysis of a nationally representative sample to determine whether food available in school vending machines explained school-level variation in dietary behaviors. Previous studies have examined school vending machines in single geographic locations or have examined student-level means and proportions in larger samples without controlling for or modeling the sampling design. In the current study, when combined with an indicator of school poverty status, the types of food offered in vending machines explained 71%, 72%, 31%, and 28% of between-school variation in the dietary intake of fruit and/or vegetables, sweets, soft drinks, and chips, respectively, of younger students. These re-

Table 3
Estimates of regression coefficients in the multilevel regression analyses

Predictors	Younger group (grade 6–8) (n = 3,692)				Older group (grade 9–10) (n = 2,238)			
	Fruit and/or vegetables	Sweets	Soft drinks	Chips	Fruit and/or vegetables	Sweets	Soft drinks	Chips
n	3,631	3,613	3,621	3,604	2,207	2,207	2,207	2,212
Level 1								
Female	.152	.369***	−.152	.145	−.081	.194	−.419***	.055
Grade	−.088	.153	.089	.074	.009	−.253	−.050	−.407***
FAS	.096*	.010	−.025	.014	.056*	−.037	−.109***	−.090
Level 2								
Vending machine	.243*	.344**	.109	.215	.072	−.218	.098	−.169
School poverty	−.011***	.009***	.012***	.011*	−.008***	.003	.011***	.015*

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4
Within- and between-school variances and ICCs in the full and reduced models

Predictors	Younger group (grade 6–8) (n = 3,692)				Older group (grade 9–10) (n = 2,238)			
	Fruit and/or vegetables	Sweets	Soft drinks	Chips	Fruit and/or vegetables	Sweets	Soft drinks	Chips
Full model								
Within	2.405	3.218	3.503	3.014	2.173	3.091	3.962	2.987
Between	.048	.042	.206	.196	.004	.102	.147	.341
ICC	.020	.013	.056	.061	.002	.032	.036	.102
Reduced model[a]								
Within	2.428	3.256	3.516	3.025	2.192	3.131	4.032	3.055
Between	.178	.156	.311	.281	.041	.101	.267	.481
ICC	.068	.046	.081	.085	.018	.031	.062	.136
Full model								
Decrease in ICC	70.6%	71.7%	30.9%	28.2%	88.9%	−3.2%	41.9%	25.0%

[a] The full model includes school-level variables (i.e., vending machine and poverty variables); the reduced model does not.

sults demonstrated that the contents of school vending machines relate to diets either positively or negatively, depending on what is sold in them. Therefore, it is important that schools address the quality of food sold in vending machines in their wellness policies. The Centers for Disease Control and Prevention's School Health Policies and Programs study, which is conducted every 6 years, reported that between the 2000 and 2006 survey years (before and after the wellness policy requirement) there was an increase in the percentage of states and districts that required for schools to be prohibited from offering "junk food" in vending machines (from 8.0% to 32.0% among states and from 4.1% to 29.8% among districts) [23]. Our study was conducted before the 2006 requirement to implement school wellness policies so it would be interesting to examine more recent HBSC data to determine whether improvements have been made in what food is typically sold by schools in their vending machines and, if so, how this has affected the dietary intake in students, as this was not examined in the School Health Policies and Programs study. It is particularly important to focus on the quality of food sold in vending machines in less affluent schools because school poverty was negatively associated with fruit and/or vegetable consumption, and positively related to consumption of soft drinks and chips in all grades (and positively related to sweets in younger grades). It would also be interesting to determine whether improving the quality of the food available in school vending machines has any effect on school performance because a recent case study reported an association between school performance indicators with the implementation of a program aimed at improving the school food environment [24].

The study methods have some limitations. A key limitation is that the measure of dietary intake used was a brief FFQ, necessitated by the nature of the HBSC study, which measures a broad spectrum of constructs in a single self-report questionnaire. It is known that people tend to misreport food intake with underreporting being the greatest among females and those who are overweight [25]. However, brief FFQ's have shown some degree of usefulness in ranking samples and testing associations with other variables, even when the estimate of individual dietary intake is imprecise [26]. Also, the HBSC survey is cross-sectional, which precludes drawing any conclusions regarding causality.

In summary, data from this study as well as other studies have demonstrated that the school food environments in schools in the United States need improvements. Schools are in a powerful position to influence the dietary intake in children during a substantial portion of their day; therefore, attention to what food they sell is necessary in trying to improve the diets of children.

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Impact of Individual and Worksite Environmental Factors on Water and Sugar-Sweetened Beverage Consumption Among Overweight Employees

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PEER REVIEWED

Abstract

Introduction
The worksite environment may influence employees' dietary behaviors. Consumption of water and sugar-sweetened beverages (SSBs) affect weight management; however, little research has evaluated the influence of worksite factors on beverage consumption. Our purpose was to determine whether individual and worksite factors are associated with water and SSB intake among overweight and obese employees.

Methods
Data were collected as part of baseline assessments for a worksite-based, weight-management intervention trial. Height and weight of participants (N = 1,482; 74% female; mean age = 47 y [standard deviation (SD) = 11y]; mean weight = 208 lbs [SD = 46 lbs]) were assessed, and participants completed a validated beverage intake questionnaire. Environmental characteristics of worksites (N = 28) were audited. A qualitative comparative analysis (QCA) was used to identify worksite conditions that may support healthier beverage intake patterns.

Results
Most participants were white (75% of sample) with at least some college education or a college degree (approximately 82% of sample). Mean water and SSB intake were 27 fl oz (SD = 18 fl oz) and 17 fl oz (SD = 18 fl oz), respectively; SSB intake (191 kcal [SD = 218 kcal]) exceeded the recommended discretionary energy intake. Statistical models did not identify any significant predictors of water intake. Female sex and increasing level of education and household income were associated with lower SSB intake; baseline body weight and greater number of worksite water coolers and vending machines were associated with higher SSB intake. The QCA identified worksite type (ie, not manual labor) as a condition necessary for healthier beverage consumption; a worksite break policy of 2 or more per day may lead to unhealthy beverage consumption.

Lower SSB consumption was noted among older participants, female participants, and among participants with higher education and income levels.

Conclusion
Workplace factors influence beverage consumption among overweight employees. Limiting vending machine availability and implementing policies that promote weight management may improve employee health.

Introduction

Obesity is a major public health concern in the United States (1), and effective, long-term weight-management intervention strategies are needed. Attention has focused on identifying dietary factors that may promote successful weight management. Americans of all age groups are consuming more daily total energy, and a significant portion of the increase in total energy intake is derived from energy-dense snacks and energy-containing beverages (2).

Consumption of sugar-sweetened beverages (SSBs), including soft drinks, fruit drinks, and energy drinks, is associated with unhealthy weight status (3). Most (ie, >75%) people in the United States aged 2 years or older consume more than 2 servings of SSBs each day (4). Excessive sugar consumption has been associated with adverse health outcomes such as greater energy intake, higher body weight, and lower intake of essential nutrients, and the American Heart Association has recommended minimizing SSB intake to half of one's discretionary calorie allowance (5). In contrast, water consumption is associated with healthier dietary patterns and a lower overall energy intake (approximately 200 kcal less per day) (6). Increasing daily water consumption facilitates weight loss and weight-loss maintenance among some populations (7,8); replacing 2 servings (approximately 200 kcal/d) of energy-containing beverages per day with noncaloric beverages (ie, water or diet soda) leads to a 2% to 2.5% weight loss in 6 months (9). Therefore, replacement of SSBs with water may be an effective weight management strategy.

To improve public health, it may be necessary to address interactions between individual and environmental influences on energy balance (10). Environmental approaches to improving health behaviors could include settings such as schools, health care systems, and communities. In addition to reaching large numbers of adults (11), worksite-based interventions may augment social support and facilitate adherence to weight-management programs (12). Financial benefits of worksite health-promotion programs include reductions in sick leave, health plan costs, workers' compensation, and disability insurance costs (13). The worksite food environment can affect food choice (12,14); however, this research has largely focused on increasing and reducing costs of healthy foods and on reducing portion sizes of foods and beverages (14–16). Pricing strategies appear to be more effective for promoting healthier snack than beverage purchases (14–16), although proportional pricing (ie, keeping price per gram consistent across sizes) may reduce large-sized soft drink purchases among overweight and obese employees (15). It remains uncertain how individual and environmental factors influence beverage consumption behaviors (17), particularly in settings such as worksites (18).

Our purpose was to determine whether individual and worksite factors are associated with water and SSB consumption among overweight and obese employees. We performed a cross-sectional analysis of data from a worksite -based, weight-management intervention trial. In addition to demographic variables and habitual beverage consumption, assessments included worksite environmental characteristics and a qualitative comparative analysis (QCA) to identify worksite conditions that may support healthier beverage intake patterns.

Methods

Individual characteristics

Data were collected as part of baseline assessments conducted at 28 small (<300 employees) to medium-sized (300–599 employees) worksites enrolled in a weight-management intervention trial (reach and representativeness reported elsewhere) (19). Baseline data collection for the larger trial began in February 2008 and was completed in May of 2009. Most worksites (approximately 60%) were recruited from rural and urban locations in southwestern Virginia. Other worksites were located in Richmond, Virginia; Norfolk, Virginia; south-central Virginia; and Denver, Colorado. Participants reported demographic factors (ie, sex, age, race, education and income level, occupation), and educational level was categorized as no high school, some high school/high school diploma, some college, college graduate, or postgraduate education. Total annual household income was categorized as less than $29,000, $30,000 to $49,999, $50,000 to $99,999 and $100,000 or more. Height and weight were measured using a WB-110A scale (Tanita Corporation, Tokyo, Japan) and were assessed without shoes, to calculate body mass index (BMI, weight in kilograms divided by the height in meters squared). Individuals were eligible for participation if they were overweight (BMI 25.0 –29.9 kg/m^2) or obese (BMI ≥30 kg/m^2) (20).

Habitual beverage intake was assessed in eligible individuals using the Beverage Intake Questionnaire (BEVQ), which is a rapid (<5 minutes), valid, and reliable quantitative self-administered tool, with a reading grade level of 6.9 (21). The BEVQ assesses total beverage consumption (in fluid ounces and in calories) and 19 specific beverage categories including water through reported consumption frequency and volume over the past month. SSB consumption was calculated on the basis of reported consumption of the following beverages: sweetened juice beverage/drink, soft drinks, regular sweetened tea, coffee with cream and/or sugar, mixed alcoholic drinks, meal replacement shakes/protein drinks, and energy drinks.

Worksite characteristics

Environmental factors were evaluated using an observational method assessment by trained evaluators, the Checklist of Health Promotion Environments at Worksites (CHEW) (22). The CHEW was used to assess the following worksite environmental characteristics: number of soft drink vending machines, number of regular soda slots, number of water coolers, and number of water fountains. Additional variables that were not explicitly tied to water or SSBs but that could reflect worksite norms for healthful living (ie, health promotion signage) were also assessed using the CHEW and included in a QCA.

Statistical analysis

Water and SSB consumption was evaluated for individual factors (baseline weight, BMI, sex, race, education, and income level) and worksite environmental factors (number of vending machines, number of regular soda slots, number of water coolers, number of water fountains, worksite size). Statistical analyses were performed using Stata 12 (StataCorp LP, College Station, Texas). Analyses included descriptive statistics, *t* tests for group differences according to worksite size, multiple linear regression models accounting for data clustering in worksites, multilevel linear mixed models, and Heckman Sample Selection models. Quantile regression models were used to examine heterogeneous impact across outcome distributions.

Because the beverage and water consumption information was available only for those employees who participated in the weight-loss programs, testing and correcting for potential self-selection bias were done to improve external validity inferences relative to any significant predictors for beverage consumption. The testing and correcting were done using the Heckman Sample Selection methods that allow for correlation between individual decisions about participating in the weight-loss program and the individual's beverage consumption behaviors. To test for the existence of selection bias, χ^2 tests on the correlation component of the maximum likelihood function were used. No selection bias was detected for SSB consumption, but bias was detected for water consumption. As a result, our tests associated with water consumption account for this bias. We also explored 2 unique ways to account for the clustering of our data (ie, individual data clustered within worksite). First, we used a multiple linear regression model whose standard errors were adjusted to account for worksite clustering. Second, we used 2-level, hierarchical, mixed linear regression models with cluster-robust standard errors to improve the confidence in our findings. All models include individual-level demographic variables (ie, age, sex, race, education, income, and baseline weight) and worksite level characteristics (ie, the numbers of water coolers, water fountains, vending machines, and regular soda slots and the total number of employees at the worksite). A *P* value of less than .05 was considered significant.

Qualitative comparative analysis

We also conducted an exploratory QCA (23) to determine whether specific environmental characteristics were associated with worksites with the most healthful beverage intake among employees when compared with those with the least healthful intake. QCA can provide preliminary information on the conditions that are necessary (ie, patterns present in all successful cases but also in some unsuccessful cases) and sufficient (ie, patterns present in only successful cases) to achieve a given outcome (24). To complete the QCA, worksites were rank-ordered from highest to lowest on water and SSB intake, using the mean water and SSB consumption reported by employees. Worksites with the combination of highest water consumption (above the mean for all 28 worksites; >28 fl oz) and lowest SSB caloric intake (below the mean for all 28 worksites; <191 kcal) were identified (n = 4; mean daily water intake = 32 fl oz, mean daily SSB caloric intake = 151 kcal) and compared with the worksites with the combination of lowest water consumption and highest SSB caloric intake (n = 5; mean daily water intake = 25 fl oz, mean SSB caloric intake = 243 kcal). A list of 10 worksite conditions that theoretically could influence employees' beverage consumption habits, which were not captured in the quantitative modeling analysis, was developed for the QCA (Table 1). Data were collected from the worksite or through observation for size, type of labor, break policy, shift work, signage, and on-site canteen or exercise facilities. Data were collected from employees on average length of a workday and the presence of worksite policies that support weight loss. Conditions present were designated by a "1" and not present designated by a "0."

Results

Of the initial sample enrolled (N = 1,780), only people with complete data on beverage intake were used in this analysis. Because of missing information on regular soda slots for 2 worksites, our final sample sizes were n = 1,482 for the beverage consumption model and n = 1,476 for the water consumption model. Most participants were female (74%) and white (75%), with some college education or a college degree (82%) (Table 2). Mean age was 47 years (standard deviation [SD] = 11 y [range, 20–86 y]), and the mean weight of participants was 208 lbs [SD = 46 lbs]. A significant portion of the participants (37%) reported an annual household income below $50,000. Mean SSB and water intake were approximately 17 fl oz and 28 fl oz, respectively (Table 2).

Fifteen worksites were classified as small (<300 employees) and 11 were classified as medium-sized (300–599 employees). Demographic differences, except for age and water intake, between small and medium-sized worksites were noted (Table 2). We observed substantial variation in the worksite beverage environment; the number of water coolers ranged from 0 to 24, the number of water fountains ranged from 0 to 32, the number of vending machines ranged from 0 to 25, and the total number of regular soda slots ranged from 0 to 289.

Results from the regression analysis are presented in Table 3. The detailed results focus on the beverage model and the first stage of the Heckman model (ie, the program participation equation), which are not reported in the table but can be obtained from the primary author (B. M. D.). The likelihood ratio test of selection bias was significant (*P* = .003). When the models were corrected for this bias, none of the individual and worksite characteristics were associated with water consumption.

The likelihood ratio test of self-selection indicated no self-selection bias in the beverage consumption equation (P = .77); therefore, we used standard multiple linear regression models (Table 3). SSB Model 1 is the linear ordinary least squares regression model with cluster-robust standard errors. The SSB Model 2 is the multilevel hierarchical model with cluster-robust standard errors. Both models showed consistent findings related to predictors of SSB consumption.

Lower SSB consumption was noted among older participants, female participants, and participants with higher education and income levels. Participants with postcollege education consumed approximately 4 fl oz less SSBs per day than those with less than a college education, and those with household income at or above $50,000 consumed approximately 3 fl oz less SSB than those with income of $49,999 or less. Furthermore, higher baseline weight was associated with a higher beverage intake.

In the worksite beverage environment, given the same number of employees (ie, holding the worksite size constant), greater water cooler and vending machine availability were associated with higher SSB consumption. A follow-up analysis was conducted to determine whether the percentage of total beverage vending machine slots devoted to regular sodas (% of regular soda slots) was associated with SSB intake, instead of the total number of regular soda slots. The percentage of regular soda slots variable was not a significant independent predictor of SSB intake in the linear or multilevel models (β = 5.47, P = .11 and .10, respectively). Overall findings were unchanged, except that vending machine number was no longer a significant predictor of SSB intake with inclusion of the percentage of regular soda slots variable in the models.

The only condition identified as necessary for "healthier beverage" consumption (Table 1) was that the worksite type is not manual labor (ie, packing, shipping, maintenance, and assembly); having a break policy of 2 or more per day may lead to unhealthier beverage consumption. Perceived worksite weight management policies were present in 3 of the 3 "healthier beverage" worksites and in only 1 of the 5 least healthy beverage worksites. No patterns for sufficient conditions were identified in the QCA.

Discussion

We did not identify any individual or worksite factors in our sample of overweight and obese employees that independently predicted water consumption. However, both individual and worksite factors were independently associated with SSB consumption. A lower intake of SSB was noted among older participants, those with higher levels of education and income, and women, whereas baseline body weight and a greater number of worksite water coolers and vending machines were positively associated with SSB intake. The finding related to water coolers and SSB intake was surprising. Certain worksites may have been more likely to have water coolers as a result of a warmer work environment, which is more likely to be present in manual labor sites; manual labor worksites are more likely to have employees who have lower educational and income levels and are, therefore, more likely to consume SSBs. This unexpected finding may be consistent with our QCA results, which identified worksite type (ie, not manual labor) as a condition necessary for healthier beverage consumption, and those of Levy et al (25) who reported that employees in job categories requiring less education (eg, service workers) were more likely to purchase unhealthy foods such as sugary beverages. Similar to findings reported by Escoto et al (26), findings from our QCA did not identify longer workdays or workweeks (ie, > 40 hours/week) as being associated with unhealthier beverage consumption among employees. However, frequent work breaks may promote unhealthy beverage consumption patterns (ie, less water and more SSBs), and having a worksite policy that employees reported as supporting their weight-management efforts may lead to healthier beverage consumption patterns. Thus, workplace factors do appear to influence beverage consumption among overweight employees.

Diet quality is generally associated with socioeconomic standing (27). Adults with less education are less likely to consume healthful diets and more likely to be overweight or obese, and those with low income and education are more likely to consume diets high in sugars (28). However, obesity prevention and treatment research has extended beyond the individual level to include environmental factors that influence weight-related behaviors (15). For example, the rise in food availability and accessibility coupled with an increase in sedentariness appears to be a prime driver of the obesity epidemic (10,17). Our findings could be of interest to those developing worksite-based interventions targeting improvements in beverage consumption patterns and reductions in body weight and possibly health plan costs. Additional strategies for improving beverage intake behaviors consistent with the US dietary guidelines (replace sugary drinks with water) and American Heart Association guidelines (limit added sugar intake) could include removing price benefits for larger sizes (ie, proportional pricing) in worksite vending machines and cafeterias and increasing availability and reducing prices of healthier alternatives to SSBs. Vermeer et al (15) reported that overweight or obese consumers were less likely to choose large soft drink sizes when proportional pricing strategies were used; 67% of overweight or obese individuals chose a medium-sized soft drink and 0% chose a large-sized soft drink with proportional pricing, compared with 33% who selected large-sized soft drinks when value size pricing was used. Reducing the cost of healthy beverages (defined by these authors as beverages with less than 50 kcal) and snack items by 10% or more and increasing availability of healthy items by 50% in worksite vending machines led to increases in sales of healthy items, although results appeared more effective for snack than beverage purchases (14). Our findings

suggest that reducing access to vending machines could encourage healthier drink choices. These findings also suggest that the health effects of worksite environmental and policy changes warrant further evaluation — specifically, the role of water cooler and vending machine availability and the frequency of work breaks.

Strengths of this investigation include a large sample size, detailed information on habitual beverage consumption using a validated tool, and evaluation of both individual factors and the worksite environment. We acknowledge several limitations. First, the population consisted of overweight and obese adults; therefore, beverage patterns were not compared with those of people with normal weight status and may not apply to the general population. Furthermore, the population predominantly consisted of white women, which also limits the generalizability of our results. Studies of nationally representative samples have identified demographic factors associated with water consumption, specifically, age and income level (29) and weight status (30). Thus, the lack of association of individual factors with water consumption could be attributed to our population being homogenous with respect to weight status (ie, primarily those who were overweight or obese), age, and income level. Information on caffeine's role in beverage selection was not evaluated, and habitual beverage consumption was self-reported. Finally, the cross-sectional nature of this investigation precludes us from drawing conclusions about causality.

This investigation represents the first extensive evaluation of the workplace environment and its influence on water and SSB consumption. Multicomponent interventions that target changes aimed at individual and environmental levels may be necessary to control overweight and obesity among adults in worksite settings, as well as in other settings such as schools or communities. As an example, Muckelbauer et al (31) conducted an intervention focused on promoting and providing drinking water to elementary school children. The intervention included educational messages delivered in the classroom by teachers and increasing water fountain availability in schools and was effective in decreasing the risk of overweight and in increasing water consumption during a school year. Furthermore, this intervention focused on schoolchildren in "socially deprived" urban areas of Germany. Process evaluation and a 19-month follow-up assessment determined the intervention to be sustainable and feasible (32). Although policy changes will not entirely solve the obesity epidemic, multicomponent interventions to improve beverage consumption behaviors and health outcomes that target individuals and their environment appear warranted. Future intervention trials are warranted to determine whether reducing SSB consumption and increasing water consumption could be an effective dietary strategy for worksite-based weight management interventions and whether individual and environmental intervention features mediate or moderate intervention effectiveness.

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Tables

Table 1. Summary Truth Table: Cross-Case Comparison of Worksite Conditions Theoretically Related to Healthier Beverage Consumption in Worksites Enrolled in a Weight-Management Intervention Trial[a]

Return

	Site Identification								
	Healthiest Worksites				Least Healthy Worksites				
Worksite Condition	**15**	**1**	**22**	**3**	**10**	**18**	**23**	**6**	**25**
Beverage intake: highest water/lowest SSB	1	1	1	1	0	0	0	0	0
1. Small worksite size[b]	0	0	1	1	0	1	1	1	0
2. Type of work: manual labor	0	0	0	0	1	1	1	1	0
3. Break policy: ≥2/d	0	1	1	0	1	1	1	1	1
4. Shift work	0	0	1	1	1	0	1	0	0
5. Workday exceeds 8 hours	0	0	0	0	0	0	0	0	0
6. Health promotion signage present	0	1	1	1	1	1	1	1	1
7. Diet signage present	0	0	0	1	1	1	0	1	1
8. On-site exercise facilities	0	0	1	0	0	0	0	1	1
9. On-site canteen	1	0	0	1	0	0	0	0	1
10. Weight management policy[c]	1	0	1	1	0	0	0	1	0

[a] Conditions present are designated by a "1," and conditions not present are designated by a "0."
[b] Worksites with fewer than 300 employees were considered small.
[c] Fifty percent or more of employees report that their employer has policies that support their weight-management efforts.

Table 2. Participant and Worksite Descriptive Characteristics, 28 Small to Medium-Sized Worksites Enrolled in a Weight-Management Intervention Trial

Return

	Full Sample	Small Worksites[a]	Medium-Sized Worksites[b]	
Variable	**Mean (Standard Deviation)**			***P* Value[c]**
Age, y	46.6 (10.9)	46.6 (11.0)	46.6 (10.9)	.94
Female, %	74.2 (43.8)	68.4 (46.5)	81.2 (39.1)	<.001
White, %	75.0 (43.3)	73.2 (44.3)	77.3 (41.9)	.07
High school or less education, %	17.9 (38.4)	12.5 (33.1)	24.6 (43.1)	<.001

Variable	Full Sample	Small Worksites[a]	Medium-Sized Worksites[b]	*P* Value[c]
	Mean (Standard Deviation)			
Annual household income ≥$50,000, %	63.2 (48.2)	59.9 (49.0)	67.3 (47.0)	.004
Body weight, lbs	207.9 (46.5)	212.8 (48.1)	201.9 (43.7)	<.001
Body mass index, kg/m^2	33.2 (6.5)	33.6 (6.7)	32.7 (6.3)	<.001
No. of water coolers	3.8 (6.1)	3.0 (6.5)	4.7 (5.6)	<.001
No. of water fountains	7.8 (7.4)	5.1 (4.5)	11.1 (8.8)	<.001
No. of vending machines	6.7 (4.9)	5.6 (2.3)	8.1 (6.7)	<.001
No. of regular soda slots	43.5 (62.0)	33.4 (26.9)	55.9 (85.9)	<.001
No. of employees	307.7 (107.6)	234.9 (42.5)	396.9 (95.4)	<.001
SSB intake, fl oz	16.8 (18.0)	17.8 (18.7)	15.5 (17.1)	.01
Water intake, fl oz	27.5 (17.9)	28.1 (18.2)	26.7 (17.5)	.13

Abbreviation: SSB, sugar-sweetened beverage.
[a] Small worksites have fewer than 300 employees.
[b] Medium sized worksites have 300 to 599 employees.
[c] *P* values calculated using *t* test.

Table 3. Multiple Regression Models: Sugar-Sweetened Beverage (SSB) and Water Intake of Employees Participating in a Worksite-Based Weight-Management Intervention Trial

Return

Characteristic	SSB Model 1: Linear OLS Model		SSB Model 2: Multilevel Model		Water Model 3: Heckman Sample Selection Model	
	β (Robust SE)	*P* Value	β (Robust SE)	*P* Value	β (SE)	*P* Value
Age	−0.13 (0.05)	.01	−0.13 (0.05)	.006	−0.07 (0.06)	.24
Female	−3.66 (1.42)	.01	−3.66 (1.41)	.01	0.85 (1.53)	.58
White	−0.32 (0.88)	.72	−0.32 (0.88)	.72	0.08 (1.65)	.96
Education[a]	−4.01 (1.15)	.002	−4.01 (1.15)	<.001	−0.002 (1.70)	>.99
High income[b]	−2.99 (1.18)	.02	−2.99 (1.17)	.01	2.38 (1.53)	.12
Baseline weight	.03 (0.01)	.01	0.03 (0.01)	.007	0.01 (0.01)	.36
No. of water coolers	0.25 (0.06)	<.001	0.25 (0.05)	<.001	−0.01 (0.10)	.91
No. of water fountains	−0.05 (0.07)	.48	−0.05 (0.07)	.47	−0.13 (0.10)	.19
No. of vending machines	0.43 (0.19)	.03	0.43 (0.22)	.02	−0.12 (0.31)	.69
No. of regular soda slots	−0.01 (0.01)	.32	−0.01 (0.01)	.31	0.02 (0.02)	.30
No. of total employees	−0.01 (0.01)	.21	−0.01 (0.01)	.19	−0.01 (0.01)	.43
No. of observations	1,482		1,482		1,476[c]	
LR test of Model 2 vs Model 1	χ^2 (1) = 0.00; *P* value = >.99				NA	
LR test of selection bias	χ^2 (1) = 0.09; *P* value = .768				χ^2 (1) = 8.98; *P* value = .003	

Abbreviations: SE, standard error; OLS, ordinary least squares; LR, likelihood ratio; NA, not applicable.
[a] = 1 if education is at or beyond college level.
[b] = 1 if income is at or beyond $50,000.
[c] Observations differ from the SSB models because 6 individuals did not report water intake. Total observations of stage 1 of the Heckman selection model = 4,666.

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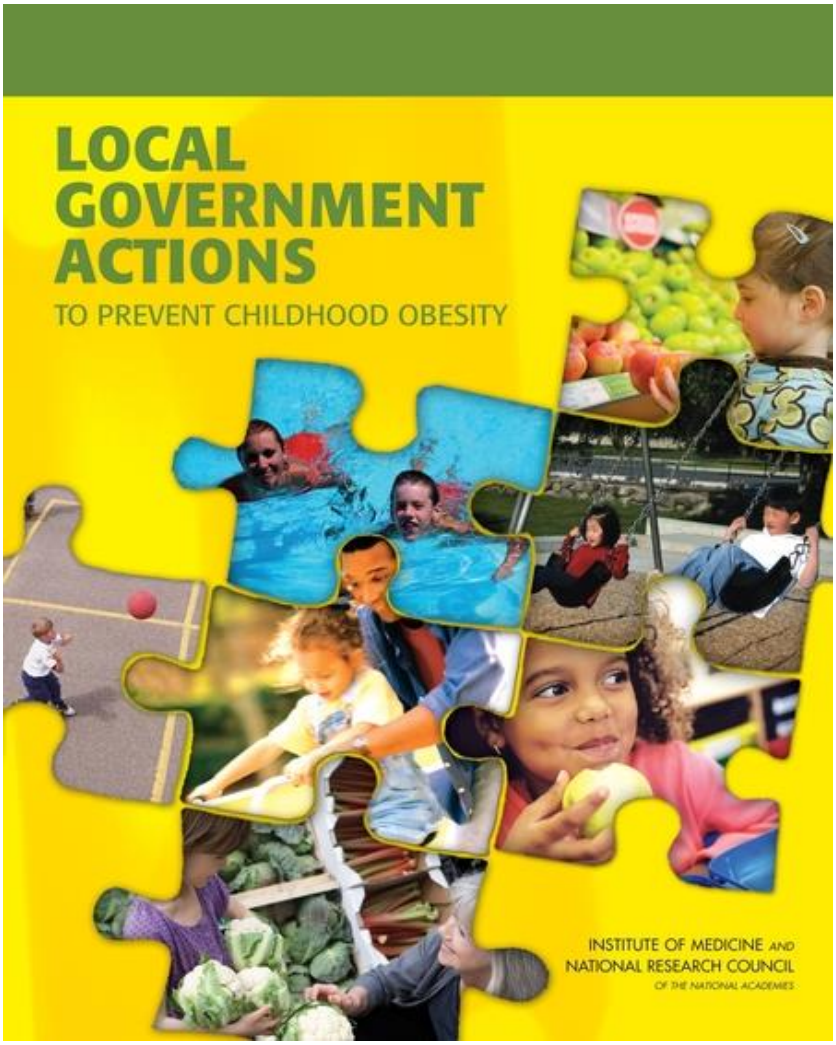

Strategy 4: Public Programs and Worksites

Ensure that publicly run entities such as after-school programs, child care facilities, recreation centers, and local government worksites implement policies and practices to promote healthy foods and beverages and reduce or eliminate the availability of calorie-dense, nutrient-poor foods.

Action Steps

- **Mandate and implement strong nutrition standards for foods and beverages available in government-run or regulated after-school programs, recreation centers, parks, and child care facilities (which includes limiting access to calorie-dense, nutrient-poor foods).**
- Ensure that local government agencies that operate cafeterias and vending options have strong nutrition standards in place wherever foods and beverages are sold or available.
- Provide incentives or subsidies to government-run or -regulated programs and localities that provide healthy foods at competitive prices and limit calorie-dense, nutrient-poor foods (e.g., after-school programs that provide fruits or vegetables every day, and eliminate calorie-dense, nutrient-poor foods in vending machines or as part of the program).

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ORIGINAL RESEARCH

Lessons Learned From a Healthful Vending Pilot Program in Delaware State Agency Buildings, 2011–2012

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PEER REVIEWED

Abstract

Introduction
Changes in food availability in worksites can result in changes in eating behavior and weight status. Nemours Health and Prevention Services, in conjunction with partners in Delaware, conducted a 6-month pilot program to assess the feasibility and impact of requiring that 75% of the items in vending machines in 3 state agency buildings have healthful items.

Methods
We collected process evaluation data from October 2011 through April 2012 by taking weekly photographs of all machines to record the number of healthful items available. Outcomes were measured through sales reports designed to enumerate changes in number and type of items sold and overall profit from each building.

Results
We found challenges in fully implementing the 75% goal. In one of the 3 buildings, all machines were compliant within 7 weeks; in another, full compliance did not occur until week 19. Despite these challenges, the number of items sold in each machine was comparable to numbers from the previous year. Total profits from each building varied across the 3 sites and during the pilot. One building had a 51% increase in profits in January 2012 compared with profits averaged for January 2011 and January 2010. In contrast, monthly profit at another building fluctuated from an increase of 6% to a loss of 30%.

Conclusion
Overall, our results suggest that collaborative efforts can result in a feasible intervention with little negative influence on profits.

Introduction

In Delaware and throughout the United States, rates of overweight and obesity are high and are continuing to rise. According to the Centers for Disease Control and Prevention, 63.4% of Delaware's adult population in 2010 was overweight (body mass index [BMI] ≥25.0) and 28.0% was obese (BMI ≥30.0) (1). Overweight and obesity are significant risk factors for numerous life-threatening chronic conditions, including diabetes, cardiovascular disease, and several types of cancer (2). Poor nutrition (ie, consuming excessive amounts of foods and beverages high in calories, sugar, and fat) and insufficient amounts of physical activity contribute to overweight and obesity (3).

