Simple interventions to improve healthy eating behaviors in the school cafeteria

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The National School Lunch Program in the United States provides an important opportunity to improve nutrition for the 30 million children who participate every school day. The purpose of this narrative review is to present and evaluate simple, evidence-based strategies to improve healthy eating behaviors at school. Healthy eating behaviors are defined as increased selection/consumption of fruits and/or vegetables, increased selection of nutrient-dense foods, or decreased selection of low-nutrient, energy-dense foods. Data were collected from sales records, 24-hour food recalls, direct observation, and estimation of plate waste. The review is limited to simple, discrete interventions that are easy to implement. Sixteen original, peer-reviewed articles are included. Interventions are divided into 5 categories: modification of choice, behavior modification, marketing strategies, time-efficiency strategies, and fruit slicing. All interventions resulted in improved eating behaviors, but not all interventions are applicable or feasible in all settings. Because these studies were performed prior to the implementation of the new federally mandated school meal standards, it is unknown if these interventions would yield similar results if repeated now.

INTRODUCTION

Recent data from the US Department of Agriculture (USDA) indicate poor diet quality among US children.¹ Specifically, most children and adolescents do not consume the recommended amounts of fruits and vegetables,^{2–4} and average intake of whole grains has been inadequate.^{1,2} Furthermore, a large increase in the prevalence of obesity in children has been associated with chronic diseases previously seen almost exclusively in adults.^{5,6} This suggests an urgent need to improve nutrition among US children.

The National School Lunch Program and the School Breakfast Program provide an important potential opportunity to improve the diet quality and health of school-aged children. Every school day, 30 million

children participate in the National School Lunch Program,⁷ and 13 million participate in the School Breakfast Program.⁸ Elementary school children consume 40% of daily calories from the National School Lunch Program, and secondary school children consume 38% of daily calories from the National School Lunch Program.⁹ Additionally, children who participate in both the National School Lunch Program and the School Breakfast Program obtain up to 47% of their daily calories at school.⁹ This substantial proportion of daily calories provides a chance to offer high-quality nutrition every school day.

Furthermore, school meals provide high-quality nutrition that low-income children may not otherwise have available. Children living in families with incomes 130% of poverty level or below qualify for free meals,

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and those in families with incomes between 130% and 185% of poverty level qualify for reduced-price meals. Recent national data show 62.1% of National School Lunch Program meals were free, and 8.3% were reduced in price.⁷ For the School Breakfast Program, 77.1% of meals were free, and 7.6% were reduced in price.⁸

The National School Lunch Program and School Breakfast Program have undergone several major changes over the years. The Richard B. Russell National School Lunch Act was originally signed into law by President Harry S. Truman in 1946.¹⁰ In 1966, President Lyndon B. Johnson signed the Child Nutrition Act, which established the National School Breakfast Program.¹⁰ In 1994, the Healthy Foods for Healthy Americans Act required the National School Lunch Program and School Breakfast Program to comply with the *Dietary Guidelines for Americans*.¹¹ To achieve this, the USDA issued the School Meals Initiative for Healthy Children. This initiative provided specific criteria for calories, protein, total fat, saturated fat, vitamin A, vitamin C, iron, and calcium.¹¹

Most recently, as part of the Healthy, Hunger-Free Kids Act of 2010, the USDA was required to issue new regulations based on the new recommendations from the Institute of Medicine to update the nutrition standards for school meals.^{12,13} The USDA published *Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule* on January 26, 2012.¹³ These standards, effective July 2012, follow “food-based menu planning” as opposed to the “nutrient standard menu planning” of the earlier School Meals Initiative for Healthy Children. Among the many changes, schools were required to double the amount of fruit served at breakfast, offer a separate fruit and vegetable component at lunch, and offer specific vegetable subgroups each week (dark green, red/orange, legumes, starchy, and other).

In addition to updated school meal patterns, the Healthy, Hunger-Free Kids Act of 2010 also required the USDA to issue standards for competitive foods. In 2013, the USDA published *National School Lunch Program and School Breakfast Program: Nutrition Standards for All Foods Sold in School as Required by the Healthy, Hunger-Free Kids Act of 2010; Interim Final Rule*.¹⁴ These regulations provide specific rules for all food sold to students at school outside of the National School Lunch Program and School Breakfast Program, including à la carte cafeteria items and foods sold in school stores and vending machines.

Although this major revision in school meal standards may have resulted in better nutrition quality of the meals being offered, it does not guarantee that diet quality will improve. To achieve this, students will need to choose healthier foods and consume enough of these

foods to impact their diet. Initially, the new meal patterns received considerable negative publicity,¹⁵ but a study conducted in the spring of 2013 suggests that students may have adjusted to the new meal patterns during the second half of the 2012–2013 school year.¹⁶ In that study, school administrators and food-service staff at 557 elementary schools completed a mail survey to assess perceived reactions to the new meal patterns. The survey measured subjective perceptions only and did not include any objective measures of students’ opinions or eating behaviors. A majority of respondents (56.4%) agreed or strongly agreed that students initially complained about the new meals, but 70% subsequently agreed or strongly agreed that the students like the new meals.

