



HHS Public Access

Author manuscript

Health Behav Policy Rev. Author manuscript; available in PMC 2021 July 16.

Published in final edited form as:

Health Behav Policy Rev. 2020 October ; 7(5): 461–472. doi:10.14485/hbpr.7.5.8.

Salad Bars and Fruit and Vegetable Intake in Title I Elementary Schools

Melanie K. Bean, PhD [Associate Professor],

Virginia Commonwealth University, Richmond, VA, United States

Alexandra Sova, BS [Research Assistant],

Virginia Commonwealth University, Richmond, VA, United States

Laura M. Thornton, PhD [Research Professor],

University of North Carolina, Chapel Hill, NC, United States

Hollie A. Raynor, PhD, RD, LDN [Professor],

University of Tennessee, Knoxville TN, United States

April Williams, MS [Research Assistant],

Virginia Commonwealth University, Richmond, VA, United States

Mary Dunne Stewart, MSW [Chief Executive Officer],

Greater Richmond Fit-4Kids, Richmond, VA, United States

Suzanne E. Mazzeo, PhD [Professor]

Virginia Commonwealth University, Richmond, VA, United States

Abstract

Objective: Despite widespread support for salad bars as a means to increase fruit and vegetable (F&V) intake within the National School Lunch Program (NSLP), empirical support for their use is limited. This cross-sectional study examined associations between salad bar access and F&V selection and consumption in Title I elementary schools in Virginia serving universal free meals.

Methods: Three matched pairs of schools (3 with salad bars; 3 without [control]) were randomly selected. Digital imagery plate waste methods assessed F&V selection, waste, and consumption. N = 1559 trays (N = 760 salad bar; N = 799 control) from 1st-5th grade students were analyzed (92.5% NSLP participation; 98.6% racial/ethnic minority).

Results: Salad bar usage varied widely (8.2%-63.8%). Different patterns of F&V selection and consumption were observed across pairs. Vegetable selection was higher in one salad bar school (+43.6g; $q < .001$) and vegetable consumption higher in 2 salad bar schools (+15.3g [$q = .005$]; +8.3g [$q = .022$]), compared with matched controls. Students in 2 salad bar schools selected more fruit than controls (+30.2g and +18g; $q_s < .001$), yet fruit consumption differed across all 3 pairs.

Correspondence Dr Bean; mealnie.bean@vcuhealth.org.

Human Subjects Approval Statement.

This research was approved by the Institutional Review Board of Virginia Commonwealth University (Protocol HM20007166).

Conflict of Interest Disclosure Statement

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

Conclusions: Salad bar access might facilitate children's vegetable intake. Inconsistent results across school pairs suggest that school food environment factors other than salad bar access influenced F&V consumption.

Keywords

salad bars; elementary school; fruits and vegetables; National School Lunch Program; nutrition; Title I elementary schools

Children from low-income and racial and ethnic minority families are especially likely to consume inadequate amounts of fruits and vegetables (F&Vs) and to rely on school meals for a significant portion of their daily caloric intake.¹ Indeed, > 30 million children in the United States (US) participate in the National School Lunch Program (NSLP).² Thus, school food policies and practices play a powerful role in shaping children's eating behaviors³ and reducing risk of poor nutrition and chronic illness.^{4,5}

School salad bars are widely promoted as a strategy to increase F&V intake and decrease food waste in the NSLP.⁶⁻⁹ Salad bars offer students a great variety of F&Vs and foster dietary choice, factors associated with increased F&V intake in children.¹⁰ Thus, salad bars have great potential to increase F&V intake. However, few empirical studies have investigated the influence of salad bars on F&V intake and their findings are mixed.⁶

For example, cross-sectional studies with middle and high-school students identified greater F&V intake in schools with salad bars;^{11,12} yet, consumption was assessed via self-report, and thus, is subject to a number of biases. In contrast, a 2005 study found that 1st-5th grade students' F&V intake, assessed via objective plate waste, was no higher in schools with salad bars compared with schools serving pre-portioned F&Vs only.¹³ However, this work might not generalize to today's children, particularly given significant changes to the NSLP, including the requirement that children must select a F&V with meals.² More recently, a cross-sectional study with middle and high school students found that fruit consumption was higher in students attending schools without salad bars. Yet, there were no differences in vegetable consumption between students attending schools with and without salad bars.¹⁴

Two quasi-experimental studies^{15,16} prospectively examined the impact of salad bars on dietary intake among elementary school students; however, results conflicted. Moreover, only one of these investigations¹⁶ was implemented under the current NSLP standards and assessed dietary intake objectively. In the first of these studies, Slusser et al¹⁵ compared F&V intake before and after salad bar installation in 3 low-income schools. F&V intake increased by 1.12 servings per day, as measured by 24-hour recalls; however, objective assessments of F&V consumption were not conducted. There was also a 2-year gap between baseline and post assessments, and a 30% student transience rate, introducing potential history effects and reducing the likelihood that the same children were assessed at both time points. Bean et al¹⁶ assessed F&V intake before and one month after salad bars were installed in 2 Title I elementary schools serving predominantly African-American children, all of whom received free meals. Using objective, digital imagery plate waste methods, they found that students selected a greater variety of F&Vs after salad bars were introduced. However, at post-test, self-served F&V portions were smaller than those served by food

service personnel, and mean F&V intake at lunch *decreased* by 0.65 cups, compared to when these foods were pre-portioned exclusively.¹⁶ Thus, increasing F&V access might not be sufficient to shape consumption in low-income students. Importantly, neither of these prior studies included comparison groups.

