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Effects of Choice Architecture and Chef-Enhanced Meals on the Selection and Consumption of Healthier School Foods:

A Randomized Clinical Trial

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Abstract

IMPORTANCE—Little is known about the long-term effect of a chef-enhanced menu on healthier food selection and consumption in school lunchrooms. In addition, it remains unclear if extended exposure to other strategies to promote healthier foods (eg, choice architecture) also improves food selection or consumption.

OBJECTIVE—To evaluate the short- and long-term effects of chef-enhanced meals and extended exposure to choice architecture on healthier school food selection and consumption.

DESIGN, SETTING, AND PARTICIPANTS—A school-based randomized clinical trial was conducted during the 2011–2012 school year among 14 elementary and middle schools in 2 urban, low-income school districts (intent-to-treat analysis). Included in the study were 2638 students in grades 3 through 8 attending participating schools (38.4%of eligible participants).

INTERVENTIONS—Schools were first randomized to receive a professional chef to improve school meal palatability (chef schools) or to a delayed intervention (control group). To assess the effect of choice architecture (smart café), all schools after 3 months were then randomized to the smart café intervention or to the control group.

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Author Contributions: Dr Cohen had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Cohen, Richardson, Cluggish, Parker, Rimm,
Acquisition, analysis, or interpretation of data: Cohen, Richardson, Catalano, Rimm.
Drafting of the manuscript: Cohen, Catalano, Rimm.
Critical revision of the manuscript for important intellectual content: All authors.
Administrative, technical, or material support: Rimm.

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MAIN OUTCOMES AND MEASURES—School food selection was recorded, and consumption was measured using plate waste methods.

RESULTS—After 3 months, vegetable selection increased in chef vs control schools (odds ratio [OR], 1.75; 95% CI, 1.36–2.24), but there was no effect on the selection of other components or on meal consumption. After long-term or extended exposure to the chef or smart café intervention, fruit selection increased in the chef (OR, 3.08; 95% CI, 2.23–4.25), smart café (OR, 1.45; 95% CI, 1.13–1.87), and chef plus smart café (OR, 3.10; 95% CI, 2.26–4.25) schools compared with the control schools, and consumption increased in the chef schools (OR, 0.17; 95% CI, 0.03–0.30 cups/d). Vegetable selection increased in the chef (OR, 2.54; 95% CI, 1.83–3.54), smart café (OR, 1.91; 95% CI, 1.46–2.50), and chef plus smart café schools (OR, 7.38, 95% CI, 5.26–10.35) compared with the control schools, and consumption also increased in the chef (OR, 0.16; 95% CI, 0.09–0.22 cups/d) and chef plus smart café (OR, 0.13; 95% CI, 0.05–0.19 cups/d) schools; however, the smart café intervention alone had no effect on consumption.

CONCLUSIONS AND RELEVANCE—Schools should consider both collaborating with chefs and using choice architecture to increase fruit and vegetable selection. Efforts to improve the taste of school foods through chef-enhanced meals should remain a priority because this was the only method that also increased consumption. This was observed only after students were repeatedly exposed to the new foods for 7 months. Therefore, schools should not abandon healthier options if they are initially met with resistance.

TRIAL REGISTRATION—clinicaltrials.gov Identifier: NCT02309840

More than 30 million students receive school meals daily,[1] and many rely on school foods for up to half of their daily energy intake.[2] Therefore, school-based interventions that encourage the selection and consumption of healthier school food components (eg, fruits, vegetables, whole grains, and white milk) can have important health implications, especially if they are sustainable and economically feasible.[3,4]

Some research has concluded that improving school food palatability should be a priority to improve students' diets.[5] In 2010, First Lady Michelle Obama launched the Chefs Move to Schools program, which promotes more palatable meals through collaborations between chefs and schools.[6] However, research examining the effect of professional chefs in schools has been limited. One pilot study[7] found that students exposed to chef-enhanced meals selected more whole grains and consumed more vegetables compared with students in control schools. Larger, long-term studies examining the effect of a chef are warranted.

