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Objectives: We explored the impact of changes to school lunch on overall food choices in a sample of middle school children in the United States (US). Methods: The IMOVE program provides healthy school lunch meals that are offered alongside standard school lunch meals. Students from one intervention (N = 162) and one comparison (N = 110) school participated. Total daily food and beverage intake was measured and dietary quality was evaluated. Results: Exposure to IMOVE led to a decrease in 0.1 fewer daily servings of sugar-sweetened beverages (p = .03) and an average daily reduction of 48.3 grams of whole milk (p = .08). Dietary quality was low. Conclusions: Recent legislation in the US to improve the school foodservice may contribute to healthier dietary behaviors of youth.

***Key words*: child nutrition; nutrition policy; school foodservice; school lunch; middle school youth**
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Current national data show that 16.9% of all children and adolescents in the United States (US) are obese.[1] Despite the unchanging prevalence of child/adolescent obesity in recent years,[2] the overall prevalence of overweight among youth ages 12-19 years has more than tripled since 1980,[3,4] and child and adolescent diets often fail to meet dietary guidelines. Youths from low-income families are disproportionately at risk for both poor nutrition and obesity.[5,6] Eating habits established in childhood persist into adulthood and influence risk for chronic diseases later in life, underscoring the importance of establishing healthy nutrition habits early.[7]

Because middle school students spend approximately 6-7 hours at school each day[8] and consume up to half of their daily calories there,[9] the cafeteria food service is an ideal vehicle for fostering healthy food choices. The literature is limited regarding interventions targeting middle school lunch meals, and even less is known about the impact of school-based interventions on food behaviors of US youth outside of school. There is evidence, however, that certain modifications to the school food environment can contribute to improved nutrition for students.[10-12] The school food environment is comprised of the federal reimbursable school lunch meal as well as competitive foods. Competitive foods and beverages are supplemental foods to the main school lunch entrée and are sold on the cafeteria line, in vending machines, school stores and snack bars, and at school fundraisers.[13,14] Because they are sold outside the realm of federal school meal programs, competitive foods and beverages are not held to the same nutritional requirements.

A 3-year intervention conducted in 6 middle schools demonstrated that improving the nutritional quality of à la carte offerings and vending

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machine selections led to positive changes in students' overall food behaviors, including reduced intake of sweet pastries and juice.[10] Another randomized controlled trial among rural public school students in grades 4-6 showed that when cafeteria lunches were updated to reflect the American Academy of Pediatrics' nutrition and portion size recommendations, students receiving the modified cafeteria intervention consumed fewer total calories and proportionately fewer calories from fat, saturated fat, and carbohydrates at lunch compared to baseline.[11] The 2004-05 School Nutrition Dietary Assessment (SNDA-III), a cross-sectional study conducted among public school students in grades 1-12 demonstrated that, compared to students who did not buy school meals, those who did consumed more fruits, vegetables, and milk in their daily diets.[12] This result is especially notable inasmuch as nutritional guidelines for school lunch at the time were based on outdated recommendations from the 1995 Dietary Guidelines for Americans (DGA).[15]

Whereas prior research shows that the school food environment impacts students' food choices, the extent to which improved lunch entrées influence food choices outside of school warrants study.[15-17] With the passing of the Healthy, Hunger-Free Kids Act (Public Law 111-296)[18] which updates school nutrition standards to be in accordance with the 2010 DGA,[19] more research and attention may be given in the future to evaluate this specific research question. Whereas the provision of more nutritious school lunches through this new legislation should enable students to make healthier choices at school, it is unclear whether these changes will impact their food choices outside of the school environment.

The present study was conducted prior to the passing of the Healthy, Hunger-Free Kids Act (HHFKA); however, it provides some valuable insight as to how changes in school lunch can impact food choices outside of school. In this study, we examined dietary behaviors of middle-school students in one school exposed to a healthy eating cafeteria intervention and an unexposed comparison school. We assessed food and beverage consumption both in and outside of school. We hypothesized that students in the intervention school who were exposed to healthy lunch meals would have patterns of food and beverage intake closer to the dietary guidelines than students in the comparison school.

METHODS

Participants

We obtained data for this study from students enrolled in one intervention school (N = 475) and one comparison school (N = 339) in the 2008-09 academic year. Characteristics for the eligible sample are shown in Table 1. All students were invited to complete a food screener at the baseline assessment, contingent on parental consent for study participation. Over 90% of those completing a baseline assessment also completed the follow-up assessment. Students completed the screener in either a health and wellness class or in homeroom after receiving instructions from their teacher.