Despite some evidence that students may be more accepting of the new meal patterns, plate waste remains a persistent concern for school meal programs. Several studies have examined plate waste since the implementation of the new meal standards.^{17,18} In a recent study of middle school students, plate waste was evaluated at 4 randomly selected schools in a single district after implementation of the new meal pattern standards.¹⁸ The study found that 22.6% of students did not eat any of the fruit they selected, and 31.4% did not eat any of the vegetables they selected. Because information was not available prior to implementation of the new standards, it is unknown if this amount of waste differs from years prior to the new requirements. In a different study, plate waste data were collected from students in grades 3 through 8 in 4 schools.¹⁷ Information was collected in 2011 and again in 2012, after implementation of the new standards. Vegetable selection did not increase, but the percentage of vegetables consumed increased significantly (24.9% vs 41.1%; $P < 0.001$). Additionally, the percentage of entrées consumed increased from 72.3% vs 87.9% ($P < 0.001$). Although students did not increase their consumption of fruit during the second year, more students selected fruit (52.7% vs 75.7%; $P < 0.001$). This resulted in more students consuming fruit overall.

The purpose of this review is to present and discuss simple, evidence-based strategies to improve healthy eating behaviors in the school cafeteria setting. The review is limited to simple, discrete interventions that are easy to implement. Therefore, complex strategies such as multicomponent interventions (i.e., cafeteria plus classroom/family education) or major menu/recipe revisions were not included.

SEARCH STRATEGY

In April 2015, a literature search of the PubMed database was completed. The following search terms were

used: “school meal” or “school lunch” or “school breakfast” or “school nutrition” combined with “fruit” or “vegetable.” A second search included “school” and “salad bar.” Additional articles were found using the “Similar articles” link in PubMed and by reviewing the references from the selected articles. Sixteen prospective, peer-reviewed original studies were included. Studies were excluded if they were conducted outside of the United States or prior to 1997, the year following the implementation of the School Meals Initiative for Healthy Children guidelines. This is the earliest year that studies were likely to be published under the School Meals Initiative for Healthy Children standards, which, for the first time, required school meals to comply with the *Dietary Guidelines for Americans*.¹¹ Studies included participants in kindergarten through 12th grade but did not include preschool, day care, or college participants. To be considered simple cafeteria interventions, the interventions had to involve discrete modifications in the food-service environment, such as adding a salad bar, reducing the price of fruits/vegetables, or offering express checkout lines for healthier food options. Additionally, studies examining the impact of after-school programs, nutrition-education programs, cooking classes, chefs at school, classroom fruit and vegetable snacks, and school gardens were excluded.

In this review, *healthy eating behaviors* are defined as increased selection/consumption of fruits and/or vegetables, increased selection of more nutrient-dense food choices (“healthier” choices), or decreased selection of low-nutrient energy-dense foods. Data were collected using a variety of sources, including sales records, 24-hour food recalls, observations of selection/consumption, and visual or weighed assessments of plate waste.

SIMPLE INTERVENTIONS TO IMPROVE SCHOOL NUTRITION

Sixteen studies were included in this section (Table 1). Nine studies were performed in elementary schools,^{19–27} 3 in high schools/secondary schools,^{28–30} and 1 in middle school.³¹ Two studies included grades kindergarten through 8,^{32,33} and 1 study included grades kindergarten through 12.³⁴ The duration of interventions ranged from 1 day²⁵ to 6 months.²³ The simple interventions are divided into 5 categories: modification of choice, behavior modification, marketing strategies, time-efficiency strategies, and fruit slicing.

Modification of choice

Two studies examined the impact of increased choice on intake of fruits and/or vegetables. In 1 study,

frequency of fruit and/or vegetable consumption was measured by 24-hour recall conducted as an in-school face-to-face interview after the introduction of a salad bar in elementary schools.²⁴ To attempt to avoid a novelty effect, the data were collected 2 months after the implementation of the salad bar. The frequency of fruit and/or vegetable consumption increased from 2.97 to 4.09 times per day ($P < 0.001$), with 84% of this increase accounted for during lunch. Furthermore, mean daily energy intake decreased from 1803 kcal/d to 1607 kcal/d ($P = 0.03$), which may be explained by less-energy-dense fruits and/or vegetables displacing higher-calorie foods.³⁵ In another study, the effect of offering a choice of 1 of 3 fruits or vegetables compared with the baseline condition (no choice: single fruit or vegetable served) was examined in a school that encompassed grades kindergarten through 8.³² As measured by weighed plate waste, fruit consumption increased from 39.7% to 67.2% ($P < 0.01$) and vegetable consumption from 23.5% to 41.7% ($P < 0.01$) when choice was offered.

In a different type of experiment, the effect of eliminating choice by requiring elementary school students to select a fruit or vegetable was examined.²¹ Fruits and vegetables were measured together as a single category. When the option to decline a fruit or vegetable was removed, the percentage of students who ate 1 whole serving of fruits and/or vegetables increased from 20% to 28% ($P = 0.01$) and the percentage who ate a partial serving (at least one-half of a serving) increased from 25% to 35% ($P = 0.01$), as measured by visual estimation of plate waste. Although this was a statistically significant improvement in fruit and/or vegetable consumption, elimination of choice also resulted in an increased number of fruit and/or vegetable servings being thrown away (0.17–0.92 serving per child; $P = 0.01$). These results may be important for schools that are considering the Offer vs Serve³⁶ option in their cafeteria.