Another method that has gained attention is to apply choice architecture strategies to modify the food environment and nudge consumers toward healthier choices.[8] More than 15 000 schools nationwide have implemented these techniques because they can increase healthier food selection after brief exposures.[9] For example, Wansink and Hanks[10] found that placing healthier foods first in a buffet line increased overall meal selection. Other techniques included placing white milk in front of sugar-sweetened milk, as well as using verbal prompts and lighting on healthier foods.[11,12] In a school cafeteria pilot study,[13] it was found that attractive signage and appealing containers for fruits and vegetables increased the selection and consumption. These techniques have typically been evaluated only a few days or weeks after implementation. Therefore, studies examining the extended daily effect of school-based choice architecture interventions are necessary.

This study was conducted to examine the effects of short-term and long-term exposure to a professional chef and extended daily exposure to choice architecture on school food selection and consumption. We hypothesized that choice architecture techniques would be more effective in improving healthier food selection, that chef-enhanced meals would lead to greater increases in healthier food consumption, and that combining these techniques would lead to the greatest benefits.

Methods

Study Design and Participants

The Modifying Eating and Lifestyles at School Study (MEALS Study) was a randomized clinical trial in 2 urban, low-income school districts in Massachusetts. The MEALS Study was a collaboration between the nonprofit, antihunger organization Project Bread (http://www.ProjectBread.org) and the Harvard School of Public Health to examine the short-term and long-term effects of a professional chef (ie, chef intervention) and the effect of extended daily exposure to a choice architecture intervention (ie, smart café intervention) on students' school food selection and consumption. Fourteen elementary and middle schools from 2 school districts were recruited to participate in the fall of 2011. All students in grades 3 through 8 were given consent forms and surveys requesting demographic information (ie, sex, race/ethnicity, and date of birth). Students in grades 1 through 8 were also recruited using passive consent procedures (no identifying information was collected). The present study focuses primarily on the students with active consents. Consenting students participated if they received a school lunch on a study day (schools had closed campuses).

Baseline food selection and consumption were measured in the fall on 2 nonconsecutive days in all participating schools (Figure). Afterward, 4 schools were randomly assigned to receive a professional chef to enhance the school meals, and the remaining 10 schools continued to receive standard school meals (only schools in one of the participating districts were eligible for randomization to the chef because of their food service contract). After 3 months of exposure to chef-enhanced meals, school food selection and consumption measures were collected in the chef and control schools. Immediately afterward, 2 chef schools and 4 control schools were randomly assigned to receive the smart café intervention. The remaining 6 schools continued as controls. After 4 months (ie, 7 months of total exposure to the chef intervention, 4 months of exposure to the smart café intervention, or both), school food selection and consumption measures were collected again. This study was approved by Harvard School of Public Health's institutional review board. The study protocol can be found in the trial protocol in the Supplement.

Interventions

Several schools received a professional chef (with a culinary degree), hired by Project Bread. The chef collaborated with the schools 2 to 3 days per week throughout the school year to create recipes to improve the palatability of the foods and teach the cafeteria staff culinary skills. The 2 participating chefs used standardized training methods and recipes in the schools. The recipes were created using cost-effective commodity foods available to schools and incorporated whole grains, fresh and frozen produce, healthier polyunsaturated and monounsaturated fats instead of saturated fats, and seasonings without added salt or sugar (recipes are available at http://www.projectbread.org/reusable-components/accordions/download-files/school-food-cookbook.pdf). The students were repeatedly exposed to several new recipes on a weekly basis during the 7-month intervention period.

The smart café intervention consisted of multiple modifications to the school cafeteria, incorporating choice architecture strategies. A list of previously successful techniques was presented to the participating school districts, and the modifications that both districts agreed on were implemented (the smart café intervention was the same in all schools). To encourage vegetable selection, participating schools offered them at the beginning of the lunch line. Fruits were placed in attractive containers, and other fruit options were placed next to the cash registers. Signage and images promoting fruits and vegetables were prominently displayed. To encourage white milk selection, it was placed prominently in front of sugar-sweetened milk (eg, chocolate milk). All the modifications were simultaneously present and applied daily by existing food service staff for 4 months until the postintervention data collection period. These modifications were monitored regularly by study staff to ensure consistent implementation.

