

RESEARCH ARTICLE

Promoting the Purchase of Low-Calorie Foods From School Vending Machines: A Cluster-Randomized Controlled Study

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ABSTRACT

BACKGROUND: Vending machines account for food sales and revenue in schools. We examined 3 strategies for promoting the sale of lower-calorie food products from vending machines in high schools in the Netherlands.

METHODS: A school-based randomized controlled trial was conducted in 13 experimental schools and 15 control schools. Three strategies were tested within each experimental school: increasing the availability of lower-calorie products in vending machines, labeling products, and reducing the price of lower-calorie products. The experimental schools introduced the strategies in 3 consecutive phases, with phase 3 incorporating all 3 strategies. The control schools remained the same. The sales volumes from the vending machines were registered. Products were grouped into (1) extra foods containing empty calories, for example, candies and potato chips, (2) nutrient-rich basic foods, and (3) beverages. They were also divided into favorable, moderately unfavorable, and unfavorable products.

RESULTS: Total sales volumes for experimental and control schools did not differ significantly for the extra and beverage products. Proportionally, the higher availability of lower-calorie extra products in the experimental schools led to higher sales of moderately unfavorable extra products than in the control schools, and to higher sales of favorable extra products in experimental schools where students have to stay during breaks. Together, availability, labeling, and price reduction raised the proportional sales of favorable beverages.

CONCLUSION: Results indicate that when the availability of lower-calorie foods is increased and is also combined with labeling and reduced prices, students make healthier choices without buying more or fewer products from school vending machines. Changes to school vending machines help to create a healthy school environment.

Keywords: behavior; health promotion; obesity; environment.

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Overweight and obesity are growing health problems worldwide. Because the prevalence of both conditions increases when adolescents grow into adulthood, their prevention should start early in life. Many studies have examined the dietary risk behaviors related to overweight and obesity, such as children's and adolescents' consumption of high-fat snacks and

their low consumption of fruits and vegetables. These behaviors are common among youngsters in the Netherlands, as they are among those in other Western societies.¹⁻³

In the Netherlands, there is no tradition of school meal services. Students take their lunch from home, or buy food in the school canteen or neighborhood shops.

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During the day, however, they have opportunities to buy beverages and extra foods, for example, candies and potato chips from vending machines at their schools. Vending machines are present in almost all Dutch schools, most containing only high-calorie extra foods and soft drinks, and few or no low-calorie products.⁴ These extra foods and soft drinks are often energy-dense, are sold in large portions, and compete with basic foods that provide important nutrients. The intake of energy-dense food in large portions helps raise children's energy intake.⁵⁻⁷

School-based interventions are a promising approach to preventing overweight and obesity in children.^{8,9} They are intended to improve young people's ability to make healthy decisions and to create a healthy environment.¹⁰⁻¹⁵ Individual approaches which focus on promoting nutritional knowledge and awareness have had only limited success in promoting the long-term maintenance of healthy eating habits: when an intervention stops, individuals often return to their previous behaviors.¹⁶ For this reason, environmental interventions have focused on factors outside the individual—such as the availability and accessibility of foods—that might influence nutritional behavior.

The literature shows that the sale and consumption of healthy foods can be influenced by increasing the availability of healthy foods.¹⁷⁻²⁰ Similarly, purchasing behavior can be positively influenced by guiding customers toward healthier choices through strategies such as labeling, and by providing information, reminders, and reinforcements.²¹⁻²³ However, as the effect of labeling alone is small, it will probably be more effective if it is combined with other methods.²⁴⁻²⁶ Another strategy that may influence buying behavior is by reducing the price of low-calorie foods.²⁴

Although more attention has been drawn to school-based interventions that focus on changing the availability and accessibility of foods in vending machines, we know of few intervention studies that have investigated a combination of strategies to influence the nutritional choices young people make when using a vending machine.²⁴ This study in a school setting investigates the effects of the following 3 strategies on the volume of sales from vending machines and on students' product choices: (1) increasing the availability of lower-calorie foods, (2) labeling, and (3) reducing prices for lower-calorie products. Thus, we examined the effects of the 3 strategies on (1) the total sales volumes of products from vending machines, and (2) high school students' choice of products from such machines. We hypothesized that because students would substitute high-calorie products for lower-calorie ones, total sales volumes would not increase. We also expected that the proportion of lower caloric food products in total sales

would increase, and that the proportion of high caloric food products would decrease.