The timing of choice may also impact healthy eating behavior. One study compared entrée selection by elementary school students who preordered lunch in the morning compared with that by students who made their spontaneous choice in the cafeteria line. Students who preordered lunch entrées were more likely to select the healthier, more nutrient-dense entrée than were students who selected entrées in the cafeteria line (29.4% vs 15.3%, odds ratio [OR] 0.35–0.86). The authors hypothesize that preordering may “preempt hunger-based, spontaneous selections” as well as “eliminate the sensory cues” that influence choice.¹⁹

Behavior modification

One study examined the effect of token reinforcement on fruit and/or vegetable intake. In this experiment,

Table 1 Studies of simple interventions to improve healthy eating behaviors

Reference	Sample	Study design	Intervention	Outcomes
French et al. (1997) ²⁸	2 high schools; n = 3366 students	Crossover	3-wk intervention: à la carte prices for fruit, salad, and carrots reduced by 50%. Sales data collected before, during, and after intervention	Fruit sales quadrupled during intervention (14.4–63.3 pieces/wk; $P < 0.001$) and carrot sales doubled (35.6 vs 77.6 packets/wk; $P < 0.021$). No change in salad sales. No difference between baseline and post-treatment. Cost: no change in overall à la carte sales revenue
Hakim & Meissen (2013) ³²	1 school, grades K–8; n = 2064 observations	Prospective	1-mo intervention: choice of 1 of 3 fruits or vegetables at lunch each day compared with baseline condition (no choice: single fruit or vegetable). Data on weighed plate waste collected for 2 d before and 2 d during intervention	Consumption of fruit increased from 39.7% to 67.2 % ($P < 0.01$) and vegetables from 23.5% to 41.7% ($P < 0.01$) as measured by weighed plate waste. Cost: negligible cost of food containers and staff time
Hanks et al. (2012) ²⁹	1 high school; C = 602 observations, T = 482 observations	Prospective	8-wk intervention: “convenience” line in cafeteria offering limited choices of only healthier foods compared with standard cafeteria line. Plate waste data collected for 2 d before and 2 d during intervention	Number of healthier foods selected increased from 0.66 to 0.79 foods/student ($P = 0.00$). No change in consumption of healthier foods. Consumption of less-healthy foods decreased from 182.5 to 131.5 g/student ($P = 0.00$).
Hanks et al. (2013) ¹⁹	2 elementary schools, grades 1–5; n = 272 students	Crossover, randomized by classroom	4-wk intervention: classrooms randomly assigned to preorder lunch entrée in the morning or choose entrée in the cafeteria line. Lunchtime sales records collected	Students who preordered were more likely to select healthier entrees than were students who chose in line (29.4% vs 15.3%, OR = 0.55; 95%CI, 0.35–0.86). Healthier entrée was defined as the more nutrient-dense entrée
Hanks et al. (2013) ³⁰	2 secondary schools, grades 7–12; n = 3762 observations	Prospective pilot study	2-mo intervention: express cafeteria line with healthier options, vegetables labeled with descriptive names, fruit displayed in attractive bowls or stands, verbal suggestions by cafeteria workers to select FV. Visual plate waste data collected 2 d before and 4 d during intervention	Percentage of students who selected fruit increased from 47.3% to 53.7% ($P = 0.012$), and percentage who selected vegetables increased from 35.8% to 44.0% ($P < 0.001$). Percentage of students who consumed at least $\frac{1}{2}$ serving of fruit increased from 40.4% to 47.7% ($P = 0.004$), and percentage who consumed at least $\frac{1}{2}$ serving of vegetables increased from 33.7% to 42.0% ($P < 0.001$). Cost: less than \$50 and 3 h of time.
Hendy et al. (2005) ²⁰	1 elementary school, grades 1, 2, and 4; n = 188 students	Prospective, randomized by classroom	6-wk intervention: token reinforcement given for children to consume either $\frac{1}{8}$ cup of fruit or $\frac{1}{8}$ cup of vegetables at lunch 3 times per week. Tokens could be exchanged for small prizes weekly. Consumption recorded by direct visualization. Consumption measured as number of meals where at least $\frac{1}{8}$ cup of FV consumed. Preference ratings for FV were collected	Group reinforced for eating fruit showed increased consumption of fruit ($P < 0.001$). Group reinforced for eating vegetables showed increased consumption of vegetables ($P < 0.001$). Absolute values not provided; data in graph form. Preference ratings for fruit group increased at 2 wks post intervention ($P < 0.02$) but did not persist at 7 mo. Preference ratings for vegetable

(continued)