Accordingly, the sub-sample used for this analysis consisted of students whose parents gave informed consent for survey participation and who completed both baseline and follow-up dietary surveys (N = 162 in the intervention school, N = 110 in the comparison school). An approximately equal proportion of students from the intervention and comparison schools (36.5% and 35.2%, respectively) completed the 2 surveys. We collected sociodemographic information at baseline, including body mass index (BMI) measured by school nurses. We accessed enrollment data from the school district database, including student's name, school ID, date of birth, sex, race/ethnicity, grade, and eligibility status for free or reduced price lunch.

Instruments

The primary outcome for this study was average daily food and beverage intake assessed by the Block Kids Food Screener, a 42-item abbreviated food frequency questionnaire (FFQ) that assesses intake levels of individual food items, food groups, and selected nutrients with acceptable validity.[20] The Screener is based on the same nationally representative dietary survey data as the lengthier Block Kids FFQ, which has demonstrated reliability and validity for use with minority populations and adolescents.[21-23]

The Screener measures usual intake of common foods and beverages by asking respondents to report the frequency and portion sizes of foods consumed throughout the day – not just during school lunch – in the past week.[20] Six frequency responses range from "none" to "every day last week," and 3 portion options are customized for the individual

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Table 1
Sociodemographic Characteristics of Students in the Analytic Sample, by School

Characteristics	Intervention School (N = 162)[a]	Comparison School (N = 110)[a]	p-value[c]
Age [mean (SD)]	12.6 (0.9)	12.8 (0.9)	0.03
Eligible for free/reduced price lunch [% (N)]	53.1 (86)	34.6 (38)	0.003
Body Mass Index (continuous)			
BMI [mean (SD)]	20.4 (4.6)	20.9 (4.6)	0.39
BMI z-score [mean (SD)]	0.3 (1.2)	0.4 (1.1)	0.36
BMI percentile [mean (SD)]	59.0 (32.5)	62.5 (29.4)	0.38
Body Mass Index (categorical) [% (N)]			
Underweight (<5th percentile)	6.0 (9)	1.9 (2)	0.45
Healthy weight (5th-84th percentile)	61.6 (93)	66.4 (69)	
Overweight (85th-94th percentile)	19.9 (30)	18.3 (19)	
Obese (≥95th percentile)	12.6 (19)	13.5 (14)	
Grade [% (N)]			
6th	32.7 (53)	36.4 (40)	0.08
7th	25.3 (41)	34.6 (38)	
8th	42.0 (68)	29.1 (32)	
Sex [% (N)]			
Male	46.3 (75)	45.5 (50)	0.89
Race/Ethnicity[b] [% (N)]			
White	42.0 (68)	79.1 (87)	p < .0001
Black/African American	1.9 (3)	4.6 (5)	
Asian/Pacific Islander	53.1 (86)	13.6 (15)	
Hispanic	3.1 (5)	1.8 (2)	
Multi-race/other race/ethnicity	0.0 (0)	0.9 (1)	

Note.
a = Sample sizes may be different for sociodemographic variables due to missing information for some participants.
b = Race/ethnicity was recoded from 32 categories into a 5-group categorization.
c = The p-values indicate whether there are significant differences between the intervention and comparison schools.

foods on the survey, with "a little," "some," and "a lot" being the most common options. We examined 51 of the most relevant food, food group, and nutrient exposures, but report here only the most informative individual exposures.

We also computed a measure of overall dietary quality using the Recommended Food Score (RFS) chosen as the best fit for our data.[24] The RFS assesses food consumption without regard to reported portions,[24] making it useful for a study of adolescents. The RFS is based on self-reported consumption of foods that are recommended by the dietary guidelines. We computed a score for each student by summing the number of recommended foods reported on the Block Kids Food Screener as having been eaten at least once in the past week. The maximum RFS for our sample was 21, with a higher score indicating greater approximation of the dietary guidelines, and therefore, a higher quality diet.

Sex-specific BMI-for-age percentiles were calculated using students' height and weight as measured by school nurses according to standardized procedures. BMI was used to categorize the students as either obese (BMI-for-age ≥95th percentile), overweight (BMI-for-age 85th to <95th percentile), healthy weight (BMI-for-age 5th to 84th percentile), or underweight (<5th percentile).[25] BMI was also examined as a continuous measure by employing BMI z-score, a standardized BMI that is calculated using an external reference population to statistically adjust for sex and age differences.[26,27]

Intervention and Study Design

The program evaluation used a quasi-experimental study design conducted in one urban school district in Massachusetts serving a low-income community of racially-diverse students. We chose one middle school at random to receive IMOVE, a school-based environmental intervention; another middle school in that same district served as the comparison site. All students in both schools were eligible to participate in the foodservice portion of the study, using a process of passive consent for exposure to the cafeteria program. Parents could actively dissent, but none did. Parental consent was required for students to complete study surveys. Students in both schools had access to standard school lunch meals yet only those in the intervention school had access to IMOVE lunches. Food purchase patterns were measured in both schools and are reported separately. Participation in school lunch was high with roughly 97% of all enrolled students in the intervention and comparison school making at least one purchase in the school lunch line over the study period.