METHODS

Participants

A cluster-randomized controlled design was used. Participating schools were recruited in 4 areas of the Netherlands, and were randomly assigned to the experimental or control condition, stratified by geographical area. The experimental schools implemented the changes in the vending machines, while the control schools made no changes. The intervention started with a total of 40 schools: 20 experimental schools and 20 control schools. Due to the withdrawal of 4 caterers responsible for school vending machines, 7 experimental schools and 4 control schools dropped out of the study. Due to incomplete data registration, 1 other school could not continue the study. The results presented in this study therefore represent data from 13 experimental schools and 15 control schools.

Procedure

The intervention consisted of 3 strategies that were introduced in school vending machines in 3 successive 6-week phases. The experimental schools introduced the 3 intervention methods consecutively; finally combining all 3 strategies in phase 3. The intervention took place in 2007. Phase 1 ran from the end of January until mid-March, phase 2 ran from mid-March until the end of April, and phase 3 ran from the end of April until mid-June. The control schools kept their original products and prices and did not use labeling. Per phase, the intervention introduced the following.

Phase 1: Increasing the Availability of Lower-Calorie Products. Energy-dense extra foods and drinks were replaced by lower-calorie foods and drinks. Products were grouped into 3 food groups: (1) extra foods, that is, products with empty calories that deliver only energy and no important vitamins or minerals, (2) basics, that is, nutrient-rich products that might be part of a daily diet, and (3) beverages, that is, all fruit juices, and also sugar-sweetened and light drinks.

Extra foods were categorized into <100 Kcal products (termed "favorable"); 100-170 Kcal products (termed "moderately unfavorable"), and >170 Kcal products (termed "unfavorable"). On the basis of nutritional content such as their fat, sugar, and fiber, basic products were also categorized into favorable, moderately unfavorable, and unfavorable. Beverages were grouped into 2 categories, as moderately unfavorable category was not available.

On the basis of the recommendations of the Netherlands Nutrition Centre, the unfavorable products in the vending machines were replaced by moderately

unfavorable or favorable products. Under these recommendations, 75% of the products offered in a vending machine should be favorable or moderately unfavorable; no fewer than 25% should be favorable. As long as the 75% criterion was met, foods were not necessarily replaced by the same type of product, such as a high-calorie soft drink by a similar low-calorie one.

Phase 2: Labeling Products. In phase 2, information labels were attached to the products in the vending machines to indicate the product category and to give information about the product. The labels showed a raised thumb for the favorable products, a raised index finger for moderately unfavorable products, and a downturned thumb for unfavorable products. The basic and beverage labels were green (favorable), orange (moderately unfavorable), and red (unfavorable). The extra labels were in different shades of red, favorable products being indicated in the lightest shade of red.

The labels were placed next to the prices inside the machines or on the buttons outside. At this stage of the intervention, students were handed flyers containing information on the 3 food groups extra food, basic food, and beverage groups, and their relative favorableness, the information being based on caloric or nutritious value. At the same time, posters containing this information were hung near the machines. All materials were pretested among high school children.

Phase 3: Reducing the Price of Lower-Calorie Products. In phase 3, the prices of favorable and moderately unfavorable products were reduced by EUR 0.10 (this is roughly US\$0.10) per product, an average reduction of 10%. Schools were advised to reduce the prices of favorable products, but due to the low availability of these products, it was left to schools and caterers to decide whether they would reduce the prices of favorable and moderately unfavorable products alike, or only the price of 1 of these categories.

The logic of starting the experiment by changing the range of products sold from the vending machines was that the effect of this change was of primary interest to this study. The obvious next step in the intervention was to inform the students about the changes to the product range, and to study the additional effect of food labeling. It was decided that the logical last step of the intervention would be to study the combined effect of lower prices, the greater availability of favorable products, and the students' knowledge of the advantages of the lower-priced (ie, more healthy) products.

Responsibility for changing the product range in the vending machines, and also for the labeling and price reductions indicated by the research team, lay with the relevant school staff, canteen staff, or catering companies. The experiment was prepared in collaboration with many stakeholders involved in the

schools' food supply, that is, students, school boards and teachers, school canteen staff members, school catering companies, and government authorities. In various ways, the project organization supported the school staff and catering companies with their changes to the vending machines. An independent specialist in the field of school facilities and foods was contracted to advise schools and vendors on a range of healthy foods for the machines. Health-promotion officers from community health organizations encouraged the schools in their regions to participate in the project, and also helped the schools with the changes to the machines. The project organization ran a help desk which was on stand-by for questions and troubleshooting. During the intervention phases, the guidance by the project staff ensured that the schools stayed on track with the strategies they had planned.