Worksite-based interventions designed to improve employee health are a possible method to address obesity (4,5). People consume a significant amount of their daily total calories while at work; one study suggested that adults consume 20% of calories from sugar-sweetened beverages at work (6). The nutritional quality of foods and beverages sold in vending machines historically has been poor. Items commonly sold in conventional vending machines are generally high in calories, sugar, and saturated fat, thus contributing to poor eating habits among many adults (7,8).

Recognizing vending machines as an important venue for promoting nutritional choices that are more healthful than those typically offered, Nemours Health and Prevention Services (NHPS), the health promotion and disease prevention arm of Nemours pediatric health system, partnered with the Delaware Division of Public Health and the state licensing agency responsible for the oversight and implementation of the Delaware Division of the Visually Impaired Business Enterprise Program. This partnership developed and implemented a 6-month healthful food and beverage vending program at 3 pilot sites in Delaware.

The goal of the pilot program was to increase the availability of healthful vended items, maximize consumer choice for these items, and educate consumers on nutrition. The objective of this evaluation was to answer the following questions:

1. Has the program improved the nutritional quality of the food and beverage items available to employees and visitors at pilot sites?
2. To what extent have employees and visitors purchased more healthful items?
3. Have changes in the nutritional quality of vended foods and beverages affected the revenue from machines at pilot sites?

Methods

Development of the pilot program

The 3 pilot sites were chosen to represent the diversity of Delaware: one building in a northern urban location, one building in a central location on the legislative mall in the state's capitol city, and one building in a southern rural location. The northern building housed one food machine and 4 beverage machines, all of which were included in the program; the central building had one food and 2 beverage machines, but one of the beverage machines was not included in the program; and the southern building had 2 food and 2 beverage machines, but only the food machines were included. The Division of Public Health and the Business Enterprise Program are part of Delaware's Department of Health and Social Services, and the pilot sites are Department of Health and Social Services office buildings.

The pilot program began with an assessment of employee interest and preferences for food and beverage items. After surveying employees at the 3 sites and conducting on-site taste tests of potential new items, the selection of foods and beverages was adjusted in favor of more healthful alternatives.

The pilot program ran for 28 weeks, from October 26, 2011 through April 24, 2012. The program required that at least 75% of the items in all vending machines at the pilot sites meet NHPS' "Go" or "Slow" food guidelines and that no more than 25% would be "Whoa" items. The 75% goal was set by the director of the Division of Public Health, and contracts were put into place between parties that reflected this goal and the overall goals of the project. The Go, Slow, and Whoa nutrition guidelines (9) were developed by NHPS in 2010 on the basis of current science (eg, Dietary Guidelines for Americans, recommendations by the Institute of Medicine for schools). Go or Slow items must contain no more than 200 total calories, 35% of calories from fat, 10% of calories from saturated fat, and 200 mg of sodium. Nuts and seeds are exempt from these requirements because of their fiber, vitamin E, and superior fat content; however, these items must meet the criteria for sodium and calories. Additionally, Go and Slow foods must contain no trans fats, and candy is not allowed. All foods that do not meet these criteria are classified as Whoa foods. Go beverages consist of water without added flavoring or additives; Slow beverages consist of 100% fruit juices or contain no more than 10 total calories per 8-oz serving (eg, diet sodas and teas, flavored water).

Selection of more healthful items was also based on a subset of the Canteen Vending Services' Balanced Choice Options that meet NHPS guidelines (10). New items included baked chips, 100-calorie packs of popular cookies and crackers, trail mix, energy bars, diet soda and diet tea, and flavored water. Similar options were offered at each site, although some adjustments were made in response to preferences expressed via taste tests or surveys. To encourage employees to purchase the more healthful items, these items were marked with a special symbol and promoted with signage on or around the machines. Additional marketing of the pilot program and the new items and nutrition information was shared in a series of 5 e-mail messages to staff at each site and in a newsletter for all state employees.

Because of concerns over revenue loss, a monetary safeguard agreement was established between the Business Enterprise Program and the Division of Public Health. The Division of Public Health agreed to reimburse vendors for any monthly losses incurred during the pilot program; a loss was defined as an amount less than the average gross revenue for the same month in the previous 2 years.

Evaluation of the pilot program

One key assumption of the evaluation was that 2 markets of employees were potentially affected by this program: those who had been purchasing the less healthful items from the vending machines and those who had not been purchasing any items from the machines. The program was designed to change the buying behavior (via changes in access to more healthful items) of the former market and encourage the latter market to use the machines.

The evaluation used existing data (eg, monthly sales reports) wherever possible to reduce burden on participants. Additional data were collected via photographic documentation of the vending machines. These data were supplemented with online surveys and interviews of stakeholders, including but not limited to drivers, operators, and employees at the pilot sites; this evaluation does not include the findings of the interviews or the surveys.

To objectively document the contents of the vending machines during the study period, each machine was photographed weekly by a trained building employee. The photographs were then sent to NHPS and converted into planograms, diagrams that provide details on placement of products in retail environments. The planograms were used to determine whether machines complied with the 75% goal, assess the number and type of sold-out items, and confirm pricing. If an item was out of stock or the machine did not meet the 75% goal, the study team contacted the Business Enterprise Program to remedy the problem. Data were recorded in a spreadsheet and tracked during the 28-week study period.

Monthly sales reports included information about each item sold in each machine and the amount of revenue generated. We also had access to data on items sold during the same 28-week period in the previous year and access to data on monthly profits made by each building during the study period and during the previous 2 years.

Analysis

We calculated the proportion of Go and Slow items in each machine to determine compliance on a weekly basis at each site. We also analyzed the number and proportion of Go, Slow, and Whoa items in each machine according to the following 5 periods: period 3, November 23 through December 27; period 4, December 28 through January 24; period 5, January 25 through February 21; period 6, February 22 through March 27; and Period 7, March 28 through April 24. We compared the total number of items sold in each period with the number of items sold during the same period in the previous year. Although the beverage machines in the southern location were exempt from the contract with the Business Enterprise Program, the vendors were permitted to stock the machines with the more healthful options, and we included these machines in our analysis.

We calculated the monthly profit at each site for 6 months beginning with November 2011. We compared these monthly profits with the profits made in the same months in the 2 years before the pilot; for example, November 2011 was compared with November 2010 and November 2009. Because of the limited availability of data, we could not compare the profits of the pilot sites with the profits of sites not participating in the pilot program; these data could have explained any changes in sales that were not caused by the pilot (eg, normal fluctuations in sales of vending items, the economy).

Results

Has the program improved the nutritional quality of the foods and beverages available to employees and visitors at the pilot sites?

In several buildings, we faced challenges in bringing the machines into compliance with the 75% goal and in continuing to achieve this goal throughout the pilot. At the beginning of the pilot program at the northern site, only 28% of the food items and 49% of the beverage items were Go or Slow items. By the third week, 75% of the items in the food machine were more healthful items, but the beverage machines were not fully compliant until after week 13 (Figure 1).

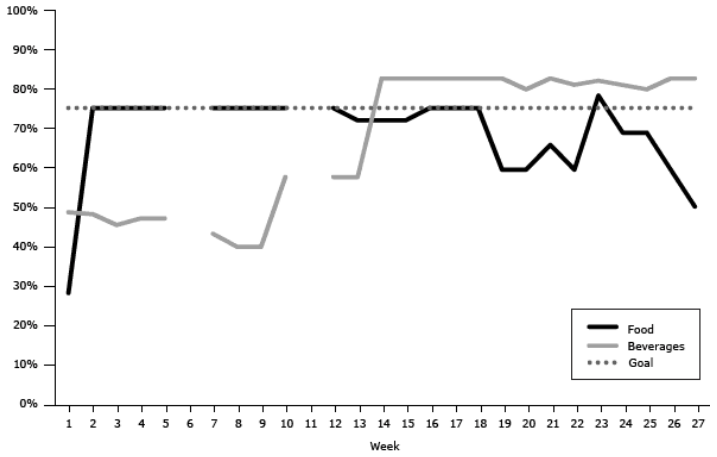

Figure 1. Percentage of Go and Slow foods and beverages available in vending machines by week, northern pilot program site, Delaware state agency buildings, 2011–2012. The values for beverages are averages for the 4 beverage machines. Breaks in data indicate weeks for which data were unavailable.

At the central location, at the beginning of the pilot program, only 25% of the food items and 12% of the beverage items were Go or Slow items. By the third week, 75% of the items in the food machine were more healthful items, but the beverage machine was not fully compliant until week 19.

At the beginning of the pilot program, only 11% of the food items and 50% of the beverage items were Go or Slow items (Figure 2) at the southern site. By the third week, 75% of items in the food machines were more healthful items, but the beverage machines were not fully compliant until after week 6.

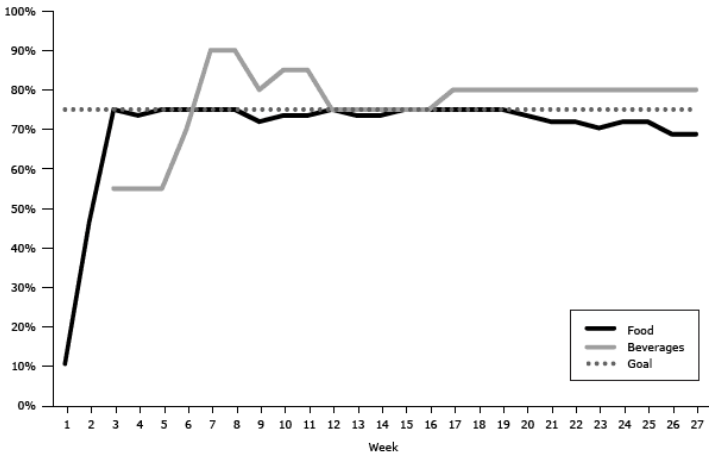

Figure 2. Percentage of Go and Slow foods and beverages available in vending machines by week, southern pilot program site, Delaware state agency buildings, 2011–2012. The values for beverages are averages for all vending machines. Breaks in data indicate weeks for which data were unavailable.

To what extent have employees and visitors purchased more healthful items?

In general, we found increases in the total number of items purchased during the pilot program compared with the previous year. For example, at the northern site, the number of items purchased in periods 5 through 7 (n = 434) (Table 1) was higher than the number of items purchased during the same periods in the previous year (n = 305). We found a 16% increase in purchases from 2011 to 2012 for period 5, a 68% increase for period 6, and a 43% increase for period 7.

At the northern site, although the number of items purchased varied during the pilot program, the proportion of purchases of Slow foods increased from 56% in period 3 to 72% in period 7 (Table 1). At the central and southern sites, purchases were fairly evenly split between Slow foods and Whoa foods. In one machine in the southern location, the best-seller (according to number of items purchased) for 3 of the 5 periods was a Slow food.

At the northern site, the proportion of purchases of Go and Slow beverages increased during the pilot period (Table 1). At the central site, we found initial increases in the proportion of more healthful beverages purchased, but by the end of the pilot program, that proportion decreased to 52% (from 63% during the first month).

Have changes in the nutritional quality of vended foods and beverages affected the revenue from machines in pilot sites?

Among the 3 sites, gains (compared with the guarantees) in monthly profits ranged from 4% ($27.68) at the southern site in March 2012 to 51% ($356.58) at the same site in January 2012. Losses ranged from −4% (−$16.74) at the central site in December 2011 to −36% (−$170.99) at the same site in January 2012 (Table 2). Overall, profits at the southern site were greater than the guarantees for 5 of 6 months of the pilot.

Discussion

Our experience of piloting healthful vending in Delaware resulted in numerous successes, lessons learned, and areas of opportunity. The program was conducted as a collaboration of public health interests (the Department of Health and Social Services and NHPS) and entrepreneurial business interests (the vending machine operators). To effectively execute the pilot program, it was critical to understand that each stakeholder was uniquely motivated. Likewise, each stakeholder group needed to have their concerns heard, validated, and woven into the negotiations on pilot parameters. Addressing these unique motivations and divergent perspectives was challenging but essential throughout the process — even getting the pilot off the ground. The Director of Public Health played a key role and provided guidance, vision, and insight on a weekly basis; was debriefed on process details throughout the pilot; and was able to maintain relationships with all stakeholders. Additionally, the director firmly determined the level of compliance to be 75%. During planning discussions, revenue concerns were addressed and business cases for success were shared. At the conclusion of negotiations, vending operators held firm in their request to receive a subsidy for potential losses. This subsidy requirement illustrates the balance and compromise needed for a collaborative initiative to move forward.

The processes of the vending industry, from supply chain to distribution, worked in our favor at the southern site. These machines easily complied with the 75% goal, and few issues arose during the pilot program in sustaining the 75% goal. Often, at the other sites, the food supply company made unapproved product substitutions, incorrectly stocked the machines according to the healthy and pre-approved planogram, or no longer carried a particular item in the warehouse. Not all parties in distribution channels were aware of, or agreed to, pilot goals. The substitution of incorrect products required additional project management oversight and ultimately accounted for a majority of machine noncompliance.

We did not find substantial reductions in the number of units sold overall from the previous year; sales reductions were a concern of the vendors during the planning process. At the southern site, vending machine profits were 51% higher in January 2012 than profits averaged at that site for January 2011 and January 2010, and profits there were above average levels for 5 of 6 months of the pilot program. However, under the agreement between the Business Enterprise Program and the Division of Public Health, the vending operators were compensated a total of $1,383 during the pilot for overall revenue loss and product spoilage caused by the shorter shelf life of more healthful items.

Additional research is needed to understand customer preferences. Although general customer preference and taste surveys were conducted before the pilot program, additional research could determine whether new customers were enticed to use the vending machines or whether repeat and existing customers were purchasing more healthful items than before. Insight into customer preferences can help in the tailoring of healthful product offerings, thereby theoretically motivating the customer to use the machine, make healthful food purchases, and increase sales revenue for the machine's owner. Our pilot program engaged customers through new, more healthful product taste testing, online taste preferences surveys, and a series of e-mails featuring a more healthful product and health facts (eg, "Sugary beverages like regular soda, sweetened teas, and energy drinks provide little or no nutritional benefit and lots of empty calories. Replacing one regular soda that contains 10 teaspoons of sugar a day with water can save you 150 calories or 15 pounds per year!").

To support and sustain a component of healthy behavior change, contract terms must be in place to support healthy vending. Although our pilot program successfully operated outside of the regular contract negotiation process, we recommend that healthful vending specifications be included in a formal contract with a food service provider so that projects can be sustained. Many models exist around the nation, and Nemours Healthy Vending and Concessions Guidelines can also serve as a tool in defining healthful specifications for any food service operation (9,11). In 2012, these guidelines were used to inform the US General Services Administration for revision of food and beverage standards for contracted cafeteria, concession, and vending services on federal property (12).

Our evaluation has several limitations. We did not have data on vending machines in buildings that did not participate in the pilot, so it is possible that changes in profits from the machines in the pilot program could have occurred had the pilot program not been implemented. Furthermore, research suggests that comprehensive workplace health promotion efforts hold the most promise for significant change in healthful eating and physical activity (13); this program included only one component. If additional workplace efforts related to healthful eating had been implemented at these sites, we may have found different outcomes. In addition, changes were made to the prices of unhealthful food and beverage items (eg, receiving a larger size candy bar for a reduced price and reducing the price of sodas) just before the pilot program began; the influence of those changes on net profit is unknown.

Acknowledgments

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Tables

Table 1. No. (%)[a] of "Go," "Slow," and "Whoa" Food and Beverage[b] Items Sold in Vending Machines in Pilot Program, Delaware State Agency Buildings, 2011–2012

Item type[b]	Period 3 (11/23–12/27)	Period 4 (12/28–1/24)	Period 5 (1/25–2/21)	Period 6 (2/22–3/27)	Period 7 (3/28–4/24)
Food Items					
Northern site					
Slow	77 (56)	51 (65)	72 (59)	124 (71)	99 (72)
Whoa	60 (44)	28 (35)	50 (41)	51 (29)	38 (28)
Total, n	137	79	122	175	137
Central site					
Slow	55 (49)	52 (44)	64 (53)	97 (53)	83 (52)
Whoa	57 (51)	65 (56)	57 (47)	86 (47)	78 (48)
Total, n	112	117	121	183	161
Southern site					
Slow	181 (54)	91 (47)	133 (48)	217 (49)	127 (47)
Whoa	157 (46)	104 (53)	147 (52)	224 (51)	141 (53)
Total, n	338	195	280	441	268
Beverage Items					
Northern					
Go	35 (11)	26 (10)	16 (7)	22 (6)	22 (7)
Slow	131 (42)	85 (34)	121 (51)	189 (55)	159 (50)
Whoa	149 (47)	139 (56)	98 (42)	130 (38)	135 (43)
Total, n	315	250	235	341	316
Central					
Go	3 (3)	3 (3)	2 (2)	9 (6)	1 (1)
Slow	58 (60)	62 (72)	75 (69)	80 (56)	42 (51)
Whoa	35 (36)	21 (24)	31 (29)	55 (38)	40 (48)
Total, n	96	86	108	144	83

[a] Percentages may not total 100% because of rounding.

[b] Categories of "Go," "Slow," and "Whoa" items established by Nemours Health and Prevention Services (9). Slow food items contain no more than 200 total calories, 35% of calories from fat, 10% of calories from saturated fat, and 200 mg of sodium. Nuts and seeds are exempt because of their fiber, vitamin E, and superior fat content; however, these items meet criteria for sodium and calories. Go beverages consist of water without added flavoring or additives. Slow beverages consist of 100% fruit juice or contain no more than 10 total calories per 8-oz serving (eg, diet sodas and teas, flavored water). All items not classified as Slow or Go are classified as Whoa.

Table 2. Net Gain or Loss in Total Profits for Participating Vending Machines Compared With Guarantees for Each Pilot Site, Delaware State Agency Buildings, 2011–2012

Site	Net Gain or Loss, $ (%)					
	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012
Northern	−99.63 (−17)	−35.88 (−6)	−181.73 (−30)	−159.03 (−27)	38.62 (6)	−33.13 (−6)
Central	−93.39 (−20)	−16.74 (−4)	−170.99 (−36)	−61.09 (−13)	−95.34 (−20)	−134.74 (−29)
Southern	88.23 (13)	282.33 (40)	356.58 (51)	−60.67 (−9)	27.68 (4)	213.08 (30)

American Dietetic Association

RESEARCH

Perspectives in Practice

Managing Sales of Beverages in Schools to Preserve Profits and Improve Children's Nutrition Intake in 15 Mississippi Schools

DENISE M. BROWN, PhD, RD, LD; SURESH K. TAMMINENI, MBBS, MS

ABSTRACT

School environments that provide consistent and reliable nutrition information promote the development of healthful eating in children. High-energy, nutrient-poor beverages offered for sale to children during the school day compete with healthful choices. The primary objective of this prospective, quasiexperimental study was to encourage children to choose more healthful beverages during the school day without adversely affecting the profits realized from vending sales. Fifteen of 18 schools completed voluntary changes to beverage sales practices during the school day between August 2005 and May 2006. Twelve of 15 schools reported increased profits from the previous year (2004-2005) while offering more healthful beverage choices at discounted prices. Units of carbonated soft drinks sold declined when sports drinks, 100% fruit juice, and water were made available in their place. Passive marketing in the form of vending machine fronts, attractive pricing with a nominal 10% to 25% discount, and changing the types and proportions of beverages offered encouraged children to make more healthful choices. Local school administrators were receptive to making changes to beverage sales when local needs were incorporated into the study design. Profit information from this study informed state legislators and the Mississippi State Board of Education in the development and adoption of statewide snack and beverage vending guidelines. Registered dietitians serve as advocates to foster these collaborative efforts, inform key decision makers, and work in their local communities to develop and promote healthful practices in K-12 school settings.

J Am Diet Assoc. 2009;109:2036-2042.

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The need for action to treat and reverse the prevalence of childhood obesity is well documented (1-3). Mississippi has the highest reported incidence of both adult and childhood obesity in the nation. Kolbo and colleagues (4,5) using measured heights and weights reported that more Mississippi children in grades 6 through 8 are overweight or at risk of overweight than previously reported. The prevalence of obesity (>95th percentile for body mass index) in Mississippi children measured in 2005 reached 25.5% of children in kindergarten through 12th grade with another 18.4% reported in the overweight category (>85th percentile but <95th percentile for body mass index). Obesity rates were highest in middle school children (28.8%) (5). Schools are recognized as an appropriate setting to provide consistent and reliable information and opportunities that foster healthful food and activity choices (6-9).

French and colleagues (10) used a differential pricing strategy that minimized lost revenues in worksite and school settings in Minnesota. Price reductions of 10%, 25%, and 50% resulted in increased sales of low-fat products compared to higher-fat snacks in both worksites and schools. Similarly, North Community High School in Minneapolis, MN, used lower prices for water, 100% fruit juice drinks, and sports drinks, in combination with vending machine placement and school policy changes to encourage the consumption of water by students (11). Our study built on the work of French and colleagues (10) by studying a rural state, with a large number of economically disadvantaged communities (69.5%), small school districts (73% with 3,500 students or less enrollment), and underserved populations of African-American students (51.2%) (12).

The challenge to balance the long-term health and well-being of children against limited financial resources is daunting, especially in low-income rural settings. The goal of this exploratory study was to maintain profits from beverage sales while offering more healthful choices to students. Superintendents and principals working with beverage distributors used a combination of the differential pricing strategy of French and colleagues (10) with a 50% reduction in the availability of sugar-sweetened beverages offered to students during the school day. Demonstrating successful strategies for preserving revenues while simultaneously encouraging students to make healthful beverage choices are needed to encourage school administrators and legislators to adopt school wellness programs with proven success to meet the provisions of the Child Nutrition and WIC Reauthorization Act of 2004 (Public Law 108-265).

METHODS

The study protocol was reviewed and approved by the University Institutional Review Board. An agreement to participate letter assuring anonymity for each school was obtained from the appropriate school administrator. The study was conducted in three phases. Phase 1 identified schools to participate, included a protocol review and initial onsite visits. During each site visit the principal investigator met with school administrators to review the study protocol, data collection documents, and toured the school or schools participating in the study. Phase 2 encompassed the data collection throughout the 2005-2006 school year (August 2005 to May 2006). Each school contact was responsible for completing data collection documents and mailing those documents to the researchers in pre-paid addressed envelops. Phase 3 included data analysis, report preparation, and presentations at statewide meetings. Schools were provided a $3,000 incentive per school disbursed in three $1,000 payments following submission of data at required times during the project.

School Participation

This study was modeled on a similar studies conducted in Minnesota (10,11) using a prospective, quasiexperimental nonrandomized design. School participation was solicited through the Office of Healthy Schools, Mississippi Department of Education Web site. All Mississippi school districts (152) were invited to participate at the recommendation of the Office of Healthy Schools. The Mississippi Department of Education sent an informational notice electronically to all superintendents as part of the Monday morning memo from the State Superintendent. A single-page application coordinated through the Office of Health Schools was used by school administrators to express interest in participating in the study. Twenty schools responded to the invitation and were offered an opportunity to review the protocol and participate in the study. Schools were selected to represent the maximum number of geographic regions in Mississippi, to reflect a range of income, ethnic diversity, and student enrollment. A total of 18 schools agreed to participate; 15 schools completed all study requirements. Junior/middle and high schools were targeted for the study based on the availability of beverage sales. Little or no beverage sales were reported in elementary school settings. In communities with lower population density, students attend one school, called an Attendance Center, which includes all grades (K-12). A high volume of beverage sales were noted through school stores in K-12 Attendance Centers (141 schools statewide); therefore, two K-12 schools were included in the study. The final study participants included two K-12 attendance centers, eight middle/junior high schools, and five high schools.

Participant schools reflected the economic, ethnic, and regional variations throughout the state. School enrollments ranged from 350 students to 2,000 students. The percentage of free meals in the Child Nutrition Program was used as a measure of socioeconomic status of the study sample, ranging from a low of 14% to 100%. The eight counties reflected the northeast, northwest, central, south central, and coastal areas of the state. The only unrepresented area was the east central counties. No schools in these counties responded to the invitation to participate.

Passive Marketing of Beverages

Three changes to beverage vending were implemented over the course of the 2005-2006 school year. Schools agreed to work with beverage vendors to change the faces of vending machines or display cases in school stores to reflect physical activity, school logos, or any of the more healthful beverage choices. Schools also agreed to change the drinks offered to increase the number of more healthful choices offered and reduce the number of sweetened non-nutritive beverages. The more healthful choices were defined as water, 100% fruit juices, and sports drinks. Although sports drinks included sweeteners and electrolytes, because total energy was 50% lower than either full-energy soft drinks or 100% fruit juices these beverages were classified as healthful. Full-energy soft drinks and other sweetened non-nutritive beverages could comprise up to one half of vending machine slots or school stores shelf space. Only one middle school eliminated the sale of all sweetened non-nutritive beverages; the other 14 schools offered the maximum 50% of the total units of sweetened non-nutritive beverages. At the smallest schools one beverage vending machine was accessible by students. The largest schools reported 10 vending machines available to students on campus. Each school could determine the specific mix of beverages offered to meet local needs as long as no more than 50% of the choices included sugar-sweetened beverages. The proportion of 100% fruit juice, water, and sports drinks was determined locally by school administrators; the total combination of these three alternative beverages was required to represent at least 50% of all choices offered to students. Schools were asked to price more healthful drinks lower than sweetened non-nutritive beverages by 25% when possible (actual pricing ranged from 10% to 25% discounts).

Standardized data collection sheets were developed and provided to each participating school during an onsite visit with the principal investigator. The study requirements were explained during this initial visit, the data collection sheets and reporting requirements were also discussed with each school administrator. A second visit occurred midway through the school year. Financial data, school meals data, and volume of beverage sales were collected on a monthly basis reflecting only sales during the school day. Project coordinators at each school collected the data directly or obtained the data from the beverage vendors and recorded the information on data collection sheets. Data sheets were mailed to researchers monthly using prepaid, addressed envelopes. Telephone and electronic e-mail reminders were used to ensure timely submission of required data. Project coordinators were contacted either by telephone or electronic mail to clarify any missing or incomplete data. Once data collection sheets were reviewed and clarified, if needed, data were transcribed into data files.

Statistical Analyses

Descriptive statistics included mean sales, ranges of sales, mean profits and units sold, and frequencies were determined using SPSS (version 13.0, 2006, SPSS Inc,

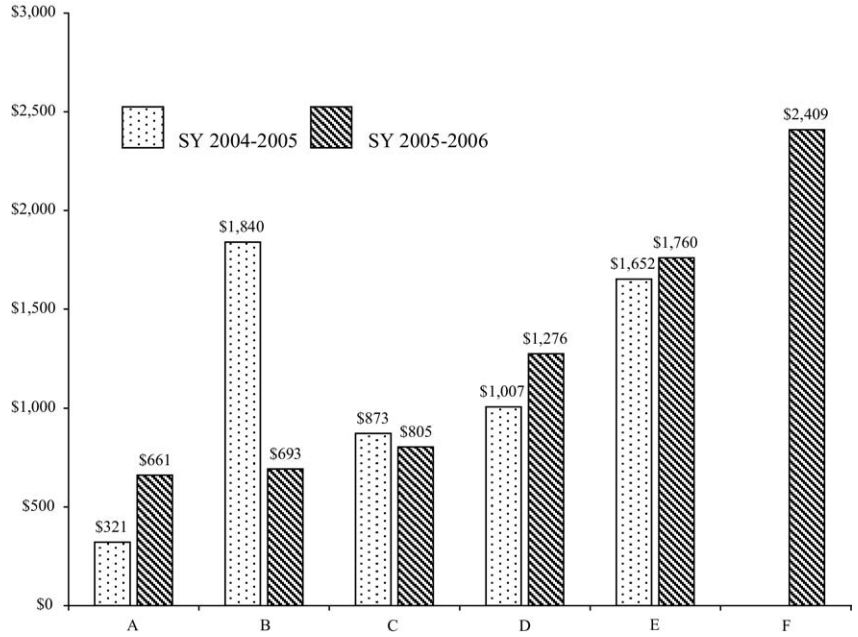

Figure 1. Beverage profits from school year (SY) 2004-2005 compared to beverage profits from SY 2005-2006 in Mississippi schools, Part I. School F submitted no 2004-2005 data. School L reflects the total for three schools in the same district participating in the study. School I profits in 2004-2005 include all beverage sales. Administrators were unable to separate sales during the school day from total sales.

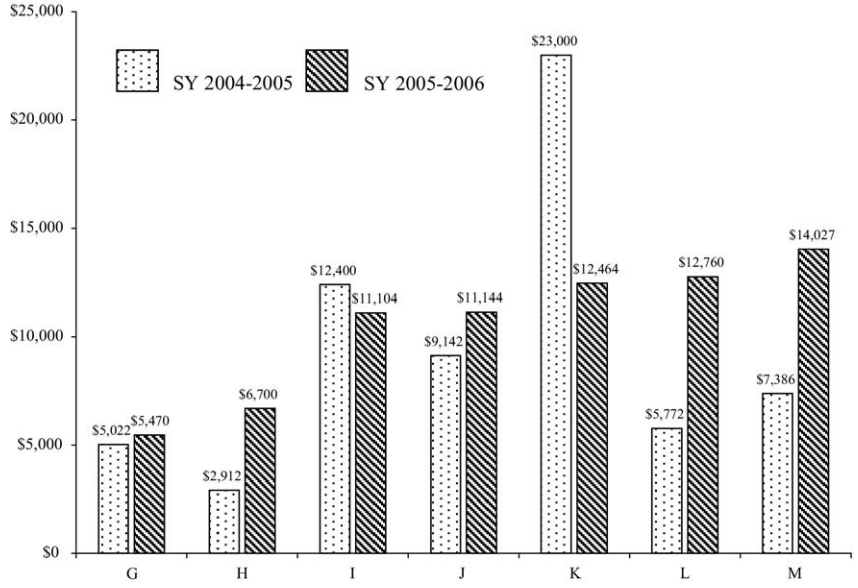

Figure 2. Beverage profits from school year (SY) 2004-2005 compared to beverage profits from SY 2005-2006 in Mississippi schools, Part II. School L reflects the total for three schools in the same district participating in the study. School I profits in 2004-2005 include all beverage sales. Administrators were unable to separate sales during the school day from total sales.

Chicago, IL). Data reported from the 2004-2005 school year submitted at the beginning of the project were compared to data submitted during the 2005-2006 school year aggregated on an annual basis.

RESULTS

Figures 1 and 2 display a comparison of the total profits realized the year before and following implementation of the voluntary beverage choices ordered by increasing 2005-2006 profits. Relative to profits, three schools reported lower profits in the 2005-2006 school year as compared to the 2004-2005 school year. During the first 3 months of the project school B sold soft drinks for $0.75 with water and 100% fruit juices were priced at $0.50. Beginning in January 2006, the school administrator increased the price of soft drinks to $1 and both water and 100% fruit juice were

increased to $0.75. Total annual profits in 2005-2006 were lower than those reported in 2004-2005. School C reported a slight decline in total profits. Sales of 100% fruit juice and sports drinks increased, while water sales decreased; no soft drinks were sold in this school. School F had no 2004-2005 data for comparison.

The largest decline in profits was noted in school I. There were significantly fewer beverage sales were reported in the 2005-2006 school year. Following a review of data submitted from 2004-2005, researchers discovered that total drink sales were reported for the 2004-2005 school year that included sales during after school events. The school administrators were unable to identify what percentage of the 2004-2005 beverage profits reflected sales during the school day, making a meaningful interpretation of these data problematic.

In seven schools and the three combined schools from one district (depicted as school L on Figure 2), profits increased from school year 2004-2005 to school year 2005-2006 and, in some instances, almost doubled. These findings are encouraging. Children chose more healthful beverages when those beverages were offered and priced attractively. These findings are comparable to those reported by French and colleagues (10) in Minnesota schools (11). The range of profits for both 2004-2005 and 2005-2006 captured the extent of financial incentives to schools to offer beverages for sale during the school day. These profits were from the direct sales of beverages and did not include any other incentives provided by beverage vendors.

The Table reports the number of units of full-energy carbonated soft drinks, 100% fruit juice, sports drinks, and water. The Table highlights the variability in the approaches used by participating schools. Although a mean and standard deviation are reported for each category, these data must be interpreted with caution. Sales of carbonated drinks were still significant in 2005-2006, with seven schools reporting a decline in sales and two schools reporting increased sales. School L (two middle and one high school combined data) eliminated soft drink sales in 2005-2006. Two schools (C and E) did not permit soft drink sales in either year. Fruit juices were not offered in 10 participating schools in 2004-2005 but were added in nine of these 10 schools in 2005-2006. Sales of 100% fruit juice in three schools that sold juice in 2004-2005 increased in 2005-2006. Sports drinks were a new choice in four schools, eliminated as a choice in two schools and never offered as a choice in school I during 2005-2006. Nine schools reported increased sales in sports drinks. Water was added as a choice in schools B and F during 2005-2006 and sold in the all other schools both years. Units of water sold were unchanged in two schools, increased in eight schools, and declined in three schools.