Significant resources are allocated to installing and operating school salad bars. For example, *Salad Bars to Schools* has donated over 5,676 salad bars.¹⁷ Yet it is unknown if salad bars achieve their intended purpose of enhancing "...healthy eating opportunities for kids in schools."¹⁷ Thus, there is a great need for rigorous investigations examining dietary consumption patterns in schools with salad bars, compared with schools serving pre-portioned F&Vs only. These investigations are particularly needed in schools serving children from low-income and racial and ethnic minority backgrounds.^{18,19}

In the current study, we investigated how salad bars are associated with F&V consumption in an urban, low-income elementary school district serving universal free meals. It was hypothesized that students in schools with salad bars would have: (1) greater F&V intake, and (2) less F&V waste, compared with students in schools without salad bars. Salad bar usage within schools was also examined.

METHODS

Participants

This investigation occurred in a central Virginia school district with > 12,000 elementary school students (> 90% African-American or Latinx); 22 of its 25 elementary schools are Title I and > 90% of students participate in the NSLP. All students are eligible for free meals under the Community Eligibility Provision of the Healthy Hunger-Free Kids Act (HHFK);²⁰ thus, this district serves a population at high risk for food insecurity. In the 2015-16 school year, salad bars were installed into 18 elementary schools. Funding limitations precluded installation in all schools; those receiving salad bars were selected by the district, guided by factors such as cost to retrofit the lunch line.¹⁶ Only Title I schools were included in this investigation. Thus, 17 schools with salad bars and 5 schools without salad bars were eligible. Three matched pairs of schools were randomly selected: half had salad bars, and half served pre-portioned F&Vs only. All 1st-5th grade students receiving school lunch on rating days were eligible. Kindergarten students were not permitted to use the salad bar. Across schools, NSLP participation was 85.6%-99.8% on rating days. Parent notification with opt-out option was used, and student verbal assent was obtained in the lunch line.

Procedure

Design and random selection.—A cross-sectional design was implemented. Matching procedures were developed to maximize school similarity on all but salad bar presence. Schools were first categorized based on percent of racial/ethnic minority students (ie, 85% or < 85% African-American/Latinx) and the cafeteria environment (ie, percent adherence to Smarter Lunchroom principles, designed to encourage healthier meal selections via choice architecture and behavioral economics, assessed by trained raters in a prior investigation²¹). Based on these ratings, schools were categorized as being above, below, or within one

standard deviation (SD) of the mean Smarter Lunchroom score for all district elementary schools. Ultimately, 3 schools with salad bars were randomly selected. They were then matched to schools without salad bars (Table 1).

Training.—Cafeteria raters were trained following a standardized protocol that included observed practice taking photographs from a standard angle (45°) and distance using mock trays. Training included strategies to minimize interference with lunch flow and maximize data quality (eg, removing visual obstructions).

Laboratory raters were trained to rate item selection and consumption from photographs. Because of the variable reference portions from salad bars, raters were also trained to assess portion sizes for self-serve F&Vs using photographs and standard portion sizes as guides.²² Raters viewed images of plated and post-consumption trays and documented: (1) which items were selected, (2) starting portions of salad bar F&V (to the nearest ¼ cup); and (3) percent plate waste in 20% increments for each item. Raters had to achieve interrater reliabilities of 0.80 (assessed via intraclass correlations; ICCs), as well as ICCs 0.80 when compared with a “gold standard” rating, to indicate readiness for study participation. The gold standard represented either a measured portion (self-serve starting portions and waste) or consensus rating determined by 2 independent investigators, with a third resolving discrepancies (for pre-portioned items); see^{16,22} for additional training details. Interrater reliability across 9 raters was excellent for estimating starting portions (ICC = 0.94) and plate waste (ICC = 0.84) at study onset.

Control schools.—In control schools, all food was pre-portioned or served by cafeteria staff. Consistent with NSLP requirements, students had to take at least one fruit (½ cup requirement) or vegetable (¾ cup vegetable requirement); they were permitted to take up to one fruit and up to 2 vegetables (pre-portioned).

Salad bars.—Salad bars included F&Vs only and followed a consistent menu across schools. Once installed, both salad bars (self-serve, for which portions varied) and pre-portioned (or served by staff) F&Vs were available; thus students could choose F&Vs from the lunch line, the salad bar, or both. Other meal components came from the lunch line. Salad bar F&Vs were included as part of the reimbursable meal; thus, schools were required to adhere to minimum USDA serving size guidelines. Students used a “spoodle” (1 spoodle = ¼ cup) to self-serve from the salad bar; printed signs guided portions. However, fruit on the salad bar was typically cupped, in a standard ½ cup serving, to control portions.

Cafeteria procedures.—In October 2016, validated digital imagery plate waste assessments were conducted, consistent with prior school lunch investigations.^{16,23} There was one rating day per school pair. Each pair was assessed concurrently for menu consistency and to minimize potential maturation and history effects.²⁴ Digital imagery plate waste methods included securing a numbered label (indicating child grade) on students’ trays as they exited the lunch line, and taking a digital image. At the end of lunch, students left trays on the table. Raters prepared the trays (eg, removed visual obstructions) and took another image documenting plate waste. Labels were numbered so pre and post-consumption images of the same tray could be matched; they were also color-coded to track

sex (assigned by staff), consistent with previous school lunch investigations.^{16,25} All images were taken digitally with iPads (Apple, Cupertino, CA) at a ~45° angle and uploaded onto computers in the laboratory for rating.