Data Assessment

During all 3 phases of the project, school staff, canteen staff, or catering companies kept records of the schools' data on sales from the machines. They registered stock supplies, orders, and sales. The measurement procedure was tailored as much as possible to the school's system for registering food sales.

Wherever possible, sales were registered directly from the machines using the automatic registration meters inside the machines. Sales were registered using standard registration forms which included a standardized list of almost 400 different products sold from the machines. The products on this list were categorized by the Dutch Nutrition Centre according to the 3 food groups (extra foods, beverages, and basic foods), and the 3 categories (favorable product, moderately unfavorable product, and favorable product).

Per school, the standard lists were used for weekly or biweekly reporting of the sales data to the research team. The project team kept track of the quality of the schools' or catering companies' data. To help prevent recall and information bias, data were gathered over short (ie, 1-week) periods, and standardized registration procedures were used. The research team made an Excel (Microsoft Corporation, Redmond, WA) file of each school's sales data, and used pivot tables to summarize sales per food group and category per intervention phase.

Data were gathered in phases 1 to 3, and comparability between the experimental and control groups was secured at baseline by the randomization of schools. Due to practical difficulties concerning research in a school setting, it was not feasible to perform a baseline measurement in the weeks before the experiment started: data collection during the experiment was already too heavy a burden for the schools and catering companies. By omitting a

baseline measurement, we could reduce schools' and companies' inputs into the project.

Implementation

In 1 experimental school and 3 control schools, phase 1 was implemented in mid-February, and in 1 other experimental school it was implemented at the beginning of March. In these schools phase 3 lasted for 5 and 3 weeks, respectively, due to the start of summer vacation.

On their visits to the schools in phase 3—by which time the recommended strategies should have been implemented—research assistants established how successful implementation had been. Although full implementation of the intervention was achieved in only 23% of the experimental schools, the implementation of the strategies (measured on a scale indicating the completeness with which a school had introduced them) was acceptable in 69% of the total number of experimental schools.

The implementation of the 3 strategies in the schools' vending machines was less complete for beverages than it was for extra foods. There were 3 reasons for the incomplete implementation of the 3 strategies: (1) some product information which had already been made available by caterers and product manufacturers (such as the Coca Cola company) was already in use at the schools; (2) attractive products were lacking in the lower-calorie categories; and (3) there were technical problems with vending machines with regard to the adjustment of prices.

Data Analysis

Chi-square and independent sample *t* tests were used to test for differences in the background characteristics of the experimental and control schools, that is, the number of students, their level of education, the number of machines, the presence of a counter in machines, any policy that allowed students to leave the school premises, and the number of points of sales—such as shops, supermarkets, and fast-food restaurants—within a 1-km radius of the school.

As schools were the unit of measurement, the sample sizes were small. To increase the robustness of the data, we aggregated the sales for each school that had more than 1 vending machine. The number of machines per school varied and was too small to perform multilevel analyses.

To determine whether the intervention had affected overall sales volumes, we examined total sales volumes. To test for differences in total product sales and in mean product sales between experimental and control schools, we performed analysis of covariance, controlling for characteristics that significantly differed between the experimental group and control group. To allow for the number of potential consumers of the

products, sales volumes were divided by the number of students at the school. Cohen's *d* effect sizes were computed.

To test for changes in students' purchasing behavior between phases, we established the relative sales of favorable, moderately unfavorable, and unfavorable products for all product groups (extra foods, basics, and beverages). Analyses of covariance took the proportions of products sold as dependent variable, took the experimental and control conditions as independent variables, and controlled for background characteristics.

Two repeated-measures analyses were performed, 1 for extra foods and 1 for beverages, with predefined contrasts for the comparisons between phases 1 and 2, and between phases 2 and 3. In the analysis we used the proportions of products sold in each of the 3 phases as the dependent variables, the experimental and control condition as the independent variable, and the background characteristics as covariates. SPSS 14.0 for Windows (SPSS Inc., Chicago, IL) was used for the analyses.

RESULTS

Characteristics of the Schools

As the experimental schools had significantly fewer shops in the nearby surroundings than the control schools, the characteristics of the experimental and control schools differed in only 1 respect: the number of shops within a radius of 1 km of the school (to a maximum of 10 minutes' walking distance) (Table 1).