The study took place before initiation of the new US Department of Agriculture school meal standards. Therefore, students were not required to select a fruit or vegetable but were required to take 3 meal components overall. These included a fruit, vegetable, milk, meat or meat alternative, or grain (entréeswere typically mixed dishes with both meat and meat alternative and grain components).

Measures

The primary outcomes for the study were the selection and consumption of school meal components. Consumption was measured using established plate waste methods[14–16] on 2 randomly selected, nonconsecutive days at baseline and during the 2 postintervention data collection periods (6 days' total per school). Before the lunch period began, research assistants labeled each tray with a unique identifying number and weighed 10 random samples of each food item offered using a food scale (1130800; Oxo) to determine a stable baseline weight. Trash cans were removed from the cafeterias. At the beginning of each lunch period, an announcement was made reminding students of the study and that participation was voluntary. After students selected their meals, research assistants standing discreetly by the cafeteria line exits recorded the foods and the tray number. Students with active consents were asked to include their name on their tray (no identifying information was collected from students with passive consents). At the end of the meal, research assistants collected all of the trays and recorded the tray numbers and names of students with active consents. The weight of each remaining food was individually recorded.

Plate waste data collected in the winter (3 months of exposure to chef-enhanced meals) were considered short-term measures because of the limited number of times students were exposed to the new foods on the menu cycle. Plate waste data collected in the spring were considered long-term measures because students were exposed to the new foods multiple times over 7 months. During this period, the 4-month exposure to the smart café intervention was considered extended daily exposure because students were exposed to the environmental modifications every day.

Statistical Analysis

Data from students with active consents were used for the analyses. To reduce within-individual variability, only 968 students who had data collected on all study days before and after implementation were included to calculate the point estimates, while those with missing data points contributed to the variance calculations in the analyses. Differences in students' selection and consumption of food components in the 3 intervention groups (chef, smart café, and chef plus smart café) and control schools were analyzed. The analyses used multilevel modeling with SAS PROC GLIMMIX (logistic regression for selection) and SAS PROC MIXED (mixed-model analysis of variance for consumption), accounting for students nested within schools and repeated measures among students as random effects (SAS, version 9.4; SAS Institute Inc). These models adjusted for age, sex, race/ethnicity, and baseline selection or consumption of the food component. To analyze white milk and sugar-sweetened milk selection and consumption, only schools with both white and sugar sweetened milk available on all the study days were included in the analysis, and data from the smart café and the chef plus smart café schools (3 schools) were collapsed (some schools opted to have only white milk available on certain days).

We also conducted secondary analyses examining the selection and consumption among students with passive consents, accounting for clustering of observations within schools and treating observations on each study day as independent. These students were not included in the primary analyses because unique identifying information was not collected. As such, these data could not be used in repeated-measures analyses, and we further could not match and control for an individual's baseline selection and consumption levels.

Results

Among 2638 students participating in the MEALS Study with active consents (38.4% of eligible participants), approximately half of the participants were female (range, 50.7%–56.0%), and 82.2% to 90.3%wereHispanic (Table 1). Students were on average 11.5 years old (age range, 8.0–16.6 years). The percentage of students eligible for free or reduced-price meals ranged from86.9%to 95.0%. The student demographics were similar among those with active consents and the general population in participating schools. Baseline selection and consumption of the school food components are summarized in Table 2. All students selected an entrée, and on average 71.3% to 75.0% of the entrées were consumed. Fruit selection varied from 46.9% to 79.1%, and consumption ranged from 51.7% to 69.6% (0.28–0.38 servings of fruits). Similarly, vegetable selection varied from 39.7% to 62.0%, and consumption ranged from 17.7% to 38.9% (0.08–0.19 servings of vegetables). Most students selected sugar-sweetened milk (76.0%–79.1%), with only 9.2% to 9.6% of students taking white milk, and approximately 70% of the milk was consumed overall.

We first tested the hypothesis that short-term exposure to the chef intervention would change the selection and consumption habits. After 3 months of exposure in the winter of 2012 (Table 3), entrée and fruit selection remained unchanged, but the odds of vegetable selection increased (odds ratio [OR], 1.75; 95% CI, 1.36–2.24) compared with the control schools. The percentage consumption of these meal components remained unchanged, but overall consumption in the cafeteria increased with more students selecting vegetables.