Reference portions.—On rating days, research staff took photographs and measurements (using a calibrated food scale, Ozeri Pronto Digital Food Scale [Model ZK14-S; Ozeri Kitchen]) of 3 reference portions of all F&Vs offered at lunch. An average was used as each item's reference portion. Because salad bar items were self-serve, and thus, the starting portions variable, reference portions were created in the laboratory. Specifically, 2 research dietitians independently created and weighed 3 serving sizes (eg, ¼ cup, ½ cup, ¾ cup) of all F&Vs offered on the salad bars, using the same preparation methods (eg, diced, sliced, or whole) as schools. These photographs served as reference portions for raters quantifying starting portions of salad bar items. Product information for all foods served was obtained by the school district dietitian and used to enter all foods served into Nutrition Data Systems for Research (NDSR), using the average of the 3 weights.

Rating procedures.—In the laboratory, trained, independent raters (individuals not involved in taking photographs, masked to study hypotheses) simultaneously viewed pre- and post-consumption images. Using REDCap, raters recorded which F&Vs were selected and estimated the percent of each item remaining in 20% increments. Visual stimuli (pie charts for each rating, from 0% to 100% left) assisted raters in making judgments.²⁶ Raters also estimated the plated volume of salad bar items selected to the nearest ¼ cup, using reference images to make judgements. The amount of food missing was assumed to have been consumed. However, if evidence of an item (eg, container) was missing, raters did not assume consumption, as the food could have been shared, discarded, or brought out of the cafeteria), and the item was not rated; ~20% of trays were double rated, with ICC's remaining excellent (0.81-0.90). This method for estimating volume and waste for salad bars with variable portions has been previously validated, with interrater reliabilities of 0.91-0.99, and validity estimates of 0.74-0.98 across all vegetables, based on ICCs.²²

Measures

Demographics.—School, grade, and sex were obtained from labels affixed to trays.

F&V selection and waste.—F&V selection (number selected), portions (grams) served and consumed, and waste were calculated (details below). Only whole F&Vs were included. Fruit juice (considered a “fruit” in the NSLP)² and F&Vs included as part of the entrée (eg, pizza sauce) were not included.

For F&V consumption, serving size and plate waste ratings were calculated. These values were used to create 3 F&V consumption/waste variables: (1) *portion served* (grams) of each type of F&V selected; each portion served is estimated based on the serving size and the NDSR weight per serving (for self-serve salad bar items, the *portion served* is the estimated starting portion x measured weight of a standard portion); (2) *portion consumed* (grams): grams consumed = grams served * (1 – % plate waste). These values were summed for all F&V items on each tray to obtain the *total portion consumed* of F&Vs, respectively; (3)

overall % waste was calculated as: (total portion served – total portion consumed)/total portion served. These 3 variables were generated for “Total Fruit” and “Total Vegetables” for analyses.

Data Analysis

Analyses were conducted using SAS v9.3 (SAS Institute, Cary, NC). Descriptive statistics were calculated for tray characteristics (sex, grade, and number of trays with F&V selections [N, %]) and for outcome variables (mean and SD) by school. Image pairs (N = 1636) were rated in the laboratory; 4.7% (N = 77) of trays with F&Vs were not ratable (ie, visual obstructions, missing item, or missing label); significantly more trays from salad bar schools were non-ratable ($p = .0001$). Thus, N = 1559 trays were analyzable.

Chi-square tests evaluated whether the number of F&Vs offered and the number of students selecting F&Vs differed between salad bar and control schools. Uncorrected p-values are presented. Two-level multilevel mixed models were initially applied, accounting for cluster effects at the school level, to evaluate group differences (salad bar = 1, control schools = 0). The unit of analysis was the individual tray and covariates were sex, grade, and school pair (designated as 1, 2, and 3); the interaction of school pair by group was also included in models. Because this interaction was significant in many of the models, complicating interpretation of group effects, analyses were stratified by pair so the effect of salad bars on the outcome measures could be evaluated. Specifically, generalized linear models were applied (choosing appropriate response variable distribution and link functions for each outcome) to evaluate group differences for each pair of schools. The unit of analysis was each individual tray; grade and sex were included as classification covariates. Thus, separate results were obtained for each school pair. Within pair results were corrected for multiple testing by the False Discovery Rate (FDR):²⁷ this statistical approach corrects for random events that falsely appear significant. FDR is less stringent than Bonferroni, yet has greater power to find truly significant results. Corrected p-values $< .05$ (presented as q-values) were considered significant.

RESULTS

The opt-out rate was 3.1% in salad bar schools; 2.8% in control ($p = .73$). Across the 3 school pairs, there were 760 trays in schools with salad bar and 799 in schools without salad bars. Table 2 presents foods were available on rating days. Entrée selections were consistent between each pair, with a few exceptions: 2 schools served a limited number of leftovers from the day prior (in addition to the planned entrée); one school did not offer sandwiches. F&V availability varied between groups. Schools without salad bars offered between 3-7 fruit and 2-4 vegetable options; salad bars schools offered 1-5 fruit and 7-10 vegetable options. There was no difference in the number of fruits offered ($p = .29$). However, salad bar schools offered more vegetables ($p = .006$). Of note, only one salad bar school offered fresh fruit self-service. The others offered fruit cupped, whole, or pre-packaged.

Table 3 presents the distribution of sex and grade and the number (%) of students who selected F&Vs, by group and school. More than 80% of students in salad bar schools selected vegetables, compared with less than 60% in control schools ($p < .0001$). In salad bar

schools, an average of 8.0% of vegetable servings and 18.4% fruit servings were from the salad bar. The proportion of students who used the salad bar for any item was also examined (given that students could select from both the salad bar and the lunch line): 17.1% of trays included a salad bar vegetable (Pair 1 = 8.8%, Pair 2 = 29.1%; Pair 3 = 11.8%). Only the Pair 2 salad bar school offered self-serve fruit on the salad bar; 62.7% of students selected a salad bar fruit. Overall, 30.7% of trays included a salad bar item (Pair 1 = 8.2%, Pair 2 = 64.2%; Pair 3 = 12.1%).