There appeared to be no specific impact of enrollment or the percentage of children receiving free meals on profits or units sold. The largest, most affluent schools were not the most profitable schools relative to beverage sales. Similarly, schools with 75% to 95% free meals were in the middle profitability range ($6,000 to $14,000). Schools with 100% free meals reported between $300 and $5,000 in profits.

DISCUSSION

More than 87% of Mississippi schools offered snack and beverage sales as reported in 2006 (13) and more than 78% of these schools reported the sale of soft drinks and fruit flavored drinks. As reported by Kolbo and colleagues (4,5), 43.9% of Mississippi children are obese or overweight—the energy contribution of beverages for sale during the school day is one possible factor. This study supports the findings of French and colleagues (10) that changing the choices offered to student during the school day can result in behavior change. Passive marketing in the form of vending machine fronts, attractive pricing with a nominal 10% to 25% discount, and changing the types and proportions of beverages offered encouraged children to make more healthful choices. Reducing the volume of sugar-sweetened beverages by 50% and offering either lower energy or more nutrient-dense options can support other efforts in the schools to promote nutrition integrity. More importantly, the changes in beverage choices did not result in substantial loss of profits, a common concern of school administrators. Capturing the financial affect of alternative beverages is information essential to local school boards for informed decisions relative to district-wide policies.

Consumption of sugar-sweetened beverages increased an estimated 135% from 1977 to 2001 (14-16). Epidemiologic and experimental evidence support the conclusion that increased consumption of sugar-sweetened beverages is associated with weight gain in children and adolescents (16). The total energy content in 100% fruit juice is similar to an equivalent volume of many non-nutritive sugar-sweetened beverages and does contribute to total daily energy intake. O'Neil and Nicklas (17) concluded data do not support a systematic association between moderate consumption of 100% fruit juice consumption and overweight in children or adolescents. The nutritional contribution of 100% fruit juice is important to meeting daily nutrition requirements. Although specific mechanisms to account for the observed association are yet to be defined (17,18), strategies to reduce the consumption of sugar-sweetened beverages and substitute moderate amounts of nutrient-rich beverages such as low-fat milk and 100% fruit juices are prudent (17,18). Before participating in this study, only three of the study schools offered 100% fruit juices to students. Anecdotally, principals and superintendents stated they did not believe these beverages would be attractive to students. This was an incorrect perception, especially in junior high and middle school schools. Children in these grades have the highest obesity rate in Mississippi schools, encouraging more healthful choices is imperative to improve nutrient intake (5).

This study reports profits from beverage sales during the school day, information not easily accessible in many school districts. Superintendents and principals find these revenues essential to supplement local budgets. These profits are viewed as discretionary funds used to support otherwise unfunded priorities. The range of profits in both years ($321 to $23,000 in 2004/2005; $661 to $14,027 in 2005-2006) demonstrates the variability in profit by individual schools. The higher profits achieved in some schools may be a factor of school location. Schools located far from convenience stores, restaurants, and ma-

Table. Comparison of units of beverages sold based on 12-oz portions before and after implementation of voluntary beverage guidelines to improve the quality of beverages offered to students during the school day

	Soft Drinks			100% Fruit Juice			Sports Drinks			Water		
School	2004/2005	2005/2006	Change	2004/2005	2005/2006	Change	2004/2005	2005/2006	Change	2004/2005	2005/2006	Change
A[a]	10,824	3,840	−6,984	0	144	144	0	1,560	1,560	192	192	0
B	5,090	4,564	−526	0	838	838	0	8,328	8,328	0	1,440	1,440
C	0	0	0	168	379	211	552	973	421	988	447	−541
D	10,820	7,776	−3,044	792	1,176	384	936	3,024	2,088	168	168	0
E	0	0	0	0	1,118	1,118	1,429	1,355	−74	1,914	1,120	−794
F	0	8,650	8,650	0	0	0	0	760	760	0	196	196
G	14,800	11,250	−3,550	390	1,005	615	2,795	5,220	2,425	690	1,230	540
H	0	5,750	5,750	0	4,085	4,085	1,776	0	−1,776	1,295	3,190	1,895
I[b]	69,000	12,284	−56,716	0	1,905	1,905	0	0	0	1,670	1,822	152
J	26,000	25,000	−1,000	0	72	72	200	4,900	4,700	120	3,425	3,305
K	53,000	23,931	−29,069	0	736	736	0	1,980	1,980	1,275	1,400	125
L[c]	11,616	0	−11,616	0	7,968	7,968	4,560	0	−4,560	936	10,008	9,072
M	22,824	21,218	−1,606	0	342	342	2,295	6,000	3,705	2,280	1,376	−904
Mean±standard deviation	17,229±21,452	9,559±8,858		104±236	1,521±2,216		1,119±1,415	2,623±2,677		887±771	2,001±2,619	

[a]Zero values in the table reflect no sales of those beverages for the specified time frames. For example: Schools C and E sold no soft drinks in either year. Schools F and H sold no soft drinks in 2004-2005 but did sell those beverages in 2005-2006. School L sold soft drinks in 2004-2005 but discontinued sale of those beverages in 2005-2006.

[b]Data for 2004/2005 included all units sold including afterschool events, 2005/2006 included units sold only during the school day.

[c]Data were summarized for three schools that participated in the study, only aggregated data were available due to Hurricane Katrina during 2005-2006.

jor cities offered fewer options to students. Although all campuses required students to remain on campus during the day, the two most profitable schools were also most distant from homes and other business. The affluent school district schools (14% free meals) were within closer proximity to homes and stores, possibly providing an opportunity for family members to provide other sources of beverages. Alternatively, the high school students in particular may have been willing to wait until after school to make beverage purchases. Either of these situations could result in fewer sales of beverages at school. Profitability is dependent on the pricing strategies established by individual schools. School B failed to recover expenses based on initial pricing strategies. Profits from beverage sales were achieved when a second pricing strategy was implemented, however, below those reported in 2004-2005. Determining appropriate pricing strategies is crucial to achieving profitability.

Financial incentives provided for this study encouraged school administrators to implement policies to promote healthful behaviors. Whately Blum and colleagues (19) reported similar success with low-fat, low-sugar, portion-controlled competitive food guidelines in Maine high schools where a financial incentive was combined with trained personnel. Intervention schools significantly improved the nutrient quality of the snack and beverage offerings. Whately Blum and colleagues (19) did not measure revenue from either vending or à la carte sales, an acknowledged limitation of their study. The implementation of voluntary beverage guidelines in 15 Mississippi schools adds additional evidence to the Maine study that small rural school districts can offer nutrient-rich vending choices and maintain profits. A key concern for school administrators is how to meet both the nutritional and health needs of children while preserving needed funding (20). Replacing $600 to even $1,000 may be feasible with alternative fundraising activities; however, recovering profits of $11,000 to $14,000 requires careful planning and additional creative approaches. School administrators, school staff, parents, and children must support those activities that concurrently meet nutrient intake and school profit objectives.

This study was initiated when the environment for changing vending practices during the school day was dependent on the cooperation of vendors and school administrative staff. Whatley Blum and colleagues (19) also identified a need to partner with the food and beverage industry to reduce barriers for offering nutrient-rich foods. In early 2005, previous efforts to encourage regulatory oversight or statewide guidelines within the state legislature were unsuccessful. A joint state senate and house nutrition subcommittee was convened in early 2006 to evaluate possible legislative actions. Data from this study were used to inform the subcommittee that crafted a senate bill requiring the development of snack and beverage vending guidelines, signed into law in April 2006 by the Mississippi governor. Statewide vending guidelines were formally adopted by the Mississippi State Board of Education in October 2006 that addressed nutrient, portion size, and energy requirements for all sales of foods and beverages during the school day. Phased implementation of the guidelines began in January 2007; guidelines will be fully implemented during the 2008-2009 school year.

A number of study limitations are evident. The nonrandomized design and limited descriptive statistics provide only baseline information. No data were collected on actual beverage consumption, only purchasing behaviors are reported. Although a quasiexperimental study can be useful in identifying trends and broad themes, statistical inferences are not possible. The study commenced a few days before the arrival of Hurricane Katrina. The five schools directly affected by the storm continued participation in the study and completed all data collection requirements. Monthly data comparison by school was not completed as originally planned due to lost school days immediately following the storm. Days lost during recovery from the storm were either recovered during the school year at scheduled breaks or by extending the end of the school year. All schools met the minimum required school days of attendance. Once data were aggregated on an annual basis, no impact from the storm relative to total days of school or total school enrollments was noted.

CONCLUSIONS

Registered dietitians have a significant role to play at the local and state levels. Active engagement in research in local school settings and membership or participation in local school district wellness committees are just two venues. Although not the original intent of this study, providing timely evidence that vending practices can be changed to support healthful choices without harming school profits was useful for supporting Mississippi Senate Bill 2602 in April 2006 and the subsequent development of the Mississippi State Board of Education Vending Regulations for Mississippi Schools adopted October 2006.

This study was conducted in a wide range of school settings, enrollments, and socioeconomic levels provided a mechanism to communicate that change was possible in very diverse settings. Developing working relationships with school district administrators, both in the local community and across the state resulted in a network of educators willing to work in collaboration with researchers, local practitioners, state legislators, state board of education, and a private foundation. Registered dietitians possess the skills to foster these collaborative efforts, inform key decision-makers, serve on school wellness committees, support school wellness policies, and work in their local communities to develop and promote healthful practices in K-12 school settings. Although the Child Nutrition and WIC Reauthorization Act of 2004 (Public Law 108-265) mandated the first step to require wellness policies for each school district, there is a need to determine not only the health outcomes but also fiscal outcomes of implementing these policies. Individual states and local school districts are held accountable for implementing wellness policies. If wellness policies negatively affect the financial position of the school district, what is the incentive for school administrators to comply?

How well this approach can be applied in other states and school settings requires further investigation. The long-term influence of statewide policy changes on health outcomes is yet to be measured. In an economically disadvantaged rural state such as Mississippi many chal-

lenges face local school boards. The statewide vending policies are flexible enough to permit schools to generate revenues while encouraging healthful choices for the children and school staff.

Collaborative efforts are needed within the community involving all participants to ensure balanced and comprehensive solutions to developing healthful behaviors in our youngest, most vulnerable citizens. Measuring financial outcomes as well as behavioral and health outcomes of the numerous initiatives targeted in schools is needed. Influencing public policy locally, regionally, and nationally requires specific data about the potential financial effects of proposed policy changes, particularly for local and state decision-makers.

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Preferring the One in the Middle: Further Evidence for the Centre-stage Effect

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Summary: The location of an item influences a person's preference for that item, but it is unclear whether there is a preference for items located on the right or in the centre. In replication of the centre-stage effect, it was found that when participants were presented with a line of five pictures, they preferred pictures in the centre rather than at either end. This applies when the line of pictures was arranged horizontally or vertically and when participants selected from five pairs of identical socks arranged vertically. The results support the centre-stage explanation of location-based preference rather than the hemispheric difference or body-specific accounts. Implications of the effects of location on consumer choices and preference decisions are discussed.

INTRODUCTION

When choosing an item from a range of items, the choice that people make is influenced by the characteristics of the various items. However, one factor that influences choice, which people may not be aware of when making their decision, is the item's location. Several studies have found that an item's location can influence preference for that item (Wilson & Nisbett, 1978; Shaw, Bergen, Brown, & Gallagher, 2000; Valenzuela & Raghubir, 2009). It is possible that an item's location can influence choice in a wide range of situations, including consumer choices in shops and online, responding to questionnaires, selecting a member of a team and when choosing political candidates during television debates. As every object occupies a location and preference choices are made by people very frequently, it is important to understand how location can influence preference decisions (Shaw et al., 2000; Raghubir & Valenzuela, 2006; Valenzuela & Raghubir, 2009).

The exact nature of location-based preferences is equivocal, with some studies finding a preference for items on the right side (Nisbett & Wilson, 1977; Kruglanski, Chun, Sleeth-Keppler, & Friedman, 2005) and other studies a preference for items located in the centre (Christenfeld, 1995; Shaw et al., 2000; Raghubir & Valenzuela, 2006; Valenzuela & Raghubir, 2009). The aim of the current series of experiments was threefold: first, to determine which location increases preference for an item; second, to determine whether location-based preferences occur when the items are presented in a questionnaire; and finally, to test different theoretical accounts of location-based preferences.

The first evidence that location influenced preference was reported by Nisbett and Wilson (1977) who found that when 52 consumers were asked to make a choice between four identical nylon stockings arranged in a line, they preferred the rightmost stockings. The preference for stockings increased the further right they were positioned, with 12% of participants selecting the leftmost stockings, and 17%, 31% and 40% of participants selecting stockings in the next three rightward positions (Wilson & Nisbett, 1978). Wilson and Nisbett (1978) tentatively suggested that the right-side preference (RSP) was a temporal order effect rather than a position effect, with participants moving from left to right and selecting the last item in the line after all the options had been considered.

In replication of Nisbett and Wilson's study, Kühberger, Kogler, Hug, and Mösl (2006) conducted four experiments, which examined whether participants' introspections could predict the RSP before they completed the task. In addition to finding that participants had some ability to predict the RSP, they found that a trend ($p < .10$) toward an RSP only emerged when the items (identical shirts) were separated by 70 cm but no evidence of a side preference when they were separated by 1 cm. The separation of approximately 70 cm is similar (but smaller) to that used by Nisbett and Wilson (approximately 90 cm). On the basis of these results, Kühberger et al. suggested that the spatial separation of the items is crucial to obtaining the side preference and that if the separation is sufficient, then participants will show a preference for the last item considered.

A further replication of Nisbett and Wilson's study was conducted by Kruglanski et al. (2005) who proposed that a decision in Nisbett and Wilson's task was largely governed by two factors: the desire to make a good choice and the desire to reach a decision quickly. Kruglanski et al. predicted that the RSP would emerge when the participant's desire to reach a decision quickly gained precedence, because after considering the options (with people proceeding from left to right), it would be fastest to reach a decision by selecting one of the last items they considered. In one condition, the importance of making the best choice was increased by emphasising the accuracy of the choice. In a second condition, the need to make a quick decision was increased by putting the participants under time pressure. The results were in line with predictions, with 81% of participants choosing the two rightmost choices in the time-pressure condition and only 33% of participants choosing the two rightmost positions in the accuracy condition.

An alternative explanation of the RSP was proposed by Drake (1987) who suggested that it could be caused by the

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way emotions are differently lateralised in the hemispheres (see also Casasanto, 2009; Puccinelli, Tickle-Degnen, & Rosenthal, 2006), with the anterior region of the right hemisphere having a greater role in mediating negative emotions and anterior regions of the left hemisphere (LH) having a greater role in mediating positive emotions (Davidson, 1984, 1992). If the LH has a greater role in positive affect, it might cause items on the right side to be viewed more positively (Reuter-Lorenz & Davidson, 1981) and therefore promote the RSP. This is because items viewed on the right side will have a greater tendency to go to the LH, even in free view situations (Jansari, Tranel, & Adolphs, 2000), and orienting attention to the right of space is believed to activate the LH (Kinsbourne, 1970). In support of this interpretation, it has been found that emotional faces presented on the right are perceived more positively than when presented on the left (Davidson, Mednick, Moss, Saron, & Schaffer, 1987; Natale, Gur, & Gur, 1983; Jansari et al., 2000) as are cartoons (Dimond, Farrington, & Johnson, 1976) and neutral faces (Rodway, Wright, & Hardie, 2003). Hemispheric differences in emotional processing have also been used to explain the right-seat preference in cinemas (Okubo, 2010), and there is therefore a range of evidence in favour of a hemispheric asymmetry explanation of the RSP.

A further possible cause of the RSP is that it is a product of the tendency to associate the right side with good things and the left side with bad things (see McManus, 2002 for a review). The idea that an association between right and good (and left and bad) can influence location-based responses has been extensively examined by Casasanto (2009) who proposed the body-specificity hypothesis (see also Phaf & Rotteveel, 2009; Beilock & Holt, 2007; Cretenet & Dru, 2004, 2009), which suggests that the way people interact with the world influences their thoughts about the world. Because right-handers respond more to the world with their dominant right hand, they learn to make associations between the right side of space and positive attributes and the left side of space with negative attributes, whereas left-handers form the opposite association. In a series of experiments using a forced-choice task with two locations, Casasanto found that right-handers were more likely to place items with positive attributes (e.g. a good animal) in a box on the right side and items with negative attributes in a box on the left side, whereas left-handers did the opposite and placed positive items on the left side. On the basis of these findings, Casasanto suggests that the RSP might be a product of right-handers being more numerous in the population and in the sample used in Nisbett and Wilson's study. As explained by the body-specificity hypothesis, right-handers associate the right side with positive items, so they might have viewed items on the right as more preferable.

Other evidence, from the field of consumer psychology, suggests that instead of an RSP, there is a preference for items located in the centre of an array (Christenfeld, 1995; Shaw et al., 2000; Raghubir & Valenzuela, 2006; Valenzuela & Raghubir, 2009). In the study of Kühberger et al. (2006), when the participants were asked to predict what results would be obtained, they predicted that there might be a bias toward choosing items in the centre, suggesting that they had reasons for thinking that the central items would be preferred. In relation to this, Raghubir and Valenzuela (2006) found that when people decided to retain or eliminate a participant from a group, the people who occupied central positions were less likely to be eliminated. They termed this the 'centre-stage' effect and suggested that people's choice decisions are guided by the heuristic that 'important people occupy the middle'. They examined data from the television show 'The Weakest Link' and found that viewers overestimated the performance of people in central positions and overlooked their errors, causing them to be less likely to be eliminated. This suggested that viewers were not simply paying more attention to people in the centre but that central positions are believed to be occupied 'by good (or important) people' (Raghubir & Valenzuela, 2006, p. 70). In a further series of experiments, Valenzuela and Raghubir (2009) found that the centre-stage effect generalised to beliefs about products, with products in the centre (of a line of three) viewed as most popular and chosen most often.

Valenzuela and Raghubir's (2009) results replicate those of Christenfeld (1995) and Shaw et al. (2000) who also found a preference for items in the centre. Shaw et al. showed that participants had a much greater tendency to select the middle highlighter pen from a set of three similar pens, and they proposed that an attentional focus towards the central item might cause the central preference. However, Valenzuela and Raghubir (2009) used indirect measures of attention, such as memory and visualisability of central items, and found that memory was less accurate for items in the centre position. They therefore concluded that the evidence was more consistent with a centre-stage heuristic causing the preference for central items rather than an effect of attention.

It is apparent from the literature that different studies have obtained different location-based preferences. Despite there being several potential explanations of the RSP and substantial evidence for a rightward bias when the choice is between two options (e.g. in emotion and body-specific studies), the original RSP reported by Nisbett and Wilson has not been extensively replicated. Moreover, when choosing from three or more items, the evidence for a preference for items occupying the centre is more consistent. Therefore, the first aim of the current study was to examine which location promotes preference. It was believed that this would enable a greater understanding of the causes of location-based preferences and the circumstances under which an RSP or a central preference may emerge. A further aim was to examine, for the first time, whether location-based preferences can be obtained for items arranged in a questionnaire. It was reasoned that if certain locations promote preference (centre preference, or the RSP) and this is caused by body-specific effects, or a centre-stage heuristic, or hemispheric differences in emotion, then location-based preferences might also emerge when participants have to select between items arranged in a questionnaire (rather than on a table). In addition, as items are often selected in questionnaires (and from booklets, catalogues and screens), it examined the possibility that the effects of location on preference would be obtained in a much wider range of presentation formats.

EXPERIMENT 1

Introduction

This first experiment examined the effects of item location on item preference by using a questionnaire where each choice question consisted of five pictures arranged in a line. Nisbett and Wilson used identical real stockings where participants might have thought they were using subtle differences in the colour and texture of the stockings to guide their choices. As these attributes are not present in pictures, using identical pictures was likely to have caused participants to question the aim of the study and potentially make random responses. Therefore, it was decided to use similar pictures of the same item, or type of item, (e.g. five pictures of butterflies, the same breed of dog, the same waterfall) arranged in a line. As the pictures were different, but similar, it was expected that preferences for particular pictures would emerge but that such preferences might not eliminate potential effects of item location on item preference.

Rather than having only four items, as in Nisbett and Wilson's study, a central option was included to test the possibility that a central location might promote preference more strongly than other locations (e.g. Valenzuela & Raghubir, 2009). If the centre-stage heuristic operates, then there should be increased preference for items located in the centre resulting in a significant quadratic trend in the data. With the recent findings of Valenzuela and Raghubir, and those of other studies using a central location, we predicted that there would be an increased preference for items located in the centre.

The alternative theoretical accounts of location-based preference provided by the body-specific and hemispheric explanations predict different results from the centre-stage account. To test predictions derived from the body-specific hypothesis, we used right-handed participants and manipulated the preference question, with half of participants asked to choose the item they most preferred and half of the participants the item they least preferred. If, as suggested by the body-specific account, an RSP is caused by an association between right and positive, in right-handers, then they should have a bias towards the right when selecting the item they most prefer. This should result in a significant linear trend with increased preference for items on the right. If right-handers also associate the left with negative attributes, then there should be a tendency for them to select the left side when asked to select the item they least prefer. This should also result in a significant linear trend but with the items on the far left chosen more frequently as the least preferred items. The hemispheric activation account of location-based preferences would predict the same linear trends as the body-specificity account, with left hemisphere activation (and an RSP) when making the most prefer choice and right hemisphere activation (and a left-side preference) when making the least prefer choice.

Participants

One hundred right-handed participants (65 females and 35 males) from the University of Chester and South Cheshire College (mean age = 22.3; $SD = 5.15$), completed the questionnaires. Handedness was determined by self report as this has proved to be a very accurate and reliable measure of handedness (Casasanto, 2009). Fifty participants completed the 'most prefer' questionnaire, and 50 completed the 'least prefer' questionnaire, with 10 participants completing each of the five different versions of the questionnaires.

Materials

The questionnaire consisted of 17 questions, and each question consisted of five pictures arranged in a line. The pictures in each question were different examples of the same item, or type of item, and came from picture databases (http://www.theperfectpicture.org.uk/ and Google images). They were selected to be similar to each other, to reduce actual differences between items, whilst also being distinct enough to provide genuine choice. Examples included pictures of butterflies, specific breeds of dog (e.g. five border terriers), scenic views, flowers, roses, autumnal trees, tropical beaches, waterfalls and wolves. The pictures were printed in greyscale to eliminate effects of colour on preference and make the images even more similar to each other. Each picture was 2.3 cm wide and 2.01 cm high. The picture presented at location 1 was positioned 1.3 cm from the left edge of the page, and each picture was separated by 1.5 cm. The picture at location 5 was positioned 2 cm from the right edge of the page (A4 paper, 21×29.7 cm).

Depending on the condition participants were allocated to, above each line of five pictures was the statement 'Which of these do you most prefer?' or 'Which of these do you least prefer?'. The words 'most prefer' and 'least prefer' were presented in bold. There were three questions on the first five pages and two questions on the last page.

To examine the effect of item location independently from item preference, the location of the items was counterbalanced, using a Latin square, across five different versions of the questionnaire. Each new version was constructed by moving the items one position to the left [or to the end of the line (location 5) if they were previously at location 1] so that each item was presented in each location equally often across participants.

Procedure

The participants were approached and asked whether they would be willing to participate in the study. They were told that their participation was voluntary and that they had the right to withdraw at any time. They signed a consent form and then completed the questionnaire.

Results

The mean percentage choice of items at each location for the 'most' and 'least' prefer questionnaires is presented in Figure 1. The data show greater selection of 'most prefer' items when they are located in the centre than at either end of the line and slightly greater selection of 'least prefer' items when they occupy location 5.

To examine the prediction that items in the centre would be most preferred, we conducted a trend analysis on the

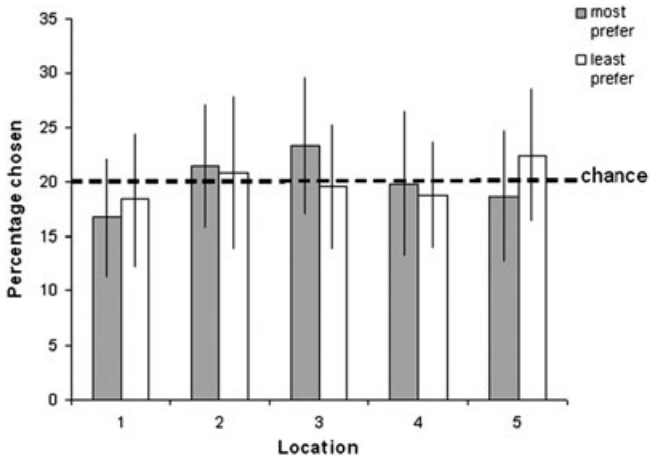

Figure 1. Mean percentage choice of items at each location for the 'most prefer' and 'least prefer' questions in Experiment 1. Bars represent 95% confidence intervals

preference data with Location (1, 2, 3, 4 and 5) and Preference question ('most prefer' and 'least prefer') as factors. For the quadratic trend, there was a significant interaction between Location and Preference question, $F(1, 98) = 5.48$, $p = .021$, $\eta^2 = .053$. A trend analysis for the 'most prefer' question revealed a significant quadratic trend, $F(1, 49) = 8.3$, $p = .006$, $\eta^2 = .15$, reflecting higher preference for items in the centre and lower preference for items at the two end locations (see Figure 1). In contrast, for the 'least prefer' question, the analysis of trends was not significant.

To ensure that centre choice did not simply indicate indifference to similar items, we examined the effect of individual items on choice decision. A series of 1×5 chi-squared analyses was conducted for responses to each question (see Table 1). For the 'most prefer' question, significant preferences for individual items were demonstrated for 16 out of the 17 questions. Similar strong preferences were also obtained for the 'least prefer' question with participants showing significant preferences for individual items in all but two questions. These results show that the participants were not choosing items randomly or selecting the central option because of indifference, as has been suggested to occur on some rating scales (see Kulas, Stachowski, & Haynes, 2008), but were choosing the items based on their specific preferences. Recall that we used item-to-location counterbalancing. Thus, it appears that the centre-stage effect emerges because of a location-based preference and not as a result of indifference.

Discussion

When participants chose the item they most preferred, there was a significant trend for participants to select an item located in the middle position rather than the end positions. This replicates the centre-stage effect (Valenzuela & Raghubir, 2009; Shaw et al., 2000), but in a completely different task, using pictures rather than products and a questionnaire rather than real items. When choosing the least preferred item, the item's location did not significantly influence preference. There was no RSP for either choice decision. If anything, the numerical trend was in a direction opposite to those predicted by the body-specific account in the 'least prefer' condition, with a non-significant numerical trend towards right choices.

These results show that item location influenced item preference and that the effect of location depends on the choice being made. The lack of evidence for an RSP is likely to be due to the differences between this study and the research reported previously, including the fact that the items were presented simultaneously (rather than being considered in sequence), a different presentation format was used and the items were not identical. The results therefore do not question the validity of the RSP but suggest that it may only be present in limited circumstances and does not transfer to questionnaires or when non-identical items are used.

Table 1. Percentage choice of each item for the 17 questions in the 'most' prefer and 'least' prefer questionnaires in Experiment 1

Question	Preference									
	Most					Least				
	1	2	3	4	5	1	2	3	4	5
1 Butterflies	38	6	28	8	20	10	6	8	68	8
2 Butterflies	10	14	18	54	4	36	24	18	4	18
3 Flowers	50	6	16	14	14	2	30	28	10	30
4 Mushrooms	20	10	32	6	32	26	2	8	54	10
5 Fields	32	8	18	26	16	8	54	10	12	16
6 Terriers	8	6	24	12	50	26	20	12	34	8
7 Butterflies	42	38	6	6	8	4	0	10	36	50
8 Roses	16	18	8	32	26	68	14	4	2	12
9 Island	20	42	12	8	18	12	16	34	24	14
10 Swans	10	12	10	20	48	30	44	18	8	0
11 Rock forms	18	26	28	8	20	6	30	14	34	16
12 Swamp	12	24	28	10	26	8	16	22	42	12
13 Horses	50	18	10	10	12	20	12	16	28	24
14 Trees	6	14	38	20	22	78	2	4	8	8
15 Waterfall	34	20	24	8	14	0	24	4	62	10
16 Weimaraners	34	8	46	4	8	20	38	6	18	18
17 Wolves	24	24	32	10	10	12	4	32	32	20

Importantly, the results also do not support potential explanations of how location might influence item preference in this task. For example, the body-specificity hypothesis and the hemispheric hypothesis do not appear able to explain why the middle location resulted in an increase in preference for items. In addition, the effect does not appear to be caused by participants simply selecting the middle item because of indifference to the questions, as has been suggested to occur for questionnaires (e.g. Kulas et al., 2008). Analysis of item preferences showed that for each question, specific items were consistently preferred despite the similarity of the five items, showing that the participants were making decisions based on the features of the individual items (in addition to being influenced by the item's location). Therefore, Valenzuela and Raghubir's (2009) centre-stage account remains the most convincing explanation of these results.

EXPERIMENT 2

Introduction

The second experiment examined the effects of array format on location-based preferences. It examined whether the tendency to prefer the item located in the centre extended to vertically arranged items. Although Experiment 1 did not find evidence that the effect of location on preference was caused by body-specific associations, it is possible that it is influenced by universal semantic associations between locations and attributes. As Casasanto (2009) proposes, in vertical arrays, top positions are universally associated with positive attributes and bottom positions with negative attributes. If this association influences location-based preferences, there should be a significant linear trend to prefer items in higher positions when the items are arranged vertically (see also Chandon, Hutchinson, Bradlow, & Young, 2009). However, if the centre-stage heuristic continues to determine the effects of location on preference in vertical arrangements, then there should still be a preference for items in the centre. Therefore, a significant quadratic trend should be obtained if the centre-stage effect operates for vertical arrangements in questionnaires.

Participants

Thirty five right-handed participants (20 females, 15 males) from the University of Chester (mean age = 21.1; $SD = 2.4$) took part in the study. Handedness was determined by self report.

Materials

The same questionnaire used in Experiment 1 was used in this experiment. However, the questions (again consisting of five pictures) were now arranged vertically as columns, with the first picture in the top location and the fifth picture in the bottom location. For each question, each picture was separated by 7 mm on the vertical axis. Each question was also separated from the next question by 4 cm. Three questions were presented on the first five pages (A4 paper), and two questions were presented on the last page.

Procedure

The experiment was identical to Experiment 1 except that the items in each question were arranged vertically and only the 'most prefer' questionnaire was used.

Results

The mean percentage choice of items at each location is presented in Figure 2. As can be seen, the participants show greater preference for items when they are located in the centre than when they are at the top or bottom locations.

To investigate the relationship between location and preference, we conducted a trend analyses on these data. There was a significant quadratic trend, $F\ (1, 34) = 5.32$, $p = .027$, $\eta^2 = .135$, with participants showing increased preference for items located towards the centre (locations 2, 3 and 4) and least preference for items at the top (location 1) and bottom (location 5) locations. No other effects were significant.

Discussion

In replication of Experiment 1, a significant quadratic trend was obtained with participants tending to prefer items in the centre rather than at the top and bottom locations. This demonstrates that the effect of location on preference is robust and generalises to the vertical arrangement of items. The results also suggest that, for questionnaires, the location-based preference effect is not caused by a universal association between the top position and positive attributes, as there was no evidence that the top position increased preference for items. These results support the centre-stage account and suggest that items occupying central locations are the most preferred even for vertical arrangements. Finally, the results suggest that the centre preference does not depend on specific left-to-right eye scanning patterns people have acquired from reading and which they may use when choosing from a horizontal line of items.

EXPERIMENT 3

Introduction

The previous experiment demonstrated that the centre-stage effect generalised to questionnaire items arranged vertically.

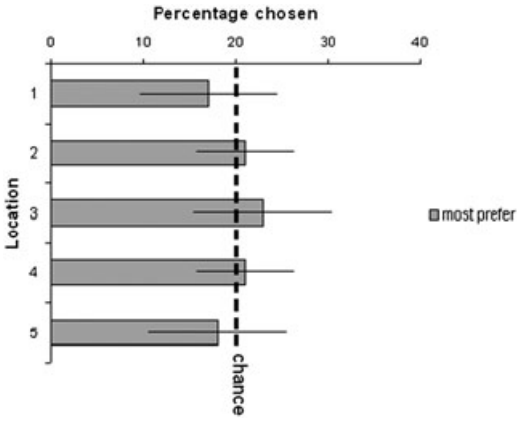

Figure 2. Mean percentage choice of items at each location in Experiment 2. Bars represent 95% confidence interval

It is possible, however, that because the items in the questionnaire were viewed by participants on a page placed horizontally, the association between height and positive attributes was eliminated and did not influence the preference decision. That is, with real items arranged vertically, the actual height of the items in space will be highly salient and may influence preference choices if higher locations are associated with positive attributes. Therefore, Experiment 3 tested whether the centre-stage effect was also present for real items arranged vertically or whether the universal association between greater height and positive attributes now determined preference decision.