The mean number of students in the experimental schools was 778 (SD = 484); in the control schools it was 833 (SD = 504). The teaching by the participating Dutch schools was comparable to grades 7 to 12

Table 1. Characteristics of Experimental and Control Schools

Characteristics		Experimental	Control
Schools	N	13	15
Number of students	Mean (SD)	777.7 (484.1)	833.4 (503.8)
Level of education	Percent		
Low		39	47
Mixed		31	40
High		31	13
Number of machines	Mean (SD)		
Extra foods		1.6 (1.2)	1.4 (0.7)
Drinks		1.8 (1.5)	1.9 (1.5)
Presence of counter	Percent		
Yes		69	87
No		31	13
Students are allowed to leave the school area	Percent		
Yes		69	53
No		31	47
Number of shops in school surroundings	Mean (SD)	3.4 (1.8)	5.7 (2.8)*

**p* < .05.

in the United States. The study groups comprised schools of different educational levels, but these levels did not differ significantly between the experimental and control schools. The schools teaching to a lower educational level, whose students ranged in age from 12 to 16, combined vocational training with theoretical education. Those teaching to a higher educational level, whose students ranged in age from 12 to 18, would eventually provide access to polytechnic and scientific training. Up to grade 12, the mixed schools taught levels of both lower and higher education.

About half the schools allowed their students to leave school during breaks and free hours. The mean number of vending machines in the schools was about 1.5 for machines selling extra foods and almost 2.0 for machines selling beverages. Many schools also sold foods over the counter in the student canteen.

Sales Volumes

To test whether students in the experimental and control schools purchased a similar number of products from the vending machines, we compared mean sales volumes. Analysis of covariance, in which we

controlled for the number of shops in the school locality, showed that none of the tests were significant ($p < .05$) (Table 2). Effect sizes—that is, Cohen's d —were small. Although the sales volumes of extra foods in phase 3 were greater in the experimental group than in the control group, the effect size was also small. In the experimental schools, only small quantities of basic products were sold from the vending machines; in the control schools, no basic foods were sold. It was therefore impossible to compare these products.

Intervention Effects

The proportions of products sold were used to test the effectiveness of the 3 strategies, that is, higher availability of lower-calorie foods, and labeling and price reductions for low-calorie products. The mean proportion of moderately unfavorable products sold, that is, 100-170 Kcal in the extra foods product group, was significantly higher in all phases in the experimental group than in the control group (Table 3). In all phases, the mean proportion was twice

Table 2. Mean Sales Volumes in Experimental and Control Schools per Food Category Averaged for Number of Students per School*

	Phase 1 [†]					Phase 2 [†]					Phase 3 [†]				
	Experimental		Control		ES [§]	Experimental		Control		ES	Experimental		Control		ES
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Extra	5.39	2.22	4.89	3.86	0.03	4.59	1.99	4.10	3.21	0.04	4.12	1.89	2.73	1.90	0.16
Basic	0.21	0.25	—	—	—	0.13	0.11	—	—	—	0.17	0.27	—	—	—
Beverage	2.23	2.59	2.26	1.23	0.00	2.15	2.30	2.09	1.32	0.01	2.16	1.95	1.99	1.15	0.02
Total [‡]	7.77	4.66	7.29	4.96	0.02	7.08	4.11	6.38	4.45	0.04	6.61	3.54	4.82	2.85	0.14

*The number of schools varied according to which product categories were sold there.

[†]Phase 1 = higher availability of lower-calorie foods, phase 2 = product labeling, phase 3 = price reduction.

[‡]Total means have been assessed only for those schools that sell both extra foods and beverages.

[§]ES = standardized mean difference (Cohen's d).

Table 3. Mean Proportions (%) and Standard Deviations (SD) of Products Sold per Product Group and Category. Differences in Proportions Between Phases for Experimental and Control Schools

