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

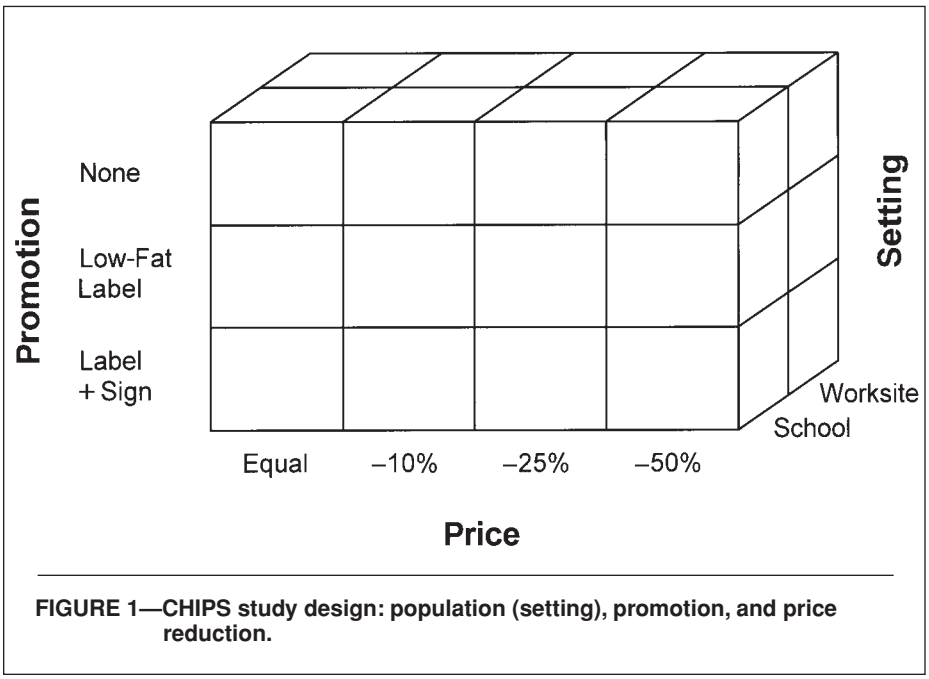


FIGURE 1—CHIPS study design: population (setting), promotion, and price reduction.

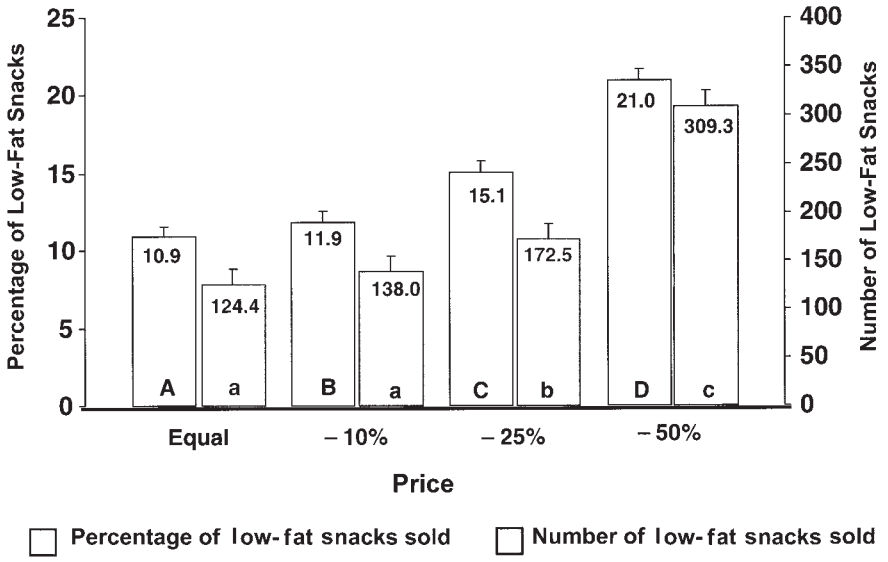
used for the analysis because of its efficiency in handling balanced and unbalanced cases and its ability to handle multiple random effects such as those involved in the present study design.

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

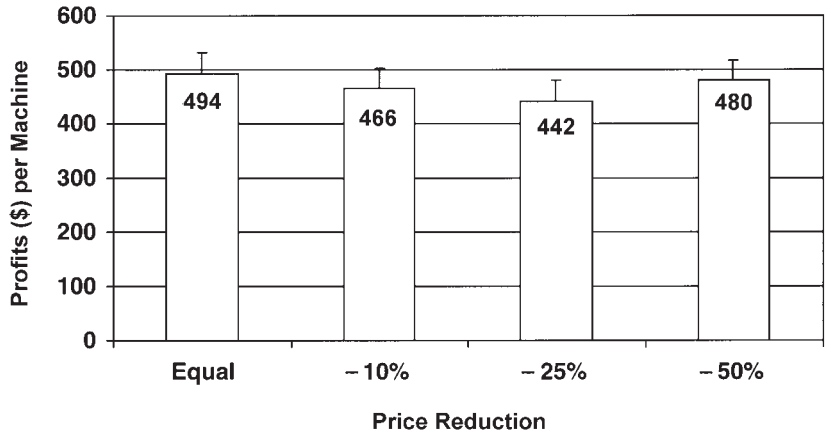


FIGURE 3—Profits in dollars (price minus cost) per machine per treatment period, by price reduction condition: CHIPS study, Minneapolis–St. Paul, Minn, 1997–1999.

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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