In this study, the participants were presented with a vertical line of five identical pairs of white socks. To control for the possibility that participants might select items that were closest to eye level, the height of the display was manipulated. On the basis of the results of Experiment 2, it was predicted that the centre-stage effect would still operate with real items and that participants would prefer the central pair of socks irrespective of the height of the display.

Participants

One hundred participants (50 males and 50 females) from the University of Chester (mean age = 23.96; $SD = 8.68$) took part in the study. There were 92 right-handed and eight left-handed participants. Fifty participants (27 females, 23 males) chose the socks when the display board was in a high position and 50 participants (27 males, 23 females) chose the socks when the display board was in a low position.

Materials

The five pairs of white socks were attached to a sheet of A1 (59.4 ×84.1 cm; in portrait orientation) sized blue card. The blue card displaying the socks was then attached to a portable whiteboard and easel, which had adjustable height settings. The socks were displayed at two different heights (High display and Low display) during the experiment. For the high display condition (approximately at head height), the top edge of the sock display was 171 cm above the ground, and for the Low display condition (approximately at thigh height), the top edge of the sock display was 99 cm above the ground. For both display positions, the top pair of socks was placed 12 cm below the top edge of the display board, and the remaining four pairs of socks were positioned in a vertical line below this top pair, with each adjacent pair separated by 17 cm (measured from the centre of the pairs of socks).

Procedure

Each participant was tested individually in a quiet room. They were instructed that they would be presented with a vertical line of five pairs of white socks and they would be asked to point to the pair of socks that they most preferred. The experimenter recorded the participant's response. Half of the participants were presented with the High sock display and half were presented with the Low sock display.

Results

The number of participants choosing the pair of socks at each location for the High display and Low display conditions is presented in Table 2. As can be seen, the pattern of responding for the two display conditions was similar.

The total number of participants choosing pairs of socks at each location is presented in Figure 3. The data show that most participants chose the middle pair of socks and that the pairs of socks in the lowest two locations were chosen least.

A chi-squared test of goodness-of-fit was performed to examine whether the five identical pairs of socks at each location were equally preferred. This showed that preference for the five pairs of socks was not equally distributed $\chi^2\,(4, N = 100) = 29.1$, $p < .001$, with the pair of socks in the centre most preferred and socks in locations 4 and 5 the least preferred. Additional binomial analyses showed that the choice of socks in the middle location differed significantly from chance (20%, $p < .05$), whereas the choice of socks in location 1 did not differ significantly from chance. Therefore, in replication of the centre-stage effect, the pair of socks in the middle location was the most preferred. An additional binomial analysis showed that the choice of socks at location 4 was significantly lower than chance ($p < .006$). Therefore, although preference was greatest for the central pair of socks, there was significantly reduced preference for the pairs of socks at the two lowest locations.

Discussion

This experiment demonstrated that the centre-stage effect obtained with items arranged vertically in a questionnaire generalises to real items arranged vertically. The results therefore add further support to the centre-stage effect.

Table 2. Number of participants choosing sock pairs at each of the five locations when the display was High or Low in Experiment 3

	Number of participants choosing socks				
	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
High	14	12	14	6	4
Low	12	13	20	4	1

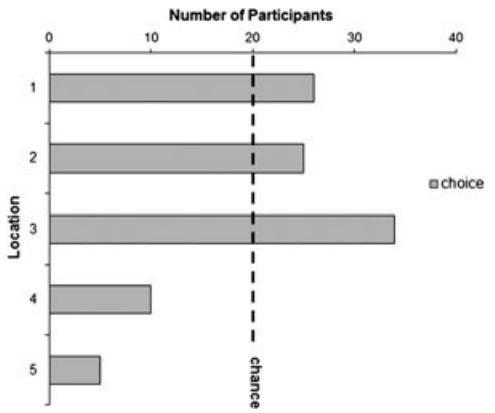

Figure 3. Number of participants choosing pairs of socks at each location in Experiment 3

However, although the central pair of socks was the most preferred, there was also a significant reduction in preference for pairs of socks at the lowest two locations, which did not depend on the actual height of the socks in space but on their relative height in the line of socks. This finding provides some support for the view that the universal association between height and attributes influences location-based choice, with a markedly reduced preference for the socks at the lowest two positions. It therefore appears that both the centre-stage heuristic and the height-association bias might have been operating to influence preference, so that there was a reduction in preference for the two lowest options and a concomitant increase in preference for the top two options, although preference was still greatest for socks in the centre.

It is possible that the reduced preference for the items at the two lowest locations emerged in this experiment, but not in Experiment 2, because of differences between the experiments. For example, in Experiment 3, identical items of clothing were used, but in Experiment 2, non-identical pictures of items were used. This could have changed the nature of the participant's decision, perhaps with the decision based on the quality of the product rather than on preference, even though participants were asked to choose by preference. A further possibility is that the relative location of the items in space was much more salient in Experiment 3 than it was for Experiment 2, which caused the association between greater height and positive attributes to influence choice in Experiment 3 but not in Experiment 2.

Taken together, the results of Experiment 2 and Experiment 3 suggest that the choice of real consumer items displayed in a shop may be more influenced by an association between height and attributes than are pictures of those items displayed on a screen or in a catalogue. However, the centre-stage effect appears to operate both with real items and pictures of items so that items in the centre remain the most preferred.

GENERAL DISCUSSION

This series of experiments shows that the location of an item presented in a questionnaire can influence preference for that item. The exact pattern of preference depends on the question asked, but when items are presented in a vertical or horizontal line, there is a clear tendency to prefer items at the centre and have lower preference for items at end positions. Therefore, the centre-stage effect reported by Valenzuela and Raghubir (2009) and others (Christenfeld, 1995; Shaw et al., 2000) was replicated on three occasions but with an entirely new task and in a vertical arrangement. It was also shown that the centre-stage effect with questionnaires was unlikely to emerge as a result of indifference.

When real items were presented vertically, there was evidence for a centre-stage effect. However, the results also indicated that an association between relative height and positive attributes can influence preference, with items at the two lowest locations showing reduced preference and an equivalent increase in preference for items at the two top locations.

Our results suggest that the RSP does not generalise to questionnaires and may not be present in most typical choice scenarios. As proposed by Kruglanski et al. (2005), the RSP could depend on items being considered in sequence and having limited time to make the decision (see also Valenzuela & Raghubir, 2009). When items are presented simultaneously, there is consistent evidence that the middle item is preferred (Shaw et al., 2000; Christenfeld, 1995; Raghubir & Valenzuela, 2006). The failure to obtain the RSP in the three experiments reported is also unlikely to be due to using five locations, and a centre location, rather than the 4 locations used by Nisbett and Wilson. This is because Christenfeld (1995) still obtained a preference for the two middle options when choosing which toilet cubicle from four identical cubicles to visit and when circling one x from a row of four identical x's.

The results of these experiments question the validity of the hemispheric (Drake, 1987) and the body-specific accounts (Casasanto, 2009) as universal theories of location-based preference because both theories are unable to predict choice behaviour when there are three or more locations. When there is a central location, there is a preference for items located in the centre, and it is not apparent how either theory is able to explain this preference. In choice situations consisting of two locations, body-specific associations can determine choice (Casasanto, 2009), but this does not seem to be the case when several locations are used. It seems that the circumstances under which body-specific effects influence location-based choices need to be explored in greater detail.

To conclude, the effects of location on preference observed in these experiments add to the body of evidence clearly demonstrating that location plays an important role in preference decisions. The results may also have many practical implications. If item location influences preference during the millions of purchasing choices that occur every day, it will be exerting a substantial influence on consumer behaviour. Moreover, choices from a range of options are made in many other contexts (e.g. legal and occupational), and it remains to be investigated whether the central preference remains with other formats and whether it extends to other types of decision. As choices play a crucial role in many aspects of human functioning, the role of location in choice has the potential to exert great influence.

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Pricing and Availability Intervention in Vending Machines at Four Bus Garages

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Objective: To evaluate the effects of lowering prices and increasing availability on sales of healthy foods and beverages from 33 vending machines in 4 bus garages as part of a multicomponent worksite obesity prevention intervention. **Methods:** Availability of healthy items was increased to 50% and prices were lowered at least 10% in the vending machines in two metropolitan bus garages for an 18-month period. Two control garages offered vending choices at usual availability and prices. Sales data were collected monthly from each of the vending machines at the four garages. **Results:** Increases in availability to 50% and price reductions of an average of 31% resulted in 10% to 42% higher sales of the healthy items. Employees were mostly price responsive for snack purchases. **Conclusions:** Greater availability and lower prices on targeted food and beverage items from vending machines was associated with greater purchases of these items over an 18-month period. Efforts to promote healthful food purchases in worksite settings should incorporate these two strategies.

During the past 20 years, the prevalence of obesity among U.S. adults has increased markedly from 22.9% in 1988 to 34% in 2006.[1,2] Currently, 72 million U.S. adults are obese.[2] Environmental influences are widely recognized to be important contributors to excess weight gain and the development of obesity.[3] Environmental influences on food choices include the pervasive availability of energy-dense foods in almost every setting in which people live and work. Energy-dense foods are also inexpensive and marketed in ways that highlight "value," including low prices and large portion sizes.[3]

Food Environment, Food Choices, and Obesity

Worksite Environmental Strategies to Promote Healthy Food Choices

The worksite is an important environment in which the majority of the adult population spends a significant portion of their day over a period of years.[4] Intervention strategies that change worksite environmental factors related to food, such as the types of foods available and their prices, have been examined in previous worksite nutrition intervention studies.[5–10] In both school and worksite settings, pricing, alone or in combination with availability, had a strong, dose-response effect on sales of healthy snacks from the vending machines.

Transportation Workers and Environmental Nutrition Interventions

Transportation workers comprise about 190,488 employees and, thus, represent a large U.S. employee population.[11] In comparison with people in other occupations, transportation workers are at higher risk with respect to poor dietary intake and obesity.[12–15] Transportation workers, such as bus operators, have limited opportunities for healthful eating during their workday (on the route) and often have irregular work hours that may pose additional barriers to establishing and maintaining healthful eating behaviors.

Despite their high risk for obesity and poor dietary behaviors, few interventions have targeted transportation workers. The lack of empirical research evaluating nutrition intervention strategies in transportation workers is not surprising, given the difficulty of intervening with a worker population whose worksite is in motion and changes on a daily basis. However, because this worker population is at such high risk for obesity and its health-related morbidities, intervention strategies need to be developed and evaluated that could potentially promote and sustain healthful eating behaviors that could prevent excess weight gain and obesity.

This article reports the details of one component of a multicomponent worksite environmental intervention to prevent obesity among bus operators. The combined effects of availability and pricing strategies in vending machines on changes in sales of healthy vending foods and beverages were examined during the 18-month intervention period. It was hypothesized that the combined effects of increasing the availability and decreasing the prices of healthy food and beverage choices in vending machines at the bus garages would increase the sales of these healthy choices.

MATERIALS AND METHODS

Study Overview

Data for this study were collected as part of a multicomponent worksite obesity prevention intervention (Route H). Results from the main trial are reported elsewhere.[15,16] The Route H study was conducted in collaboration with the Metro Transit Council of Minneapolis, Minnesota. Four garages in the metropolitan Minneapolis to St Paul area were selected to take part in the study. The four bus garages were paired on physical characteristics (urban location and number of employees) and then randomized within pairs to intervention or comparison conditions by the toss of a coin. The two intervention garages received an 18-month intervention to increase the availability of healthy foods and physical activity opportunities at the worksite. Intervention components included increasing availability and lowering prices of healthy vending machine items, improvements in the garage fitness room facilities, periodic group-based behavioral programs such as healthy eating challenges, group-based walking programs, group-based self-weighing programs, and fitness classes such as yoga, personal training, and strength/flexibility programs. The control garages received no intervention. Measurements completed at baseline, and 2-year follow-up included measures of body weight, food choices, and physical activity behaviors. Vending machine sales were reported monthly during the 18-month intervention. The study obtained approval from the University of Minnesota Institutional Review Board Human subjects Protection Program.

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Vending Machine Intervention

The vending machine intervention was implemented for the entire 18-month study period. The two key components of the vending intervention were to increase the availability and to lower the prices of healthier food and beverage choices in the vending machines at the two intervention garages. These two strategies were selected because they have been shown in previous research, separately and combined, to have strong effects on food and beverage purchases[5–10] and were implemented in tandem. The strategies are especially effective when implemented in settings in which the food environment is constrained and the population is somewhat captive, such as at a bus garage, at school or worksite cafeteria, or in vending machines. In this study, the bus garages' only on-site source of food was the vending machines. Limited cooking facilities were available, including a microwave, toaster, and hot plate, in the break room area. Employees could bring food from home and store it in refrigerators in the garage break room. Only at two urban garages, restaurants, fast food chains, and convenience stores were within walking distance.

The researchers worked in close collaboration with the vending machine service company to implement the vending intervention. Before the start of the intervention, inventories were completed of every machine in intervention and control garages. Research staff identified potential healthier foods and beverages that could be substituted into the vending machines to increase the availability of healthy vending choices in the intervention garages' vending machines. Taste-testing activities were conducted with the garage advisory groups before the selection of the new vending products. In addition, suggestion boxes were placed in the garage vending machine areas to solicit driver input about vending choices throughout the intervention period. Suggestions were used to identify preferred healthy choice items, but did not influence the ratio of healthy to less healthy items available in the machine.

Healthy vending choices were defined separately for the different types of foods and beverages available in the vending machines (ie, beverages, snacks, and entrees). All vending machine foods and beverages were classified as healthful or not according to nutrition criteria for calories (snacks 150 calories or fewer; entrees 400 calories or fewer; and beverages 50 calories or fewer); fat (30% or fewer calories from fat); and sugar (35% or less by weight). Examples of healthy and unhealthy items include the following: 1) entrees: turkey lean pocket versus pepperoni hot pocket; 2) snacks: Nutrigrain bar versus Snickers bar; and 3) beverage: diet soft drink versus regular soft drink. Other examples of healthy vending choices included bagels, fresh fruit, baked chips, 100 calorie wheat snack cracker packet, and lower-calorie frozen entrees.

Plans for reconfiguring the vending machines in the intervention garages were devised before the start of the intervention. Control garage vending machines continued to offer the same items as before the study and did not change items during the intervention period. Planagrams (product placement maps for each machine) were created for both intervention and control garage vending machines. Vending machine service personnel were trained by the research staff to stock the machines according to the specific planagram for each vending machine. Vending machine service personnel were instructed to stock the control garage vending machines according to the control machine planagrams to ensure that the control garage vending machines continued to offer the same items throughout the intervention and to prevent contamination of the vending machine intervention across garages.

The number of rows in each machine for healthy products was negotiated in advance with the vending machine service company and remained constant for the 18-month period. Prices for the healthy food and beverage items were also programmed into the machines at the start of the study and remained constant throughout the intervention period. The goal of the vending intervention was to make 50% of the available vending offerings meet healthy criteria and to price these items 10% lower than the usual price for the item. Fifty-percent availability was chosen based on our previous successful school-based cafeteria intervention in which healthy food availability was increased by 50%.[9] Ten-percent price reduction was chosen based on our previous vending machine pricing interventions in which a 10% price reduction was sufficient to increase sales of healthy vending choices.[5]

Sales data were collected from the vending service company on a monthly schedule and included data from intervention and control garages. Sales data were collected by the vending service staff by using a handheld computer that logged sales and fills for every machine each time the vending staff person serviced the machine. Therefore, the sales data were very accurately collected using the most modern vending sales tracking technology available. Fidelity to the vending machine planagram for healthy food availability and prices was measured weekly by in-person site visits by trained research staff who observed the machines using the specific planagram for each machine. Visits were made to both intervention and control garages to ensure that additional healthy snacks were not inadvertently placed in the vending machines at the control garages. Vending route service staff received a small monthly financial incentive for maintaining accurate product placement in the garage vending machines for which they were responsible for servicing. Accuracy of placement was extremely high, with only occasional misplaced items. When research staff observed a misplaced item, vending service staff were contacted immediately and the misplaced item was removed at the earliest possible date (usually within 1 to 2 days).

Vending Data Coding and Computation

Vending sales data were summarized into the broad categories "healthy" and "unhealthy" for the purpose of analysis. Counts of the number of items sold and sales dollars were summed across items and machines within machine type. For example, the number of healthy snack items sold within snack machines was summed across the one or more snack vending machines within a given garage. Proportion of healthy snack sales was computed by dividing the number of healthy items by the sum of the healthy and unhealthy items. These were summed across the 18-month intervention period for the purpose of analysis.

Survey Measures and Data Collection

Evaluation data were collected on-site at each of the four garages at baseline and follow-up (2 years). All garage employees who worked at each of the four garages were eligible to complete the evaluation measures. Participants were recruited using a variety of methods, including paycheck distribution fliers, signs posted in the garages, fliers distributed at health fair events, information in employee newsletters, and instant text messaging on the buses. Participants received a $20 incentive for completing the behavioral measurement survey and for having their height and weight measured by trained research staff. The average survey participation rate across the four garages was 78% at baseline and 74% at follow-up.

The surveys included self-report measures of food choices and the frequency of use of the garage vending machines. The food choices instrument was adapted from two existing instruments for which validity has been evaluated.[17,18] Participants reported their past month frequency of consumption of foods targeted by the intervention, such as fruits and vegetables (3 items), high-fat snack foods (9 items), and sugar-sweetened beverages (2 items). Vending machine frequency of use was measured using three questions about frequency of use of each type of vending machine during the past month (cold beverage, cold food, and snack food). Response

TABLE 1. Number and Proportion of Healthy and Unhealthy Food and Beverages By Vending Machine Type

Machine Type	*N*	Healthy Slots (%)	Healthy Price ($), Mean	Unhealthy Price ($), Mean	Price Difference % (Healthy − Unhealthy)/ Unhealthy, Mean
Intervention garages ($n = 2$)					
Cold beverage	8	53	0.73	0.81	−10
Cold food	2	56	0.65	2.08	−69
Frozen food	2	46	1.63	1.65	−1
Snack	3	61	0.63	1.14	−45
Control garages ($n = 2$)					
Cold beverage	9	32	0.84	0.86	−2
Cold food	3	NA*	NA*	NA*	NA*
Frozen food	2	8	1.55	1.40	+11
Snack	4	16	0.53	0.60	−12

*NA, cold food vending healthfulness information not available at control garage.

options were once a month or less, two to three times a month, one to two times a week, or three or more times a week. Responses to the vending frequency of use were dichotomized for analysis to any or no use during the past month.

Statistical Analysis

All analyses were conducted using SAS (16; SAS, Inc, Cary, NC).[19] Vending machine changes in the intervention garages began immediately, and sales data are averaged over the 18 months of the intervention. With no baseline data from which to calculate sales changes, we used control garage sales as the reference and calculated the difference between the intervention and the control garages in the percent of healthy food items purchased. Similarly, we calculated the percent difference in the dollars paid for healthy foods. The ratio of these differences indicates how responsive purchases of healthy food items are to price differentials between intervention and control garages. Within food type (ie, entree, snack, and beverage), the price of unhealthy foods is taken as the standard.

Analyses of the survey data included data from any employee who worked at the garage and completed the survey. For drivers contributing data at both baseline and year 2, the effect of the intervention was estimated using a baseline-adjusted mixed model of drivers nested in garages. A two-stage analysis of adjusted garage means was conducted on employees with data from only one time point. The nested cohort and two-stage estimates were pooled, with weights inverse to the variance. All analyses were adjusted for age, gender, education, income, marital status, race, and smoking status. Means presented in Table 2 are drawn from the entire cross-sectional sample at each time point.

RESULTS

Demographic Characteristics of Transportation Workers

Seventy-three percent of the employees who completed the surveys were bus drivers; 16% were bus maintenance staff; 8% other jobs (such as dispatchers); and 3% were managers. Seventy-nine percent of the employees were men, with an average age of 47 years (age range 19 to 79 years). Sixty-three percent were white. Forty-nine percent had completed high school/vocational school or had less education, and 43% reported annual household incomes before taxes of <$50,000. Most workers had been employed with the transit company ≥6 years, and about one third had been working with the transit company 15 years or longer. Overall, the prevalence of obesity among the transit workers was very high. The average body mass index was 32.3 kg/m^2, and 56% were obese (body mass index ≥30 kg/m^2).

Availability and Price of Healthy Vending Food and Beverages During Intervention Period

Before the intervention, both the intervention and the control garages offered very few food or beverage choices that met the healthy criteria used for the study. At the beginning of the intervention period, the 33 vending machines were reconfigured as given in Table 1. Table 1 summarizes the availability and price of healthy and unhealthy food and beverage items in the intervention garages (top panel) and control garages (bottom panel). In the intervention garages, the percent of healthy items available in the vending machines was within the target range set by the intervention (50% healthy items) and ranged from 46% to 61%. Average prices for the healthful vending foods in the intervention garages were 31% lower than the unhealthy foods. In the control garages, the availability of healthy vending machine selections was similar to that available before the intervention and ranged from 32% for cold beverages to 8% for frozen foods. In control garages, average prices for healthy and unhealthy foods were similar to each other. Thus, the intervention target price reductions of −10% and increased availability of +50% for healthy foods were successfully implemented in the intervention garages, and no changes were made in the control garage vending availability or prices.

Sales of Healthy Vending Food and Beverages During Intervention Period

Sales data during the 18-month intervention showed that the percent of healthy food items purchased was higher in the intervention garages compared with that of control garages. Employee purchases were considerably more price responsive for snack purchases compared with cold beverage purchases or frozen food purchases. For example, during the price reduction period, sales of the healthy snacks in the intervention garages were 48% of the total snack items purchased. Sales of healthy snacks in the control garages, where no price reductions were in effect, were only 6% of the total snack items purchased. Thus, the comparative healthy snack purchase ratio (intervention versus control) was about 5. Healthy cold beverage sales, by contrast, comprised about 54% of the total beverage sales in the intervention garages and 40% in the control garages. The comparative healthy cold beverage purchase ratio was 0.5. Healthy frozen foods comprised 24% of total frozen food

TABLE 2. Self-Reported Vending Machine Use and Food Choices Among Metropolitan Bus Operators

	Intervention Garages($n = 2$)		Control Garages($n = 2$)		Intervention Effect*
	Baseline	Follow-Up	Baseline	Follow-Up	
No. surveys	554	513	540	552	
Garage vending machine use (past month: % any use)	85.8	80.7	88.4	85.4	−3.5
Fruits/vegetables (servings per day; 4 items)	2.2	2.2	2.0	1.9	0.25
Snacks/sweets (servings per day; 9 items)	1.2	1.0	1.3	1.1	−0.12
Sugar-sweetened beverages (servings per day; 2 items)	0.6	0.5	0.6	0.5	0.04

*Pooled intervention effect: inverse variance weighted effects for cohorts and cross-sectional participants. The value is not a simple net difference.[16]

sales in the intervention garages and 14% in the control garages, for a ratio of 0.78 for healthy frozen food purchases.

Frequency of Vending Machine Use Reported by Bus Operators

Table 2 presents the self-reported survey frequency of vending machine use reported by bus operators at baseline and after the 18-month intervention in the intervention and control garages. Overall, vending machine use was modest. At baseline, 32% reported using the snack food vending machine three or more times per week during the past month (17% reported 5 to 7 days per week); and 34% reported using the cold beverage vending machine three or more times per week (19% reported 5 to 7 days per week). Only 8% reported using the cold food vending machine three or more times per week (3% reported 5 to 7 days per week). Frozen food vending machine use was not queried on the survey.

At follow-up, drivers in both intervention and control garages reported less frequent vending machine use compared with baseline. No significant differences were observed between the intervention and control garages in the percent of drivers who reported using the vending machines three or more times per week. Changes in self-reported sugar-sweetened beverages, snack food, and fruits and vegetables were similar among drivers in intervention and control garages.

DISCUSSION

This study showed that the proportion of sales of healthy food and beverages from vending machines in metropolitan bus garages was higher when the availability of healthy foods and beverages in the machines was increased and the prices lowered. Sales of healthy foods at the intervention garages were on average about double that of the control garages (55% of items sold at intervention garages compared with 19% at control garages). These findings are consistent with previous studies in worksite settings that used pricing and availability to promote healthful vending choices.

The inconsistency between the aggregate sales data and the individual survey self-reported behavior is similar to the results found in a recent school-based cafeteria environmental intervention to promote healthful food choices through increases in availability.[9] In that study, sales of healthful foods increased when healthy foods were increased in availability, but student surveys of food choices did not show changes in reported food choices.

Several reasons may explain the apparent inconsistent findings between the aggregate vending sales data and the individual driver self-reported food choices. First, the vending machines are located in the bus garages, and only a small proportion of bus drivers use the vending machines frequently. Second, dietary recall data from this study (not presented here) show that only about 90 kcals per day are obtained at the vending machines, hence, the overall impact of changes in the vending machine choices will be small, at best. Most drivers obtain the food that they consume at work from sources other than the vending machines.

Despite limitations (described below), vending machine interventions can still be an important component of a multicomponent worksite intervention package. Although it is unrealistic to expect a single vending machine intervention to change overall dietary intake, vending machine interventions that are combined with a package of strategies implemented at the worksite may be effective in significantly impacting dietary intake and food choices. Vending machine interventions also may have effects on other important mediators of dietary behavior, such as perceived norms, social support, perceived environmental opportunities, and knowledge and attitudes about healthful eating.[15,16]

Strengths of this study include the careful implementation and monitoring of the vending machine changes during a lengthy intervention period. Research staff monitored the vending machines during the intervention with weekly site visits to garages to observe the vending machines. Accurate and complete data were collected for the entire study period by working closely with the vending machine service company drivers and managers. Thus, the vending intervention was implemented with high fidelity and the sales data quality was high.

Limitations of the study were that only aggregate sales data are available. It was not possible to know whether the vending intervention influenced individuals to change their vending food and beverage choices or whether the intervention attracted new patrons who were self-selected in terms of their interest in healthy eating. Self-report survey data on vending machine frequency of use showed overall decreases in the vending machine frequent users. However, the objective sales data did not show such temporal declines in total vending sales (data not shown). Sales data also reflect the vending use behavior of the drivers who are physically at the garages and, therefore, have access to the vending machines. The survey data, by contrast, represent a much broader range of bus operators, some of whom do not spend time at the garage and, thus, have little exposure to the vending machines.

In conclusion, pricing and availability interventions in worksite vending machines promote sales of the targeted healthy food and beverage items as part of a multicomponent environmental intervention and may contribute to change in overall dietary intake. However, worksite nutrition interventions that target the physical food environment at the worksite may be less effective in changing overall food choices among mobile worker populations, such as bus operators, compared with worker populations that spend most of the workday at the worksite, such as in office settings.

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Pricing and Promotion Effects on Low-Fat Vending Snack Purchases: The CHIPS Study

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ABSTRACT

Objectives. This study examined the effects of pricing and promotion strategies on purchases of low-fat snacks from vending machines.

Methods. Low-fat snacks were added to 55 vending machines in a convenience sample of 12 secondary schools and 12 worksites. Four pricing levels (equal price, 10% reduction, 25% reduction, 50% reduction) and 3 promotional conditions (none, low-fat label, low-fat label plus promotional sign) were crossed in a Latin square design. Sales of low-fat vending snacks were measured continuously for the 12-month intervention.

Results. Price reductions of 10%, 25%, and 50% on low-fat snacks were associated with significant increases in low-fat snack sales; percentages of low-fat snack sales increased by 9%, 39%, and 93%, respectively. Promotional signage was independently but weakly associated with increases in low-fat snack sales. Average profits per machine were not affected by the vending interventions.

Conclusions. Reducing relative prices on low-fat snacks was effective in promoting lower-fat snack purchases from vending machines in both adult and adolescent populations. (*Am J Public Health.* 2001;91:112–117)

Although intake of dietary fat as a percentage of total energy has declined in recent years, levels remain higher than the 30% recommended.[1–5] It is unclear whether absolute fat intake has increased, decreased, or stayed the same over the past decade, however, because total energy intake may be increasing.[2,6,7] The relative contributions of excess dietary fat and excess total energy to the development of obesity are unclear.[2,6–9] However, dietary fat intake is of interest because of its relationship to cardiovascular disease and cancer.[10] Thus, dietary practices that contribute to excessive fat intake need to be identified, so that public health interventions targeted at modifiable dietary behaviors may be implemented. This issue is of great importance for adolescents, because dietary behaviors established in childhood can continue into adulthood and potentially affect long-term health.[11]

Among the potential dietary behaviors that could contribute to high fat intake is the consumption of convenience foods.[12–14] Vending machine snacks are a prime example of convenience foods that are pervasive in diverse community settings such as worksites and secondary schools. Research has shown that more than 1.5 million vending machines were located at such sites in 1998.[15] Industry-wide vending sales increased by 5.6% in 1998, to $23.3 billion.[15] Not only are vending machines ubiquitous, but the food choices offered in snack vending machines are largely high in fat. One study of vending machines in secondary schools showed that only 27% of machines offered a low-fat snack choice such as pretzels, while 60% offered candy bars and 57% offered chips.[16] The candy/snack segment alone in 1998 represented 25% of vending sales and generated $5.92 billion in revenue.[15]

Vending machines offer a convenient venue for examining environmental nutrition intervention strategies such as product availability, promotional marketing, and pricing.[17–19] The array and pricing of food selections are controlled by the vendor and can easily be manipulated. Little nutrition intervention research has been done involving the use of vending machines, however, and the majority of existing research suffers from design limitations that make the results difficult to interpret.[19–22]

A recent vending machine study showed strong pricing effects for low-fat vending snack purchases. Sales of low-fat snacks increased by 80% during a 3-week period when low-fat snack prices were reduced by 50%.[22] Pricing strategies have also been shown to be effective in promoting purchases of healthful foods such as fruits, vegetables, and salads.[23,24] In a worksite cafeteria, lowering fresh fruit and salad bar prices by 50% increased sales 3-fold.[24] In a high school cafeteria, sales increased 2-fold to 4-fold when prices for fresh fruit and baby carrots were reduced by 50%.[23]

The results of this series of studies clearly show the effect of large decreases in price on both foods considered "healthful" and less nutritious "snack foods." A limitation in the literature has been the lack of studies comparing promotional strategies alone or in combination with pricing strategies with regard to modifying food purchases. In addition, a detailed examination of the impact of various strategies on revenues has not been conducted. In the vending machine study just described,[22] average profits per machine per week were $116, and this total was reduced to $66 per machine per week during the 50% price reduction period. Further research on the impact on revenues of various price reductions for promoting health-

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ier food choices is needed for evaluation of the feasibility of such interventions in real-world settings.

The adolescent population represents a growing demographic segment in the United States, and this group is expected to increase by 10% during the next 5 years.[25] Teens have increasing autonomy over their food choices and spend about $5.4 billion annually on fast food.[26] Adolescents derive a larger proportion of their total energy from high-fat snack foods and are the least likely of all age groups to meet national recommendations regarding dietary fat intake.[1,27,28] Strategies need to be identified that might be uniquely effective in promoting improved dietary choices in this population segment. Adolescents could prove to be more responsive than adults to pricing of snack foods, given the more central role that snacks play in their diet.[1,27,28]

The purpose of the present study—Changing Individuals' Purchase of Snacks (CHIPS)—was to examine the effect of environmental interventions on food choices among adolescents and adults in a naturalistic setting. Vending machines were selected as a vehicle to explore pricing and promotion strategies for influencing low-fat food choices at diverse community sites. This study expanded on our previous research by examining 3 interrelated issues. First, several levels of pricing reduction were examined to determine whether smaller price reductions would increase sales of targeted snacks while maintaining overall profitability. Second, 3 different levels of promotional signage were evaluated with regard to the independent effects of promotional signage on low-fat vending snack sales. Third, differences in responsiveness to pricing and promotional interventions among adolescent and adult populations were examined via implementation of the interventions in vending machines at worksites and secondary schools.

Methods

Design

The study examined pricing and point-of-purchase promotion effects on sales of low-fat and regular vending snacks at 12 worksites and 12 schools in Minneapolis–St. Paul, Minn. Sites represented a convenience sample of customers of a large vending machine service company in the midwestern United States and were selected for demographic and geographic diversity. Four levels of pricing and 3 levels of promotion were examined in a Latin square design (Figure 1).[29] The 4 levels of pricing were (1) equal price, (2) 10% price reduction for low-fat snacks, (3) 25% price reduction, and (4) 50% price reduction. The 3 levels of promotion were (1) no signs, (2) signs labeling low-fat snacks, and (3) signs labeling low-fat snacks combined with signs placed on vending machines encouraging a low-fat snack choice. The overall design was a 2 (setting: workplace or school) × 4 (pricing: equal, 10% reduction, 25% reduction, 50% reduction) × 3 (promotion: none, label only, label plus sign) factorial.