To test our second hypothesis that children need repeated, long-term exposure to new foods, we assessed the selection and consumption again in the spring of 2012, after 7 months of exposure to the chef intervention. We also assessed the selection and consumption after extended daily exposure (4 months) to the smart café intervention. Again, entrée selection remained unchanged in all the intervention schools compared with the control schools (Table 4). The odds of fruit selection significantly increased in the chef (OR, 3.08; 95% CI, 2.23–4.25), smart café (OR, 1.45; 95% CI, 1.13–1.87), and chef plus smart café (OR, 3.10; 95% CI, 2.26–4.25) schools compared with the control schools. Among students who selected fruits, the servings of fruits consumed were significantly greater in the chef schools compared with the control schools (0.17; 95% CI, 0.03–0.30 cups/d), but the smart café had no effect (−0.00; 95% CI, −0.13 to 0.11 cups/d). The odds of vegetable selection increased in the chef (OR, 2.54; 95% CI, 1.83–3.54), smart café (OR, 1.91; 95% CI, 1.46–2.50), and chef plus smart café schools (OR, 7.38, 95% CI, 5.26–10.35) compared with the control schools. Increases in consumption were also seen in schools with the chef component: the percentage of vegetables consumed increased by 30.8% (95% CI, 17.7%–43.8%) (OR, 0.16; 95% CI, 0.09–0.22 cups/d) in chef schools and by 24.5% (95% CI, 10.0%–39.0%) (OR, 0.13; 95% CI, 0.05–0.19 cups/d) in chef plus smart café schools compared with the control schools. In the smart café schools where students had access to both white and sugar-sweetened milk, there were no significant changes in the selection or consumption of white or sugar-sweetened milk.

In secondary analyses, we examined global differences in the selection and consumption because students who agreed to participate using active consent procedures may have differed from the general student body. Overall, there were no substantial differences in the selection of entrées, fruits, and vegetables after both short- and long-term exposure to the chef intervention and extended exposure to the smart café intervention among those with passive consents (n = 6873 [99.4% of eligible participants]) compared with the active consent group. There were also no substantial differences in consumption among those with passive vs active consents.

Discussion

To our knowledge, this is the first long-term plate waste study to test 2 different methods to increase students' selection and consumption of healthier school meals. Overall, we found that both collaborating with a chef to enhance the school meals and using choice architecture techniques (smart café) provide benefits. However, improving food quality and palatability was a more effective long-term method to increase consumption of healthier school foods. Choice architecture techniques increased fruit and vegetable selection but had no effect on white milk selection after extended exposure. In addition, choice architecture techniques had no effect on food consumption among students who selected a food component. The chef intervention significantly increased both fruit and vegetable selection. Furthermore, after long-term exposure to the enhanced meals, the chef intervention also led to significant increases in the amount of fruits and vegetables consumed. This was likely because of the improved palatability of the foods, an increase in the variety of fresh fruit options, and the weekly presence of a professional chef in the lunchroom. Entrée selection and consumption remained high during the intervention. This provides strong support for collaborating with chefs to provide healthier, more palatable meals.

Previous research involving choice architecture and behavioral psychology has documented large and important changes in the selection of certain types of healthier foods, including fruits and vegetables, soon after environmental modifications are made.[10,17,18] For example, one study[17] found that presenting children with vegetables having attractive names (eg, x-ray vision carrots) can lead to substantial increases in vegetable selection after only one exposure. Similar to our study, this research found that these increases in the selection persisted over 4 weeks of exposure, although consumption was not measured. Our study found that consumption was not affected after extended exposure. While it is possible that the choice architecture led to brief improvements that were diminished over time, it is also possible that improving palatability is necessary to influence consumption. Therefore, choice architecture alone was not sufficient to have lasting effects on consumption.