Table 1 Continued
Reference

Reference	Sample	Study design	Intervention	Outcomes
Jones et al. (2014) ³³	1 school, grades K–8; n = 180 students	Crossover	13-d intervention: students instructed to increase their lunch consumption of either fruit or vegetables on different days to help the imaginary hero characters obtain more energy to battle the villains. A game display made of art materials was posted in the cafeteria to chart the hero's progress. Total weighed cafeteria FV waste was collected	group did not increase from baseline (effect almost significant at $P < 0.07$) or at 7 mo post intervention Intake of fruit increased by 84% on game days (17.7 g vs 32.6 g; $P < 0.01$). Intake of vegetables increased by 28% on game days (11.4 g vs 14.7 g; $P < 0.05$). Cost: material costs were minimized by using readily available art supplies. Monitoring of FV waste resulted in labor cost
Just & Price (2013) ²¹	3 elementary schools; n = 11 494 observations	Prospective	3- to 10-d intervention: Students required to select a FV at lunch compared with baseline condition of no FV requirement. Data on visual estimation of plate waste collected	Percentage of students who ate 1 serving of FV increased after requirement (20%–28%; $P = 0.01$). Percentage of students who ate a partial serving (at least $\frac{1}{2}$ of a serving) increased (25%–35%; $P = 0.01$). Number of servings thrown away increased (0.17–0.92 serving/child; $P = 0.01$) Cost: \$1.72 for 1 additional student to eat 1 serving of FV for 1 d
Just & Price (2013) ²²	15 elementary schools; n = 47 745 observations	Prospective, randomized by school; controlled	2- to 3-wk intervention (5 lunch periods): schools randomized to 1 of 5 groups to incentivize eating a serving of FV. Data on visual estimation of plate waste collected. T1: money given immediately T2: prize given immediately T3: prize given at end of month T4: prize given at end of month C: No treatment	Percentage of students who ate 1 serving of FV increased with any reinforcement (33.3%–59.9%; $P = 0.01$). Largest increase observed when \$0.25 given on the same day (32.7%–71.2%; $P = 0.01$). No difference in consumption 2 wks after treatments discontinued. Cost: \$69/child/y to eat serving FV daily. FV waste decreased by 40%
Schwartz (2007) ²³	2 elementary schools; T = 309 students, C = 337 students	Prospective pilot study, randomized by school; controlled	6-mo intervention: cafeteria workers provided verbal prompt, "Would you like fruit or juice?" at lunch. Parent volunteers observed fruit and 100% fruit juice consumption on 2 d	70% of students at T school consumed a fruit serving vs 40% in C school (no P value provided). Cost: did not result in increased food waste
Slusser et al. (2007) ²⁴	3 elementary schools, grades 2–5; n = 337 students	Prospective pilot study; no controls	2-mo intervention: salad bars provided at lunch in school cafeteria. 24-h food recall collected before and 2 mo after introduction of salad bar	Mean daily consumption of FV increased from 2.97 to 4.09 times/d after salad bar ($P < 0.001$). Increase in FV consumption almost all due to increase during lunch (84%). Mean daily energy intake decreased from 1803 kcal to 1607 kcal ($P = 0.03$)
Swanson et al. (2009) ²⁵	1 elementary school, grade K–4; n = 491 students	Crossover	Day 1: sliced apples and oranges offered at lunch Day 2: whole apples and oranges offered Data on visual estimation of plate waste collected	More students selected sliced oranges compared with whole oranges (16.2% vs 5.5%; $P < 0.05$). More students consumed at least 50% of orange when it was sliced compared

(continued)

Table 1 Continued
Reference

Reference	Sample	Study design	Intervention	Outcomes
Wansink et al. (2012) ²⁷	Study 1: 5 elementary schools; n = 147 students Study 2: 2 elementary schools; n = 1047 students	Study 1: crossover Study 2: crossover	Study 1 Day 1: carrots served (unnamed control) Day 2: carrots given attractive name (X-ray Vision Carrots) Day 3: post-test control (unnamed carrots) Data on weighed plate waste collected. Study 2 20-d preintervention control period 20-d intervention period: hot vegetables labeled with creative names (e.g., Power Punch Broccoli). Vegetable selection recorded	with whole (10.2% vs 2.3%; $P < 0.05$). No effect was found for slicing apples Study 1 Students consumed a greater percentage of carrots when carrots were given an attractive name compared with other 2 conditions (65.9% vs 32.0% for Food of the Day vs 35.1% for unnamed control; $P < 0.01$). No increase in carrot selection Study 2 Selection of hot vegetables increased by 99% in the intervention group ($P < 0.01$) Cost: negligible. Student volunteers created names and name cards Elmo sticker on apple nearly doubled frequency of apple selection ($P = 0.06$). Approaches statistical significance. Elmo sticker on cookie did not affect cookie selection. Unknown character sticker did not affect apple selection
Wansink et al. (2012) ²⁶	7 elementary schools, 8- to 11-year-olds; T = 208 students	Crossover	Day 1, control: apple and cookie, neither with sticker Day 2: cookie with <i>Elmo</i> sticker and apple with no sticker Day 3: apple with <i>Elmo</i> sticker and cookie with no sticker Day 4: cookie with no sticker and apple with unknown character sticker Day 5: post-test control Data on choice collected by observation	
Wansink et al. (2013) ³¹	6 middle schools; T = 3 schools; C = 3 schools; n = 2150 students	Randomized by school; controlled	1-mo intervention: 3 schools were provided with commercial fruit slicers for apples. Apple sales data collected for 1 mo. Data on visual estimation of plate waste collected for 2 d before and 2 d during intervention	Apple sales increased by 71% in T schools compared with C schools ($P < 0.01$). There were fewer students who wasted at least 1/2 apple in T schools (32% vs 60%; $P = 0.03$) and more students who ate more than 1/2 apple in T schools (71% vs 40%; $P = 0.02$). Cost: fruit slicer, \$200 (\$1.00–\$1.25/d for school year)
Wansink et al. (2013) ³⁴	1 school district, grades K–12; T = 35 students; C = 1460 students	Nonrandomized; controlled	5-wk intervention: parents received feedback by email about meal purchases for 5 wks. Data on à la carte sales collected	Cookie purchase per day decreased in T group compared with baseline: 14.5% vs 6.5% ($P = 0.03$). No significant difference in fruit, vegetable, flavored milk, ice cream, or chips purchases