Intervention Procedure

Vending route drivers and supervisors were trained by study staff on the study protocol approximately 2 weeks before the intervention and again at the midpoint of the study. Study staff set up each of the 55 vending machines. Setup included placement of low-fat snacks in 2 designated rows of the vending machine and placement of the appropriate low-fat labels or signs. Low-fat snacks were defined as snacks with 3 g or less fat per package. Approximately 10 low-fat snack columns were placed in each machine (of a total capacity of 60; about 17% of the total placements available in a machine). Low-fat snack availability was constant across pricing and promotion conditions. Thus, pricing effects were not confounded with availability.

Each of the 12 treatment conditions shown in Figure 1 was implemented at each of the 24 sites in a randomly assigned sequence in such a way that period effects (if any) were balanced over experimental conditions during each month. Each treatment remained in effect in all of the snack vending machines at a given site for a 4-week period. At the end of each month, research staff met the drivers at the machine to change the prices and signage for the next study condition.

Weekly site visits to each worksite and school by study staff provided information about fidelity of implementation. Accuracy of placement was consistently high across all sites during the 12 months of the intervention (average placement accuracy: 93%; range: 82%–100%).

Sales Data Collection

Sales data were recorded continuously throughout the intervention. Each time the machine was serviced, manual inventory counts were performed by vending route drivers separately for low-fat and regular snacks and were recorded on the driver's machine inventory card. These sales data were entered into a database at the central office. The sales database tracked sales within machines over time. Low-fat snack categories included low-fat chips, low-fat candy, low-fat pastry, low-fat snacks, and low-fat cookies. For analyses, both low-fat categories and regular categories were combined to yield 2 categories, low-fat snacks and regular snacks.

Statistical Analysis

The study was a randomized trial in which sites were assigned a randomized sequence of treatment conditions (a total of 12). The unit of observation was the vending machine (sales from each machine). The unit of analysis was the site (sales per site, pooling across all machines at the site). All analyses were conducted with the SAS statistical computing package.[30] SAS PROC MIXED was

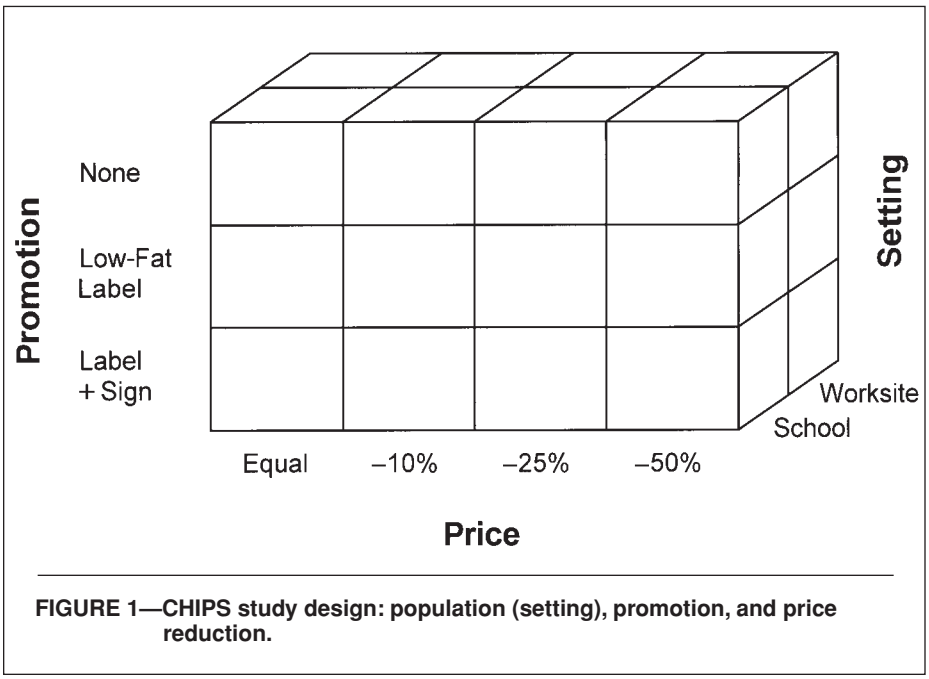


FIGURE 1—CHIPS study design: population (setting), promotion, and price reduction.

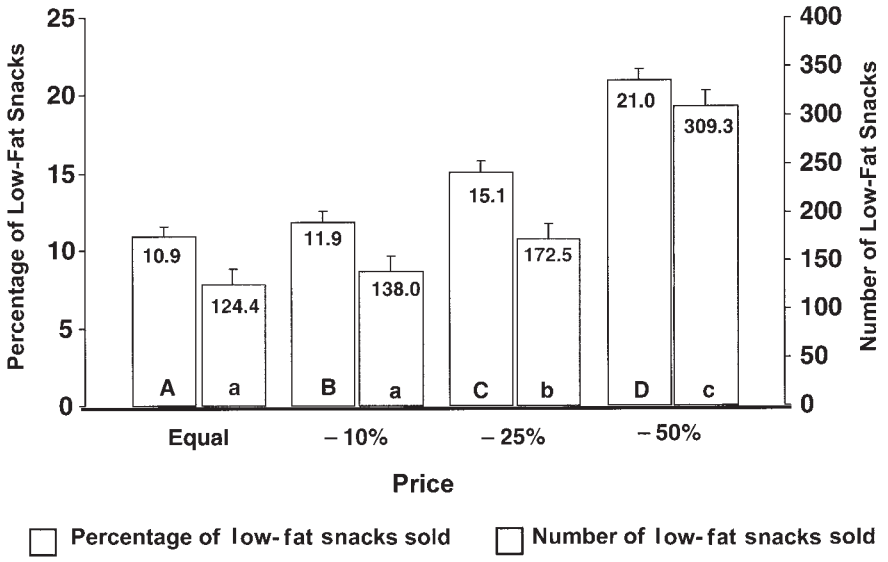
used for the analysis because of its efficiency in handling balanced and unbalanced cases and its ability to handle multiple random effects such as those involved in the present study design.

The analysis of variance model was a 3-way factorial in which setting (worksite or school) was crossed with price and promotion; machine sales formed exchangeable repeated measurements. Each machine involved 12 treatments and 4 weekly measures. Fixed variables included setting (worksite or school), price reduction (none, 10% reduction, 25% reduction, 50% reduction), and promotion (none, label only, label plus sign). Random variables included site (24 sites) and machines (1–5 per site) nested within site.

Two-way interactions of setting with promotion and price reduction were examined and, with 1 exception, were found to be nonsignificant; therefore, they were dropped from the model. Means reported were derived from main effects models and were adjusted for other model variables. The denominator degrees of freedom were 22, 44, and 66 for setting, promotion, and price reduction, respectively. Main effects were considered statistically significant at $P<.05$, and interactions were considered significant at $P<.01$.

Sales data represented the primary outcome, and these data were considered in 3 ways: (1) proportion of low-fat snack items, (2) absolute number of low-fat snack items, and (3) net profits (dollar sales minus wholesale cost to the vendor). Sales data for each machine were pooled across weeks to create a total for the 1-month treatment interval for each experimental condition. The dependent variable was average sales per site per experimental period (averaged across all machines at a given site).

Total product volume was also examined to determine whether the intervention affected overall sales volume. Examination of sales volume is helpful in determining whether increases in low-fat snack sales are due to increases in the total number of products sold or to customers' switching snack choices but not to increases in the absolute number of snacks purchased. Both absolute volume and log volume were examined. Log volume was examined for adjustment for overall differences in mean levels of sales volume across settings, because schools and worksites differed dramatically in initial absolute sales volume (reported later). Means from the equal price/no label condition are reported as an additional reference point for interpretation of the results. This condition most closely reflected a "control" condition in which low-fat snacks were priced equally to regular snacks and did not include any signage or labeling.



Note. Different letters within each set of bars (white, shaded) indicate significantly different means according to post hoc comparisons ($P<.05$).

FIGURE 2—Percentage of low-fat snacks sold and total number of low-fat snacks sold per machine per treatment period, by price reduction condition: CHIPS study, Minneapolis–St. Paul, Minn, 1997–1999.

Two types of missing data occurred in the CHIPS study. First, one school discontinued participation in the study after 3 months and a new, similar school was recruited to take part. Second, data were missing in 2 site–treatment condition combinations (out of a total of 288) involving the same company. This problem was addressed via regression imputation. The unbalanced data were analyzed, and the predicted entries (based on both fixed and random effects) for the 2 missing cells were saved. In each cell, a realized value of the component of variance for the machine was added. Estimates involving the original unbalanced data were very similar to those involving the imputed data. Therefore, only the results based on the original data are reported.

Results

Low-Fat Snack Sales

Over all treatment conditions, the average percentages of snack sales that were for low-fat snacks were 12.6% at schools and 16.9% at worksites ($F_{1,22}=12.66$, $P<.002$). In the equal price/no label condition, the average percentage of snack sales that were for low-fat snacks was 9.9%. Price reduction was significantly associated with percentage of low-fat snack sales ($F_{3,66}=156.89$, $P<.001$; Figure 2). Under equal pricing (averaged across promotion conditions), 10.9% of snack sales were sales of low-fat snacks. Price reductions of 50%, 25%, and 10% were associated with increases in low-fat snack sales of 93%, 39%, and 9%, respectively. Each price reduction condition was significantly different from every other price reduction condition in post hoc mean comparisons ($P<.05$). The total number of low-fat snacks sold was significantly different by price reduction condition ($F_{3,66}=96.98$, $P<.001$; see Figure 2).

Post hoc mean comparisons showed that the number of low-fat snacks sold in the 10% price reduction condition did not differ significantly from the number of low-fat snacks sold in the equal price condition. Price reductions of 25% and 50% were associated with significant increases in the absolute number of low-fat snacks sold relative to the equal price and 10% price reduction conditions ($P<.05$). The total number of low-fat snacks sold differed significantly between the 25% and 50% price reduction conditions (post hoc comparisons, $P<.05$). There was a significant interaction between setting and price reduction ($F_{3,66}=13.9$, $P<.0001$). The size of the increase in the number of low-fat snack sales in the 50% price reduction condition was slightly larger at schools than at worksites.

Promotion of low-fat snacks was significantly and independently associated with greater low-fat snack sales ($F_{2,44}=3.48$, $P<.04$). The percentages of low-fat snacks sold in the no-label, label-only, and label-plus-sign

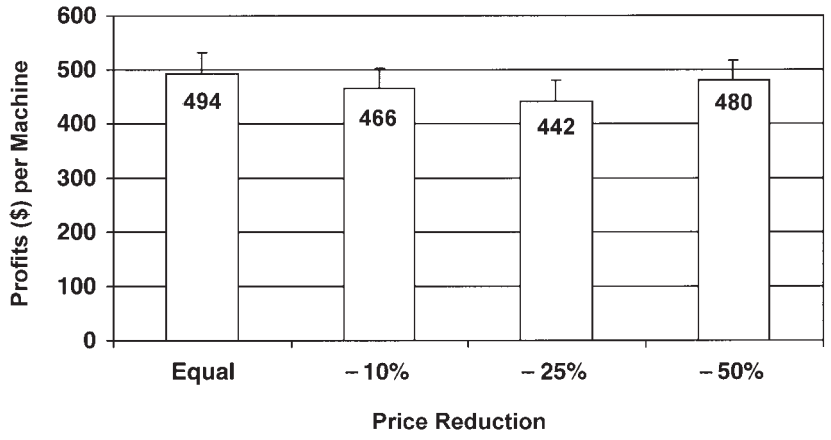


FIGURE 3—Profits in dollars (price minus cost) per machine per treatment period, by price reduction condition: CHIPS study, Minneapolis–St. Paul, Minn, 1997–1999.

conditions were 14.3, 14.5, and 15.4, respectively. Only the label-plus-sign condition differed significantly from the no-label condition in post hoc mean comparisons ($P<.05$). Total number of low-fat snacks sold did not differ significantly by promotion condition.

Profits in Dollars per Machine

The average profit (price minus cost) per machine per period was $470 (Figure 3). Overall profits in the equal price/no promotion condition were $512 per machine. Profits per machine per treatment period were significantly higher at schools ($684) than at worksites ($257) ($F_{1,22}=35.84$, $P<.001$). There were no significant main effects for price or promotion, and no significant 2-way interactions, on vending machine profits.

Sales Volume

Overall sales volume averaged across all treatment conditions was 1389 products per machine per period. Overall sales volume in the equal price/no promotion condition was 1512 products per machine per period. Sales volume at schools was significantly higher than at worksites (1928 and 807 per machine per period, respectively; $F_{1,22}=29.10$, $P<.001$). Promotion was unrelated to sales volume. However, price reduction was significantly associated with sales volume ($F_{3,66}=11.01$, $P<.001$). Sales volumes in the equal price, 10% reduction, 25% reduction, and 50% reduction conditions were 1325, 1309, 1280, and 1557 products, respectively.

Post hoc mean comparisons showed that sales volume was significantly higher in the 50% price reduction condition than in the 3 other price reduction conditions, which did not significantly differ from each other. There was a significant interaction between setting and price reduction ($F_{3,66}=4.84$, $P<.004$). The size of the sales increase in the 50% price reduction condition was slightly larger at schools than at worksites. However, the setting×price reduction interaction term was not significant when log sales volume was the dependent variable.

Discussion

Lowering the prices of low-fat vending snacks had a strong effect on sales of low-fat snacks from vending machines at diverse worksites and secondary schools. Sales of low-fat snacks increased proportionately with increasing price reductions. Labels and signage promoting low-fat snack choices had small but positive statistically significant effects on low-fat snack sales. Machine profits were not significantly affected by the price reduction or promotional signage. Pricing and promotion had similar effects in adolescent and adult populations. These findings are consistent with our previous work, which showed large positive effects on sales of low-fat vending snacks[22] and fresh fruit and vegetables[23,24] with 50% price reductions. The results of the present study extend our previous work by showing similar effects on sales of low-fat vending snacks with smaller price reductions and by demonstrating small but independent effects for labels and promotional signs.

A small, 10% price reduction increased the percentage of snacks sold that were low fat without increasing the absolute number of low-fat snacks sold or the total sales volume. This finding suggests that customers may have been substituting a low-fat snack for a regular snack, a positive result from a public health promotion perspective. However, when prices were reduced by 25% or 50%, the absolute number of low-fat snacks sold increased, as did the total sales volume in the 50% price reduction condition. This finding suggests that customers may have been increasing the number of snacks they purchased from the vending machine. If this were the case, overall energy intake from vending machine snacks might be higher than if a single, higher-fat vending snack had been purchased, an undesirable outcome in terms of public health efforts to promote healthful eating behaviors.

In fact, these data illustrate the current confusion with respect to public health messages about nutrition.[8,9] Messages urging lower fat intake may be interpreted by some to mean that portion size is unimportant if the food energy consumed is low fat or fat free. Alternatively, increases in sales volume could reflect the attraction of a greater number of customers to the vending machines when prices were lowered by 50%. Athough this outcome is positive from a business perspective, its interpretation is unclear from a public health perspective. These issues should be addressed in future research that tracks food choices at the individual level.

Although large price reductions on low-fat vending snacks might have the undesired outcome of increasing total energy from foods of low nutritional value, our previous work shows similar effects for price reductions on healthful foods such as fresh fruit and vegetables.[23,24] Price reductions that lead customers to double the number of fruits and vegetables they purchase, or that attract new customers, would be a positive outcome from both a business and a public health perspective. Such a strategy reduces cost as a barrier to fruit and vegetable consumption and could increase the number of people reaching the 5-a-day goal for fruit and vegetable intake.[31]

In the present study, lower prices on low-fat snacks were not associated with smaller profits. Post hoc mean comparison tests showed a significant quadratic trend, which provides interesting information for designing future research studies. Small price reductions, or larger price reductions combined with higher sales volume, might make a low-pricing strategy for low-fat snacks economically feasible in real-world settings such as worksites and schools. Another potentially feasible approach to maintaining or perhaps even increasing profits that has not yet been empirically evaluated is to raise prices on high-fat items while simultaneously lowering prices on low-fat items. This would allow sales of high-fat foods to subsidize lower prices on low-fat foods while maintaining overall profits.

Consider the 25% price reduction condition (Figure 2). The low-fat snack sales increased to 15%, so that other snacks constituted 85% of sales, for a ratio of 6:1. A price increase of 4% on other snacks would be needed to offset the 25% price reduction for the low-fat snacks. This creates a 29% price difference, so lowering the prices of low-fat snacks by only 20% and raising prices 4% on other snacks might be sufficient to increase low-fat snack sales and offset profit losses from lower prices on low-fat snacks. The challenge is to find the optimal price increase for high-fat foods that would curb demand for the less healthful, high-fat foods while maintaining enough sales to turn a profit that would offset the lower profits on the lower-priced low-fat items.[18,32]

Promotion of low-fat snacks using labels and small signs had a small but significant independent positive effect on low-fat vending snack sales. There are several reasons the promotion intervention might not have had strong effects on vending snack sales. Simple placement of signs on the machines may not be enough to change behavior. A strong promotional intervention such as larger signs, other media involvement, or an in-person promotion might produce larger effects on sales. Other promotional approaches might involve de-emphasis on fat content and a greater focus on taste, brand, or functionality.

Although it was originally hypothesized that adolescents would be differentially responsive to the pricing strategy, no significant interactions were found for population and strategy type on low-fat snack sales. Both adolescents and adults were price sensitive. The particular segment specifically interested in low-fat foods may be more likely to select a low-fat vending snack regardless of pricing or promotion.[33–36] Lower pricing and greater promotion of low-fat snacks are 2 effective approaches to changing food choice behavior among the broader population of adult and adolescent consumers who are not positively predisposed toward lower-fat snack choices. Even small improved dietary choices among teens could help establish longer-term healthful dietary practices that could potentially affect lifetime health.[11,23,27,28]

A study limitation was the inability to determine whether increases in sales were due to substitution of a regular snack with a low-fat snack, increases in the number of purchases by existing customers, or new customer sales. The pattern of total number of low-fat snack sales and total sales volume suggests that substitution may have taken place in the 10% price reduction condition. However, in the 50% price reduction condition, customers may have been increasing the absolute number of low-fat snacks they purchased or new customers may have been patronizing the vending machines. Future studies are needed to examine, within individuals, different patterns of food choices (e.g., substitution vs increased purchases) that occur under different-sized price reductions.

The effect of low-fat snack purchases on food choices at other times during the day is also not known. People who made low-fat snack choices at the vending machine could have (1) compensated for their lower-fat snack choice by selecting higher-fat foods later in the day, (2) generalized their lower-fat food choice to other eating situations during the day, or (3) made no additional changes in food choices during the day. If people were increasing the number of low-fat snacks they purchased in the 50% price reduction condition, it is not known whether their total energy intake was reduced later to compensate.[8,9]

Other study limitations included the limited type and number of low-fat snacks available and the relatively short time period for each treatment condition. Low-fat snack selections were limited in variety, and the effects of pricing and promotion may vary by food type. However, our previous research revealed strong effects for 50% price reductions on fresh fruit and vegetables.[23,24] The problem of empty slots (time delay between a slot's emptying and a driver's refilling the machine) may have limited the size of the observed effects on sales, especially in the 50% price reduction periods.

Future research should examine the effects of simultaneous price increases on high-fat foods and price reductions on low-fat foods. Such research would provide useful information about the effectiveness and feasibility of food pricing strategies that could be self-sustaining in real-world settings. Valuable insights into the determinants of people's food choices and the generalizability of changes in food choices could be gained by following a cohort of individuals to evaluate the effects of low-fat food choices in one setting on their food choices in other settings during the day. Future research could also examine whether concurrent pricing and promotion through vending and school or worksite food services could achieve even larger effects on sales of low-fat foods from both sources (cafeterias and vending machines).

Conclusions

The present study clearly demonstrates that lowering prices is a very effective method of promoting desired food choices in community-based settings and that it can be done while maintaining overall profitability. People who are concerned with promoting good nutrition at schools, worksites, and other community settings need to make tasty, healthful food choices available at attractive prices while maintaining overall profitability. □

Contributors

S. A. French implemented the study, wrote the paper, and conducted the data analysis. R. W. Jeffery and M. Story provided advice about study implementation and editorial input on the paper. K. K. Breitlow coordinated the daily activities related to study implementation. J. S. Baxter created and managed the database and conducted the data analysis. P. Hannan provided advice about statistical and analytic issues and editorial input on the paper. M. P. Snyder assisted with school food service data collection.

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SPECIAL TOPIC

Public Policy Versus Individual Rights in Childhood Obesity Interventions: Perspectives From the Arkansas Experience With Act 1220 of 2003

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PEER REVIEWED

Abstract

Childhood obesity is a major public health problem. Experts recommend that prevention and control strategies include population-based policies. Arkansas Act 1220 of 2003 is one such initiative and provides examples of the tensions between individual rights and public policy. We discuss concerns raised during the implementation of Act 1220 related to the 2 primary areas in which they emerged: body mass index measurement and reporting to parents and issues related to vending machine access. We present data from the evaluation of Act 1220 that have been used to address concerns and other research findings and conclude with a short discussion of the tension between personal rights and public policy. States considering similar policy approaches should address these concerns during policy development, involve multiple stakeholder groups, establish the legal basis for public policies, and develop consensus on key elements.

Introduction

Childhood obesity has rapidly become a major public health problem; rates may have leveled, but they have not declined (1). Medical costs for childhood obesity-related illness in the United States are estimated at more than $10 billion annually (2), and future medical costs for overweight adolescents may approach $46 billion (3). Left untreated, today's overweight adolescents are expected to experience 161 million years of life complicated by obesity, diabetes, and heart disease (3).

Given the enormity of the obesity burden, a collective response is needed for addressing obesity. Opportunities are available at multiple levels — communities, schools, industry, media, families, and individuals — to reduce the prevalence of obesity (4), and a complex-systems approach, encompassing multiple levels of a social-ecological model (5), is recommended by experts (6). Political discussions are dominated by consideration of the relative weight that should be given to personal responsibility and population approaches (1).

Population-based obesity control policies are recommended (7) to affect diverse population groups and to promote healthy physical activity and eating as default or normative behaviors (8). Policy proponents argue that society is obligated to protect children and other vulnerable populations from harm and ensure their right to safe and healthy environments (1).

Arkansas Act 1220 of 2003 (9) was among the first comprehensive legislative initiatives to combat childhood obesity. Its implementation provides an example of the controversies inherent in childhood obesity policy initiatives and the tensions between individual rights and public policy.

Background of Arkansas Act 1220 of 2003

The development of Act 1220 has been described in detail elsewhere (10). Briefly, the impetus for the act can be traced to 2 conferences (10) attended by legislators in early 2002 that focused on reducing childhood obesity. Subsequently, the Arkansas House of Representatives speaker-elect requested that the Department of Health work with the Department of Education and other constituencies to draft a bill delineating school policy changes to reduce childhood obesity. This bill was introduced during the 2003 legislative session with strong support in both the state House and Senate and was passed into law quickly.

Act 1220 had 6 key elements: 1) annual measurement of body mass index (BMI) for public school children and a report of each child's BMI and associated health risks sent to parents (this element was modified in 2007 to require BMI assessment only in kindergarten and even-numbered grades 2-10), 2) elimination of access to vending machines during school for elementary school students, 3) identification of funding to hire community health promotion specialists to work with schools and communities, 4) creation of a statewide Child Health Advisory Committee (CHAC) to recommend evidence-based school nutrition and physical activity regulations, 5) public reporting of vending contracts, and 6) establishment of school nutrition and physical activity advisory committees. CHAC deliberations led to regulations enacted by the state board of education (11), including restrictions on vending machine access in all public schools.

Evaluation of the Implementation and Outcomes of Act 1220

Soon after Act 1220 became law, the Robert Wood Johnson Foundation (RWJF) funded the Arkansas Center for Health Improvement at the University of Arkansas for Medical Sciences (UAMS) to develop and analyze a statewide BMI database. RWJF also funded the UAMS Fay W. Boozman College of Public Health to conduct a process and impact evaluation of the act's implementation. The projects funded by these 2 distinct grants provide data relevant to the concerns surrounding individual rights versus public policy and how Arkansans viewed these concerns. The funding from RWJF for the evaluation will ultimately cover an 8.5-year evaluation period.

The evaluation used both quantitative and qualitative methods to obtain data from multiple sources, including principals, superintendents, randomly selected parents and adolescents (aged 14-18 y), minutes from CHAC and other relevant meetings, and perspectives from key stakeholders. Records review, key informant interviews, surveys, and telephone interviews all contributed data for the evaluation, described in detail elsewhere (10). Baseline data collection for the evaluation began in spring 2004, before implementation of any policy components, and will continue through 2012.

Reaction to Act 1220

The act passed into law with little controversy, essentially unnoticed by people outside the legislature. Subsequent attention stimulated public concern (10) in 2 primary categories — concerns related to BMI measurement and reporting and those related to changes in vending machine access and contents — specifically to individual rights versus public policy concerns.

Concerns related to BMI measurement and reporting

Act 1220 initially required public school children in grades kindergarten through 12 to have their BMI assessed annually, and reports to be sent to parents on report cards; however, this requirement was immediately modified by the legislature to require that confidential reports be sent to parents. Nonetheless, the following concerns continued to be reported:

1. **Informing parents of their children's weight status is unnecessary because they already know it**. Although parents commonly reported that they could recognize an overweight child, data indicate that even professionals have difficulty correctly classifying children's weight status (12). Evaluation data reveal that parents often do not correctly classify overweight children, although correct parental classification improved after Act 1220 implementation (13).
2. **BMI measurement and reporting violate confidentiality and invade privacy. Parents and school personnel both reported concerns in this area.** However, evaluation data gathered from parents, principals, and superintendents reveal a different attitude. Each year, a majority of parents reported being comfortable with receiving the BMI report (Table 1), and even in early years of implementation, school administrators rarely reported receiving

calls or other contacts from parents about BMI measurements. By the third year of BMI measurement, a majority of principals (64%) and superintendents (54%) reported that they had no calls from parents about the measurements (14). Some vocal parents and school administrators, and even some members of the media, raised concerns about invasion of privacy from BMI measurement. However, with the Arkansas Center for Health Improvement's leadership, health, school, and professional communities collaborated early in the act's implementation to develop procedures for BMI assessment to ensure confidentiality (10). Evaluation data support the success of these efforts; in recent years, approximately three-fourths of parents reported comfort with confidentiality of the assessment and reporting processes, and students rarely reported embarrassment (Table 1). Parent and adolescent data demonstrate that most families do not have privacy concerns about BMI assessment/reporting.

3. **Schools have neither responsibility nor time for measuring BMI**. School administrators expressed concern that schools are primarily focused on education, not reducing obesity, and that taking time to measure BMI, in particular, reduces their time for education. Nonetheless, data reveal that school personnel acknowledge their responsibility for contributing to children's overall development (15), and very few principals and superintendents actually reported logistical or other problems with BMI assessment (14).
4. **Harm (eg, increased weight-based teasing, increased eating disorders, and negative emotional consequences) may occur because of BMI assessment**. Concerns emerged from both parents and health professionals about adverse consequences related to emotions, unhealthy diets, and increased eating disorders. However, these consequences have not materialized (10). Students reported a reduction in these anticipated negative consequences over time (Table 2), although confidence intervals were wide, largely because of limited sample sizes.

Concerns related to vending machine access

The evaluation revealed the following concerns about individual versus public rights associated with vending machine changes:

1. **School budgets would be adversely affected**. School personnel expressed concern that their schools would lose revenue from reduced vending machine purchases. Although these revenues are unrestricted and therefore provide substantial flexibility in their use, 81% of schools reported vending revenues of less than $5,000 per year. Approximately 75% of schools reported stable or increased vending revenues between evaluation years 2004 and 2005 (15). Thus, vending revenues were low for most schools and apparently not affected by the legislation. Furthermore, other states have determined that vending machine revenues do not decline as healthy options increase (16).
2. **Students should not be forced to accept healthier options and will not purchase them when available.** Both parents and school personnel expressed concerns that students should not be forced to accept healthier options. However, evaluation data indicate that a majority of parents believe that schools should not have vending machines in middle and high schools (Table 3). Data also indicate that an increasing number of parents (59% in 2007, up from 51% in 2004) believe that schools should have only healthy options in vending machines, and most parents reported believing that schools should have at least a balance of healthy and unhealthy options. Although the evaluation did not assess student purchases, other research reports that students purchase healthy options when these are available (16).
3. **Students will get unhealthy options elsewhere if these options are unavailable at school.** Principals and superintendents, in particular, expressed the belief that having less access to unhealthy options in schools might cause students to purchase more unhealthy options outside of school (14). However, data from middle schools in Connecticut demonstrate that replacing low-nutrition items in schools with healthier options resulted in decreased student consumption in school of unhealthy beverages and salty snacks but no increase in unhealthy consumption at home (17). The study did not specifically assess out-of-school purchases but did demonstrate that low-nutrition food and beverage consumption does not necessarily increase, at least at home, with a shift toward healthier options in schools.

Legal Rationales for and Against Government Actions in Addressing Obesity

The overarching legal concern raised with Act 1220 by proponents of individual rights was whether the legislature and, later, health and education departments, acted

beyond their legal authority. Government entities have the sole, legitimate authority to pursue actions and initiatives intended to improve public health (1). Private entities pursue public health policies legitimately when acting as an agent of state or federal governments. However, the population perspective of public health programs and policies inevitably affects individual rights and freedoms (18). Maximizing public health protections may require restricting individuals' freedoms to behave in ways that are potentially deleterious to the population's health. For example, food safety regulations restrict the freedom of food growers, processors, transporters, and vendors to act without limits, but because of restrictions and requirements placed on these entities, the public enjoys safer foods. Having fewer restrictions maximizes individual freedom but may not acceptably guarantee the public's health. In contrast, more restrictions can reduce foodborne illnesses but lessen freedom of action by individuals and companies. From a societal perspective, although the health and safety of the public are valued, in the United States, an even higher value is typically placed on individual rights and freedoms.

Government authority to act

Authority to protect the public's health rests primarily with state governments, although the federal government does have some responsibility in this area. State governments act under 2 primary types of legal authority: *parens patriae* power (state power to act for those who cannot care for themselves) and police power (state power to act in pursuit of the public's health, welfare, safety, and morals) (19). Although both types of authority allow the state to act to ensure public health, *parens patriae* authority typically has less impact than police power authority (20).

In addressing the individual and population burden of childhood obesity, Arkansas acted within its established authority to protect and promote the public's health (21). The effectiveness of this effort appears to have contributed to a decreasing prevalence of obesity in Arkansas without resulting in adverse consequences (22). These gains in public health came about, however, as a result of individual-level restrictions. Act 1220 limited student access to vending machines, mandated schools to disclose vending contracts, restricted their freedom to contract, and required students to complete BMI assessment without express parental consent. Although opposition has been modest, a limited but vocal group maintains that restricting individual freedoms, even given the public health goals, is an impermissible exercise of government authority.

Individual rights and freedoms

In our federalist government system, individual rights and freedoms are guaranteed by the US Constitution, state constitutions, and federal and state laws. The US Constitution is the express descriptor of individual rights and limits the federal government's ability to act against them (23). Selected rights and clauses within rights are especially relevant to the context of individual rights. The rights of due process and equal protection, the Fourth Amendment protection against unreasonable search and seizure, and Article I's commerce and contracts clauses all place limits on the government's authority to act by expressly delineating individual rights and freedoms (19).

Individuals enjoy certain rights of privacy regarding their activities and personal information, established through federal and state laws (and promulgated through regulation and interpretative guidance). Two are particularly notable for this discussion: the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and the Family Education Rights and Privacy Act of 1974 (FERPA) (19). Both HIPAA and FERPA safeguard the confidentiality of individual information against release to the government or other entities without explicit consent. However, these safeguards are not uniformly applied or always clearly understood, and their implementation can create conflict.

A consideration of HIPAA and FERPA clearly exemplifies the conflict between public health policy and individual rights. When aggregated, individual health data can guide policy makers and public officials in developing and evaluating responses to public health threats such as obesity. Yet, this aggregation is possible only through collection and release of individual-level information. In its original iteration, Act 1220 required schools to collect student BMIs and send reports to parents but did not address parental consent. The legislation was later amended to include a provision for parents to choose not to have their child assessed. However, the legislation does not address parental consent to include their child's information in data sets for further analysis.