Designed specifically for middle school, IMOVE promotes healthy eating behaviors by providing increased access to nutritious school lunch meals and appropriate portion sizes at the same price point as regular school meals. IMOVE and its implementation are described fully elsewhere.[28] At the time IMOVE began, the National School Lunch Program (NSLP) guidelines for school meals adhered to the 1995 DGA. IMOVE meals, served alongside standard school lunch, followed more stringent nutritional criteria by providing less than 25% of calories from total fat, less than 10% of calories from saturated fat, and more servings of fruits, vegetables, and whole grains. IMOVE offered nutritionally balanced weekly menus featuring a variety of ethnic cuisines, and included more fresh produce than the conventional school lunch meals. IMOVE meals were created by a registered dietitian to be culturally varied, representing ethnic cuisines including but not limited to Mexican, Asian, and Italian-inspired menus.

The program used promotional posters, nutritional information, and a unique logo to identify the IMOVE choice for students at the point of purchase. Monthly cafeteria events, fresh fruit and vegetable taste-tests and displays, and raffle prizes engaged students and incentivized participation. From September through June, all students in the intervention school had the option to purchase either IMOVE meals or standard school lunch meals on a daily basis. To incentivize participation, students received a raffle ticket every time they purchased either an IMOVE hot meal or salad entrée; winners were chosen every 4 to 6 weeks to receive prizes that promoted physically active lifestyles. Students in both schools had access to the same range of á la carte items sold in the cafeteria including fruit, low-fat dairy, breads, chips, baked desserts, and frozen ice cream treats. Neither middle school had vending machines.

IMOVE does not include any specific criteria or requirements for general wellness. Accordingly, both middle schools were operating under the same wellness policy adopted by the district participating in this study. Institutionalization of a wellness policy at the time of this study was a requirement of the Child Nutrition and WIC Reauthorization Act of 2004 (P.L. 108-265, Section 204),[29] which requires public school districts participating in the NSLP or other child nutrition assistance programs to adopt and implement a wellness policy by the first day of the 2006-2007 academic school year.

Data Analysis

We merged the students' self-reported dietary data with their sociodemographic information in the school district database. Our analyses compared intervention and comparison school students and evaluated changes in diet over the course of one school year. We conducted descriptive analyses of sociodemographic variables for students who completed the baseline dietary assessment, stratified by

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experimental condition. To evaluate sampling bias, we compared the profiles of the analytical sample (students who completed both dietary assessments) to the overall eligible population of students enrolled in the two schools. To assess the significance of differences between groups, we conducted stratified analyses using either t-tests (continuous variables) or chi-square tests (categorical variables). For any table with a cell frequency of 5 students or less, we used Fisher's exact test.

We examined unadjusted means for nutrient, food, and food group intakes for the analytic sample at both baseline and follow-up. With the intervention and comparison school data examined separately, we created difference scores for each dietary variable by subtracting the baseline mean from the follow-up mean. We analyzed the continuous RFS similarly. We used regression modeling to assess the effect of the intervention on each nutrient, food, and dietary index outcome, controlling for age, sex, race/ethnicity, grade, eligibility for free or reduced price lunch (an indicator of socioeconomic status, SES), and baseline BMI z-score. We reported parameter estimates with standard errors to illustrate the estimated effect of the intervention using analytic methods employed in similar studies.[30] We conducted 2-tailed hypothesis tests with alpha set at the .05 level of significance using the SAS Statistical System version 9.1.3.[31]

RESULTS

Participant Characteristics

A similar proportion of students enrolled in both schools received parental consent and completed the baseline dietary survey, yet parents of only about one-third of eligible students returned signed consent forms, restricting the size of the analytical sample. Rates of completion of follow-up surveys exceeded 90% in both schools. The analytical sample consisted of 272 students, slightly more than half of whom were female (Table 1). Students in the intervention school were slightly younger on average than those in the comparison school (12.6 years versus 12.8 years, $p = .03$) and more likely to be eligible for free or reduced price lunch (53.1% vs 34.6%, $p = .003$). White students comprised the majority in the comparison school sample (79.1%), and Asian/Pacific Islander students were the majority in the intervention school (53.1%, $p < .0001$). We controlled for these statistically significant differences in multivariate analyses.