Product	Category	Phase 1 ^{†,}		Phase 2 ^{†,}		Phase 3 ^{†,}		Δphase -Phase 2 [‡]		Δphase -Phase 3	
		Exp	Control	Exp	Control	Exp	Control	Exp	Control	Exp	Control
Extra	<100 [§]	1.6 (1.9)	0.9 (1.5)	1.9 (1.8)	0.8 (1.1)	1.2 (1.1)	0.8 (1.2)	0.2 (0.7)	-0.1 (1.3)	-0.2 (1.2)	0.0 (0.8)
	100-170	44.2 (15.3)	20.1 (7.8)*	44.9 (13.5)	18.3 (8.1)*	46.5 (14.0)	19.7 (9.0)*	0.8 (4.3)	-1.8 (7.9)	2.6 (7.0)	1.4 (5.8)
	>170	54.2 (16.4)	78.9 (7.6)*	53.2 (14.1)	80.8 (8.3)*	52.3 (14.1)	79.4 (8.6)*	-1.0 (4.4)	1.9 (8.2)	-2.4 (8.0)	-1.4 (5.5)
Beverage	A [§]	38.3 (15.9)	22.4 (15.3)**	37.2 (14.0)	26.0 (14.1)**	42.2 (14.4)	26.6 (15.0)*	-1.1 (9.3)	3.7 (7.3)	4.5 (6.0)	0.6 (5.9)
	C	61.7 (15.9)	77.6 (15.3)**	62.8 (14.0)	74.0 (14.1)**	57.8 (14.4)	73.4 (15.0)*	1.1 (9.3)	-3.7 (7.3)	-4.5 (6.0)	-0.6 (5.9)

* $p < .05$; ** $p < .10$.

[†]Analyses of covariance were performed with proportions of products sold as dependent variable and the experimental and control conditions as independent variable; we controlled for the number of shops in school surroundings. These analyses could not be performed for the basic products.

[‡]Two repeated-measures analyses were performed with predefined contrasts for the comparisons between each pair of phases. We used the proportions of products sold in each of the 3 phases as the dependent variables, and the experimental and control condition as the independent variable; the covariate in the analyses was the number of shops in the school surroundings. These analyses could not be performed for the basic products.

[§]Favorable products: <100 Kcal or light drinks, waters, fruit juices (A). Moderately unfavorable products: 100-170 Kcal. Unfavorable products: >170 Kcal or regular soft drinks or sweetened fruit juices (C).

^{||}Phase 1 = higher availability of lower-calorie foods, phase 2 = product labeling, phase 3 = price reduction.

as high: around 45% in the experimental schools, against 20% in the control schools.

The mean proportion of favorable beverages was significantly higher only in the last phase (when the prices of these products were reduced): 42.2% in the experimental school, against 26.6% in the control schools. In phases 1 and 2, there was a trend effect between the experimental and control groups for the differences in the mean proportions of favorable beverages sold ($p < .10$). The mean proportions of favorable beverages were 1.5 higher in the experimental schools than in the control schools.

The additional effect of labeling and price reduction was analyzed using repeated-measures analysis. No significant extra effect could be shown. None of the tests for the effect of condition by time were significant (Table 3).

As the effect of the intervention may have been larger when a student was not allowed to leave school, we conducted an additional analysis to test the interaction between “condition (experimental vs. control)” and “the school’s permission to leave the school area.” This interaction effect was significant for the sales of favorable extra products in phases 1 and 2. The difference in the sales of these products between the experimental and control groups was much larger when students were not allowed to leave school (3.6% vs. 0.4% in phase 1; 4.1% vs. 0.8% in phase 2) than when they were allowed (1.2% vs. 1.6% in phase 1; 1.3% vs. 1.1% in phase 2). However, when prices were reduced in phase 3, this effect did not remain.

DISCUSSION

We explored the effects of changing the range of products in school vending machines, and also of labeling and price reductions, on purchases of extra foods such as candies and potato chips, and of basic foods and beverages. This study shows that changes to school vending machines increase students’ purchases of lower-calorie foods.

Our results show that while the total sales volumes of extra and beverage products were not significantly different between experimental and control schools across the intervention periods, the sales of products in the moderately unfavorable extra foods category (100-170 Kcal) were significantly higher in the experimental schools than in the control schools. This was the case in all phases, although the sale of these products had already been raised by the provision of a substantial proportion of lower-calorie extra products in the vending machines.

Similarly, it was shown by exploring the interaction between condition (experimental vs. control) and permission to leave the school that there was an effect on the sales of favorable extra foods (lower than 100 Kcal) in phases 1 and 2. One variable—permission

to leave the school area—seemed to be relevant to the intervention effect on sales of low-calorie products in the schools. This is consistent with the general opinion that it is important to keep children in the school when supermarkets and other shops are nearby, which is generally the case in the Netherlands.

When, in phase 3, the change in product range was combined with labeling and price reduction, more beverages in the favorable category were sold at the experimental schools than at the control schools.