Extent of government authority to act against individual rights and freedoms

Thousands of federal and state laws and agency regulations direct the government to pursue public health initiatives. Numerous court decisions confirm use of

government power in these instances, either through express grant at the federal level or under cover of police power and *parens patriae* at the state level. However, although no legal challenges to Act 1220 have emerged, the extent of this authority is not settled. The issues that policy makers and legal analysts debate include 1) the extent to which government authority to regulate interstate commerce through the Commerce Clause can support federal government action and 2) the boundaries of state police power (20). Thus, legal challenges to approaches such as Act 1220 may emerge as the debate about government authority continues.

Conclusions and Implications for Public Health

Arkansas Act 1220 of 2003 was one of the first comprehensive legislative approaches to attempt to reduce childhood obesity through school-based policy changes. Its implementation raised substantial concerns related to public health policy versus individual rights. States considering similar legislation should address concerns that can emerge (eg, those related to BMI measurement and reporting and access to vending machines), involve multiple stakeholder groups, establish clearly the legal basis for public policies, and develop consensus regarding key policy elements. These efforts may help develop greater consensus about approaches to reducing childhood obesity and may lessen concerns.

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Tables

Table 1. Positive Parent and Student Responses to School-Based BMI Measurements and Reports, Arkansas, 2004-2008[a]

Response	Year, % Expressing Response				
	2004	2005	2006	2007	2008
Parents					
Comfortable with receiving a BMI report from child's school	70.3	67.1	67.6	60.8	63.4
Comfortable with confidentiality of BMI measurement and reporting processes	69.4	71.4	72.9	69.3	75.3
Students[b]					
Experience little or no embarrassment from BMI measurement process	89.8	91.1	92.3	86.3	88.7

Abbreviation: BMI, body mass index.
[a] Source: Evaluation of Arkansas Act 1220 (14).
[b] Adolescents aged 14-18 y.

Table 2. Negative Student[a] Responses to School-Based BMI Measurements and Reports, Arkansas, 2004-2009[b]

Response	Year, % Expressing Response					
	2004	2005	2006	2007	2008	2009
Concern about weight	23.9	28.6	25.6	24.9	23.9	21.4
Teasing by peers because of weight	11.9	9.3	5.9	12.2	6.9	5.4
Beginning a diet within past 6 months	29.4	23.3	25.8	27.0	18.7	19.5
Taking diet pills	6.1	5.1	2.4	5.1	2.4	2.5

Abbreviation: BMI, body mass index.
[a] Adolescents aged 14-18 y.
[b] Source: Evaluation of Arkansas Act 1220 (14).

Table 3. Parent Opinions About Availability and Contents of Vending Machines in Arkansas Secondary Schools, 2004-2007[a]

Opinion	Year, % Expressing Opinion			
	2004	2005	2006	2007
Middle and high schools should not have vending machines at all.	57.0	58.1	60.6	51.8
Machines should have only healthy contents.	50.5	55.5	60.5	58.7
Machines should have both healthy and less healthy options.	42.9	39.4	35.1	38.5
No changes should be made to vending contents; they are fine as they are.	6.6	5.1	4.5	2.8

[a] Source: Evaluation of Arkansas Act 1220 (14).

Second-Year Results of an Obesity Prevention Program at The Dow Chemical Company

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Objective: Evaluate innovative, evidence-based approaches to organizational/supportive environmental interventions aimed at reducing the prevalence of obesity among Dow employees after 2 years of implementation. **Methods:** A quasi-experimental study design compared outcomes for two levels of intervention intensity with a control group. Propensity scores were used to weight baseline differences between intervention and control subjects. Difference-in-differences methods and multilevel modeling were used to control for individual and site-level confounders. **Results:** Intervention participants maintained their weight and body mass index, whereas control participants gained 1.3 pounds and increased their body mass index values by 0.2 over 2 years. Significant differences in blood pressure and cholesterol values were observed when comparing intervention employees with controls. At higher intensity sites, improvements were more pronounced. **Conclusions:** Environmental interventions at the workplace can support weight management and risk reduction after 2 years.

To address the epidemic rise in obesity rates,[1] many US companies have introduced health promotion and disease prevention programs focused on reducing the prevalence of overweight and obesity among their workers.[2] Traditionally, employers have offered individualized behavior change programs and, more recently, some have complemented these with environmental interventions that support individual health improvement efforts.[3] Multicomponent environmental interventions, defined as "strategies that involve changing the physical surroundings and social, economic, or organizational systems in order to promote individual behavior change,"[4] have not been well evaluated, and there is limited knowledge about their ability to achieve long-term behavior change and reduce health risks in employed populations. Of the 47 worksite programs to control overweight and obesity, which were reviewed by the CDC Task Force on Community Preventive Services, there were only four studies that examined policy and environmental changes in the worksite.[5]

Environmental interventions are based on a social-ecological model that encourages adoption of healthy behaviors through changes in routine activities.[6] Workplace environmental interventions include offering healthier food choices in cafeterias and vending machines; facilitating physical activity opportunities through promotion of staircase use, creation of marked walking trails, or installation of bike racks on company grounds; and changing company culture by, for example, establishing health improvement goals that align with the organization's overall mission.[7]

Researchers and practitioners agree that leadership and management support is critical to the success of workplace health promotion programs, especially when aligning organizational and employee health objectives with interventions that modify the physical work environment.[8–12] Experts in the field postulate that interventions that blend individual educational and environmental strategies will produce greater effects than individual approaches alone.[13–19] However, evidence of effectiveness, in terms of increased levels of physical activity, improved eating habits, reduced weight, or reductions in other health risks such as cholesterol, blood pressure, and blood glucose levels, has been inconsistent.[4,20,21] This may be because of the dearth of studies using rigorous research designs, long enough follow-up periods, control and comparison groups, and examination of a broad range of health outcomes. There is also little information on the effects of varying the dose of interventions, for example, comparing moderate versus more intense environmental interventions, on outcomes and on which elements of these environmental interventions achieve the best results.

This article presents 2-year results from a study evaluating the effects of worksite environmental interventions on changes in employee overweight and obesity rates and associated health risks. The study is one of seven funded by the National Heart, Lung, and Blood Institute (NHLBI) to investigate the health and economic impacts of health improvement programs that emphasize environmental and social-ecological interventions on the prevention and management of obesity at the workplace.[3]

This is a follow-up analysis to a previous article that presented interim (year 1) results from this study.[22] Readers are advised to review that manuscript and other associated publications[3,23–26] to learn more about the background of the study, its research design, instrument development and validation, and a detailed description of the interventions used.

In the year-1 analysis, we found a modest but statistically significant treatment effect on weight (1.5 pounds) and body mass index (BMI; 0.2) when comparing employees at intervention (treatment) with control sites, largely because control subjects gained weight. Nevertheless, no differences were observed in the prevalence or rates of overweight and obesity between treatment and control employees after 1 year of exposure to environmental interventions. For other health risk factors, intervention effects were noted. When compared with control subjects, intervention site employees had significantly greater decreases in systolic and diastolic blood pressures, no improvement in total cholesterol, and an increase in blood glucose levels. We concluded that, in 1 year,

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environmental changes at the workplace can achieve only modest improvements in certain health risks.

In this article, we extend the time horizon for observing the effects of these environmental interventions and present the results for a 2-year cohort of employees, some of whom were exposed to environmental interventions and others not. In addition, we report on the differential effects of those exposed to what we termed moderate- versus high-intensity environmental interventions.

MATERIALS AND METHODS

Objectives

With the above interim results as a backdrop, we sought to determine whether 2 years of exposure to environmental interventions would achieve more pronounced and long-standing changes in employees' health risks and behaviors. Thus, our primary aim was to test whether employees at worksites that implemented environmental interventions, in addition to standard individually oriented programs, would achieve greater reductions in weight, BMI, and prevalence of overweight and obesity. We also examined other biometric and behavioral risks typically measured in health promotion programs including blood pressure, total cholesterol, blood glucose, nutrition, physical activity, tobacco use, stress, and alcohol consumption.

A secondary aim was to evaluate the differential effects of intervention dose, or intensity, comparing changes in each of the outcomes for employees at high-intensity and moderate-intensity sites with those of employees at control sites. High-intensity sites provided a combination of individual, environmental, and management commitment programs; moderate-intensity sites provided individual and environmental programs; and control sites only provided individual programs. These are described in further detail below.

Setting

Study participants were employed by The Dow Chemical Company (hereinafter referred to as "Dow"). Dow provides a broad range of products and services to people in 160 countries, including fresh water supplies, food products, pharmaceuticals, paints, packaging, and personal care items. Fifty-four percent of Dow's US employees are laborers, clerical staff, or technical workers. The remaining workers are professionals or managers (44%) or in sales (2%). Most (75%) of Dow's employees are male, 82% are white, and their average age is 43 years.

Twelve Dow sites were recruited for the study: nine intervention worksites in Texas ($N = 8$) and Louisiana ($N = 1$) and three control sites in West Virginia ($N = 1$), New Jersey ($N = 1$), and Louisiana ($N = 1$). Eight sites were manufacturing facilities; two focused on research, development, and administrative functions; and two housed manufacturing, research and development, and administrative staff. Most of the sites were large (ranging in size from 57 to 5000 acres) and operated multiple business units.

Because the interventions were directed at organizational and environmental changes, all of the employees at the study sites were designated as participants in the study. Before the study, Dow had extensive individually focused employee health promotion programs in place at all the study sites, and these programs continued throughout the study period regardless of treatment or control site designation.

Study Design

By using a quasi-experimental design, we evaluated the effects of environmental interventions implemented at two levels of intensity (intervention sites) in comparison with standard Dow health promotion programs (control sites). Dow's management wanted to assign all 12 sites to the treatment condition but was convinced by study researchers to withhold environmental interventions for 2 years at control sites, so that treatment and comparison site data could be analyzed to determine intervention effects. Thus, three sites were selected as comparison sites by Dow's leadership, and site leaders were instructed not to introduce new environmental interventions for 2 years, although individually oriented programs were allowed to continue.

Dow's leadership selected as their control sites the locations that were not planning any large-scale health promotion initiatives in the near term, which would potentially interfere with the research, and that had basically the same business profile and core health promotion programs at baseline as the interventions sites. This was done to ensure that Dow's core programming would continue to be implemented consistently across all study sites—both intervention and control. Dow considered number of health promotion staff at the sites and their capabilities, site leadership support for health promotion, and any planned site initiatives that might impede implementation. Finally, Dow wanted to make sure that the sample sizes for control sites were adequate.

The nine remaining sites were matched on size and other relevant measures and then randomly assigned to moderate- or intense-intervention conditions based on a coin flip. Employees at all study sites were encouraged to participate in the health risk assessment (HRA) and biometric screening programs, although no financial incentives were offered for their participation. The intervention was implemented over a 2-year period from April 1, 2006, to March 30, 2008.

Baseline data (collected in the first quarter of 2006 using an electronic HRA survey instrument) consisted of employee demographic information and self-reported health behaviors. All HRA participants were offered the opportunity to avail an appointment for biometric screenings but not all of them took advantage of the free service. Biometric screening measures (height, weight, blood pressure, total cholesterol, and blood glucose) were collected by health professionals shortly after HRAs were administered. Employees who participated in the biometric screenings were provided individual written feedback and counseling on their health risks. Follow-up HRA and biometric assessments were then collected during the first quarters of 2007 (year 1) and 2008 (year 2). The follow-up biometric assessments were only offered to participants who participated in the HRA in the following year (ie, the researchers did not contact participants who had a biometric screening in 2006 but did not take the HRA in 2007).

Because this study was not a randomized design, we examined baseline demographics to determine whether there were significant differences between the intervention and control participants and controlled for these differences using a propensity weighting method. Methods used to adjust for baseline differences between treatment and control subjects are described later in this article. When comparing overweight and obesity prevalence between subjects at intervention and control sites, there were no significant differences between groups at baseline. Baseline overweight and obesity prevalence rates at interventions sites were 36.1% and 26.6%, respectively compared with prevalence rates for overweight and obesity at control sites, which were 36.7% and 25.6%, respectively.

Interventions

All sites (intervention and control) offered Dow's standard health promotion and risk reduction programs throughout the study period. These individually focused health promotion interventions included the following: dissemination of health education materials (newsletters, intranet site, posters, and home mailings); physical activity and weight management counseling; health assessments; online behavior change programs; reimbursement for participation in community-based weight management,

tobacco cessation, or diabetes education programs; and preventive screening reimbursements.

Moderate-intensity interventions comprised two main components: 1) environmental prompts that encouraged employees to make healthy food choices and be physically active; and 2) point-of-choice messages to encourage healthy eating and physical activity, such as strategically placing signs in front of stairwells, vending machines, and cafeterias. Other parts of the intervention included modifying vending machine items and cafeteria menus, creating and marking walking paths at all sites, disseminating targeted messages that encouraged healthy eating and physical activity, making available an online weight tracking program, offering pedometers to workers, establishing wellness ambassadors at local departments, and developing an employee recognition program for those adopting or encouraging others to adopt healthy lifestyles.

High-intensity treatment sites received all of the above interventions and added elements designed to more directly influence organizational culture and leadership commitment to employee health. At these sites, interventions included 1) setting health objectives as a component of the sites' management goals, 2) providing management training on health-related topics, 3) compiling and sharing feedback reports to site and senior leaders at corporate headquarters on the sites' achievement of certain program participation targets, and 4) providing additional support and training to the wellness ambassadors. These activities were designed to encourage worksites to explicitly include employee health as an important business objective and to hold site leadership accountable for employees' engagement in health promotion programs. All study procedures were reviewed by Institutional Review Boards at Cornell and Emory Universities, Dow's Health Services Review Board, and the NHLBI Data Safety and Monitoring Board.

Outcome Variables

Biometric data were collected using standardized protocols developed by Dow Health Services. Behavioral risk data were collected using standardized instruments developed by the research organizations participating in the NHLBI studies.[3] HRAs were administered online using Dow's established Intranet survey vendor, Valtera, Inc.

Biometric measures included height, weight, BMI, total cholesterol, blood pressure (systolic and diastolic), and blood glucose. Blood pressure, cholesterol, and blood glucose values were analyzed as continuous variables and were also categorically dichotomized as high versus low risk based on standard clinical definitions of high risk. BMI was analyzed as both a continuous and categorical variable, ie, normal (not at risk/low risk, BMI = 18.0 to 24.9 kg/m^2), overweight (moderate risk, BMI = 25.0 to 29.9 kg/m^2), or obese (high risk, BMI = 30.0+ kg/m^2). BMI was calculated from the height and weight measurements collected from participants. Weight was analyzed only as a continuous variable.

During the course of the study, we found that some individuals' height changed from baseline to follow-up. Although we hypothesized this was because of employees removing their shoes during one measurement and not during the other (many of Dow's blue-collar employees wear heavy, durable boots for protection), we needed to control for this difference. Because it was unclear which height was the most accurate (from the first or second assessment), we used the first measure of height and eliminated any participants (N = 11) whose height changed by more than 6 inches from baseline.

Behavioral health risk outcomes, dichotomized as high versus low risk, were scored using several HRA questions and included indicators for poor nutrition, lack of physical activity, tobacco use, high alcohol use, and high stress. Definitions of health risks for all outcome variables are presented in Table 1.

TABLE 1. Definitions of Health Risk Outcomes Groups

Biometric risk factors	
Normal weight	BMI 15–24.9* kg/m^2
Overweight	BMI 25.0–29.9 kg/m^2
Obese	BMI ≥30 kg/m^2
High blood pressure	Blood pressure 160/100 mm Hg or higher (systolic/diastolic)
High cholesterol	Total cholesterol 240 mg/dL or higher
High blood glucose	Blood glucose 126 mg/dL or higher
Behavioral risk factors	
Poor nutrition	4 or more fast food meals per week OR 2 or more sweetened beverages per day OR 3 or fewer fruit and vegetable servings per day
Lack of physical activity	Does not engage in any moderate or strenuous physical activity at least once per week
Tobacco use	Currently using tobacco
High alcohol use	Men: 3+ drinks per day OR 15+ drinks per week Women: 2+ drinks per day OR 8+ drinks per week
High stress	Reported experiencing high stress over the past 4 weeks and poor ability to deal with stress

*Based on consultation with medical directors at Thomson Reuters, any employee with a BMI <15 kg/m^2 was removed from this analysis as these values were considered to be potentially unreliable, inaccurate, or illogical.

Statistical Methods

Before conducting the comparative analyses, propensity score weights were applied to equalize baseline differences between intervention and control sites employees.[27] The propensity score weights were based on the predicted probability of being employed at the intervention sites. By using logistic regression, we modeled the probability of working at an intervention site based on the employee's age, gender, ethnicity, wage status (salaried or hourly), work status (type of job), education, and health risk status (using the Charlson Comorbidity Index[28] and the Psychiatric Diagnostic Group severity indices). The propensity score weights used in the analysis was the inverse of the predicted probability of being used at an intervention site (ie, 1/predicted probability).

To control for employee differences when comparing the results from intense, moderate, and control sites, a different set of propensity score weights was created using a multinomial logistic regression model for the same predictor variables used to adjust for intervention and control groups. The model predicted the conditional probability of receiving a particular level of intervention, ie, being at the intense, moderate, or control sites. The propensity weight applied to each of the three study arms was the inverse of the predicted probability of being employed at an intense, moderate, or control site.[27]

We first examined the changes in biometric and behavioral risk factors over the 2-year period by comparing outcomes for intervention sites (moderate and intense combined) versus control sites and then for intense and moderate sites separately compared with control sites. To analyze within-group changes in risk factors over time (ie, whether employees at a given site improved their risks over time), paired t tests were used for continuous variables (ie, weight, BMI, blood pressure, and cholesterol), and McNemar

χ^2 tests were used for categorical variables to compare changes in the proportion of employees at high versus low risk for the health behaviors of interest.

Difference-in-differences (DID) methods were then used to compare between-group changes in outcomes over time (time 3 − time 1), ie, whether changes in risks were more pronounced at intervention sites compared with control sites. The DID analysis also allowed us to control for baseline values that may be because of long-standing differences in the demographic and health risk profile of employees at any given site. All DID analyses were adjusted using the propensity score weights described previously.

Finally, we needed to control for the variability across workplaces caused by outside forces other than the intervention. At some sites, leaders and program champions were more aggressive in implementing programs than at others. Size of the site influenced the degree to which interventions could be put in place because some sites were quite small (about 100 employees), whereas others quite large (over 4000 employees). Some sites had cafeterias whereas others did not, and some offered fitness facilities or access to community facilities and others did not. In some sites, leadership was relatively stable, and in others, leaders were often changed. In our study, some sites experienced layoffs during the course of the study, were slated for closing, or were sold off to another company.

To control for the effects of being at a worksite that received the intervention and the likely correlation of measures among employees within the worksite, we applied statistical methods widely applied when conducting a clustered randomized trial.[29] The worksite's influence on outcomes was evaluated by including a site-level variable in the predictive models, using either a fixed effect in the model for categorical (binomial) outcomes or a random effect in the model for continuous outcomes.

The analysis exploring site-level effects on outcomes was conducted alongside the main analysis that only considered intervention effects on individual employees, without regard to site-specific influences. The two analyses were performed to address the debate among researchers regarding the need to control for site-level effects when sites, rather than individuals, are randomized into treatment and control conditions. Thus, results are presented with and without a site-level adjustment. Binomial outcomes were modeled using the SAS GLIMMIX procedure, and the continuous outcomes were modeled using the S MIXED procedure. All statistical analyses were conducted using the SAS 9.1 software package (SAS, Inc, Cary, NC).

Missing Value Calculation

Study attrition in analysis of biometric data was controlled for using a nonresponse weighting procedure.[30–32] A logistic regression model was constructed to predict the probability of not participating in a follow-up assessment for employees contributing baseline data. The model based its predictions on the employee's age, gender, Charlson Comorbidity Index score, education, work status, and assignment to an intervention or control condition. A nonresponse weight was calculated as the inverse of the predicted probability of not having a missing response (ie, 1/predicted probability). The nonresponse weight was further multiplied by the intervention group propensity score as described above.

In addition, a mean-based imputation procedure was used to account for missing biometric data for the cohort group of employees (missing data were reported for 0.0% to 1.7% of participants for each outcome variable). This involved imputing missing values based on the mean value of the variable taken from the control group. For example, if a participant's BMI was missing at follow-up, the missing value was replaced with the "average BMI" of subjects in the control sites at follow-up. Outcomes with missing data were then recalculated based on these imputed values.

Results presented below are for the main analyses, not accounting for missing data. Overall, our findings were unaffected by missing data, and so, those alternative results are not shown in this article and are available on request.

RESULTS

Participation

There were 10,281 employees (8013 at intervention sites and 2268 at control sites) who were eligible to participate in the study. Our target goal was to recruit 6000 employees from this pool of eligible employees (ie, 60% participation rate). At time 1, 5124 employees participated in the HRA (49.8% participation rate). Of the time-1 HRA participants, 3504 also enrolled for the biometric screenings (68.4% of HRA participants). The final cohort of HRA participants consisted of 2431 employees who participated in both time 1 and time 3, of which, 1521 also provided biometric data. Additional information regarding participation in the various treatment arms is displayed in Fig. 1.

Comparisons Between Intervention and Control Groups

Table 2 shows the baseline demographic and health status comparisons between intervention and control group employees before and after propensity score adjustment. Before adjustment, intervention group subjects were younger, had a higher proportion of minorities, and were more educated. Intervention group employees also consisted of more hourly-wage employees and were more likely to be operatives, laborers, and service workers. Gender and health status were similar for the intervention and control groups even before adjustment.

After propensity score adjustment, all differences between intervention and control groups were no longer statistically significant, showing that the propensity score weighting process was successful. All subsequent analyses comparing intervention and control subjects used propensity score-weighted groups.

Changes in Weight and BMI

Table 3 displays the propensity score adjusted changes in employee weight and BMI for intervention and control group employees. As shown, average weight and BMI was unchanged at the intervention sites but increased significantly at the control sites ($P < 0.01$). However, the proportion of overweight employees increased significantly at the intervention sites ($P < 0.01$) and the proportion of obese employees decreased significantly at the control sites ($P < 0.01$).

In the DID analysis presented in Table 4, a net 1.6-pound difference between intervention and control group employees was observed in favor of the intervention group ($P < 0.01$). The difference between groups was not because of intervention group employees losing weight, but rather because of control group employees gaining weight by an average of 1.3 pounds. Similarly, a 0.3-differential in BMI between intervention and control groups occurred because control group subjects increased their BMI significantly without a corresponding decrease in BMI for intervention group employees. These results were upheld even after controlling for autocorrelation among employees within site (ie, controlling for site effects). However, no differences were observed for changes in overweight and obesity prevalence when comparing treatment and control subjects.

Results for the three-group comparisons are presented in Tables 5 and 6. The high- and moderate-intensity groups main-

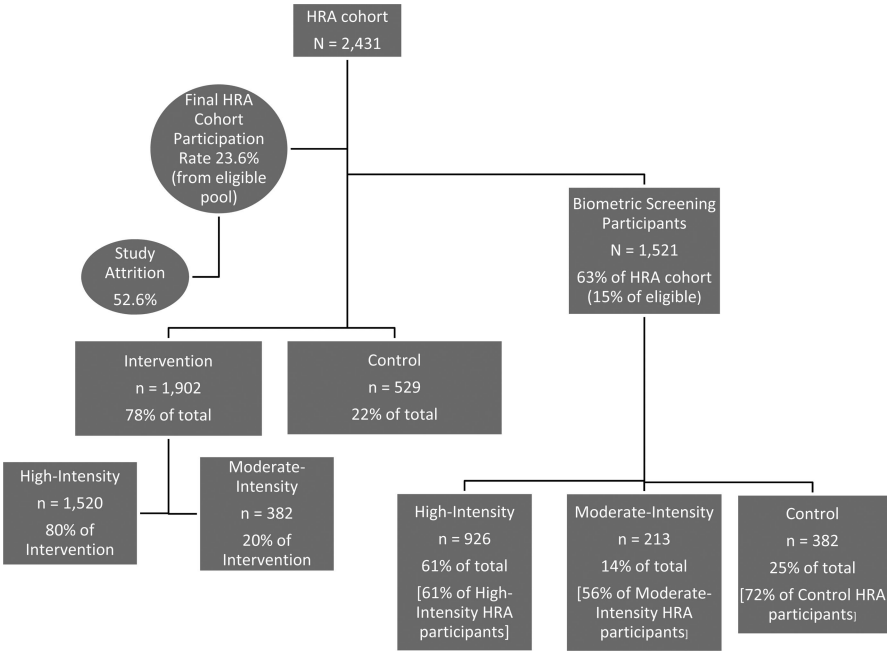

FIGURE 1. Participation rates for HRA cohort and biometric screening cohort participants.

TABLE 2. Baseline Demographics Characteristics of the HRA Cohort

	Unadjusted*			Adjusted*		
	Intervention (n = 1902)	**Control (n = 529)**	***P***	**Intervention (n = 1902)**	**Control (n = 529)**	***P***
Average age† (yr)	43.9	46.4	<0.0001	44.6	44.8	0.5313
% Female‡	27.30	27.40	0.9552	27.10	27.00	0.8862
Ethnicity‡			0.0001			0.0953
White (%)	75.10	83.20		77.10	79.10	
Education‡			<0.0001			0.3606
Not indicated (%)	24.50	51.40		30.40	30.40	
Less than bachelor degree (%)	28.80	8.10		24.50	22.80	
Bachelor degree (%)	35.50	23.80		32.90	35.00	
Masters or doctorate (%)	11.20	16.60		12.20	11.80	
Wage status			<0.0001			0.3594
Salaried (%)	63.20	74.10		65.10	63.90	
Hourly (%)	36.80	25.90		34.90	36.20	
Work status‡			<0.0001			0.2063
Officials and managers, professionals, and sales (%)	49.00	51.40		49.40	49.60	
Technicians, office and clerical, and craft workers (skilled) (%)	35.30	40.60		36.60	38.10	
Operatives (semi-skilled), laborers (unskilled), and service workers (%)	15.70	7.90		14.00	12.40	
Charlson Comorbidity Index‡	0.27	0.26	0.8038	0.26	0.24	0.4152
Number of psychiatric diagnostic groups‡	0.16	0.15	0.5027	0.16	0.15	0.7337

*"Unadjusted" refers to analyses conducted without using propensity score weighting methodology, whereas "adjusted" indicates that propensity score weighting methodology was used to account for covariates.
†P values are the results of t test between the control and intervention sites.
‡P values are the results of χ^2 analyses between the control and intervention sites.

tained their weight and BMI, whereas the control group employees gained an average of 1.3 pounds ($P < 0.01$), and their BMI increased an average of 0.2 points ($P < 0.01$). Although the net difference in average weight between the high-intensity and control groups was significant at 1.5 pounds ($P < 0.05$), the net difference between the moderate-intensity and control group subjects' weight of 1.3 pounds was not significant. After controlling for site effects, the net difference in average weight and BMI was significant ($P < 0.05$) for both the high- and moderate-intensity employees compared with controls. No significant impact on rates of overweight

TABLE 3. Biometric Cohort Outcomes for Primary Hypotheses by Intervention and Control With Propensity Score Weighting

	Intervention (n = 1139)				Control (n = 382)			
	2006	2008	Δ	*P*	2006	2008	Δ	*P*
	Percentage at high risk				Percentage at high risk			
Obese	31.0	30.0	−1.0	0.2339	33.8	31.7	−2.1	0.0013
Overweight	39.8	42.9	3.1	0.0032	41.0	40.9	−0.1	0.9143
	Average value				Average value			
Weight	189.3	189.0	−0.3	0.3801	187.9	189.2	1.3	0.008
BMI	28.3	28.2	−0.1	0.3348	28.0	28.2	0.2	0.005

TABLE 4. Comparison of the DID Analysis Not Controlling for Site Level Effects With the DID Analysis Controlling for Site Level Effects: Intervention vs. Control Groups–Overweight and Obesity

	Not Controlling for Site Effects		Controlling for Site Level Effects	
	Intervention vs Control		Intervention vs Control	
Primary Hypotheses	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*
Obese	1.1%	0.4274	0.5%	0.9216
Overweight	3.2%	0.1232	5.2%	0.2252
Weight	−1.6	0.0051	−1.6	0.0050
BMI	−0.3	0.0028	−0.3	0.0027

*"Δ b/t Treatment" was calculated as intervention vs. control, Δ refers to either the percent at risk or the average value.

and obesity was found for either the moderate or intense group subjects, with and without controlling for site effects.

Changes in Blood Pressure, Total Cholesterol, and Blood Glucose

Examining changes in other biometric values, intervention group subjects experienced greater net improvements than control group subjects in blood pressure (systolic and diastolic; $P < 0.01$) and total cholesterol ($P < 0.05$). Blood glucose levels increased for both intervention and control subjects, and the net differences between groups were not significant. After controlling for site effects, the significance levels for all these findings remained unchanged. In high risk prevalence, the only significant net reductions between intervention and control groups were found in blood pressure, but these differences were no longer significant after controlling for site effects. Results are presented in Tables 7 and 8.

When comparing outcomes for these biometric values by intensity of treatment, effects were generally more pronounced at the high-intensity sites when compared with control sites. As shown in Tables 9 and 10, both systolic blood pressure and cholesterol levels were reduced to a greater extent at high-intensity sites than at moderate-intensity sites compared with control sites. We observed an impact by treatment intensity where the high-intensity sites compared with control sites showed a significant net difference in cholesterol ($P < 0.05$), whereas the net difference between moderate-intensity sites and controls was not significant. In terms of risk prevalence, we found a treatment intensity impact in favor of the high-intensity sites for blood pressure when compared with control sites ($P < 0.01$). Most of these results were supported after controlling for site effects except for comparisons of high-intensity versus control sites for high blood pressure risk, which became not significant, and moderate-intensity versus control comparisons for diastolic blood pressure, which became significant ($P < 0.05$).

Changes in Behavioral Risk Factors

Within treatment conditions, significant improvements were noted in nutrition and physical activity ($P < 0.01$), and improvement in stress levels approached significance ($P = 0.054$) for the intervention group. For the control group, significant improvements were observed for nutrition, tobacco use, and stress ($P < 0.01$). Risks for poor nutrition and physical activity showed a net improvement of 6.4% ($P < 0.01$) and 3.2% ($P < 0.05$), respectively, for the intervention group in comparison with the control group. However, after controlling for site effects, these differences were no longer statistically significant. No intervention effects were found for tobacco use, high alcohol use, or high stress (Tables 11 and 12).

Comparison of outcomes for intervention versus control groups by level of intervention intensity showed that both moderate- and high-intensity group employees achieved significant net risk reductions in poor nutrition compared with control sites ($P < 0.05$ and $P < 0.01$, respectively), although these were not significant after controlling for site effects. An intensity impact was found for poor physical activity in favor of the high-intensity sites, where the high-intensity sites had a significant net risk reduction ($P < 0.05$) compared with controls, whereas no such significant net difference was found for the moderate-intensity sites. Controlling for site effects yielded no significant net differences for both of the intervention arms compared with controls for poor physical activity. No intervention effects were found on tobacco use, high alcohol use, and stress (Tables 13 and 14).

DISCUSSION

Our study sought to determine whether environmental and social-ecological interventions introduced at the workplace, alongside individually oriented interventions, would produce additional health benefits when compared with individually oriented programs alone. During a 2-year period, a cohort of Dow employees were exposed to two levels of environmental and social-ecological interventions at the workplace, in addition to individual interventions, and their experience was compared with a control group of employees who only received individual interventions.

Nine worksites received environmental interventions, and three served as controls. Of the nine intervention sites, four received what was termed moderate interventions, primarily focused on providing greater access to, and information about, healthy eating and physical activity. Five high-intensity sites built on the moderate-intensity interventions by seeking to increase local leadership engagement in health promotion and weight reduction initiatives. This was done by setting site goals related to participation and engagement in programs, aligning department and site goals, offering more leadership training and feedback, and putting in place

TABLE 5. Biometric Cohort Outcomes for Primary Hypotheses by Intensity With Propensity Score Weighting

	High Intensity (n = 926)				Moderate Intensity (n = 213)				Control (n = 382)			
	2006	2008	Δ	*P*	2006	2008	Δ	*P*	2006	2008	Δ	*P*
	Percentage at high risk				Percentage at high risk				Percentage at high risk			
Obese	30.4	29.3	−1.1	0.1634	29.4	31.1	1.7	0.0489	33.7	31.6	−2.1	0.0014
Overweight	39.5	43.2	3.7	0.0005	43.3	45.4	2.1	0.0587	41.1	40.9	−0.2	0.8609
	Average value				Average value				Average value			
Weight	188.9	188.7	−0.2	0.6399	187.9	187.9	0.0	0.9827	188.0	189.3	1.3	0.0071
BMI	28.2	28.2	0.0	0.5604	28.3	28.3	0.0	0.8326	28.0	28.2	0.2	0.0045

TABLE 6. Comparison of the DID Analysis Not Controlling for Site Level Effects With the DID Analysis Controlling for Site Level Effects: High, Moderate and Control Groups–Overweight and Obesity

	Not Controlling for Site Effects				Controlling for Site Effects			
	High Intensity vs Control		Moderate Intensity vs Control		High Intensity vs Control		Moderate Intensity vs Control	
Primary Hypotheses	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*
Obese	1.0%	0.5315	3.8%	0.1193	0.3%	0.9486	0.1%	0.8780
Overweight	3.9%	0.0857	2.3%	0.5087	5.5%	0.2246	4.4%	0.4714
Weight	−1.5	0.0163	−1.3	0.1454	−1.5	0.0148	−2.1	0.0333
BMI	−0.2	0.0089	−0.2	0.1817	−0.2	0.0075	−0.3	0.0341

*"Δ b/t Treatment" was calculated as intervention vs. control, Δ refers to either the percent at risk or the average value.