White milk selection was not affected by the choice architecture techniques implemented in this study. It is possible that this was because of reduced effectiveness over time. This modification met with substantial resistance from teachers, who were concerned that younger students were having trouble accessing the less prominently displayed sugar-sweetened milk. The schools returned to the previously used display methods for selling sugar-sweetened milk soon after the study was concluded, suggesting that this method may not be acceptable in all schools, particularly elementary schools. Other methods may be more successful, including offering more white milk compared with sugar-sweetened milk to make white milk appear more normative. However, when this approach was offered as a smart café modification, the schools rejected it for being too burdensome because it would likely require staff to refill the sugar-sweetened milk too frequently. Therefore, schools may want to consider policies that limit sugar-sweetened milk. Previous research has found that, with sufficient time to acclimate, students with access to only white milk select and consume similar quantities of milk compared with students who have access to both white and sugar-sweetened milk.[7] Changes to competitive food guidelines or US Department of Agriculture school meal requirements that limit sugar-sweetened milk would also encourage white milk selection and consumption.

The improvements in diet seen using the chef-enhanced meals can have important health implications for students. More students selected vegetables, and their consumption approximately doubled in schools with the chef component, which translated to students consuming an additional 0.75 cups of vegetables per week. The decreases in vegetable waste were similar to those observed in the pilot study,[7] which also used a professional chef. In addition, more students selected (and then consumed) fruits in chef intervention schools. Last, the interventions may have exposed students to new, healthier foods that they may then choose to consume outside of school. Further research on school lunch programs should include long-term, prospective studies to assess the importance of exposing children to novel fruits and vegetables early in life to influence healthier consumption in adolescence and young adulthood.

This study had several limitations. Only students in low-income, urban school districts were included. However, these results are likely generalizable to other low-income students, who may benefit the most from school-based nutrition interventions. In addition, only elementary and middle schools were included in the study. Future studies should examine the effect of these interventions at the high school level. It is also possible that different environmental modifications may be more effective in increasing white milk selection at the elementary and middle school levels. Future studies should investigate alternate, novel choice architecture techniques that may also improve consumption. While differences in participants with active and passive consents were not observed, selection bias may have influenced some of the study findings because students with active consents may have been more receptive to the environmental changes. Strengths of this study include the randomization of schools to the intervention groups and the ability to track students over time.

Conclusions

To our knowledge, this is the first study to examine both the short-term and long-term effects of a chef intervention, as well as the influence of extended exposure to choice architecture techniques, on school meal selection and consumption. These results suggest that both chef-enhanced meals and choice architecture should be used to increase fruit and vegetable selection. While using choice architecture may be a good short-term strategy to increase healthier food consumption, it does not appear to be a successful long-term strategy. This research shows the importance of measuring both the selection and consumption after an extended exposure when examining choice architecture techniques. This study also reaffirms that a chef intervention focusing on school food quality, palatability, and variety is an effective method to improve the selection and consumption of fruits and vegetables over time. The data also suggest that initiatives such as the Chefs Move to Schools program should emphasize the sustained involvement of a chef for greater effects on children's diets. Finally, this study also confirms the importance of repeated exposures to new school foods.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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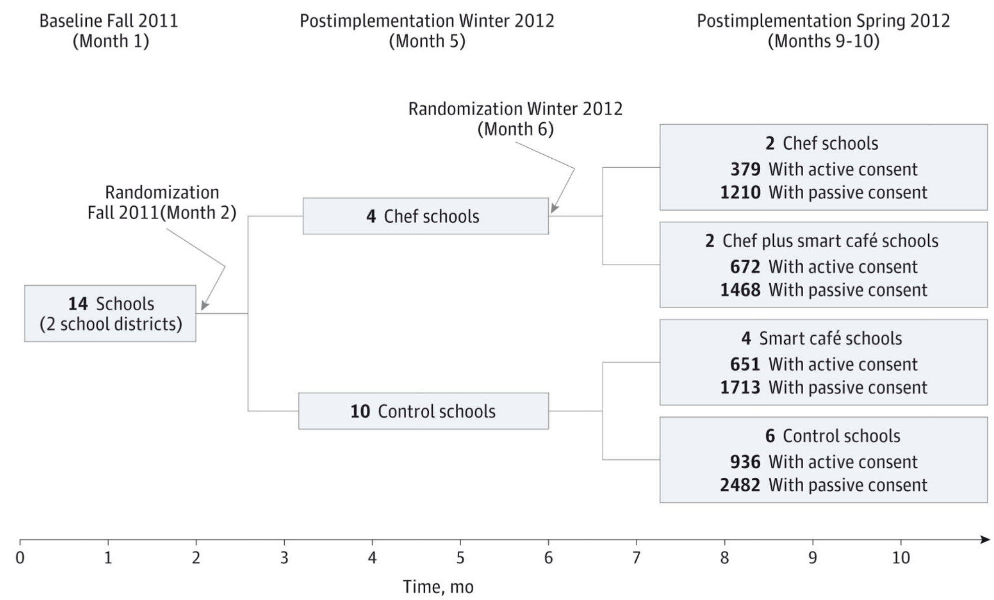