Unadjusted Analysis of Food and Beverage Intake

At baseline, compared to students in the intervention school, students in the comparison school consumed slightly higher amounts of most nutrients including fat, protein, carbohydrates, and sodium (Table 2). Students in the intervention school consumed an average of 8.0 teaspoons of added sugars per day, versus 8.5 teaspoons in the comparison school. Average daily whole milk consumption was greater at baseline in the intervention school than the comparison school (97.8 grams and 70.5 grams, respectively), and average soda/soft drink consumption was slightly less among students in the intervention school at baseline (127.9 grams versus 130.4 grams). Total daily fruit and vegetable consumption was low among students in both the intervention and comparison schools, at approximately 1.5 cup equivalents of fruit and less than one cup equivalent of vegetables reportedly consumed per day.

At the 9-month follow-up assessment, students in the intervention school were consuming fewer added sugars and less total sugar and total carbohydrates (contributing to the observed lower glycemic load) than students in the comparison group (Table 2). All nutrients examined shifted more favorably among students exposed to IMOVE versus the comparison condition. Most notable was the relatively stable consumption of added sugars in the intervention sample (increasing by 0.02 teaspoons) compared to the measurably larger increase in average daily consumption of added sugars among students in the comparison school (1.6 teaspoons).

Fruit and vegetable intake and dairy consumption decreased slightly in both schools over the school year ($p < .05$) but IMOVE's impact was greatest for beverage choice. The intervention school showed an average decrease in whole milk consumption by 42.3 grams, whereas the comparison school showed an increase in whole milk consumption by 1.3 grams ($p < .05$). Average daily soda consumption decreased in the intervention school by 13.4 grams and increased in the comparison school by 32.5 grams. None of the findings

Table 2
Unadjusted Means (95% CI)[a] of Selected Nutrients, Foods, and Food Groups, by School

	Intervention School (N = 162)			Comparison School (N = 110)		
Nutrient	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**
Total fat (gm)	50.3 (46.1, 54.6)	50.7 (44.9, 56.5)	0.4 (-5.2, 6.0)	51.0 (45.2, 56.9)	51.4 (45.5, 57.3)	0.4 (-5.6, 6.3)
Saturated fat (gm)	17.8 (16.3, 19.3)	18.0 (16.1, 19.9)	0.2 (-1.7 2.1)	19.0 (16.9, 21.1)	19.5 (17.3, 21.6)	0.5 (-1.6, 2.6)
Total protein (gm)	55.1 (50.9, 59.2)	55.4 (49.2, 61.5)	0.3 (-5.5, 6.1)	56.2 (50.0, 62.4)	56.0 (49.3, 62.6)	-0.2 (-7.3, 6.8)
Total carbohydrates (gm)	163 (151, 175)	147 (135, 158) **	-17 (-29, -5)	175 (160, 192)	170 (156, 185) **	-6 (-20, 8)
Total fiber (gm)	10.7 (9.8, 11.6)	9.2 (8.4, 10.1) **	-1.5 (-2.3, -0.6)	11.6 (10.2, 13.0)	10.6 (9.5, 11.7) **	-1.0 (-2.3, 0.3)
Total sugars, naturally occurring in foods/ juices (gm)	94.4 (87.0, 101.7)	85.2 (78.4, 91.9)*	-9.2 (-16.3, -2.0)	101.1 (92.2, 110.0)	101.5 (92.5, 110.5)*	0.4 (-7.7, 8.5)
Sugar/syrup added to foods/beverages (tsp)	8.0 (6.9, 9.0)	8.0 (7.0, 8.9)*	0.02 (-1.1, 1.1)	8.5 (7.3, 9.8)	10.1 (8.8, 11.4)*	1.6 (0.4, 2.8)
Food (gm)	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**
Milk						
2%	89.1 (62.0, 116.3)	119.7 (89.1, 150.2)	30.5 (-0.0, 61.1)	103.5 (65.0, 142.1)	89.5 (51.6, 127.4)	-14.1 (-53.6, 25.5)
Whole	97.8 (67.9, 127.7)	55.5 (34.7, 76.3)	-42.3 (-70.8, -13.8)	70.5 (38.9, 102.0)	71.8 (40.2, 103.4)	1.3 (-32.3, 34.9) ***
1%	48.3 (25.5, 71.2) ***	43.5 (23.1, 63.8) ***	-4.9 (-24.6, 14.9)	101.0 (61.8, 140.1) ***	84.0 (50.8, 117.2) ***	-17.0 (-63.0, 29.0)
Non-fat	12.8 (1.7, 24.0)	7.5 (1.4, 13.6)	-5.3 (-15.8, 5.1)	24.3 (4.3, 44.3)	15.8 (2.2, 29.5)	-8.5 (-30.9, 14.0)
Soda/soft drinks	127.9 (97.1, 158.6)	114.5 (92.8, 136.3) ***	-13.4 (-44.6, 17.8)	130.4 (91.8, 168.9)	162.8 (127.5, 198.2) ***	32.5 (-11.4, 76.4)
Food Group	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**	**Mean Daily Intake at Baseline**	**Mean Daily Intake at Follow-Up**	**Mean Difference[b]**
Fruit/fruit juice (cup equivalent)	1.7 (1.5, 1.9)	1.4 (1.2, 1.6)	-0.3 (-0.5, -0.1)	1.7 (1.5, 1.9)	1.6 (1.4, 1.8)	-0.1 (-0.3, 0.1)
Vegetables, excluding potatoes & legumes (cup equivalent)	0.9 (0.8, 1.0)	0.8 (0.7, 0.8)	-0.2 (-0.3, -0.1)	0.9 (0.8, 1.0)	0.7 (0.6, 0.8)	-0.2 (-0.3, -0.1)
Dairy (cup equivalent)	1.7 (1.5, 1.8) **	1.5 (1.4, 1.7) ***	-0.1 (-0.3, 0.0)	2.0 (1.8, 2.2) **	1.8 (1.6, 2.0) ***	-0.2 (-0.4, 0.0)
Kilocalories from sugary beverages	52.8 (40.1, 65.5)	47.3 (38.3, 56.2) ***	-5.5 (-18.4, 7.3)	53.8 (37.9, 69.7)	67.2 (52.6, 81.8) ***	13.4 (-4.7, 31.5)
Frequency of consumption of sugary beverages	0.3 (0.2, 0.3)	0.3 (0.2, 0.3) **	0.00 (-0.04, 0.04) ***	0.3 (0.2, 0.3)	0.4 (0.3, 0.4) **	0.1 (0.0, 0.2) ***