TABLE 7. Biometric Cohort Outcomes for Secondary Hypotheses by Intervention and Control With Propensity Score Weighting

	Intervention (n = 1139)				Control (n = 382)			
Health Risk	2006	2008	Δ	*P*	2006	2008	Δ	*P*
	Percentage at high risk				Percentage at high risk			
Biometric screening risk								
High blood pressure	3.9	2.2	−1.7	0.0068	1.3	2.4	1.1	0.0361
High cholesterol	10.1	9.1	−1.0	0.2429	12.0	12.0	0.0	0.9762
High blood glucose	3.9	4.2	0.3	0.4690	3.2	3.8	0.6	0.1417
	Average value				Average value			
Biometric screening value								
BP systolic	124.4	122.3	−2.1	<0.0001	123.2	128.1	4.9	<0.0001
BP diastolic	80.3	78.2	−2.1	<0.0001	79.6	79.1	−0.5	0.3862
Cholesterol	196.0	192.8	−3.2	0.0006	193.3	193.7	0.4	0.792
Blood glucose	94.3	96.2	1.9	<0.0001	95.1	95.8	0.7	0.3881

reporting mechanisms related to program accomplishments for senior leadership. Online weight tracking programs, where employees could monitor their weight gains or losses, and enhanced employee recognition programs were also put in place at all intervention sites. The three control sites continued to deliver individually oriented health promotion programs largely consisting of counseling and coaching services directed at employees prepared to make behavior change.

Over the course of the 2-year study, intervention site employees maintained their baseline weight, whereas control site employees gained weight of an average of 1.3 pounds and 0.2 BMI points. Nevertheless, there was no intervention effect on the overall prevalence of overweight and obesity for intervention group employees. These findings were consistent even after controlling for site effects.

By its nature and design, environmental intervention programs are more diffused than those that target high risk individuals directly. Thus, it is expected that effects on weight and BMI would be smaller than in individually focused interventions and that all employees, not just those at high risk, would be affected. Although our results are not to be considered clinically significant at the individual level, the incremental effect of these environmental interventions at intervention sites compared with individually focused interventions alone at control sites is promising.

Previous research has shown that worksite health promotion programs achieve a modest impact on overweight and obesity and most of these programs are individually focused. In a recent review of 47 worksites' obesity management programs by the CDC Community Guide,[5] six individually focused behavioral programs re-

TABLE 8. Comparison of the DID Analysis Not Controlling for Site Level Effects With the DID Analysis Controlling for Site Level Effects: Intervention vs. Control Groups–Blood Pressure, Cholesterol and Glucose

	Not Controlling for Site Effects		Controlling for Site Level Effects	
	Intervention vs Control		Intervention vs Control	
	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*
Biometric screening risk				
High blood pressure	−2.8%	0.0156	−2.5%	0.1351
High cholesterol	−1.0%	0.5548	−0.9%	0.7095
High blood glucose	−0.3%	0.7040	−0.2%	0.7999
Biometric screening value				
BP systolic	−7.0	<0.0001	−7.0	<0.0001
BP diastolic	−1.6	0.0015	−1.7	0.0014
Cholesterol	−3.6	0.0205	−3.6	0.0205
Blood glucose	1.2	0.1409	1.2	0.1456

*"Δ b/t Treatments" was calculated as intervention control, Δ indicates either the percent at risk or the average value.

duced workers' BMI by an average of 0.5 points, which is somewhat greater than the 0.3-BMI differential found between treatment and control site workers in this study. Although the study effects found here are modest in the near term, if sustained, they can potentially translate to long-term clinical gains. Helping employees prevent age-related weight gain may be as important as supporting their weight loss efforts, given that increased adiposity and weight gain in midlife impacts one's health at an older age.[33,34]

Participants at intervention sites also experienced a net improvement in their biometric values for blood pressure and total cholesterol compared with the control group. These results were upheld after adjusting for site-level effects. Intervention sites showed improved levels of blood pressure and total cholesterol, whereas control sites showed increases or no changes in these biometric measures, respectively. In general, the net differences between intervention and control subjects for biometric values were greater at high-intensity than moderate-intensity sites, demonstrating an intervention dose effect. Despite these improvements in biometric values at the intervention sites, the significant reduction in the percent at risk for high blood pressure was no longer significant after controlling for site-level effects. However, it is important to note that across measures (especially for blood pressure) and study arms, risk prevalence was fairly low to begin with and baseline measures were generally well within the normal range. Thus, a floor effect may be one explanation for the lack of significant risk reduction. This was also relevant to our analysis of blood glucose levels where high risk prevalence was relatively low before and after the intervention, for all employee groups.

Before controlling for site-level effects, all three treatment arms significantly reduced their risk for poor nutrition, with the intervention group experiencing a significant net improvement compared with controls. The intervention sites (primarily the high-intensity group) also demonstrated significant net improvement in physical activity compared with controls. Nevertheless, these findings became not significant after controlling for site-level effects. These results may partly explain why we did not find an effect on overweight and obesity prevalence. A longer time horizon may be needed to determine if weight loss can be achieved through adoption of healthy lifestyle habits. Three other behavioral risk factors, tobacco use, stress, and excess alcohol consumption, did not improve, nor were they expected to, because the programs did not explicitly target these health risks.

Compared with our first year results, the weight difference between intervention and control site subjects was nearly identical and of no clinical significance: a net difference of −1.5 pounds after 1 year and −1.6 pounds after 2 years. The net difference in BMI (−0.2 and −0.3) was also similar for both study periods. Thus, although no net difference in weight change was achieved after an additional year of intervention, participants in the high- and moderate-intensity treatment sites were able to maintain their weight and BMI, whereas control site subjects experienced increases in both weight and BMI over the 2-year period. The prevalence of overweight increased more at the intervention sites (3.1%) after 2 years than after 1 year (1.7%). This increase can be explained by the simultaneous change in obesity prevalence; as obese employees lost weight, they were re-categorized as overweight. Obesity rates were reduced at intervention sites after 2 years (−1.0%) compared with an increase (0.6%) after 1 year, indicating an overall positive trend of reducing obesity rates as subjects shifted down to the overweight category. An important benefit of environmental interventions is that, once in place, they continue to influence behaviors with little additional cost and effort.

A larger net effect was observed for blood pressure and total cholesterol when comparing year 1 and year 2 results, although no statistical tests were conducted to determine whether the differences from one year to another were statistically significant. (We did not statistically compare the time 3 − time 1 difference with the time 2 − time 1 difference, because it was not central to our analysis and because it would have been complex to do so. Standard statistical tests would have been inappropriate given the dependence between the two differences and given the two sets of propensity score weights accorded to each difference.) In year 1, net reductions in average systolic blood pressure, diastolic blood pressure, and total cholesterol levels were −1.6, −1.2, and −1.1, respectively. After 2 years, these measures were reduced by −7.0, −1.6, and −3.6, respectively. Also, after 2 years, a potential effect was found on poor nutrition and physical activity, which was not apparent in year 1.

Limitations

There are many limitations worth noting. First, a major concern when conducting environmental worksite interventions is determining the unit of analysis. The question often asked is whether the intervention is measured by comparing average values for a given set of employees at a site or values for each individual at that site. If the site is the unit of analysis, and only average values are used in statistical analyses, then large *N*'s (and *df*) are required to determine statistical significance, and many sites are needed to establish a treatment effect.

In this study, when we evaluated program impact using the site as a control variable in our multilevel modeling, we were at times unable to find a significant worksite-level effect, which was most likely because of our small sample size of 12 worksites. Maas and Hox[35] concluded that a minimum sample size of 50 is needed when conducting multilevel studies and that fewer numbers often lead to biased estimates of the second-level standard errors. Thus, large multisite studies with 50 or more worksites would be needed to test the effects of environmental interventions using site as the unit of analysis. This is hard to achieve in workplace studies because very few employers have enough sites to allow for such

TABLE 9. Biometric Cohort Outcomes for Secondary Hypotheses by Intensity With Propensity Scores Weighting

	High Intensity (n = 926)				Moderate Intensity (n = 213)				Control (n = 382)			
	2006	2008	Δ	*P*	2006	2008	Δ	*P*	2006	2008	Δ	*P*
	Percentage at high risk				Percentage at high risk				Percentage at high risk			
Biometric screening risk												
High blood pressure	3.8%	1.6%	−2.2%	<0.0001	5.8%	2.9%	−2.9%	0.0002	1.3%	2.4%	1.2%	0.0346
High cholesterol	9.7%	8.1%	−1.6%	0.0595	8.2%	10.7%	2.6%	0.0019	11.9%	11.9%	0.0%	0.9819
High blood glucose	3.5%	4.3%	0.8%	0.0594	3.3%	2.1%	−1.2%	0.0007	3.1%	3.8%	0.6%	0.1436
	Average value				Average value				Average value			
Biometric screening value												
BP systolic	125.4	122.7	−2.6	<0.0001	120.9	120.7	−0.2	0.8465	123.1	128.0	4.9	<0.0001
BP diastolic	80.5	78.4	−2.1	<0.0001	79.4	77.2	−2.2	0.007	79.5	79.1	−0.4	0.4205
Cholesterol	195.2	191.0	−4.2	<0.0001	197.1	197.7	0.6	0.7744	193.2	193.8	0.5	0.7200
Blood glucose	94.2	96.0	1.8	0.0003	93.8	94.8	1.0	0.2537	95.1	95.7	0.6	0.4706

TABLE 10. Comparison of the DID Analysis Not Controlling for Site Level Effects With the DID Analysis Controlling for Site Level Effects: High, Moderate and Control Groups–Blood Pressure, Cholesterol and Glucose

	Not Controlling for Site Effects				Controlling for Site Effects			
	High Intensity vs Control		Moderate Intensity vs Control		High Intensity vs Control		Moderate Intensity vs Control	
	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*	Δ b/t Treatment*	*P*
Biometric screening risk								
High blood pressure	−3.4%	0.0047	−4.1%	0.066	−2.9%	0.0675	−0.8%	0.6543
High cholesterol	−1.6%	0.3821	2.6%	0.3488	−1.2%	0.6109	0.5%	0.9069
High blood glucose	0.2%	0.8714	−1.8%	0.1459	0.3%	0.9799	−2.2%	0.3349
Biometric screening value								
BP systolic	−7.5	<0.0001	−5.1	<0.0001	−7.4	<0.0001	−5.4	<0.0001
BP diastolic	−1.7	0.0016	−1.8	0.0566	−1.6	0.0033	−1.9	0.0311
Cholesterol	−4.7	0.0049	0.1	0.9829	−4.3	0.0107	−1.2	0.6424
Blood glucose	1.2	0.1524	0.4	0.7184	1.3	0.1400	0.83	0.5516

*"Δ b/t Treatments" was calculated as intervention control, Δ indicates either the percent at risk or the average value.

TABLE 11. HRA Cohort Outcomes for Secondary Hypotheses by Intervention and Control With Propensity Scores

	Intervention (n = 1902)				Control (n = 529)			
	Percentage at High Risk				Percentage at High Risk			
Health Risk	2006	2008	Δ	*P*	2006	2008	Δ	*P*
Poor nutrition	78.3%	69.3%	−9.0%	<0.0001	74.2%	71.6%	−2.6%	<0.0025
Poor physical activity	10.2%	7.1%	−3.1%	<0.0001	5.3%	5.4%	0.1%	0.8719
Tobacco use	11.7%	11.5%	−0.2%	0.5635	7.4%	8.3%	0.9%	0.0183
High alcohol use	6.4%	5.7%	−0.7%	0.2142	2.4%	2.4%	0.0%	0.9585
High stress	2.7%	2.0%	−0.7%	0.0544	2.0%	0.8%	−1.2%	0.0008

experiments, and even if they did, they would be reluctant to withhold interventions for large numbers of employees located at control sites for an extended time period.

We struggled with this issue and, in the end, decided to focus our analyses on employees and consider them the unit of analysis, taking pains to equalize intervention and control subjects on their

TABLE 12. Comparison of the DID Analysis Controlling for Site Level Effects With the DID Analysis Without Site Level Effects

	Not Controlling for Site Effects		Controlling for Site Level Effects	
	Intervention vs Control		Intervention vs Control	
Health Risk	Δ b/t Treatment* (%)	*P*	Δ b/t Treatment* (%)	*P*
Poor nutrition	−6.4	0.0005	−5.3	0.0943
Poor physical activity	−3.2	0.0147	−0.9	0.9659
Tobacco use	−1.1	0.1419	−1.5	0.5117
High alcohol use	−0.7	0.4789	−1.6	0.441
High stress	0.5	0.5136	−0.6	0.7258

*"Δ b/t Treatment" was calculated as intervention vs. control, Δ refers to either the percent at risk or the average value.

baseline demographic and health status characteristics, so that statistically similar individuals could be followed up from time 1 to time 3. Further, to account for the reality that employees at any given site were exposed to a similar intervention, we controlled for site effects in our regression analysis, which then eliminated many statistically significant findings. This was not the case, however, for our primary outcomes of weight and BMI, where statistically significant results remained even after controlling for the site variable. Given the debate among researchers as to whether individual or site-level results should be presented when reporting findings from environmental interventions, we decided to present both sets of results.

A second important potential bias could arise from the fact that the employee cohort examined in the analysis of time 1 to time 3 results is demonstrably different from the group of employees from whom baseline data were collected. We compared baseline employees with those in the cohort and found that, compared with those who completed HRAs at baseline but not at follow-up, time 1 to time 3 cohort members were more highly educated, more likely to be salaried workers and have white-collar jobs, and more likely to be women (data not shown). We controlled for these variables in our multivariate models but acknowledge that there may be other unmeasured variables that could influence the outcomes.

Coupled with the above limitation, we experienced a relatively high attrition rate over the course of the study (52.6% overall). By study arm, attrition was 54.3% and 45.1% for the intervention and control group, respectively. This level of attrition is not unusual for worksite studies (compared with clinical trials) because employees were not compensated for participating in the study. In real-world studies of workplace obesity programs, employers may experience even higher attrition rates (as high as 76.4%) in just 1 year, despite offering financial rewards.[36]

To address the issue of missing data, we applied several statistical approaches to adjust for the potential bias due to attrition and as a way of performing sensitivity analyses to determine whether alternative methods would produce different conclusions. We applied mean-based and weight-based imputation methods, and these produced results that supported our original findings. The weight-based approach we used is preferred by many researchers, because it reduces the bias that nonresponse may cause in the estimates.[27] By using this method, we were able to include more participants in the analysis, increasing the sample size and improving the representiveness of the results. The weighting procedure was corrected for the demographic characteristics of participants with missing values. Thus, the imputed values produced were expected to be similar to those of nonresponders. Nonetheless, it may be the case that the weighting approach may increase variances of the estimates to a certain extent.[27] The methodological trade off in using this approach is between bias reductions and increased variance. Because our goal was to improve the representativeness of the sample and balance the data between different arms of the study, the weighting procedure was preferred.

The second method considered to control for missing data is referred to as baseline observation carried forward. This approach assumes that subjects who dropout of a study will maintain their baseline values. However, as shown in our analysis, as employees aged, they gained weight in the control group and maintained weight in the intervention group. Thus, we did not use the baseline observation carried forward method because we concluded it would introduce more, not less, bias to our results.

A third method of handling missing data, mean-based imputation, was applied to the analysis of biometric values for cohort participants. Because only a small proportion of subjects had missing data (0.0% to 1.7%), the mean-based imputation method was considered an appropriate approach. However, as previously mentioned, our main findings were not affected by the missing data after we applied this method; thus, we presented our results without accounting for the small amount of missing data.

A third limitation is related to attribution of outcomes to the intervention. Although we observed modest improvements in blood pressure and total cholesterol for intervention site employees, we cannot rule out the possibility that these employees may have achieved these results because of pharmacological interventions rather than environmental changes. Because we did not observe significant reductions in weight or BMI, it is entirely possible that the improvements were due to other factors such as changes in medication use. However, because we did not analyze pharmacy data in this analysis, we are unable to control for this potential bias.

A fourth limitation relates to the quasi-experimental design of the study. Although moderate- and high-intensity sites were randomly assigned, treatment and control sites were not. Because the majority of the intervention sites were located in Texas and the control sites were located in Louisiana, West Virginia, and New Jersey, factors such as geography, culture, or other unmeasured variables may have influenced the results. To determine whether we needed to control for "state" effect, we examined the overweight and obesity prevalence rates for the four states included in the study using data from the National Center for Chronic Disease Prevention and Health Promotion's Behavioral Risk Factor Surveillance System.[37] We found that the prevalence rates for overweight and obesity in New Jersey and West Virginia at baseline (2006) for overweight and obesity were 36.7% and 25.6%, respectively. In Texas and Louisiana, the prevalence was similar at 36.1% and 26.6% for overweight and obesity, respectively. Because the prevalence rates were similar across treatment and control states, we concluded that there was no need to control for a state fixed effect.

Besides these limitations, there were others that may have influenced our results. Some sites were slow to implement the interventions. Thus, we may not have had enough data to observe any long-term changes associated with weight loss or other health risks because of differential length of exposure to the interventions. That said, we did include a site effect control variable to account for this and other various site-level variations as previously explained. However, as noted above, because of our small sample size, when controlling for site effects, we may have produced biased estimates favoring a lack of effect from the intervention. For example, although at an individual level we observed significant changes in

TABLE 13. HRA Cohort Outcomes for Secondary Hypotheses by Intensity With Propensity Scores

	High Intensity (n = 1520)				Moderate Intensity (n = 382)				Control (n = 529)			
	Percentage at High Risk (%)				Percentage at High Risk (%)				Percentage at High Risk (%)			
Health Risk	2006	2008	Δ	*P*	2006	2008	Δ	*P*	2006	2008	Δ	*P*
Poor nutrition	77.6	69.8	−7.8	<0.0001	78.3	69.2	−9.1	<0.0001	74.4	71.8	−2.6	0.0027
Poor physical activity	9.9	7.1	−2.8	<0.0001	10.6	6.8	−3.8	<0.0001	5.4	5.5	0.1	0.9055
Tobacco use	12.0	11.9	−0.1	0.7908	10.9	10.3	−0.6	0.0731	7.5	8.4	0.9	0.0223
High alcohol use	6.1	6.1	0.0	0.9860	7.3	5.7	−1.6	0.0056	2.4	2.4	0.0	0.9450
High stress	2.6	1.9	−0.7	0.0479	1.8	2.0	0.2	0.5172	2.0	0.8	−1.2	0.0007

TABLE 14. Comparison of the DID Analysis Controlling for Site Level Effects With the DID Analysis

	Not Controlling for Site Effects				Controlling for Site Effects			
	High Intensity vs Control		Moderate Intensity vs Control		High Intensity vs Control		Moderate Intensity vs Control	
Health Risk	Δ b/t Treatment* (%)	*P*	Δ b/t Treatment* (%)	*P*	Δ b/t Treatment* (%)	*P*	Δ b/t Treatment* (%)	*P*
Poor nutrition	−5.2	0.0089	−6.5	0.0228	−4.6	0.1554	−7.7	0.0683
Poor physical activity	−2.9	0.037	−3.9	0.0758	−0.7	0.8909	−1.6	0.7664
Tobacco use	−1.0	0.2622	−1.5	0.2075	−1.6	0.492	−1.1	0.6896
High alcohol use	0.0	0.9904	−1.6	0.3189	−1.0	0.5851	−3.9	0.3060
High stress	0.5	0.5429	1.5	0.2236	−0.5	0.7045	−0.6	0.8039

*"Δ b/t Treatment" was calculated as intervention vs. control, Δ refers to either the percent at risk or the average value.

diet and physical activity favoring intervention subjects, these results were no longer significant when controlling for site. Further studies examining the effects of program fidelity and dose on employee participation in and awareness of program features, and their combined effects on outcomes, are needed and may provide greater insight into the effects of environmental interventions.

Finally, results may have been attenuated by differences in those who dropped out after baseline data collection and those remaining in the study at time of final follow-up. We note that our results after 2 years of exposure to the interventions are different than our 1 year results, and this may be explained by the different cohorts that were followed up for each study period (ie, the time 1 − time 3 cohort [N = 2431] was smaller than the time 1 − time 2 cohort [n = 3152]). The remaining participants were proportionally better educated and more likely to be in white-collar jobs, and were also less likely to be obese or use tobacco products than those who dropped out. Thus, any improvements in outcomes because of the intervention may have been muted because there was less room for improvement in the remaining cohort. On the other hand, cohort members had a proportionally greater high cholesterol risk than noncohort employees, and the mean value for this risk factor did improve significantly from baseline.

Despite these limitations, this study contains some notable strengths. Unlike many studies conducted in workplaces, we used a prospective, quasi-experimental design whereby employees at some sites received the interventions and others at control sites received only standard programs for a significant time period—in our case, 2 years. Also, this study collected multiple outcomes in addition to weight, enabling us to examine the effect of environmental and organizational interventions not only on weight but also on other health risks of employees. Finally, this study examined the differential effects of two levels of intervention intensity and the added value of engaging leadership in environmental and other health promotion interventions.

CONCLUSIONS

Overall, we observed a modest intervention impact on study outcomes in terms of weight and BMI, blood pressure, and cholesterol. The more intense interventions produced better results when compared with controls than did moderate interventions. Over the course of 2 years, participants at the intervention sites (high-intensity and moderate-intensity sites combined) were able to maintain their weight and BMI, whereas control subjects experienced increases in weight and BMI. These are encouraging findings. Given that national obesity rates are on the rise[1] and that people tend to gain weight as they age,[38] the small but significant effects of environmental interventions at the worksite are notable. Stemming age-related weight gain is just as much a part of the solution for reducing the prevalence of overweight and obesity as helping people lose weight.

We also found a modest intervention effect for blood pressure values in favor of the intervention group and intensity effects for total cholesterol values in favor of high-intensity sites, compared with the control sites. As for behavioral risk factors, when not controlling for site-level effects, intervention site participants showed greater improvements in diet and physical activity compared with controls. These findings were no longer statistically significant after controlling for site-level effects.

Changing employees' behaviors and modifying their health risks require focused time and attention. Environmental and social-ecological interventions often require engaging leadership support, changing the work culture, and modifying organizational policies, all of which can involve lengthy administrative approval processes.

In addition, environmental interventions, compared with individually focused ones, may take longer to implement or to be noticed by employees. Thus, the full effects of environmental interventions may not be observable within even a 2-year time horizon. Furthermore, environmental interventions are directed at all employees, not just those at high risk. Additional research, with more worksites, longer follow-up periods, and different risk groups, is necessary to gain a better understanding of the broad range of environmental interventions available at the worksite and their impact on employee health risks.

Our findings suggest that it may be worthwhile for an organization to consider low-cost environmental interventions as complementary to individual approaches for weight management. Although the effects are small in the near term, they can potentially translate to long-term clinical gains, especially if comprehensive programs that include both environmental and individual components are sustained over time.

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The Association Between Worksite Physical Environment and Employee Nutrition, and Physical Activity Behavior and Weight Status

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Objective: To explore the relationship between worksite physical environment and employee dietary intake, physical activity behavior, and weight status. **Methods:** Two trained research assistants completed audits (Checklist of Health Promotion Environments at Worksites) at each worksite ($n = 28$). Employees ($n = 6261$) completed a brief health survey before participation in a weight loss program. **Results:** Employees' access to outdoor areas was directly associated with lower body mass index (BMI), whereas access to workout facilities within a worksite was associated with higher BMI. The presence of a cafeteria and fewer vending machines was directly associated with better eating habits. Better eating habits and meeting physical activity recommendations were both related to lower BMI. **Conclusions:** Selected environmental factors in worksites were significantly associated with employee behaviors and weight status, providing additional intervention targets to change the worksite environment and promote employee weight loss.

The obesity epidemic has become a major public health concern around the world.[1] In the United States, this growing epidemic is costing employers billions of dollars every year.[2] In addition, US employers must address obesity-related health issues such as employee absenteeism, loss of productivity, and overall quality of life.[3,4] As a result, over the past 30 years, numerous worksite health promotion strategies to address employee weight status have been investigated.[5]

In fact, the literature on worksite health promotion strategies to address employee overweight and obesity is extensive,[6,7] but less is known about the influence of the physical characteristics of the worksite on employee behaviors related to dietary intake, physical activity (PA), and weight status. A recent review conducted by the Task Force on Community Preventive Services[8] found that only 4 of the 47 studies included in its review had looked at policy and environmental changes in the worksite.[6] These studies, in general, attempted to make healthy choices easier for the entire workforce by improving access to healthy foods (ie, changing cafeteria and vending machine options) and providing more opportunities to be physically active (ie, providing on-site facilities for exercise). Nonetheless, questions remained regarding the effect of environmental and policy strategies on employee weight status, and more research is needed to investigate potential associations.[6]

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As a response to this growing need, the National Heart, Lung, and Blood Institute funded seven studies to investigate the effectiveness of environmental and policy approaches to lead to weight control and obesity prevention in worksites.[9] More recently, a number of studies[10–13] have reported on the results of environmental interventions to weight control and obesity prevention. To date the results have been equivocal showing few, and inconsistent, relationships between environmental changes and employee weight status.[10–13] It may be that the specific environmental strategies used are not effective in changing employee dietary and PA behavior and thus, weight status remains constant (at best).[11] There continues to be a need for further research to better understand the potential associations between environmental factors and employee dietary and PA behavior to identify potential environmental intervention targets that may lead to more effective programs.[6]

Therefore, the purpose of this study was to investigate the association between the worksite physical environment, and employee dietary intake, PA, and weight status among a group of 28 worksites participating in the Tailored Worksite Weight Control Programs (Worksite[14]) study. We hypothesized that selected environmental factors (ie, cafeteria, number of vending machines, and presence of workout room) would have a direct relationship with dietary and PA behavior, which in turn would be associated with weight status among employees.

METHODS

Study Design

The Worksite study is a two-group, cluster randomized control trial conducted over a period of 4 years to investigate the reach and effectiveness of individually targeted, computer-mediated worksite weight loss programs. Randomization took place after an initial brief health survey (BHS) and was stratified on the basis of worksite size (100 to 300 and 301 to 600 employees). The Worksite study has been introduced and described in more detail elsewhere.[14] This study uses cross-sectional employee survey data and baseline worksite audits using the Checklist of Health Promotion Environments at Worksites (CHEW) to investigate the association between physical environmental factors and employee dietary and PA behavior and weight status. This study's protocols were approved by the Virginia Tech Institutional Review Board (protocol #07-296) and is registered at clinicaltrials.gov (NCT01880060).

Recruitment

Recruitment of worksites began in August 2007 and continued through May 2010. Worksites were identified through a variety of strategies, including (1) contacting local Chambers of Commerce and business associations; (2) advertising in local newspapers; (3) television news coverage of the project; (4) contacting insurance carriers; (5) Internet searches focusing on Web sites devoted to economic development in the targeted area; and (6) phonebook searches in targeted cities and towns.

To be eligible to participate in the study, worksites had to meet five criteria: (1) have a total workforce between 100 and 600

employees; (2) all employees needed to have access and permission to access the Internet at work; (3) all employees had to be located in the same physical environment (no branch offices or off-site locations); (4) agree to conduct a BHS of the entire employee population; and (5) management support for employee participation in kick-off and follow-up activities during the typical workday.

Twenty-eight small and medium-sized worksites were recruited to participate in Virginia ($n = 27$) and Colorado ($n = 1$), with a total employee population of 8680. Worksites included seven governmental agencies represented by city municipal services, social services, public works, state and regional housing, and water authorities ($n = 1840$), six manufacturing and distribution centers ($n = 1690$), five professional groups in law, advertising, engineering, sales, and information technology support ($n = 1820$), four medical facilities ($n = 1626$), four small colleges ($n = 1377$), and two call centers ($n = 330$). The employee population was predominantly female (64%) and white (79%), with an average age of 45.03 years (standard deviation [SD] = 12.11) and an average body mass index (BMI) of 28.84 (SD = 6.80). Additional employee demographic data are provided in Table 1.

Measures

Brief Health Survey

A BHS was developed on the basis of the recommendations by Glasgow and colleagues[15] and completed using the passive acceptance method developed by Linnan and colleagues.[16] Modifications included the use of short validated measures to assess primary health behaviors (PA and eating behaviors). Questions related to risky alcohol and substance consumption were omitted (because of potential adverse effects on participation). The BHS also gathered information on self-reported assessments of height ("About how tall are you without shoes?") and weight ("About how much do you weigh without shoes?"), which were used to calculate BMI and weight status (ie, normal weight, overweight, obese, severely obese, and morbidly obese). Sociodemographic variables included age, sex, race/ethnicity, and education.

Eating behaviors, such as consumption of sugary beverages, fried foods, fruits, vegetables, and deserts, were assessed using the previously validated Starting the Conversion (STC) assessment tool.[17,18] The responses to this seven-item scale are assigned scores of two, one, or zero, and then summed together. The higher the score, the unhealthier the diet is considered to be. This scale has been used in a variety of primary care settings[19] and found to provide consistent estimates of unhealthy eating patterns and be sensitive to change for assessing healthy eating behaviors.[18]

PA behaviors were assessed using the Center for Disease Control and Prevention Behavioral Risk Factor Surveillance Survey questions.[20] One modified question was used to assess moderate activity: (1) "Moderate activities make your heart beat faster than normal. During these activities you can talk but you can't sing, and you are breathing harder than normal. Examples include brisk walking, bicycling, vacuuming, gardening, or anything else that causes an increase in breathing or heart rate. Do you do 30 minutes or more per day of moderate physical activities 5 or more days per week?" and a second question was added: (b) "Do you do activities to increase muscle strength, such as lifting weights or calisthenics, twice a week or more?" This second question was added to capture the American College of Sports Medicine's (ACSM) recommendations of engaging in both cardio and strength training activities.[21] To determine PA status, those who responded yes to both questions were classified as "meeting recommendations." Those who responded no to one or both questions were classified as "not meeting recommendations." Similar measurement tools have shown validity and reliability in determining whether respondents are meeting recommendations.[20,22]

The BHS was introduced to employees as part of research efforts to gather information for the development of future worksite health promotion programs. The BHS was available for completion at each worksite for 2 weeks before the announcement about the upcoming weight loss program. No employees, with the exception of key decision makers (CEO's and human resource directors), were aware of the future weight loss programs being offered. Employees had the option to complete the BHS electronically or on paper. All employees who completed the BHS, regardless of the weight status, were eligible for a lottery of $250 in cash prizes. A total of 6261 employees (>72% participation rate) completed the BHS (see Table 1 for participation rates across worksite types).

Checklist of Health Promotion Environments at Worksites

During the recruitment period for the weight loss programs, trained research assistants completed worksite audits using a modified version of the Checklist of Health Promotion Environments at Worksites (CHEW[23]). The CHEW protocol, scoring, validity, and reliability documentation can be found at http://www.drjamessallis.sdsu.edu/measures.html. The CHEW is a 112-item checklist, which allows for an objective assessment of the workplace environment for elements that could influence health behaviors related to nutrition, PA, smoking, and alcohol.

The CHEW focuses on three distinct domains. The first domain assesses the physical characteristics of the workplace such as the presence of staircases and elevators, the number and contents of vending machines, food options in cafeterias and lunchrooms, the presence of bike racks and storage areas, and access to fitness facilities, changing rooms, and showers. The second domain surveys the informational environment, which included taking inventory of bulletin boards and messaging systems, the number of posters, signs, or flyers with health-related messages or opportunities and the number and placement of no-smoking signs. The third domain captures characteristics of the neighborhood surrounding the workplace for access to restaurants or food outlets, gyms or recreation facilities, and establishments to purchase cigarettes and alcohol. To increase interrater reliability, two trained members of the research team conducted worksite audits. All discrepancies between raters were resolved by returning to the worksite within a few days.