Table 4 presents the mean (SD) for each F&V outcome by school (intervention group indicated), sex, and grade. Students from salad bar schools selected more fruit by weight in Pairs 1 and 3 compared to students in control schools ($q_s < .001$), with no difference in Pair 2. However, in Pair 1, students in the salad bar school consumed more fruit than those in the control school. In Pair 2, students from the salad bar school consumed less fruit than students from the control school. No difference in fruit consumption was observed for Pair 3.

Students in the salad bar school for Pair 2 selected more vegetables (43.6 g on average) than students in the control school ($q < .001$); no differences were observed for the other 2 pairs. However, students from salad bar schools in both Pairs 1 and 2 consumed more vegetables (15.3 g and 8.3 g, respectively) than students in control schools, and percent vegetable waste was lower in the salad bar school in Pair 1.

DISCUSSION

Results indicate that more vegetables were available in salad bar schools, with no differences in fruit availability. The different patterns of results across the 3 school pairs revealed variability in selection and consumption patterns, consistent with mixed prior findings related to salad bars.^{15,16} For example, students in 2 of the 3 salad bar schools consumed more vegetables, with no greater vegetable waste, compared to control schools. Vegetable selection was also higher in one salad bar school. These promising outcomes are consistent with the major goals of the HHFKA.²⁸ However, findings related to fruit were less clear, and their interpretation complicated by the fact that only one salad bar school offered self-serve fruit. Fruit consumption patterns differed across pairs and fruit waste was higher in 2 of 3 salad bar schools. In a previous study, Bean et al¹⁶ reported that, one month after salad bar installation within this same district, students selected a greater variety of F&Vs; however, portions selected and consumed were *smaller* than when vegetables were exclusively pre-portioned. Current results extend these findings via the addition of comparison schools and suggest that vegetable consumption is higher in salad bar schools; yet, fruit consumption was inconsistent.

Results regarding vegetable consumption in salad bar schools are promising as previous school-based interventions, such as the Fresh Fruit and Vegetable Program (FFVP) have demonstrated greater effects for fruit consumption, compared with vegetables.^{29,30} Thus, perhaps a combination of salad bars and programs like FFVP could optimize students' dietary quality. Moreover, prior research found that the variety of the foods offered was positively associated with elementary schools students' F&V intake, independent of salad

bar status.¹³ Thus, offering more vegetable options, in any format, might represent a viable strategy to increase children's intake. It is unclear from this investigation if the same strategies apply for fruit.

Different patterns between school pairs were observed, suggesting that factors other than salad bar presence influence F&V consumption in schools. These other factors might include menu differences (eg, entrée popularity), assessment day differences (eg, weather), or specific aspects of the cafeteria environment. Prior research has identified multiple factors related to F&V consumption in school cafeterias, including noise levels,^{31,32} crowding,³² salad bar location,³³ lunch period length^{12,32} and timing (eg, after recess³⁴), and student involvement in menu planning.¹² Schools within pairs were rated on the same day and menus were matched; yet, these factors differed between pairs. Furthermore, given homogeneity of many of these factors (eg, salad bar location and lunch period length) and the small number of schools assessed, we could not examine how these factors might have been associated with consumption. Future studies should examine these factors in more schools. However, results suggest that salad bars are not the sole determinant of students' dietary behaviors. Thus, although salad bars can have a positive influence on intake, they should not be viewed as a panacea for the challenges of poor dietary quality.

Limitations and Strengths

Data are cross-sectional. Thus, it is not known whether children's F&V consumption changes as their familiarity with the school salad bar increases, or if it differs from that evident prior to salad bar installation. Prospective, randomized controlled trials examining F&V consumption in schools with and without salad bars are needed.

Salad bars in this district were offered in addition to pre-portioned F&Vs on the serving line. This model is not uncommon and has been observed in prior research.¹⁴ However, this approach makes it impossible to isolate the impact of salad bars on students' F&V selection and consumption patterns. This design also introduced confounds related to F&V familiarity (eg, of canned³⁵ and/or heated F&Vs on the lunch line) competing with fresh F&V on the salad bars. Indeed, in a prior salad bar investigation, students reported being surprised that vegetables in the salad bar were cold.¹⁶ Offering F&Vs both in salad bar and pre-portioned formats also precludes evaluation of the impact of serving style (self-serve vs pre-portioned). This factor is important to assess systematically, as choice is proposed as a potential mechanism associated with salad bar use. Offering choice might be particularly important under the current NSLP guidelines, which require students to take a fruit and/or vegetable with meals.² Indeed, 85% of 4th and 5th grade students in a prior study liked having the ability to choose F&Vs from their school salad bar.¹⁶ As noted, although located on the salad bars, fruits in the salad bar schools were often served pre-portioned, not self-serve. Thus, serving style differed for F&Vs on the salad bar. The more favorable findings for vegetables in this investigation might reflect this difference. Increasing accessibility to a variety of F&Vs and fostering choice are 2 empirically and theoretically-supported mechanisms proposed to explain how salad bars might impact dietary consumption,^{13,36-41} and warrant further investigation. Lastly, given varying palatability of different F&Vs,

examination of how menu pairings, preparation style, and variety of F&Vs impacts consumption patterns can inform strategies to optimize F&V intake and minimize waste.