Although studies of interventions that change school-food regimes have produced mixed results, they have nonetheless produced positive effects on the sale and consumption of healthier products such as water or low-fat foods.¹⁷⁻²⁰ Our study also showed that environmental change can have encouraging effects on the sales of lower-calorie extra foods and beverages. The provision of more lower-calorie foods in the vending machine had an effect, also when it was combined with labeling and reduced prices. However, repeated measure analysis could not prove that distinct effects were produced when labeling and price reduction were added to the different product range in the vending machines. Other studies have also found the effectiveness of labeling to be limited.²⁴⁻²⁶

With regard to price reduction, French et al showed that the effect of reducing prices by 25% and 50% on the sales of low-fat snacks from vending machines was much larger than when they were reduced by 10%. At a 50% reduction, however, total sales volumes also increased.²⁴ The 10% price reduction in our study might have been too low to greatly affect students’ choices. But because 25% or 50% price reductions on lower-calorie products are not very likely in real-life vending machines, we did not test them in this design.

Limitations

A baseline measurement was not included in the study design; however, as this study was designed as a school-based randomized controlled study, it strengthened the assumption that differences between the experimental and control schools can be ascribed to the experiment. The similar characteristics of the schools in the experimental and control groups at baseline (eg, student size, number of vending machines, and presence of a counter) all indicate that experimental and control groups were comparable. Our analyses accounted for differences in the availability of snack points in the schools’ surroundings. We controlled for external factors such as seasonal effects and lower school attendance close to vacations, because these were relevant for both experimental and control schools alike.

Because the study was conducted in a real school setting, it shows intervention effects in real life. Our results may therefore have been influenced by a few

difficulties we encountered when implementing the intervention in particular schools. One difficulty was the limited extent to which the implementation of intervention strategies was completed, which may explain the lack of distinct effects of labeling and price reduction relative to those produced by changing the product range. Sample sizes were too small to test how much the effect of the experiment was influenced by the degree to which the 3 strategies had been implemented.

Another difficulty was that, due to the start of the summer vacation, the duration of the last phase of the intervention was not 6 weeks at all schools. Although we corrected for this shorter follow-up by adding mean school sales for the missing weeks, the sales of products remained lower in phase 3 than in phases 1 and 2. Another explanation may be the absence of students due to school exams, especially those in the older age group, who have more money to spend on vending machine items.

Although difficulties were caused by the fact that the measures taken with regard to the machines were left to the schools and vendors, the researchers' partnership with these actors also can be viewed as a study strength, because the organization of the research project in real life adds to the external validity of the study.

The intervention strategies could not always be implemented as easily as planned. The partial adherence to our recommendations on the product range for the vending machines was due to the lack of products that met our requirement of less than 100 Kcal per item, except for light drinks and waters in the beverage group. While basic products such as dairy drinks and fruits and vegetables are to be preferred for their nutrition value, such products were not sold in vending machines at the control schools. Even at the experimental schools, the sales volumes of basic products were low. Nonetheless, our results show that, when they were introduced, some of these healthier products were sold, if only in small numbers.

At some schools, technical problems made it difficult to implement the price reduction. Similarly, some caterers and food industries were less willing to participate in this phase, as they did not want the price reduction to influence their profits from the machines.

We recommend that further research is conducted on the range of foods preferred for school vending machines, and on ways consumer information can be provided and price variations can be applied. More research is also needed on how each of the 3 strategies—that is, changing the product range, labeling products, and reducing prices—has an added effect on the consumption of healthy foods. Finally, further

research should be conducted to establish the effectiveness of multicomponent interventions comprising educational interventions and environmental change (such as changes to vending machines) in achieving healthy eating behavior in schools.

IMPLICATIONS FOR SCHOOL HEALTH

Many stakeholders and parties were involved in this study, which showed that school boards, caterers, and the food industry make important contributions to changing the school-food environment. A positive attitude on the part of these stakeholders is necessary for proper collaboration and the successful implementation of the different strategies.

Although we encountered positive attitudes in the school boards, attitudes were less collaborative in schools involving commercial catering firms. Interviews with these firms identified 2 related barriers to collaboration: the firms' doubt that students would welcome changes to the product range, and their fear that changes would reduce income.

As for students, those interviewed thought it was important to the school environment to change the product range. Their reasons for this lay in the overweight epidemic. However, with regard to their own direct needs, they regarded such changes as less relevant.

As the school environment may be more important than individual decision making about food choice in determining what children consume, environmental interventions in schools are used to promote healthy diets.^{12,16,27,28} This study showed that changing the products sold in school vending machines contributes to a healthy school environment.

Human Subjects Approval Statement

The study protocol was approved by the internal TNO Review Board.

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