Abbreviations: C, control; FJV, fruit/juice/vegetable; FV, fruits and vegetables; K, kindergarten; T, treatment.

elementary school students were given tokens for eating at least one-eighth cup of fruits and/or vegetables at lunch for 6 weeks.²⁰ These tokens could be exchanged for prizes at the end of each week. Consumption of fruits and/or vegetables increased with token reinforcement, as measured by direct visualization ($P < 0.001$, no absolute values provided). Preference ratings for fruit, but not vegetables, increased significantly 2 weeks after the intervention. This increase did not persist 7 months later.

One study provided elementary school students with virtual reinforcement for eating fruits and/or vegetables.³³ Their consumption increased when they were told to provide more energy to their imaginary hero character by eating more fruits and/or vegetables. Fruit intake increased from 17.7 to 32.6 g on “game days” ($P < 0.01$), and vegetable intake increased from 11.4 to 14.7 g ($P < 0.05$).

One study used money or small prizes as incentives to eat a serving of fruit and/or vegetables in elementary school.²² Furthermore, the treatment groups were divided into those students given rewards immediately and those given rewards at the end of the month. As measured by visual estimation of plate waste, the percentage of students who ate 1 serving of fruit and/or vegetables increased from 33.3% to 59.9% with any intervention ($P = 0.01$). The largest increase was seen when the students were offered \$0.25 (a quarter) on the same day (32.7% to 71.2%; $P = 0.01$). The difference in consumption did not persist when data were collected 2 weeks after the intervention.

In a different type of experiment, the effects of verbal prompting on fruit or fruit juice consumption in elementary school were examined.²³ Selection and consumption of fruit or fruit juice was measured by direct visualization on 2 separate days in a treatment and control school. In the treatment school, cafeteria workers provided the verbal prompt, “Would you like fruit or juice?” On day 1, students in the treatment group, when compared with controls, were more likely to select a fruit (OR = 3.96; 95% confidence interval [95%CI], 2.2–7.0), but not juice. Consumption of at least one-half serving of fruit was higher in the treatment group (OR = 3.5; 95%CI, 2.0–6.2), but there was no difference in juice consumption. On day 2, students at the treatment school were more likely to select a fruit (OR = 1.9; 95%CI, 1.1–3.3) and juice (OR = 2.1; 95%CI, 1.2–3.8). Students in the treatment school were more likely to consume at least one-half serving of fruit (OR = 2.3; 95%CI, 1.1–3.3) and juice (OR = 2.9; 95%CI, 1.5–5.5).

Lastly, 1 study looked at the effects of providing feedback to parents on students’ lunchtime food choices in grades kindergarten through 12.³⁴ For 5 weeks,

parents received weekly emails reporting their child’s selection of National School Lunch Program food components and specific à la carte items. The daily percentage of students in the treatment group who purchased cookies decreased during the intervention period (14.5% vs 6.5%; $P = 0.03$).

Marketing strategies

One study utilized price reduction to encourage healthier food purchases in high school.²⁸ A price reduction of 50% for fruit, salad, and carrots sold à la carte at lunch was implemented for 3 weeks. During the treatment period, fruit sales increased by 4-fold (14.4–63.3 pieces/wk; $P < 0.001$ and carrot sales doubled (35.6 vs 77.6 packets/wk; $P < 0.021$). Differences did not persist during the postintervention period. Furthermore, no measurement of consumption was obtained.

Two studies, published in a single article, examined the impact of providing creative names for vegetables in elementary schools.²⁷ In the first experiment, carrots were named “X-ray Vision Carrots,” “Food of the Day,” or no name (control) for 1 day at each of 5 elementary schools. Although naming did not change the number of carrots selected, students consumed a greater percentage of the carrots when they were named X-ray Vision Carrots compared with the two other conditions, as measured by weighed plate waste (65.9% for X-ray Vision Carrots, 32.0% for Food of the Day, and 35.1% for unnamed control; $P < 0.01$). In the second experiment, hot vegetables received creative names (i.e., X-ray Vision Carrots and “Power Punch Broccoli”) for 20 school days. During the intervention period, selection of hot vegetables increased by 99% ($P < 0.01$).