Research design and time line of implementation for the MEALS Study.

Figure.

Consolidated Standards of Reporting Trials Diagram

Research design and time line of implementation for the MEALS Study.

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Table 1

Baseline Characteristics of Students With Active Consents Participating in the MEALS Study

Characteristic	Control Schools (n = 936)	Chef Schools (n = 379)	Smart Café Schools (n = 651)	Chef Plus Smart Café Schools (n = 672)
Age, mean (range), y	11.6 (8.4–16.2)	11.2 (8.0–15.4)	12.0 (8.3–16.6)	11.4 (8.5–15.3)
Grade, mean (range)	5 (3–8)	5 (3–8)	5 (3–8)	5 (3–8)
Female sex, %	54.9	52.8	56.0	50.7
Race/ethnicity, %				
Asian	1.7	4.8	2.6	3.0
Black	8.0	2.6	3.8	2.1
Hispanic	82.2	85.2	89.7	90.3
White	7.7	7.4	3.9	4.5
Other	0.4	0	0	0.2

Abbreviation: MEALS, modifying eating and lifestyles at school.

Table 2

Baseline Selection and Consumption of School Meal Components Among Intervention and Control Schools Participating in the MEALS Study

Variable	Control Schools	Chef Schools	Smart Café Schools	Chef Plus Smart Café Schools
Selection, Mean (SE), %				
Entrée	100 (0)	100 (0)	100 (0)	100 (0)
Fruit	57.5 (40.2)	46.9 (38.0)	58.8 (38.9)	79.1 (32.9)
Vegetable	39.7 (42.1)	62.0 (43.3)	43.5 (42.6)	49.7 (33.4)
Consumption, % (95% CI)				
Entrée	74.0 (71.6–78.4)	75.0 (71.6–78.4)	73.6 (71.4–75.9)	71.3 (69.0–74.9)
Fruit	69.6 (65.8–73.3)	51.7 (45.3–58.2)	67.1 (63.5–70.7)	66.8 (62.1–69.0)
Cups of fruits	0.38 (0.36–0.41)	0.28 (0.24–0.32)	0.37 (0.35–0.40)	0.38 (0.35–0.40)
Vegetable	22.4 (19.3–25.5)	28.7 (25.2–32.2)	17.7 (15.1–20.4)	38.9 (34.7–43.6)
Cups of vegetables	0.11 (0.10–0.13)	0.14 (0.13–0.16)	0.08 (0.08–0.10)	0.19 (0.17–0.22)

Abbreviation: MEALS, modifying eating and lifestyles at school.

Table 3

Selection and Consumption of Foods Among Students Participating in the MEALS Study, After Short-term Exposure to the Chef Intervention[a]

Variable	Control Schools	Chef Schools	Value (95% CI)[b]
% of Students Selecting a Meal Component	**Mean %[c]**		**OR**
Entrée	100	100	NA
Fruit	60.1	66.9	1.46 (0.67 to 3.21)
Vegetable	46.6	57.8	1.75 (1.36 to 2.24)[d]
% of Meal Components Consumed	**Mean (SE)[e]**		**Difference[f]**
Entrée, %	73.9 (4.0)	71.7 (5.1)	−2.2 (−11.3 to 6.9)
Fruit, %	72.1 (7.9)	73.2 (9.4)	1.1 (−15.1 to −17.2)
Cups of fruits	0.42 (0.05)	0.42 (0.06)	0.00 (−0.10 to 0.11)
Vegetable, %	48.2 (8.9)	40.5 (9.8)	−7.8 (−31.5 to 16.0)
Cups of vegetables	0.24 (0.04)	0.20 (0.05)	−0.04 (−0.16 to 0.08)

Abbreviations: MEALS, modifying eating and lifestyles at school; NA, not applicable; OR, odds ratio.