For the purposes of this study, the following scales were calculated from the informational environment: PA signs (total number of signs encouraging PA within the worksite), nutrition signs (total number of signs encouraging healthy nutrition within the worksite), and weight loss signs (total number of signs encouraging weight loss within the worksite). For the PA environment, the following scales were calculated: number of stairs, presence of outdoor space for PA (outdoor space + walking paths around worksite), and presence of workout facilities. For the food environment, the following scales were calculated: presence of a cafeteria, number of vending machines (total number of soda machines + total number of snack machines + total number of coffee/hot tea machines), and number of snack machines.

Data Analysis

Individual participant data from the BHS and the CHEW were coded and entered into SPSS (SPSS 20.0)[24] by trained research assistants. Descriptive statistics (Mean, SD) for individual participant health behaviors were calculated. Furthermore, chi-square tests or analysis of variance tests with post hoc tests were conducted to assess the differences in employee characteristics across different worksite types and are presented in Table 1.

TABLE 1. Employee Characteristics by Worksite Type

Worksite Type ($n = 28$)	Governmental Agencies ($n = 7$)	Manufacturing/ Distribution ($n = 6$)	Professional ($n = 5$)	Medical Facilities ($n = 4$)	Small Colleges ($n = 4$)	Call Centers ($n = 2$)	Overall
Age, mean (SD)	46.85*** (10.73)	44.13 (12.93)	43.68 (11.55)	43.65 (12.33)	48.41*** (11.86)	40.10*** (11.66)	45.03 (12.11)
BMI, mean (SD)	29.57 (6.61)	28.66 (6.91)	27.75*** (6.29)	29.53 (7.06)	27.53*** (5.76)	32.61*** (8.98)	28.84 (6.80)
Female, %	55.7	57.3	55.2	86.9***	59.8	84.4***	64.0
Race, %							
White	69.8***	85.2	91.0	64.6***	94.8	38.9***	78.6
Black	28.0***	9.6	5.1	32.9***	3.3	59.0***	18.2
Other	2.2	5.2	3.9	2.5	1.9	2.1	3.2
Weight status, %							
Normal (18.5–24.9)	24.2***	31.5	36.8	30.0	38.2	17.8***	31.1
Overweight (25–29.9)	34.3	33.9	35.5	28.3***	35.0	29.7***	33.2
Obese (≥30)	41.5***	34.6***	27.7	41.7***	26.8	52.5***	35.7
Education level, %							
High school or less	20.9	40.0***	8.0***	14.7	13.0	18.9	20.4
Some college	32.9***	33.3***	21.7	19.5	16.1	60.5***	26.8
College or higher	46.2	26.7	70.3***	65.8***	70.9***	20.6	52.8
Not meeting the PA guideline, %	71.3***	68.1	71.7***	67.6	65.0***	68.9	68.9
Starting the conversation, mean (SD)	5.82 (2.47)	6.20 (2.70)	5.11 (2.33)***	5.56 (2.61)	5.08 (2.38)***	6.29 (2.75)	5.62 (2.56)
Presence of outdoor space, %	47.0***	62.5	18.5***	66.0	81.0***	0***	52.4
Presence of exercise room, %	32.0	32.0	0***	30.0	69.0***	100***	34.0
Presence of cafeteria, %	15.0	0***	14.0	48.0***	81.0***	0***	27.8
Number of snack machines, mean (SD)	2.95 (3.37)	3.20 (1.97)	1.73 (1.00)***	5.71 (3.78)***	2.50 (0.50)	2.32 (0.94)	3.23 (2.84)
Number of vending machines, mean (SD)	5.11 (3.07)***	7.15 (2.18)	4.48 (1.97)***	12.90 (8.72)***	7.87 (1.57)	3.98 (1.42)***	7.37 (5.33)
Employee participation rate, %	70.0	79.60***	62.80***	76.69***	71.45	77.57***	72.13

***$P < 0.001$.
BMI, body mass index; PA, physical activity, SD, standard deviation.

The relationship between the worksite physical environment and individual participant health behaviors (STC, PA level, and BMI) was examined using hierarchical linear modeling with a two-level regression model.[25] Organizational environmental characteristics (ie, food environment and PA environment) were entered as level 2 predictors of individual characteristics (BMI, STC, and PA behavior), with level 1 being the individual level predictors of age, sex, education level (1 = college; 0 = less), and race (1 = black; 0 = other). Separate models were created and tested for each primary outcome of interest using log equations to examine the relationship between the PA environment and meeting PA recommendations. During the model-building process, we first created an intercept-only model, followed by fitting individual-level (level 1) predictor variables, and finalizing with the addition of worksite-level (level 2) environmental predictors. All multilevel models were evaluated at 95% significance level ($P < 0.05$).

RESULTS

Individual Level

Survey participants were on average 45.03 (SD = 12.11) years old, with the majority being white (79%), women (64%), having completed at least some college (80%), and employed full time (93%). When assessing participant characteristics by worksite type, it was found that participants from governmental agencies and small colleges tended to be older, whereas those from call centers were younger. In addition, medical facilities and call centers had more female and black participants. Finally, employees from manufacturing/distributing worksites, medical facilities, and call centers were more likely to participate in the BHS, whereas employees from professional agencies were less likely to take part. Furthermore, BHS data also revealed that 68.9% of participants ($n = 4313$) were not meeting ACSM guidelines of 150 minutes of moderate PA per week or ACSM guidelines for strength training. Weight status data indicated about 33% of participants ($n = 1883$) were overweight (BMI >25) and 36% ($n = 2026$) were obese (BMI >30), with an average BMI of 28.85 (SD = 6.83). Finally, participants from professional agencies and small colleges reported overall healthier eating behaviors. Full results can be seen in Table 1.

Multilevel Modeling

BMI

We found that being older ($\beta = 0.05$; $P < 0.001$), being black ($\beta = 3.77$; $P < 0.001$), not meeting PA recommendations ($\beta = -2.00$; $P < 0.001$), having a higher (unhealthier diet) starting the conversation score ($\beta = 0.34$; $P < 0.001$), and not having attended college ($\beta = -0.40$; $P < 0.01$) were related to higher BMI. When including the environmental predictors, not having access to outdoor space ($\beta = -0.87$; $P < 0.05$) and having exercise rooms available at the worksite ($\beta = 0.72$; $P < 0.05$) were related to higher BMI. The informational environment variables were not included in the model as they were not present in the worksites included in this study. Full results can be seen in Table 2.

Eating Behaviors

When investigating STC as an outcome of interest, the STC model did have an improvement with the addition of environmental factors over the individual factor model ($\chi^2 = 19.47$; $df = 4$; $P < 0.01$). Namely, the presence of a cafeteria improved eating habits ($\beta = -0.51$; $P < .001$), whereas the presence of more vending machines made them worse ($\beta = 0.04$; $P < 0.05$). In addition, women ($\beta = -0.35$; $P < .01$), younger people ($\beta = -0.02$; $P < 0.001$), nonblack people ($\beta = 1.19$; $P < .001$), and people having attended at least some college ($\beta = -0.51$; $P < 0.001$) were more likely to report healthier eating. Finally, the informational environment variables were not included in the model. Full results can be seen in Table 2.

Meeting PA Recommendations

The probability of PA recommendations being met was significantly related to individual-level predictors, whereas environmental predictors did not seem to influence individual PA. Results indicate that males ($\beta = -0.1$; $P < .001$) and younger employees ($\beta = -0.002$; $P < .001$) were more likely to be physically active. In addition, the informational environment variables were not included in the model. Full results can be seen in Table 2.

TABLE 2. Multilevel Modeling Results for Individual and Environmental Characteristics as Predictors of BMI, Starting the Conversation and PA Recommendations

Variable	BMI β (SE)	Starting the Conversation β (SE)	Meeting the PA Recommendation β (SE)
Individual factors			
Age	0.05*** (0.01)	− 0.02*** (0.00)	− 0.002*** (0.001)
Female	−0.25 (0.20)	− 0.35** (0.10)	− 0.1*** (0.01)
Black	3.77*** (0.45)	1.19*** (0.23)	− 0.02 (0.04)
Education	−0.40** (0.12)	− 0.51*** (0.04)	0.004 (0.006)
Meeting PA recommendations	−2.00*** (0.16)		
Starting the conversation	0.34*** (0.04)		
PA environmental factors			
Outdoor space	−0.87* (0.40)		0.02 (0.02)
Exercise room	0.72* (0.36)		− 0.008 (0.02)
Food environmental factors			
Cafeteria	−058 (0.36)	− 0.51*** (0.11)	
Snack machine	0.12 (0.11)	− 0.03 (0.03)	
Vending machine	−0.01 (0.06)	0.04* (0.02)	

*$P < .05$, **$P < .01$, ***$P < .001$.
BMI, body mass index; PA; physical activity; SE, standard error.

DISCUSSION

The purpose of this study was to investigate the relationship between worksite physical environmental factors and employee dietary intake, PA, and weight status. Our results indicate that selected PA environmental factors may be directly associated with employee BMI. In fact, the association between the presence of outdoor opportunities such as walking trails and open space and lower employee BMI might be one of the first findings of its kind. Of particular interest is that outdoor opportunities were not directly associated with PA levels indicating a potential distinct association with BMI without improving PA levels. This lack of direct association between outdoor opportunities and PA could be due to the PA measures used in the study. The measures used did not account for overall activity, but just leisure time activity with occupational activity not included. This fact could partially account for the results of PA environmental factors being associated with BMI, but not directly with PA levels. Nevertheless, to our knowledge, most studies[10–13,26] so far have not been able to find direct links between PA environmental factors and employee BMI.

Nevertheless, counter to our hypothesis, the presence of workout facilities at worksites was associated with a higher employee BMI. Although this is another new finding in terms of the association between PA environmental factors and employee weight status, it goes against the generally accepted idea that workout facilities at workplaces have a positive impact on employee PA and BMI. In fact, our results showed no association between workout facilities and employee PA levels. It could be that worksites with a higher proportion of overweight and obese employees were more likely to build these facilities to address this growing problem. In addition, it could be that employees with a higher BMI feel less comfortable using workout facilities at their workplace. Moreover, it could be that the PA measures used did not fully capture overall PA levels or the fact that self-reported BMI could have influenced these associations. Unfortunately, because of the cross-sectional nature of the study, we are not able to investigate these causal relationships, and thus determine whether the facilities came before or after employees' weight status. Additional studies investigating the potential mechanisms explaining this finding are needed.

Furthermore, our overall hypothesis that food environmental factors would be directly associated with healthier eating behaviors, and thus indirectly associated with employee BMI was supported. Our findings indicate that the presence of a cafeteria and lower numbers of vending machines have a direct association with healthier eating behaviors. Although these environmental factors had no direct association with BMI, healthier eating behaviors were highly associated with lower employee BMI. Conversely, recent studies[10,11] have shown that environmental strategies to increase the availability of healthier food choices in worksite cafeterias and vending machines may not be the best approach to reduce employee BMI. Combined with our results, these findings suggest that just providing employees with information and access to healthier food options may not be enough, and additional strategies to reduce unhealthy food choices may also be needed. Although adding a cafeteria to a worksite may provide new options for healthier foods, once the cafeteria is built additional strategies may be needed to increase its utilization. Furthermore, just the addition of a cafeteria may not lead to healthier food options. Worksite-based interventions may be needed to ensure the availability of healthier food options and eliminate unhealthier choices. Finally, alternative strategies such as the elimination of some vending machines and its unhealthy options from the worksite may provide better results. These strategies need to be further tested in longitudinal studies.

A major limitation of this study is the cross-sectional nature, which does not allow for causal conclusions. An association between the physical environment and employee BMI was found; however, we are not able to determine the directionality of this relationship. Another limitation was the use of self-report measures of all individual-level variables. Self-report measures often overestimate desired behaviors (ie, PA and healthy eating) and underestimate less desirable ones (ie, weight). In addition, the self-report measures used in this study may not fully capture overall PA and eating behavior, as such all results must be considered within the limitations of the measures used. Furthermore, although we observed the availability of cafeterias, we did not evaluate the quality of the food being offered; thus, we are not able to determine whether the food options were related to employee BMI. Nevertheless, our results seem to suggest that the presence of a cafeteria may be positively associated with eating behaviors, independently of its food offerings. Some of the strengths of the study include, but are not limited to, (1) the use of an objective measure for environmental factors; (2) the use of multilevel modeling techniques, which allowed the full use of individual-level data without aggregating employee data at the worksite level as previous studies[10,26] have done; and (3) a high employee response rate (72% overall).

CONCLUSIONS

Our findings provide preliminary evidence that selected worksite environmental factors may be directly and indirectly associated with employee BMI. Access to outdoor spaces and walking trails may have a protective influence on employee weight status, whereas worksite workout facilities were found to have a negative association. In addition, the presence of a cafeteria and lower amounts of vending machines were associated with healthier eating habits, which in turn were associated with lower employee BMI. These findings stress the potential that worksite environmental factors may have in influencing employee dietary behavior and weight status. Nevertheless, further research with longitudinal and intervention designs is needed to investigate these causal pathways and provide additional justification for making such changes in worksite settings.

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COMMUNITY CASE STUDY

Working With Community Partners to Implement and Evaluate the Chicago Park District's 100% Healthier Snack Vending Initiative

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PEER REVIEWED

Abstract

Background
The objective of this case study was to evaluate the acceptability, sales impact, and implementation barriers for the Chicago Park District's 100% Healthier Snack Vending Initiative to strengthen and support future healthful vending efforts.

Community Context
The Chicago Park District is the largest municipal park system in the United States, serving almost 200,000 children annually through after-school and summer programs. Chicago is one of the first US cities to improve park food environments through more healthful snack vending.

Methods
A community-based participatory evaluation engaged community and academic partners, who shared in all aspects of the research. From spring 2011 to fall 2012, we collected data through observation, surveys, and interviews on staff and patron acceptance of snack vending items, purchasing behaviors, and machine operations at a sample of 10 Chicago parks. A new snack vending contract included nutrition standards for serving sizes, calories, sugar, fat, and sodium for all items. Fifteen months of snack vending sales data were collected from all 98 snack vending machines in park field houses.

Outcomes
Staff (100%) and patrons (88%) reacted positively to the initiative. Average monthly per-machine sales increased during 15 months ($84 to $371). Vendor compliance issues included stocking noncompliant items and delayed restocking.

Interpretation
The initiative resulted in improved park food environments. Diverse partner engagement, participatory evaluation, and early attention to compliance can be important supports for healthful vending initiatives. Consumer acceptance and increasing revenues can help to counter fears of revenue loss that can pose barriers to adoption.

Background

Interventions in various food environments have been conducted to promote healthful eating. Such interventions include expanding farmers markets (1), increasing fresh food inventory in small stores (2,3), financing programs to support full-service groceries in underserved communities (4), and initiating healthy vending machine programs (5–7). Most healthful food interventions focus on school and community settings. Few have focused on parks (8,9).

Parks are an important public space for promoting health, especially in urban settings with limited open space (10), not only through physical activity but also through access to healthful food. Parks are the second largest public provider of food to children in

the United States, serving 985,000 meals in 2011 (11). They can play an important role in improving access to healthful food and beverages. As demand grows for diverse approaches to improving food environments, communities may benefit from information about healthful food initiatives in local, state, and national parks.

The objective of this case study was to evaluate the acceptability, sales impact, and implementation barriers for the Chicago Park District's 100% Healthier Snack Vending Initiative, launched in 2011. The central evaluation questions were 1) what were patron and staff reactions to the more healthful snack vending items, 2) how did more healthful snack vending sales change during the initiative, and 3) what barriers need to be overcome to strengthen the initiative?

Community Context

Chicago has approximately 2.7 million residents, of whom approximately 40% are white, 33% are black, and 29% are Hispanic (12). One in 5 (20.0%) children entering kindergarten and nearly 1 in 3 children (29.2%) entering 6th grade is obese (13).

The Chicago Park District is the largest municipal park system in the United States, with 580 parks and 260 field houses covering more than 8,100 acres. Nearly three-quarters of the district's programs serve children and youth. In 2012, 188,422 (76%) of the 246,548 program participants were children and youth. Parks are located throughout the city, including in community areas where access to healthful food is limited (14). Chicago is one of the first US cities to improve the food environment of parks through a more healthful snack vending initiative. In April 2010, the district sought bids for a snack vending contract that included nutrition standards for snack items that limited serving sizes, calories, sugar, fat, and sodium for all items. Beverage vending was handled through a separate contract set to expire at a later date and was not included in this initiative.

In August 2010, the district executed a 5-year contract with a large national vendor. The contract called for placing 98 snack vending machines in indoor field houses throughout the park system. No park has more than 1 snack vending machine. The contract states that 100% of items sold will meet the following nutrition standards:

1. No more than 250 kcal per serving;
2. No more than 42 g of added sweetener per 20 oz;
3. No more than 35% of kcal from fat (with the exception of seeds and nuts);
4. No more than 10% of kcal from saturated fat;
5. No trans fats;
6. No more than 35% total weight from sugar and caloric sweeteners (natural fruit juice allowed);
7. No more than 400 mg of sodium per serving;
8. At least 5 items must contain less than 250 mg of sodium per serving;
9. No more than 2 servings per package.

A park district staff member, who is a registered dietitian, led the development of nutrition standards, which are based on guidelines from the Alliance for a Healthier Generation (AHG) and the American Heart Association (AHA). The contract also states that all vending machine items will be priced uniformly ($1 per item at the time of evaluation) to eliminate price as a driver of consumer choice. Except for packages of 100-calorie items, the nutrition content of items was not visible to consumers. Snack items chosen on the basis of the new standards included fruit snacks, granola bars, and baked chips.

The previous snack vending contract, which had no nutrition or pricing requirements, expired 2 years before the initiative and allowed items such as cookies, candies, and chips. These vending machines were removed, providing an opportunity to start fresh with new machines and new items. Before implementation of the initiative, district staff from 4 parks participated in a pilot nutrition training and taste-testing session of new snack items. These sessions were poorly attended and resulted in minimal changes in nutrition knowledge among participants. No communications were made to park patrons about the initiative before installation of the new vending machines. To establish an evidence base for informing future vending contracts, district staff and partners decided to conduct an evaluation of the initiative.

Methods

Building community partnerships

The initiative was supported by Chicago's Healthy Kids, Healthy Communities (HKHC) project, funded by the Robert Wood Johnson Foundation. HKHC supported policy, systems, and environmental changes to improve nutrition and increase physical activity for children outside of school settings. The Chicago HKHC leadership team, composed of staff from 1 lead and 4 supporting community-based organizations (CBOs), a local childhood obesity prevention consortium, and the district, played key roles in supporting the initiative and its evaluation. The CBOs provided a consumer perspective, helped district leadership understand the value of the initiative for park patrons, and helped shape evaluation questions and approaches. District staff led the initiative in the park system and ensured access to district facilities and sales data. The obesity prevention consortium provided content expertise and

introductions to national consultants for contract development, and its director of evaluation and community research led the evaluation. The project was approved by the institutional review board at the Ann and Robert H. Lurie Children's Hospital of Chicago.

Data collection

The evaluation used quantitative and qualitative research methods. Observation and interview data were collected from a convenience sample of 10 parks representative of the sociodemographic characteristics of Chicago, the variation in park amenities throughout the district, and the geographic regions of the district. Within each region, parks were selected according to the race and ethnicity of surrounding neighborhoods, including 4 predominantly white, 3 predominantly black, 2 predominantly Hispanic, and 1 racially and ethnically mixed neighborhood. Selected parks included a mix of larger regional and smaller neighborhood parks with diversity of space and amenities (Table).

Research assistants conducted semistructured interviews with park staff in summer 2012. One staff member from each park was selected from a list of volunteers. Staff interviews lasted 20 to 60 minutes and explored staff attitudes toward more healthful health snack vending, snack vending purchasing behaviors, observations of snack vending machine issues (stocking and functioning), and interactions with park patrons and their snack choices. Park staff provided written consent for interview participation.

Research assistants observed consumer snack vending purchases during spring and summer 2012. They conducted observations at each park on different days of the week and times of day to capture data on the diversity of program participation and purchasing behaviors. Research assistants visited each park an average of 2.8 times and recorded items purchased, sex and age of the purchaser (child, teen, young adult, adult), whether the purchaser was alone or with others (categorized as children, teens, young adults, or adults), when the items were consumed (upon purchase or at some later time, unseen by the observer), and by whom (by purchaser or by another). Research assistants stood nearby each vending machine to conduct observations but recorded their observations once patrons left the vicinity to reduce patron awareness of being observed. No consent was obtained for vending purchase observations.

Research assistants observed machine conditions and item compliance and stocking during each park visit from fall 2011 through summer 2012. They examined the number of empty slots in each machine to understand how well machines were stocked. A slot is a spot in a vending machine from which a snack is selected; each machine has 40 slots. District management-level staff also observed conditions, compliance, and stocking during park visits.

Research assistants administered a 16-item survey (in English) with park patrons aged 18 or older during summer 2011 and summer 2012. At each park visit, research assistants approached each patron who was in close proximity to a vending machine. Research assistants explained the survey purpose, invited the patron to participate, and determined their age eligibility. Surveys lasted approximately 2 minutes per patron. Questions assessed perceptions of the new snacks and solicited suggestions for improvements. Support for a healthful beverage initiative was also assessed (but not evaluated as part of this study). Park patrons gave verbal consent for survey participation. No incentives were provided for survey completion.

Monthly sales data for June 2011 through August 2012 were provided by the vendor via electronic files to the district and then transmitted to evaluators. Sales data were provided for 98 vending machines. These data were analyzed by vending machine, by item, and by park location.

Analysis

Quantitative data were analyzed using SPSS 16.0 (IBM Corporation). Monthly vending sales were analyzed from when the vending machines were first installed (June 211) through the end of the evaluation period (August 2012). Baseline sales data and nutritional contents of vended items from before the initiative were unavailable for comparison because of the 2-year gap in vending services. Research assistants individually analyzed qualitative interview data for recurring themes. They then compared their individual analyses and refined the themes for coding to enhance inter-rater reliability. Refined themes were shared with the evaluation partners for discussion and revision. A manageable number of interview themes made computer software unnecessary for coding and data organization.

Outcomes

Nine park staff members (1 per park) were interviewed from 9 of the 10 sampled parks. At 10 sampled parks, 130 park patron surveys and 27 patron purchasing observation sessions were completed. Observations of machine conditions and compliance were conducted during 27 purchasing observation sessions and 26 staff visits. Fifteen months of vending machine sales data were analyzed. Twenty-six unique observations of snack vending machine conditions and stocking were completed.

Patrons overwhelmingly approved of the more healthful snack vending items; 88% of those surveyed reported liking the snack vending items they tried. Almost all (98%) patrons purchasing snacks from the vending machines indicated that they would purchase the snacks again. The main reason given for disliking the

more healthful snacks was that they were not healthful enough. Almost all interviewed park staff (89%) had tried items from the machines. Of those, 100% reported liking the products they had tried.

Eighty-one purchases were observed during 27 observation sessions: children were involved in 44 purchases, 22 of which were made alone and 22 of which were made with an adult. Teenagers made 18 purchases. Approximately 70% of the snack items were consumed in view of the observer.

Generally, sales trends followed the machine deployment schedule with the exception of large dips in January and June 2012 (Figure 1). Overall monthly average sales per machine increased from $84 in June 2011 to $371 in August 2012.

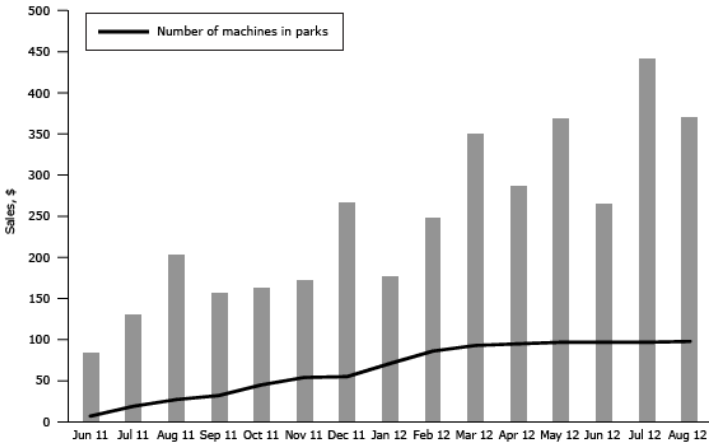

Figure 1. Average monthly sales per machine during the machine deployment period (June 2011 through August 2012).

Sales exceeded the expectations of both district staff and vendors. Average monthly sales volume per machine also exceeded industry sales estimates of $300 per month for snack vending machines located in "average" locations, which typically have 10 sales per day (15).

Compliance and operational issues during the first 2 years of the contract included stocking of noncompliant items, failure to restock on a timely basis, and machine malfunctions, the latter 2 of which are not specific to stocking of healthful items.

From January through September 2012, 54 instances (or about 0.8% of slots) of stocking noncompliant items were documented. Driver error (stocking of noncompliant items) and mislabeling of items (noncompliant items labeled as compliant in the warehouse) were identified as the primary reasons for noncompliance. To address these issues, the vendor provided drivers with training on the nutrition standards, began pre-boxing compliant items to eliminate the need for drivers to select compliant items from the list of available items, and monitored labeling more closely.

Restocking of machines was uneven among parks. Some parks reported no problems, while others reported repeated instances of out-of-stock items. The number of slots empty per machine ranged from 0 (a completely stocked machine) to 21 (more than half of slots empty). On average among all observations, 7 slots per machine were empty (Figure 2). In 11 of 15 months, the number of empty slots surpassed the industry average of 5 empty slots per machine.

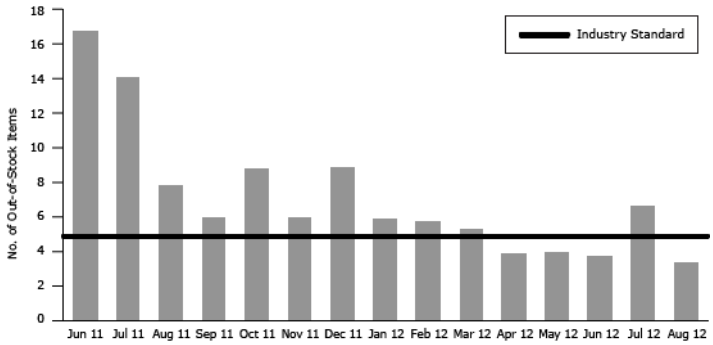

Figure 2. The average number of out-of-stock items (empty slots) per machine at time of refill by month (June 2011 through August 2012).

Machine malfunctions included failure to vend products, accept money, and give change. More than half (55%) of the malfunctions were failure to vend products and accept money.

Interpretation

Our evaluation, conducted in a subset of 10 parks, found sufficient evidence of success. The initiative was well received: nearly all patrons and staff reported liking the more healthful offerings. The initiative was also fiscally successful: monthly sales grew over time, surpassing initial projections and industry averages. These findings can inform efforts in other municipalities to improve the nutritional value of snacks offered in park vending machines.

Partnerships played a key role in the success of implementation and evaluation. The joint effort of district staff, community advocates, and policy and obesity experts enabled the creation and execution of the new contract. The partnership enabled the research team to collect data from park patrons and staff, access sales data, and identify implementation issues.

The district worked with the vendor to resolve compliance issues; these issues may have affected sales and are important for entities to consider when examining more healthful vending options. Data on compliance, out-of-stock items, and machine malfunctions were helpful in interpreting sales outcomes and identifying corrective actions. As healthful vending programs become more common, vendors may learn from strategies implemented in our initiative, including the trainer of drivers and the pre-boxing of compliant items.

Even with compliance and stocking challenges, we found that per-machine monthly sales of more healthful vending items increased greatly. One possible explanation for this large increase may have been the absence of vending machines for 2 years before the initiative, which may have caused patrons to fall out of the habit of purchasing snacks at parks. The rise in sales may have occurred as consumer awareness of the new machines increased. The initiative received positive media attention locally, and obesity was gaining more local attention as a critical health issue, which may also have encouraged consumers to buy the new items.

The Centers for Disease Control and Prevention recommends that communities increase availability of more healthful food and beverage choices in public service venues (16). The Chicago Park District's 100% Healthier Snack Vending Initiative does this by applying nutrition standards consistent with AHA and AHG guidelines. Such approaches can provide opportunities, cues, and support for more healthful behaviors and may be more sustainable than traditional public health approaches focused on individual behavior change (17). Improving access to more healthful foods through machine-vended snacks is a strategy that has demonstrated success in schools and worksites. This strategy can be pursued by using various tactics individually or in combination, including pricing more healthful foods at lower cost, preferential placement of more healthful items in vending machines, signage promoting more healthful foods, increasing the number of more healthful items stocked as a proportion of all items in vending machines, and nutrition education (18–20).

We found no other studies of snack vending interventions that included only items meeting nutritional standards and uniform pricing, so our initiative is unique. This community case study contributes to the emerging evidence that such an initiative can be accepted by consumers and can meet or surpass sales expectations. These are important findings given that fear of revenue loss is often cited as a barrier to implementing healthful vending initiatives. Our experience can help to assuage those fears in other communities and provide support for the district's new healthful beverage vending initiative. Although we could not compare pre-initiative sales with sales during the initiative, our study found that the average sales per machine increased monthly after the initiative was launched and that sales levels exceeded projections. We also found that 88% of park patrons surveyed liked the more healthful vending items, and 98% would purchase from the machines again, signaling that future revenue loss is unlikely.

As with any program evaluation, generalizing outcomes beyond the evaluation context should be done with caution. The evaluation was limited by sample size and by data collection methods. A larger, randomized sample of parks may have strengthened outcomes but was not feasible because of the initiative's implementation schedule. Although pre-initiative data would have helped us to understand the overall impact on revenues, the findings of acceptability and increasing revenues over time that exceeded expectations are important and positive.

The initiative has led to improved food environments in Chicago parks. We found that 54.4% of snack vending purchases in parks were made by or for children, so improvements are likely to have a greater effect on children than on adults. Finally, the success of the initiative paved the way for the district to issue a request for proposals for healthful beverage vending, and a contract was awarded in 2013.

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Table

Table. Characteristics of Chicago Park District Parks Included in Evaluation of Chicago Park District's 100% Healthier Snack Vending Initiative

Park	Race/Ethnicity of Surrounding Community	Average Annual Household Earnings in Surrounding Community, $	Geographic Region of City	Wellness Center[a]	Fitness Center[b]	Playground	Fields	Swimming Pool	Other	After School Program Park Kids
1	Black	50,110	South	No	No	Yes	Soccer, football, baseball	No	Basketball, tennis	Yes
2	Black	32,388	South	No	No	Yes	No	Outdoor	Basketball, gym, tennis	No
3	Hispanic	52,060	North	No	No	Yes	Soccer, football, baseball	Outdoor	Basketball, gym, tennis, track, outdoor ice rink, lagoon, pond	No
4	Hispanic and white	45,240	Central	No	No	Yes	Soccer, football, baseball	Outdoor	Basketball, fishing, gymnastic center, tennis, water playground, lagoon, pond	No
5	White	47,934	North	Yes	Yes	No	No	No	Gymnastic center, gym, culinary center, climbing wall, dark rooms	No
6	Hispanic	44,059	North	No	Yes	Yes	Soccer, football, baseball	Indoor and outdoor	Basketball, gyms, skate park, tennis, water playground, volleyball	No
7	Black	42,680	Central	No	Yes	No	Soccer,	Outdoor	Basketball,	Yes

[a] Wellness centers provide multifaceted, year-round nutrition and fitness programs. Fitness classes, fitness arcading, and interactive fitness equipment are designed to help children and adults have fun while they get fit. There are 6 wellness centers in the Chicago Park District.

[b] Fitness centers are fee-based and feature state-of-the-art equipment such as computerized treadmills, cross trainers, upright bikes, recumbent bikes, free weights and benches, cable crossovers, multistation weight machines, and core-focused weight equipment. There are 70 fitness centers in the Chicago Park District.

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Table. Characteristics of Chicago Park District Parks Included in Evaluation of Chicago Park District's 100% Healthier Snack Vending Initiative

Park	Race/Ethnicity of Surrounding Community	Average Annual Household Earnings in Surrounding Community, $	Geographic Region of City	Wellness Center[a]	Fitness Center[b]	Playground	Fields	Swimming Pool	Other	After School Program Park Kids
							football, baseball		boxing, gym	
8	White	50,821	North	No	Yes	Yes	Soccer, football, baseball	Outdoor	Gym, tennis, theaters	Yes
9	White	61,285	North	No	No	Yes	Baseball	Outdoor	Basketball, fishing, gym, tennis, roller hockey rink, lagoon, pond, wetlands	Yes
10	White	58,182	Central	Yes	Yes	Yes	Soccer, football, baseball	Outdoor	Basketball, beaches, gyms, trails, tennis, lagoon, pond, wetlands	Yes

[a] Wellness centers provide multifaceted, year-round nutrition and fitness programs. Fitness classes, fitness arcading, and interactive fitness equipment are designed to help children and adults have fun while they get fit. There are 6 wellness centers in the Chicago Park District.

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