Lastly, 1 study utilized branding to increase apple selection in elementary school.²⁶ On 3 separate days, apples were offered with Elmo character stickers, unknown character stickers, or no sticker. Selection of apples almost doubled when they were labeled with an Elmo character sticker (approached statistical significance at $P = 0.06$).

Time-efficiency strategies

In an 8-week study of high school students, an express cafeteria line offering healthier foods only (salad/sandwich bar, vegetables, fruit, and milk) was provided in addition to the standard cafeteria line.²⁹ When compared with baseline, the number of healthy foods selected increased from 0.66 to 0.79 foods per student ($P < 0.01$) during the intervention period. Despite increased selection, consumption of healthier foods did not increase significantly. However, consumption of

less-healthy foods decreased from 182.5 to 131.5 g per student ($P < 0.01$), as measured by weighed plate waste.

A similar experiment was also conducted in 2 secondary schools as a pilot study.³⁰ In addition to providing a healthy express line (sandwiches, fruits, and vegetables), vegetables were labeled with descriptive names, fruit was displayed in attractive bowls/stands, and verbal prompts were given by cafeteria staff (i.e., “Would you like to try...?”). After implementation, the percentage of students who selected fruit increased from 47.3% to 53.7% ($P = 0.012$), and the percentage of students who selected vegetables increased from 35.8% to 44.0% ($P < 0.001$). Furthermore, the percentage of students who consumed at least one-half serving of fruit increased from 40.4% to 47.7% ($P = 0.004$), and the percentage who consumed at least one-half serving of vegetables increased from 33.7% to 42.0% ($P < 0.001$), as measured by visual estimation of plate waste.

Fruit slicing

Two studies examined the effects of slicing fruit on selection and consumption.^{25,31} When sliced fruit was offered in elementary school, the percentage of students who selected an orange increased from 5.5% to 16.2% ($P < 0.05$).²⁵ The percentage of students consuming at least one-half of the orange increased from 2.3% to 10.2% when sliced fruit was offered ($P < 0.05$), as measured by visual estimation of plate waste. No statistically significant difference was seen for apple slicing.

A similar study was conducted in middle school using a commercial fruit slicer.³¹ The percentage of daily apple sales increased by 71% in the treatment schools compared with the control schools ($P < 0.01$). Furthermore, a greater percentage of students consumed at least one-half of the apple in the treatment schools (71% vs 40%; $P = 0.02$), as measured by visual estimation of plate waste.

DISCUSSION

In summary, all types of simple interventions resulted in some improvement in healthy eating behaviors (Table 2). However, not all interventions are applicable or feasible in all schools settings or in all age groups. Furthermore, the interventions may not be equally effective in all age groups.

Although utilizing rewards (i.e., token reinforcement, money) did result in increased fruit and/or vegetable consumption in all 3 reward-based studies in this review, these results did not persist after the intervention concluded.^{20,22} This suggests that the rewards would have to be ongoing to obtain persistent improvement in fruit and/or vegetable consumption.

Furthermore, this type of intervention may require significant resources in terms of cost and labor. All 3 of these studies were conducted in elementary schools.^{20,22,33} Therefore, it is unknown whether the results would be different if rewards were used in older age groups.

One study that utilized price reduction demonstrated impressive improvements in sales of fruit and carrots, but no data on actual food consumption were collected.²⁸ Because this study was conducted in high school, it is unclear if price reduction would have a similar outcome in younger age groups. Furthermore, it would be interesting to test the effect of raising the price of low-nutrient energy-dense foods in addition to decreasing the cost of healthier items.

Fruit slicing, depending on the type of fruit and the age group, also resulted in improvement in consumption.^{25,31} The inconsistent outcomes for sliced apples may be due to the different age groups in the 2 articles. As the authors discussed in the original study, students may not want to eat whole fruit due to orthodontic braces or fear of messiness.³¹ These concerns may be more common in middle school compared with elementary school. Additionally, the study by Swanson et al.²⁵ only lasted 1 day. Thus, it is unknown if the outcomes would be similar in a longer study. In the future, an experiment comparing consumption of whole fruit or sliced fruit with consumption of fruit chunks or fruit salad eaten with utensils might result in significant differences.

Studies that utilized modification of choice, either by increasing selection of fruits and/or vegetables or removing the option to decline a fruit and/or vegetable, resulted in increased fruit and/or vegetable consumption in all 3 studies.^{21,24,32} These studies were conducted in elementary or schools encompassing grades kindergarten through 8. It is unknown whether the outcomes would be similar in middle schools or high schools.

Studies that utilized creative names or branding demonstrated increased selection or consumption of these foods.^{26,27} None of these studies were conducted in middle schools or high schools. Therefore, it is unclear whether these strategies would be effective in older age groups. Furthermore, widespread branding of foods in the cafeteria would likely require permission because of trademark laws. Using a local celebrity, such as an athlete, to endorse fruits and/or vegetables may be an interesting strategy to try for all age groups.