Schools in this study were all Title I and predominantly ethnic/racial minority, thus the influence of demographic factors on outcomes could not be assessed due to the relative homogeneity of the sample. Future research should continue to investigate school and individual-level influences on salad bar use and their association with F&V consumption in a larger, more heterogeneous sample. Finally, this study did not assess whether the higher vegetable consumption in salad bars schools affected consumption of other meal components and total caloric intake. These data could inform obesity prevention and school policy implementation.

This study's strengths include its sample of students at high risk for obesity and related comorbidities with high reliance on school meals, the extremely high participation rate, and the objective assessment of trays yielding a significant amount of standardized data, enhancing generalizability. Furthermore, internal validity was enhanced by matching schools on key variables prior to randomization.²⁴ Photographers and raters were blind to study hypotheses. They also completed rigorous training and conducted independent double ratings of ~20% of meals to minimize the influence of any potential bias. This study is also the first to apply validated methods²² to estimate starting portions and waste from self-serve salad bars using digital imagery.

IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

Salad bars were associated with greater vegetable consumption among elementary school students. Increasing salad bar access might improve children's vegetable intake, consistent with priority objectives outlined by the World Health Organization⁴² and the Office of Disease Prevention and Health Promotion,⁴³ with the goals that Americans consume a healthy diet, rich in F&Vs, and that healthy options are available and affordable. Nonetheless, inconsistent patterns across school pairs highlight the importance of other school food environment factors on F&V selection and intake. Schools considering committing resources to school salad bars should carefully consider their intent. Although salad bars have potential to increase F&V intake and reduce waste, data are not clear. Installing a salad bar might have other benefits (eg, student satisfaction), which could increase support for their use. Schools should also identify other modifications to their school food environments that might promote healthy eating (eg, reducing noise, altering lunch seating, timing). Salad bars might change dietary intake, yet it appears likely that additional strategies are also needed, and that specific school-level factors should be considered in decision-making.

It is important to also note that the status of school salad bars during, and after, the coronavirus disease (COVID-19) pandemic is unknown. The US Centers for Disease Control and Prevention's guidelines for re-opening schools during COVID-19⁴⁴ recommend that children bring their own meals or are served plated meals in classrooms, eliminating communal cafeterias and buffet-style serving, such as salad bars. Thus, salad bars are not likely to return to school meals until this pandemic has abated. Options to continue to offer

choice in a COVID-era include having students indicate their selections and have school nutrition personnel serve the meal in the classroom. However, the feasibility of this approach might vary considerably based on school size and resources. In a post-COVID-19 environment, it is recommended that schools consider additional safeguards to permit salad bar usage, including close monitoring by staff, hand hygiene prior to salad bar usage, and sneeze guards. Furthermore, it might be preferable for gloved staff to serve the food; yet to retain choice, students could indicate which F&Vs they would like and the quantity. Although this strategy does not permit students to self-serve, it still fosters choice, a mechanism with potential to optimize students' F&V intake, an important public health priority.

Acknowledgements

This work was supported by the National Institutes of Health (R03HD088985 to MKB) and CTSA award UL1TR002649 from the National Center for Advancing Translational Science (to Virginia Commonwealth University) and by the Children's Hospital Foundation. These funding agencies had no role in the design, analysis or writing of this article. A preliminary version of this work was presented at the 2019 International Society of Behavioral Nutrition and Physical Activity annual meeting.

References

1. Mirtcheva DM, Powell LM. Participation in the National School Lunch Program: importance of school-level and neighborhood contextual factors. *J Sch Health*. 2009;79(10):485–494. [PubMed: 19751310]
2. US Department of Agriculture. Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule. <https://www.govinfo.gov/content/pkg/FR-2012-01-26/pdf/2012-1010.pdf>. Published January 26, 2012. Accessed December 2, 2019.
3. Story M, Nanney MS, Schwartz MB. Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *Milbank Q*. 2009;87(1):71–100. [PubMed: 19298416]
4. He FJ, Nowson CA, MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *Lancet*. 2006;367(9507):320–326. [PubMed: 16443039]
5. He FJ, Nowson CA, Lucas M, MacGregor GA. Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies. *J Hum Hypertens*. 2007;21(9):717–728. [PubMed: 17443205]
6. Adams MA, Bruening M, Ohri-Vachaspati P. Use of salad bars in schools to increase fruit and vegetable consumption: where's the evidence? *J Acad Nutr Diet*. 2015;115(8):1233–1236. [PubMed: 25828564]
7. Harris DM, Seymour J, Grummer-Strawn L, et al. Let's Move Salad Bars to Schools: a public-private partnership to increase student fruit and vegetable consumption. *Child Obes*. 2012;8(4):294–297. [PubMed: 22867066]
8. US Centers for Disease Control and Prevention. Strategies to Prevent and Manage Obesity. Salad Bars to Schools. <https://www.cdc.gov/obesity/strategies/salad-bars2schools.html>. Published November 26, 2019. Accessed September 15, 2020.
9. US Department of Agriculture. Salad Bars in the National School Lunch Program and School Breakfast Program. Memo: SP 41-2019. <https://www.fns.usda.gov/cn/salad-bars-national-school-lunch-program-and-school-breakfast-program>. Published September 2019. Accessed July 27, 2020.
10. Hakim SM, Meissen G. Increasing consumption of fruits and vegetables in the school cafeteria: the influence of active choice. *J Health Care Poor Underserved*. 2013;24(2 Suppl):145–157. [PubMed: 23727971]
11. Terry-McElrath YM, O'Malley PM, Johnston LD. Accessibility over availability: associations between the school food environment and student fruit and green vegetable consumption. *Child Obes*. 2014;10(3):241–250. [PubMed: 24872011]