[a]Short-term selection was measured after 3 months of exposure, collected in the winter of 2012.

[b]Results are calculated using logistic regression, accounting for students nested within schools and repeated measures among students and adjusted for age, sex, race/ethnicity, and baseline selection of the food component.

[c]Results are unadjusted.

[d]Statistically significant.

[e]Calculated using least squares mean regression. Results are calculated based on students who selected the meal component, comparing the chef schools with the control schools.

[f]Chef schools minus control schools. Estimates are adjusted for age, sex, race/ethnicity, and baseline consumption of the food component using a mixed-model analysis of variance.

Table 4

Average Selection and Consumption of Foods Among Students Participating in the MEALS Study, After Long-term Exposure to the Chef Intervention or Extended Daily Exposure to the Smart Café Intervention[a]

Variable	Control Schools	Chef Schools		Smart Café Schools		Chef Plus Smart Café Schools	
% of Students Selecting a Meal Component	**Mean %[b]**	**Mean %[b]**	**OR (95% CI)[c]**	**Mean %[b]**	**OR (95% CI)[c]**	**Mean %[b]**	**OR (95% CI)[c]**
Entrée	100	100	NA	100	NA	100	NA
Fruit	51.1	71.6	3.08 (2.23 to 4.25)[d]	54.3	1.45 (1.13 to 1.87)[d]	78.1	3.10 (2.26 to 4.25)[d]
Vegetable	33.7	64.2	2.54 (1.83 to 3.54)[d]	50.6	1.91 (1.46 to 2.50)[d]	76.4	7.38 (5.26 to 10.35)[d]
% of Meal Components Consumed	**Mean (SE)[e]**	**Mean (SE)[e]**	**Difference (95% CI)[f]**	**Mean (SE)[e]**	**Difference (95% CI)[f]**	**Mean (SE)[e]**	**Difference (95% CI)[f]**
Entrée, %	80.7 (4.8)	68.1 (6.9)	−12.6 (−26.2 to 1.1)	81.6 (5.6)	0.9 (−9.9 to 12.0)	84.6 (7.1)	3.9 (−10.0 to 17.8)
Fruit, %	67.4 (6.7)	88.1 (9.9)	20.7 (−1.3 to 42.7)	63.0 (8.6)	−4.4 (−23.8 to 15.0)	58.6 (8.9)	−8.8 (−28.7 to 11.1)
Cups of fruits	0.34 (0.05)	0.51 (0.07)	0.17 (0.03 to 0.30)[d]	0.34 (0.07)	−0.00 (−0.13 to 0.11)	0.30 (0.07)	−0.04 (−0.17 to 0.08)
Vegetable, %	28.9 (5.8)	59.7 (6.1)	30.8 (17.7 to 43.8)[d]	18.2 (6.3)	−10.7 (−23.8 to 2.4)	53.4 (7.1)	24.5 (10.0 to 39.0)[d]
Cups of vegetables	0.14 (0.03)	0.30 (0.03)	0.16 (0.09 to 0.22)[d]	0.09 (0.03)	−0.05 (−0.12 to 0.01)	0.27 (0.04)	0.13 (0.05 to 0.19)[d]

Abbreviations: MEALS, modifying eating and lifestyles at school; NA, not applicable; OR, odds ratio (intervention schools vs control schools).

[a] Long-term selection was measured after 7 months of exposure to the chef intervention and extended daily exposure after 4 months of the smart café intervention, collected in the spring of 2012.

[b] Results are unadjusted.

[c] Results are calculated using logistic regression, accounting for students nested within schools and repeated measures among students and adjusted for age, sex, race/ethnicity, and baseline selection of the food component.

[d] Statistically significant.

[e] Calculated using least squares mean regression. Results are calculated based on students who selected the meal component, comparing the chef schools with the control schools.

[f] Intervention schools minus control schools. Estimates are adjusted for age, sex, race/ethnicity, and baseline consumption of the food component using a mixed-model analysis of variance.