Although this review is limited to simple cafeteria interventions, it is possible that the these interventions would have an even greater impact if they were part of a multicomponent intervention that included classroom education and family participation.^{24,37} However, in a multicomponent intervention, it is difficult to

Table 2 Summary of outcomes from simple cafeteria interventions to improve healthy eating behaviors at school

Types of intervention	Major outcomes
Modification of choice	
Introduction of salad bar in elementary school cafeteria ²²	Increased frequency of FV consumption Decreased mean daily energy intake Increased consumption of FV
Offering choice of 3 different fruits or vegetables in K–8 school ³⁰	
Elimination of choice by requiring students to select a fruit or vegetable in elementary school ¹⁹	Increased percentage of students who ate a partial or whole serving of FV
Preordering lunch in morning in elementary school ¹⁷	Increased percentage of students who ordered healthier entrées
Behavior modification	
Token reinforcement for eating FV in elementary school ¹⁸	Increased consumption of FV
Virtual reinforcement for eating FV via storytelling in elementary school ³¹	Increased consumption of FV
Money or small prizes for eating FV in elementary school ²⁰	Increased percentage of students who ate 1 serving of FV
Verbal prompting for fruit or fruit juice selection in elementary school ²¹	Increased odds ratio of selection and consumption of fruit and fruit juice
Feedback for parents on students' lunch purchases in grades K–12 ³²	Decreased percentage of students who purchased cookies
Marketing strategies	
Price reduction of 50% for fruit, salad, and carrots in high school ²⁶	Increased sales of fruit and carrots
Creative naming of vegetables in elementary school (2 studies) ²⁵	Study 1: Increased consumption of carrots, no change in selection Study 2: Increased selection of hot vegetables
Branding of apples with <i>Elmo</i> sticker in elementary school ²⁴	Increased selection of apples
Time-efficiency	
Implementation of express line offering healthier items in high school ²⁷	Increased selection of healthier items, decreased consumption of less-healthy foods
Implementation of express line offering healthier items plus descriptive names for vegetables, attractive bowls/stands to display fruit, and verbal prompts to try foods in secondary school ²⁸	Increased percentage of students who selected FV Increased percentage of students who consumed at least 1/2 serving of FV
Fruit slicing	
Slicing of apples and oranges in elementary school ²³	Increased percentage of students who selected an orange Increased percentage of students who ate at least 1/2 of orange No difference for apple slicing
Slicing of apples in middle school ²⁹	Increased percentage of students who selected an apple Increased percentage of students who consumed at least 1/2 of apple

Abbreviations: FV, fruits and vegetables.

determine if it is the classroom, the cafeteria, or the family component that has the greatest effect.³⁸ Furthermore, in the multicomponent intervention by Perry et al.,³⁹ the increase in fruit and/or vegetable consumption was greater during school lunch than during meals consumed outside of school, which suggests that cafeteria interventions may provide the biggest impact on eating behaviors. The authors also commented on the difficulty of instituting a classroom curriculum due to the limited time and resources allocated for nutrition education.³⁷ Lastly, multicomponent interventions may require significant funding and involvement from teachers, cafeteria staff, and parents.³⁸ Many of the published multicomponent studies were funded by large research organizations such as the National Cancer Institute,^{37,39–43} the National Institute of Health,^{44,45} and the Centers for Disease Control and Prevention.^{41,44} Therefore, simple cafeteria

interventions may be more practical for many schools with limited resources.

Although lower cost may be a major advantage of simple interventions compared with multicomponent interventions, only 9 of the studies in this review addressed this issue.^{21–23,27,28,30–33} Information about the cost of the interventions, as provided by the study authors, is included in Table 1. Not all of the interventions were inexpensive. For example, Just and Price²² estimated the cost of incentivizing students to eat 1 serving of fruit and/or vegetables daily to be \$69 per child per year. On the other hand, the one-time cost of the cafeteria makeover in Hanks et al.³⁰ was only \$50, and the cost of the fruit slicer in Wansink et al.³¹ was \$200 for the school year. Furthermore, several studies reported that the costs were negligible^{27,32} or minimized.³³ Thus, the costs of the interventions varied greatly, and not all are affordable for schools with limited funding.

A specific concern regarding the results of these interventions is the issue of study duration. It is possible that the novelty of the intervention influenced the change in eating behaviors, particularly in the shorter studies. Just and Price²¹ reported some evidence of a decreasing effect over time, likely due to an initial novelty effect. Only 1 intervention lasted longer than 2 months.²³ The authors of that 6-month study did not state whether the results differed statistically between the 2 data-collection days, which were 2 months apart.²³ Future studies of longer duration are required to determine if healthy eating behaviors persist over time.

Of the 8 studies that examined selection/consumption of fruits and vegetables specifically, 5 measured fruits and vegetables separately,^{20,28,30,32,33} and 3 measured fruits and vegetables as a single group.^{21,22,24} One study looked at selection/consumption of vegetables only.²⁷ This is an important distinction, as there is evidence that children prefer fruits more than vegetables⁴⁶ and consume more fruits than vegetables.⁴⁷ Therefore, future research to improve vegetable consumption specifically is critical to improving the diet of school children and adolescents.