12. Gosliner W School-level factors associated with increased fruit and vegetable consumption among students in California middle and high schools. *J Sch Health*. 2014;84(9):559–568. [PubMed: 25117889]
13. Adams MA, Pelletier RL, Zive MM, Sallis JF. Salad bars and fruit and vegetable consumption in elementary schools: a plate waste study. *J Am Diet Assoc*. 2005;105(11):1789–1792. [PubMed: 16256765]
14. Johnson CC, Myers L, Mundorf AR, et al. Lunch salad bars in New Orleans' middle and high schools: student intake of fruit and vegetables. *Int J Environ Res Public Health*. 2017;14(4):415.
15. Slusser WM, Cumberland WG, Browdy BL, et al. A school salad bar increases frequency of fruit and vegetable consumption among children living in low-income households. *Public Health Nutr*. 2007;10(12):1490–1496. [PubMed: 17610759]
16. Bean MK, Spalding BB, Theriault E, et al. Salad bars increased selection and decreased consumption of fruits and vegetables one month after installation in Title I elementary schools: a plate waste study. *J Nutr Educ Behav*. 2018;50(6):589–597. [PubMed: 29550173]
17. Salad Bars to Schools. Salad Bars + Schools. <http://www.saladbars2schools.org/>. Accessed February 12, 2020.
18. Sherry B, Mei Z, Scanlon KS, et al. Trends in state-specific prevalence of overweight and underweight in 2- through 4-year-old children from low-income families from 1989 through 2000. *Arch Pediatr Adolesc Med*. 2004;158(12):1116–1124. [PubMed: 15583095]
19. Miech RA, Kumanyika SK, Stettler N, et al. Trends in the association of poverty with overweight among US adolescents, 1971-2004. *JAMA*. 2006;295(20):2385–2393. [PubMed: 16720824]
20. US Department of Agriculture. School Meals: Community Eligibility Provision. <http://www.fns.usda.gov/school-meals/community-eligibility-provision>. Accessed September 8, 2014.
21. Bean MK, Theriault E, Grigsby T, et al. A cafeteria personnel intervention to improve the school food environment. *Am J Health Behav*. 2019;43(1):158–167. [PubMed: 30522574]
22. Bean MK, Raynor HA, Thornton LM, et al. Reliability and validity of digital imagery methodology for measuring portions and plate waste from school salad bars. *J Acad Nutr Diet*. 2018;118(8):1482–1489. [PubMed: 29656934]
23. Taylor JC, Yon BA, Johnson RK. Reliability and validity of digital imaging as a measure of schoolchildren's fruit and vegetable consumption. *J Acad Nutr Diet*. 2014;114(9):1359–1366. [PubMed: 24751663]
24. Cook TD, Campbell DT, Day A. Quasi-experimentation: Design & Analysis Issues for Field Settings. Boston, MA: Houghton Mifflin; 1979.
25. Cohen JF, Richardson S, Austin SB, et al. School lunch waste among middle school students: nutrients consumed and costs. *Am J Prev Med*. 2013;44(2):114–121. [PubMed: 23332326]
26. Connors PL, Rozell SB. Using a visual plate waste study to monitor menu performance. *J Am Diet Assoc*. 2004;104(1):94–96. [PubMed: 14702591]
27. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc Series B Stat Methodol*. 1995;57(1):289–300.
28. [govtrack.us](https://www.govtrack.us/congress/bills/111/s3307/text). S. 3307 (111th): Healthy, Hunger-Free Kids Act of 2010. <https://www.govtrack.us/congress/bills/111/s3307/text>. Published December 3, 2010. Accessed June 30, 2015.
29. Davis EM, Cullen KW, Watson KB, et al. J. A fresh fruit and vegetable program improves high school students' consumption of fresh produce. *J Am Diet Assoc*. 2009;109(7):1227–1231. [PubMed: 19559140]
30. Ohri-Vachaspati P, Turner L, Chaloupka FJ. Fresh fruit and vegetable program participation in elementary schools in the United States and availability of fruits and vegetables in school lunch meals. *J Acad Nutr Diet*. 2012;112(6):921–926. [PubMed: 22709817]
31. Graziose MM, Koch PA, Wolf R, et al. Cafeteria noise exposure and fruit and vegetable consumption at school lunch: a cross-sectional study of elementary students. *Appetite*. 2019;136:130–136. [PubMed: 30711485]
32. Gross SM, Biehl E, Marshall B, et al. Role of the elementary school cafeteria environment in fruit, vegetable, and whole-grain consumption by 6- to 8-year-old students. *J Nutr Ed Behav*. 2019;51(1):41–47.

33. Adams MA, Bruening M, Ohri-Vachaspati P, Hurley JC. Location of school lunch salad bars and fruit and vegetable consumption in middle schools: a cross-sectional plate waste study. *J Acad Nutr Diet*. 2016;116(3):407–416. [PubMed: 26625970]
34. Ang IYH, Wolf RL, Koch PA, et al. School lunch environmental factors impacting fruit and vegetable consumption. *J Nutr Educ Behav*. 2019;51(1):68–79. [PubMed: 30293942]
35. Moreno-Black G, Stockard J. Salad bar selection patterns of elementary school children. *Appetite*. 2018;120:136–144. [PubMed: 28864255]
36. Hendy HM, Williams KE, Camise TS. Kids Choice: school lunch program increases children’s fruit and vegetable acceptance. *Appetite*. 2005;45(3):250–263. [PubMed: 16157415]
37. Perry CL, Bishop DB, Taylor GL, et al. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health Educ Behav*. 2004;31(1):65–76. [PubMed: 14768658]
38. Pittman D, Parker J, Getz B, et al. Cost-free and sustainable incentive increases healthy eating decisions during elementary school lunch. *Int J Obes*. 2012;36(1):76–79.
39. Bere E, Klepp KI. Changes in accessibility and preferences predict children’s future fruit and vegetable intake. *Int J Behav Nutr Phys Act*. 2005;2:15. [PubMed: 16216124]
40. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption. *J Hum Nutr Diet*. 2005;18(6):431–443. [PubMed: 16351702]
41. Cohen JF, Richardson SA, Cluggish SA, et al. Effects of choice architecture and chef-enhanced meals on the selection and consumption of healthier school foods: a randomized clinical trial. *JAMA Pediatr*. 2015;169(5):431–437. [PubMed: 25798990]
42. World Health Organization. Health Topics: Nutrition. <https://www.who.int/topics/nutrition/en/>. Accessed July 20, 2020.
43. US Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Nutrition and Weight Status. <https://www.healthypeople.gov/2020/topics-objectives/topic/nutrition-and-weight-status>. Published August 18, 2020. Accessed September 15, 2020.
44. US Centers for Disease Control and Prevention. Coronavirus 2019. Considerations for Schools. <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/schools.html>. Published September 1, 2020. Accessed September 15, 2020