Note.
a = CI - Confidence interval
b = p-values based on t-test: * = p<.01; ** = p<.05 for significant differences between groups (intervention vs comparison school) comparing mean intake at baseline, follow-up, and difference in intake from baseline to follow-up

indicated that students in the comparison school had a healthier intake of any foods or nutrients at follow-up compared to students in the intervention school.

Multivariate Analyses

Sociodemographic covariates that were significantly associated with the unadjusted differences in nutrient, food, and food group intake were race/ethnicity and SES (*data not shown*), suggesting that these covariates had a significant independent effect on some of these dietary outcomes and needed to be included in our multivariate models. For example, race/ethnicity was significantly associated with unadjusted differences in nutrients such as saturated fat, protein, total fat, sodium, glycemic index, and sugar/syrup added to food/beverages; in foods such as soda/soft drinks, pizza, spaghetti, burritos, candy bars, cheese, and legumes; and, in food groups such as dairy and kilocalories from sugary beverages. SES was significantly associated with unadjusted differences in sugar/syrup added to food/beverages, soda/soft drinks, and kilocalories from sugary beverages.

Most of the nutrient variables were not significantly different between the intervention and comparison schools in adjusted analyses and thus are not shown here. Exposure to IMOVE resulted in an estimated decrease of 0.1 daily servings of sugary beverages (p = .03) from baseline to follow-up between groups (Table 3). Additionally, exposure to IMOVE resulted in an estimated average daily increase of 2% milk by 75.2 grams (p = .02) and a decrease by 48.3 grams of whole milk (p = .08) from baseline to follow-up. Exposure to the intervention also resulted in an estimated decrease of 1.7 teaspoons of sugar added to foods and beverages (p = .10) (Table 3).

Table 3
Effect of Intervention Status on Select Food and Beverage Intake Mean Differences (N = 272)

Nutrient/Food[a]	Intervention School [β (SE)][b,c]	p-value[d]
Total fat (gm)	-0.5 (5.3)	0.92
Saturated fat (gm)	-0.1 (1.8)	0.94
Total protein (gm)	1.5 (5.82)	0.80
Total carbohydrates (gm)	-12.5 (11.8)	0.29
Total fiber (gm)	-0.8 (0.9)	0.38
Sugar/syrup added to foods/ beverages (tsp)	-1.7 (1.0)	0.10
Soda/soft drinks (gm)	-48.3 (32.9)	0.14
Fruit/fruit juice (cup equivalent)	-0.2 (0.17)	0.22
Vegetables, excluding potatoes & legumes (cup equivalent)	-0.04 (0.09)	0.66
Dairy (cup equivalent)	0.2 (0.14)	0.17
Kilocalories from sugary beverages	-19.9 (13.6)	0.14
Frequency of consumption of sugary beverages (servings)	-0.1 (0.05)	0.03
Milk (gm)		
Whole	-48.3 (27.9)	0.08
2%	75.2 (32.0)	0.02
1%	31.6 (29.2)	0.28
Non-fat	2.5 (14.8)	0.86

Note.
a = Out of 51 variables total, only selected food and nutrient variables with substantial differences or notable findings are presented in this table.
b = Values are adjusted for age, sex, ethnicity, SES, grade, and BMI.
c = Values are estimated coefficients (SE) for the intervention school compared to the comparison school, as calculated by linear regression modeling.
d = The p-values indicate whether there are significant differences between the intervention and comparison schools.