Although the majority of these studies assessed healthy eating behaviors exclusively at school, 3 of the studies addressed the impact of the interventions outside of school.^{24,33,34} Of these studies, only 1 included a 24-hour food recall.²⁴ The authors chose this assessment method in order to specifically examine the impact of the school salad bar on both school meals and food eaten outside of school. The increased frequency of fruit and/or vegetable consumption was almost entirely accounted for by an increase at lunchtime (84%). Two studies utilized parent surveys.^{33,34} In Jones et al.,³³ parents estimated that consumption of fruit and/or vegetables increased by 0.41 cups per day at the end of the virtual reinforcement intervention compared with consumption at baseline ($P < 0.01$). In the study by Wansink et al.,³⁴ some parents reported that they modified family meals on the basis of information received from the "Nutrition Report Card" intervention. More studies that include an assessment of dietary intake outside of school are necessary to determine the effects of simple cafeteria interventions on total diet.

CONCLUSION

Not all interventions are feasible or applicable in all cafeteria settings. For example, verbal prompting would only be useful in schools that utilize Offer vs Serve or à la carte sales. Otherwise, students would automatically receive all lunch components on their trays. Similarly, implementing an express line would only occur in schools that offer à la carte items. Furthermore, not all

schools have the physical space or food-service staff for a second checkout line in their cafeteria.

Perhaps another important area to explore is the timing and duration of lunch. Although not technically a cafeteria intervention, moving recess before lunchtime was examined in a recently published prospective controlled study.⁴⁸ Compared with consumption when lunchtime was before recess, fruit and/or vegetable consumption increased by 0.16 serving per child ($P = 0.001$) when students ate lunch after recess, and the percentage of students who consumed at least 1 serving of fruit and/or vegetables increased from 22% to 33.3% ($P = 0.005$). Additionally, the duration of the lunch period may affect fruit and/or vegetable consumption. In a cross-sectional study of middle and high school students, a lunch period of at least 34 minutes was associated with a higher odds ratio of fruit consumption (OR = 1.40; 95%CI, 1.05–1.88) and vegetable consumption (OR = 1.54; 95%CI, 1.26–1.88).⁴⁹ A randomized, prospective study would be a useful next step to test this hypothesis.

Several strengths and limitations of this review should be addressed. Due to the wide variety of interventions and research methods utilized, this is not a systematic review. There are no rigorous inclusion or exclusion criteria or a meta-analysis of the outcomes. Furthermore, many types of interventions to improve nutrition were not included because of the vast quantity of available literature. These include interventions such as school gardens, classroom education, after-school programs, chefs at school programs, and multicomponent interventions. These interventions may be important to consider in addition to the ones included in this review. Lastly, the studies in this review were conducted prior to the implementation of the new meal patterns and the competitive food rules. Therefore, it is unknown whether the interventions would have the same outcomes if repeated at the present time.

The strengths of this review should also be noted. While this is not a systematic review, the narrative nature of this review may be of value for readers interested in specific areas of eating behaviors. Additionally, the literature was reviewed back to 1997. This period of time encompasses more than a generation of school children. Furthermore, whenever possible, the review discusses the outcomes in terms of absolute values or absolute percentages as opposed to merely the percent change. This will permit the reader to consider clinical importance and not just statistical significance.

While improving school nutrition is vitally important, the fiscal consequences of the new school meal standards cannot be ignored. The USDA projected that compliance with new meal standards will increase cost by \$0.10 per lunch and \$0.27 per breakfast over baseline for

the fiscal year 2015.¹³ To accommodate this increase, the USDA provides an addition \$0.06 per lunch and no additional funds for breakfast. In a national survey conducted in 2015, 70% of schools reported a negative financial impact of the new regulations on the school meal programs.⁵⁰ Therefore, many schools will have limited options for interventions because of already-strained budgets. Nevertheless, an effective and affordable simple intervention could offer tremendous benefits.

In conclusion, this review suggests there are a variety of simple strategies to increase healthy eating behaviors at school (Box 1). Some strategies may be more effective or applicable to certain age groups or settings than others. Because all of these studies were conducted prior to the implementation of the new meal patterns and new rules on competitive foods, it is unclear if these interventions would yield similar results if repeated at the present time. Future studies will be needed to assess

the impact of the new regulations on strategies to improve healthy eating behaviors.

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Box 1 Simple and effective methods to improve healthy eating in the school cafeteria

- Reduce prices of healthy foods. Sales of fruit increased by 4-fold and carrot sales doubled when prices were reduced by 50% in high school.²⁸
- Implement an express line. Offering an express line for healthier lunch options resulted in decreased consumption of less-healthy foods by 50 g per student in high school.²⁹
- Offer fruits sliced, rather than whole. Apple selection increased by 71% when apples were offered as sliced instead of whole in middle school,³¹ but not in elementary school.²⁵
- Offer more than 1 fruit and/or vegetable. Offering a choice of 3 different fruits or vegetables vs a single offering (no choice) increased consumption of fruits and vegetables by over 50% in grades kindergarten through 8.³²
- Give creative names to healthy foods. Selection of hot vegetables increased by 99% when vegetables were given creative names such as "Power Punch Broccoli" in elementary school.²⁷ Carrot plate waste decreased by 50% when carrots were named "X-ray Vision Carrots" in elementary school.²⁷
- Take preorders for lunch entrées in the morning. Preordering lunch in the morning in elementary school resulted in almost twice as many students selecting the healthier entrée.¹⁹

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