Characteristics of Randomly Selected Matched Title I Elementary Schools in Central Virginia with and without Salad Bars

Table 1

Variable	Pair 1		Pair 2		Pair 3	
	Salad Bar	Control	Salad Bar	Control	Salad Bar	Control
Racial / Ethnic Minority ^a	85%	85%	85%	85%	85%	85%
Distance from mean (SD) Smarter Lunchroom score ^a	> 1 SD	> 1 SD	> -1 SD	> -1 SD	> -1 SD	> -1 SD
Enrollment, 1 st -5 th grade (N)	357	451	528	290	299	373
Rating day attendance, 1 st -5 th grade (N) ^b	325	434	426 ^b	283	267	368
Parent opt-outs, N (%) ^c	10 (2.8%)	3 (0.07%)	5 (0.09%)	3 (1.0%)	2 (0.7%)	7 (1.9%)
Student opt-outs in line, N (%) ^d	13 (4.1%)	2 (0.05%)	2 (0.04%)	4 (1.6%)	4 (1.6%)	12 (3.8%)
NSLP participation on Rating Day, n (%) ^e	315 (96.9%)	433 (99.8%)	481 (95.2%)	245 (86.6%)	244 (91.4%)	315 (85.6%)
Lunch Duration	30 min	30 min	30 min	25 min	30 min	30 min

Note.

Pair refers to matched pairs of schools with and without a salad bar. Pairs were matched based on % Racial/Ethnic minority (above or below 85% minority) and the lunchroom environment (distance from the mean Smarter Lunchroom score). Ratings occurred on the same day within each pair to match menu and day.

SD = Standard Deviation; NSLP = National School Lunch Program

^a% racial/ethnic minority and distance from the Smarter Lunchroom mean score for the district were used as matching variables

^b 5th grade students were not in the cafeteria on the rating day due to a field trip; thus 23 students were absent from school and 79 5th graders were not present at lunch (although they received an NSLP bagged lunch, lunches were not available to be rated, thus they are excluded from attendance numbers)

^cNumber of opt-out forms received / enrollment = % parent opt-out

^dNumber of students opting out / NSLP participation on rating day = % opt-out

^eNumber of students receiving reimbursable lunch / attendance on rating day = % NSLP participation

Table 2

Entrées, Fruit and Vegetables Available on Plate Waste Rating Days at Title I Elementary Schools in Central Virginia with and without Salad Bars

Item	Pair 1		Pair 2		Pair 3	
	Salad Bar	Control	Salad Bar	Control	Salad Bar	Control
Entrée						
BBQ pork sliders, whole grain roll	X	X		X ^d		
Entrée Salad (romaine, tomatoes, and/or radishes, protein [cheese/chicken or tuna salad/ham/chicken], croutons), whole grain crackers	X	X	X	X	X	X
Yogurt parfait, fruit (canned, diced), granola	X	X	X	X	X	X
Ham or turkey or turkey bologna (cheese) sandwich, or Italian sandwich	X	X	X	X	X	X
Chicken and broccoli alfredo, whole grain rotini, garlic bread	X ^A					
Maple waffles, oven fried chicken					X	X
Teriyaki chicken (with or without egg roll)			X	X		X ^d
Fruits						
Apple (fresh, sliced)		X	X	X		
Applesauce		X				
Banana (fresh, whole)			X		X	
Grapes						X
Clementine / orange (fresh, whole)		X		X	X	
Mandarin oranges (canned)		X				
Peaches (canned, sliced)					X	X
Pears (canned, diced)		X		X		

Item	Pair 1		Pair 2		Pair 3	
	Salad Bar	Control	Salad Bar	Control	Salad Bar	Control
Plum (fresh, whole)		X				
Pineapple (canned, diced, cupped)			X	X	X	X
Orange (fresh, slices)		X	C	X	X	
Vegetables						
Baked beans (vegetarian, canned)	X	X		X ^d		
Beans, green (canned)						X
Broccoli (steamed, fresh)			X	X		
Corn (frozen or on the cobb)	X	X				
Coleslaw	X	X				
Mixed vegetables				X	X	
Side Salad (romaine or spinach, tomatoes, cucumbers and/or carrots)	X			X	X	X
Garden Patch ^b						
Spinach / romaine	X		X		X	
Three bean salad	X					
Kidney beans (canned)						X
Grape tomatoes (whole)	X		X		X	
Yellow bell peppers (rings)	X					
Cauliflower (florets)						X
Corn (cold, previously frozen, fresh)						X

Item	Pair 1		Pair 2		Pair 3	
	Salad Bar	Control	Salad Bar	Control	Salad Bar	Control
Carrots (baby/shredded)	X					
Yellow squash (sliced)	X					
Broccoli (florets)			X			
Cucumbers (sliced)			X			
Sweet potatoes (diced)			X			
Cantaloupe (cubed) ^d			X			
Orange (fresh, slices) ^d			X			
Watermelon (cubed) ^d			X			

Note.