Recommended Food Score

Dietary quality, measured by the RFS, was low for both groups at baseline (11.2 out of 21) (Table 4). At follow-up, mean RFS remained similarly low at approximately 11 points for both groups, with a 0.3 point decrease measured in the intervention school and a 0.2 point decrease in the comparison school.

DISCUSSION

Few studies have investigated how the school foodservice environment influences overall dietary behavior by examining the effects of a school cafeteria intervention on students' daily food, beverage, and nutrient intake. Although previous studies have demonstrated how changes to the competitive à *la carte* food choices offered in school can affect eating behavior[10,32] and how policy changes to school lunch entrées affect lunchtime food consumption,[33,34] there has been limited evidence regarding how changes to school lunch entrées can impact overall food choice behavior including choices outside of school.

Our study is particularly relevant considering recent legislation updating school lunch guidelines. Our results are consistent with the study hypothesis that students exposed to an environmental intervention would have healthier patterns of food and nutrient intake than students in a no-intervention comparison school. Specifically, by the end of the

Table 4
Recommended Food Score, by School

	Intervention School[a] (N = 162)	Comparison School[a] (N = 110)	p-value[b,c]
Food Score Baseline [mean (SD)][d,e]	11.2 (3.4)	11.2 (3.3)	0.98
Food Score Follow-up [mean (SD)][d,e]	11.0 (3.8)	10.9 (3.9)	0.78
Difference in Recommended Food Score[d,e] [mean (SD)]	-0.2 (3.0)	-0.3 (3.2)	0.76

Note.
a = Values are unadjusted means (SD).
b = The p-values indicate whether there are significant differences between the intervention and comparison schools at the specified time points.
c = The t-test was used to calculate p-values for continuous variables.
d = Recommended Food Score is modeled after Kant et al.[21]
e = Participants receive one point for all foods consumed that are part of the dietary index. The foods are included in the index include:

1. **Cold cereal (whole grain only)**
2. **Cooked cereal (oatmeal)**
3. **Milk (reduced, low-fat, or non-fat only)**
4. **Real fruit juice**
5. **Fruit (apples, bananas, oranges)**
6. **Applesauce, fruit cocktail**
7. **Other fruit (strawberries or grapes)**
8. **Potatoes other than French fries, hash browns, or tater tots (mashed or boiled potatoes)**
9. **Lettuce salad**
10. **Tomatoes**
11. **Green beans, peas**
12. **Other vegetables (corn, carrots, greens broccoli)**
13. **Vegetable soup**
14. **Beans (chili, pinto, or black)**
15. **Hamburgers or cheeseburgers**
16. **Chicken**
17. **Fish**
18. **Beef (beef, steak)**
19. **Other meat in a meal (meatballs)**
20. **Pork (chops, roast, ribs)**
21. **Whole wheat bread or rolls**

school year, students in the IMOVE intervention school consumed fewer sugary beverages and full-fat milk options than students in the comparison school. The reduced intake of sugary beverages seen in the intervention sample is an important finding considering the fact that sugar-sweetened drinks were not sold in the participating schools. Thus, the intervention delivered in school appears to have had a positive effect on reducing the consumption of sugary beverages outside of school. This is notable because children's homes are a significant source of such beverages, where parents or guardians decide which foods to purchase.[12]

Students in the IMOVE intervention school decreased their consumption of higher fat whole milk to a greater extent than students in the comparison school. Interestingly, students in the intervention school did not increase their intake of the lowest fat options such as non-fat and 1% milk, but instead increased their intake of 2% milk. This finding reflects milk consumed both at school and at home. Dairy consumption in our study sample was below the recommended 3 servings per day, contributing to the nutritional vulnerability of this population.

As measured in this study, there were no significant associations between the IMOVE intervention

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and fruit and vegetable intake. This is somewhat surprising and is probably related to the methodological limitations described below. IMOVE focused heavily on increased provision and promotion of fresh fruits and vegetables through its food-service recipes, school lunch menus, extra produce delivered to schools, taste-testing opportunities, and student-focused promotional events. Given these concerted efforts in the intervention school to increase access to fruits and vegetables, an observable impact on consumption was expected.

Our findings are consistent with another study that sought to increase fruit and vegetable consumption through availability and promotion in the school cafeteria. Using a modified beverage and snack questionnaire to assess food behavior, this three-year study assessed the impact of restricting vending machine and à la carte options in a middle school while making a fresh fruit and vegetable bar available to all students.[10] Similar to our study, the authors found no difference in self-reported fruit and vegetable intake between students in the intervention and comparison schools. Clearly, increasing consumption of fresh fruits and vegetables at school is challenging, yet warrants continued attention as consumption of these nutrient-rich foods tends to drop off during the middle school years.[12] Coupling environmental changes with a nutrition education component, which IMOVE did not have, may result in greater impacts.

Of note, overall diet quality was quite low in our study sample, as measured by the RFS, indicative of the nutritional risk faced by this vulnerable adolescent population, which matched the obesity-related risk profile of low SES, urban location, and racial/ethnic diversity. For students in both schools, mean scores for the RFS were approximately 11 out of a maximum of 21. Accordingly, on a weekly basis, students' diets contained only half of the recommended foods included on the FFQ. This diet quality assessment extends the observation of individual food groups that fell below DGA levels (dairy, fruits and vegetables). Whereas IMOVE may have had a positive effect by reducing intake of added sugars, these poor levels of dietary quality that remained unchanged over the course of the study suggest that a school-based environmental intervention alone will not be sufficient to offset the extent of this population's nutritional risk. More comprehensive initiatives are needed, supported by adequate resources, enforced by strong policies, introduced early, sustained over time, and engaging families and community partners.

Still, a 3-year study that applied a multi-component intervention strategy in middle school demonstrated similar challenges. The HEALTHY study's intervention included modification of the total school food environment (including cafeteria meal programs, snacks and à *la carte* options); a physical activity component; an educational curriculum; and, social marketing communication within the schools.[35] Using the full 100-item Block Kids Questionnaire,[36] the authors found no significant differences between the intervention schools (N = 21 schools, 1964 students) and control schools (N = 21 schools, 1944 students) in the intake of energy, nutrients, or food groups, with the exception of an increase in fruit and water intake. These authors also concluded that, in order to affect children's overall dietary habits, interventions need to expand beyond the school environment.[35]

Subsequent to IMOVE's implementation, the HHFKA brought about considerable changes to the NSLP's nutritional standards[18] by updating the nutritional guidelines for school meals set by the US Department of Agriculture (USDA). The revised USDA standards, which went into effect during the 2012-13 school year, increased the availability of fruits, vegetables, low-fat or fat-free milk, and whole grains on school menus while also establishing calorie limits and aiming to reduce sodium, trans-fats, and saturated fats.[37] These standards are in line with IMOVE's nutritional criteria, which makes the findings from our study especially relevant as the HHFKA policy attempts to achieve healthier school food environments.

Although IMOVE was developed and implemented before legislation was enacted to change school lunch entrées, the lessons learned from this evaluation are relevant to the current school food environment. The requirements and guidance provided by the HHFKA now better position schools and other settings such as afterschool programs, school breakfast, and summer meal programs to successfully replicate the healthy eating patterns endorsed by IMOVE meals. In addition, there are strategies employed by IMOVE that could be adapted to other schools and settings to maximize the impact of the HHFKA regulations: offering culturally varied school lunch meals, incentivizing healthy entrée and snack purchases, cafeteria demonstrations and taste-tests to introduce unfamiliar foods and flavors, and use of engaging promotional materials throughout the school. Further, because a program like IMOVE exposes students to healthy food choices like hummus and raw vegetables in school, food choice behaviors outside of school may be impacted by increased awareness, familiarity in taste, and increased acceptance of new snack choices.

The HHFKA will provide new opportunities for research to evaluate the effect of improved school meals on child nutrition and health indicators. Often schools have limited resources to implement new policies and programs let alone evaluate the impacts of those new policies or programs. The evaluation of IMOVE provides important information on the impact of policy change in school lunch over one academic year. With the changes imposed by the HHFKA, there will be opportunity to explore the impact of modifications to the school food environment on dietary behavior after multiple years of exposure. In addition, further research is warranted to explore effective long-term interventions that couple nutrition education with efforts targeting multiple aspects of the home and school food environment. IMOVE did not contain a nutrition education component, though changes to the school food environment might have been more effective if coupled with education.

Ongoing research is needed particularly in light of the relatively low overall dietary quality noted among the low SES and urban students in our study sample. To accomplish this, it is essential that schools actively engage in collaborative partnerships with researchers to contribute to the evidence-base. Central to this goal are strategies to overcome the barriers to parent consent that restrict student participation; increase curriculum time devoted to nutrition education; and, develop innovative dietary assessment methods using new technology to ascertain behavioral data with increased precision, less burden, and less time.

Limitations

This study has several limitations. First, self-reported dietary intake is subject to memory and recall errors, social desirability bias, and measurement error.[38] Second, the Block Kids Food Screener is an abbreviated instrument that provides a relatively crude assessment of specific dietary exposures compared to lengthier and more detailed instruments. Our ability to measure small improvements in dietary behaviors resulting from a low-intensity environmental intervention like IMOVE was limited by the use of this tool, yet, limited class time precluded the use of a longer FFQ or dietary records.

Dietary measurement error likely contributed to outcome misclassification, contributing to attenuated or null results. IMOVE meals did serve more fruits, vegetables, and whole grains than traditional school lunch meals, yet the screener did not measure these differences in intake with sufficient precision. Similarly, our ability to document important advantages that IMOVE meals have over regular school lunch, such as portion control and healthier component ingredients, was likely attenuated because of measurement error.

Type II error is possible, which could also contribute to a null result as a consequence of the small sample size. The eligible student sample was sufficiently large, but only one-third of students had parent consent which was required for participation in the dietary surveys. A larger sample size or a longer follow-up period may have resulted in more pronounced differences.

Finally, the timing of the implementation of IMOVE in relation to this report is a limitation. IMOVE was implemented several years ago, before the new HHFKA regulations, which have since been slowly implemented in schools throughout the US. Evidence from this investigation remains useful and relevant, however, given the shift in the food service environment subsequent to the passing of modern school lunch legislation. IMOVE demonstrates that changes to school lunch entrée offerings can produce a positive shift in students' dietary behaviors. When first implemented, IMOVE was a novel approach to changing school lunch entrées, standing in contrast to prior interventions focused on a la carte items, cafeteria layout, and product placement to influence food choice and eating behaviors. The IMOVE initiative provides insights to strategies that can be applied to schools now required to make substantial changes to school lunch meals in order to comply with new regulations.

IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

This study has 2 important conclusions: (1) dietary quality of middle-school students is low and needs attention; and (2) changes to the school food environment can contribute to health-promoting dietary changes overall among this target age group. This study provides evidence of decreased consumption of sugar-sweetened beverages and whole-fat milk in response to a school-based healthy eating program. This evidence is timely in light of the new HHFKA regulations updating the nutritional criteria for NSLP meals and requiring schools to respond with intervention strategies like those used in IMOVE.

The evaluation of IMOVE shows how increased awareness and exposure to healthy choices in school can impact overall dietary behavior in a vulnerable population group in need of improved nutrition. This has been an area of limited but emerging research. This study demonstrated a small, but important impact over just one school year. Future research should assess the impact of the new school lunch regulations over time within the school setting, but also in terms of young people's overall dietary behavior.

Evaluations of policy changes are essential to determine the effect of policy on behavior. Unfortunately, generating evidence of policy effectiveness requires resources that schools seldom have. As such, future school policies should consider support for evaluations to determine impact of the policy change and perhaps allocate resources or provide parameters for support for such evaluations to occur within schools. Evaluation aside, resources needed simply to implement the HHFKA regulations may be difficult for many school administrators to come by when already faced with staffing and budgetary constraints. Partnering with researchers is one way in which school administrators can bring intervention, evaluation, and educational resources to their schools. In addition, of course, these partnerships can advance the field by contributing to the research literature on evidence-based practices. Engaging stakeholders can result in both effective implementation of school-based interventions[39,40] and informative results through evaluation.

Our study indicates that changes to the school food environment can impact dietary behaviors, thus justifying the resources needed by schools to implement environmental programs and policies. However, a multi-component intervention strategy that is fully integrated through the entire school community is what has been shown to be most effective in prior research involving other age groups.[41-43] As evidenced by the modest impact measured in our study, an environmental intervention alone is unlikely to achieve the level of desired changes in food intake behavior without nutrition education in the classroom and access to healthy choices at school events, fundraisers, and celebrations. School administrators should evaluate what is in place in their districts, identify what is lacking, and allocate resources with these goals in mind. A school-wide commitment to a variety of integrated strategies can transform the norms of a school's culture when bolstered by a strong wellness policy that is enforced and upheld throughout the school community. Because even modest changes in dietary quality can have important health implications in the long-term, there is potential for schools to promote child wellness.

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Human Subjects Approval Statement

This program evaluation research was approved by the Institutional Review Board at Boston University (October 1, 2007, IRB File #1678E). Study procedures followed were in accordance with the ethical standards of the responsible committee on research involving human subjects and with the Helsinki Declaration of 1975, as revised in 2000 and 2008. Participation in the cafeteria program was allowed using passive consent with active parental dissent required (none declined), but parental informed consent was required for survey administration.

Conflict of Interest Disclosure Statement

All authors of this article declare they have no conflicts of interest.

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