Pair refers to matched pairs of schools with and without a salad bar. Pairs were matched based on % Racial/Ethnic minority (above or below 85% minority) and the lunchroom environment (distance from the mean Smarter Lunchroom score). Ratings occurred on the same day within each pair to match menu and day.

^aEntrée was left-over from day prior, thus small number of servings were available.

^bItem offered as self-serve on the salad bar; fresh and uncooked.

^cIn one salad bar school, item was offered self-serve.

^dFruit was served cupped (pre-portioned) in all other schools.

Table 3

Tray Characteristics of Lunches Rated from Title I Elementary Schools in Central Virginia with and without Salad Bars: Number of Rated Trays, Number (%) of Trays by Sex and Grade and Number (%) of Trays with Fruit and Vegetable Selections

Rated trays ^a	Pair 1		Pair 2		Pair 3	
	Salad Bar N = 250 N (%)	Control N = 321 N (%)	Salad Bar N = 279 N (%)	Control N = 214 N (%)	Salad Bar N = 231 N (%)	Control N = 264 N (%)
Male	118 (47.2)	149 (46.4)	111 (39.8)	100 (46.7)	120 (52.0)	116 (43.9)
Grade						
1	56 (22.4)	55 (17.1)	60 (21.5)	49 (22.9)	50 (21.6)	56 (21.2)
2	52 (20.8)	71 (22.1)	72 (25.8)	22 (10.3)	45 (19.5)	46 (17.4)
3	57 (22.8)	81 (25.2)	65 (23.3)	47 (22.0)	40 (17.3)	44 (16.7)
4	64 (25.6)	50 (15.6)	79 (28.3)	49 (22.9)	48 (20.8)	54 (20.4)
5	21 (8.4)	64 (19.9)	3 (1.1)	47 (22.0)	48 (20.8)	64 (24.2)
Fruit^b	79 (31.6)	181 (56.4)	225 (80.6)	93 (43.5)	100 (43.3)	189 (71.6)
Vegetables^c	204 (81.6)	294 (91.6)	241 (86.4)	136 (63.6)	229 (99.1)	41 (15.5)

Note.

Pair refers to matched pairs of schools with and without a salad bar. Pairs were matched based on % Racial/Ethnic minority (above or below 85% minority) and the lunchroom environment (distance from the mean Smarter Lunchroom score). Ratings occurred on the same day within each pair to match menu and day.

^aTrays with a pre and post-consumption image successfully matched and rated.

^bTrays that included a fruit.

^cTrays that included a vegetable.

Table 4

Mean (SD) for Number Selected, Portion Served (g), Amount Consumed (g), and % Plate Waste for Fruits and Vegetables Presented by Group (Salad Bar and Control) in Matched Pairs of Elementary Schools^{a,b}

	Pair 1		Pair 2		Pair 3	
	Salad Bar	Control	Salad Bar	Control	Salad Bar	Control
Fruits	N = 79	N = 181	N = 225	N = 93	N = 100	N = 189
Number selected^c	1.0 (0.2)	1.0 (0.00)	1.2 (0.4)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Portion selected (g)	129.0 (28.1)	98.8 (30.2)	132.5 (73.5)	127.8 (6.3)	108.1 (12.3)	90.1 (28.3)
Portion consumed (g)^d	101.1 (52.3)	67.1 (43.9)	47.8 (35.7)	86.4 (53.5)	68.5 (45.5)	69.6 (39.7)
% Waste^e	21.8 (33.9)	30.1 (39.2)	55.9 (35.4)	32.3 (41.8)	35.8 (42.4)	19.8 (36.8)
Vegetables	N = 204	N = 294	N = 241	N = 136	N = 229	N = 41
Number selected^f	1.3 (0.6)	1.1 (0.3)	1.4 (0.7)	1.0 (0.2)	1.3 (0.6)	1.1 (0.5)
Portion selected (g)	129.3 (58.8)	123.8 (27.8)	123.8 (81.4)	80.2 (17.8)	117.9 (57.5)	116.9 (36.5)
Portion consumed (g)^d	53.9 (52.6)	38.6 (53.2)	47.6 (41.0)	39.3 (37.2)	28.1 (47.5)	26.9 (44.5)
% Waste^e	56.0 (42.6)	69.4 (42.0)	55.2 (41.0)	51.7 (44.2)	76.8 (36.7)	78.0 (36.6)

Note.

Results of generalized linear models evaluating group differences presented.

^aPair refers to matched pairs of schools with and without a salad bar. Pairs were matched based on % racial/ethnic minority (above or below 85% minority) and the lunchroom environment (distance from the mean Smarter Lunchroom score). Ratings occurred on the same day within each pair to match menu and day.

^bOnly trays with fruit and vegetables, respectively, are included (N = 167 were excluded: N = 90 selected only juice; N = 57 selected an entrée that counted as their fruit or vegetable; N = 33 [9 from salad bar schools; 24 from control schools] had no fruit or vegetable).

^cNumber of fruits selected ranged from 1-3 in salad bar school and was restricted to a maximum of 1 in control schools.

^dPortion consumed was calculated as [portion selected * (1 - plate waste)].

^e% Waste was calculated as [(portion selected - portion consumed) / portion selected].

Number of vegetables selected ranged from 1-5.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript