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Salad Bars Increased Selection and Decreased Consumption of Fruits and Vegetables One-Month after Installation in Title I Elementary Schools: A Plate Waste Study

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Abstract

Objective—To evaluate the one-month impact of salad bars on fruit and vegetable (FV) selection, intake and waste.

Design—Pre-post quasi-experimental design.

Setting—Title I elementary schools in a large, urban district in central Virginia.

Participants—Students (grades 1–5; >95% African American) from two elementary schools participated in plate waste assessments (282 plates were rated at baseline; 443 at post); 4th and 5th grade students from 15 (of 18 eligible) schools (n=1193) responded to surveys.

Intervention—Digital imagery plate waste assessments were conducted before (baseline) and one-month after (post) salad bars were installed. Post-surveys examined student perceptions of salad bars.

Main Outcome Measures—FV selection, consumption, and waste.

Analysis—General linear models examined changes in outcomes, controlling for school. Frequencies and qualitative analyses were applied to survey data.

Results—At post, students selected more types of FVs (1.81 to 2.58; $P<0.001$), although FV consumption decreased by 0.65 cups ($P<0.001$). Given smaller portions selected, there was less FV waste (0.27 cups; $P<0.001$) at post. Students liked the ability to choose FV from salad bars.

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Conclusion and Implications—Short-term exposure to salad bars increased the number of FV students choose, yet decreased FV consumption. Additional strategies are needed to increase FV consumption.

Keywords

salad bars; elementary school; National School Lunch Program; plate waste

INTRODUCTION

The school food environment plays a powerful role in shaping children's eating behaviors,[1,2] particularly in schools serving children from low income families. These children are most likely to rely on school meals for a significant portion of their daily caloric intake[3] and are also most likely to consume inadequate numbers of fruits and vegetables (FVs), placing them at increased risk of poor nutrition and chronic illnesses.[4,5] School salad bars are cited as a strategy to increase FV intake within the National School Lunch Program (NSLP).[6,7] Indeed, Let's Move Salad Bars to School has donated over 5,000 salad bars via this movement;[6] further, the Centers for Disease Control and Prevention cites school salad bars as a major strategy to address pediatric obesity,[8] and the United States Department of Agriculture promotes school salad bars, citing their potential to improve nutrition, increase FV consumption and reduce waste.[9] However, there is limited (and mixed) empirical support for these claims.[10]

In the only study that prospectively examined the impact of salad bars on elementary students' FV intake, Slusser and colleagues reported a 1.12 serving increase in FV intake after salad bars were installed (assessed via self-reported 24-hour recalls).[2] Similarly, in a cross-sectional study conducted with middle and high school students, self-reported vegetable consumption was 48% greater in schools with a salad bar compared with schools serving pre-portioned FV only.[11] In contrast, presence of a salad bar was not associated with increased FV intake in a cross-sectional study that used weighed plate waste methods with elementary school students.[12] There thus remains a great need to investigate empirically the impact of salad bars, using longitudinal designs, and objective dietary asssessment methods, that are not subject to self-report bias.[13]

Salad bars foster choice, thus might be particularly effective within the newer NSLP meal standards.[14] Specifically, the 2010 Healthy Hunger Free Kids Act (HHFKA) requires that all children are served (vs. offered) a fruit and/or vegetable with each meal (the "Serve model"), and sets guidelines on variety and quantity of FVs served.[14] Strategies that allow children to choose have been demonstrated to increase their FV intake,[15] thus the "Serve model" has the potential to reduce the perception of choice. Given the significant resources allocated to installing school salad bars, and their potential to increase FV intake, there is a great need for systematic investigations examining how salad bars impact consumption patterns in children within the NSLP. These investigations are particularly needed in schools serving children from low income and racial and ethnic minority backgrounds, who are most likely to rely on school meals and who are at greatest risk for obesity and related chronic diseases.[16,17]

The current report describes results of *Eat Fresh*, a collaborative project led by Greater Richmond Fit4Kids, with an overall objective to increase access to and consumption of fresh FVs. *Eat Fresh* included installation of salad bars into 18 elementary schools (17 of which were Title I) in a large, urban school district in central Virginia in the 2015–16 school year. This district serves >90% racial and ethnic minority children (71% African American; 13% Hispanic) and has been participating in the Community Eligibility Provision of the HHFKA since 2014, allowing all students to receive free meals regardless of paperwork completion.[18] Prior to opting in to this policy, >75% of students were eligible for free and reduced meals. Over 90% of students in this district participate in the NSLP. Thus these schools have high rates of poverty, with many students living in food deserts with high food insecurity; changes to the school food environment can therefore have a major impact on students' dietary intake.

The primary aim of this investigation was to compare FV selection (number and starting portion size) and waste/consumption (percent waste and portion size consumed) before and one-month after salad bar installation, assessed via digital imagery plate waste methods.[19] We hypothesized that both FV selection and consumption would increase after salad bars were installed, and that waste would decrease. Student perceptions of salad bars after they were installed were also evaluated using a brief survey. Results can inform the initial, one-month effects of salad bars in low-income schools participating in the NSLP.

METHODS

Design

A pre-post quasi-experimental design was implemented. Two of the 17 Title I schools receiving salad bars were randomly selected for digital imagery (DI) assessments before (fall 2015) and one month after the salad bar launches at each school (spring 2016). The one school that was not Title I was excluded from randomization, given the different population served, with a lower percentage of racial and ethnic minority students. The 17 remaining schools were divided into "large" or "small" schools using a median split of their enrollment. One "large" and one "small" school were then randomly selected, using a random number generator. Baseline ratings occurred on the same day for both schools for menu consistency. Post-ratings were matched on length of exposure to salad bars (one month), but occurred on different days. Items assessing student usage and perception of salad bars were included as part of a post-only survey administered in Physical Education class by their teachers in spring 2016 (after the first partial year of exposure to salad bars). Physical Education teachers were instructed by research staff to read a short script to students about the purpose, confidentiality, and voluntary and anonymous nature of the survey. All 18 schools receiving salad bars were provided with surveys and asked to facilitate their students' completion.

Participants and Setting

There is high homogeneity within this district, with respect to race, socioeconomic status, and NSLP participation, and all elementary schools use the same menus. All 1st–5th grade students present on rating days who participated in the school lunch program (i.e., selected a

reimbursable meal) were eligible for plate waste assessments (total enrollment n = 564). Kindergarten was excluded as they were not permitted to use the salad bars. All 4th and 5th grade students (n = 2329 enrolled) in the 18 schools receiving salad bars were eligible to complete the brief survey. Surveys were limited to these grades to reduce literacy concerns with younger students.

Procedures

Parent notification—Parent notification letters were sent home via schools, which provided the opportunity for parents to opt out of ratings or surveys for their children. No parents opted out of ratings; four opted their child out of the survey. This study was approved by the Institutional Review Board of Virginia Commonwealth University.

Training—Cafeteria assessors (primarily undergraduate and graduate student volunteers) participated in a two hour training which included detailed instruction on cafeteria procedures, including assent procedures, tray preparation, and methods for taking the digital image (i.e., from a 45° angle with all four corners of the tray in the image, for consistency). Raters viewed sample images of correctly and incorrectly obtained images to recognize the need to follow protocols for accurate data collection (e.g., removing visual obstructions from the tray and using the proper angle). Training included practice preparing mock trays and taking photographs of trays at the appropriate angle and distance with feedback provided by the Investigators until appropriate methods were consistently demonstrated.

Independent raters (undergraduate students receiving research credit) were trained on assessment of digital images by the first author. Raters viewed sample images from a prior investigation and rated starting portions (to the nearest ¼ cup, for salad bar items only) and consumption in 20% increments to establish satisfactory interrater reliabilities (ICC>0.80)[20] prior to rating study images.

Cafeteria procedures—All FVs were pre-portioned or served by cafeteria staff at baseline; at post, self-serve FVs were also available on the salad bar, for which portions varied. Students served from the salad bar with a “spoodle” [1 spoodle = ¼ cup] and were permitted to take up to ½ cup of fruit and up to ¾ cup of vegetables. However, fruit on the salad bar was typically cupped, in a standard ½ cup serving or offered whole (apples and oranges). Thus both self-serve, pre-portioned (e.g., cupped) and served (e.g., with the hot lunch) FVs were offered as part of the lunch at post. The salad bar was part of the lunch line (inside the line, before the point of sale) in both schools at post.

On rating days, research staff arrived prior to the first lunch period. They approached students as they exited the lunch line and asked if they could photograph their tray (no student images were taken). If students agreed, staff affixed a numbered label (with grade recorded) on their tray and took a photograph. Students enter the lunch line in grade groups, facilitating grade identification, although grade was confirmed with students as they exited the line. All images were taken with iPads at a ~45° angle, with all four corners of the tray within the frame. Labels were color-coded to track gender, as identified by the research staff, consistent with prior investigations in the school setting.[21] Students were instructed to leave their trays on the table upon dismissal; research staff repositioned items to ensure labels and

all items were visible, and took another photograph documenting what was left unconsumed. Images were subsequently uploaded onto computers in the laboratory to prepare images for rating via matching pre- and post-consumption images using their numbered label.

Rating procedures—Three trained independent raters viewed the pre and post-consumption images simultaneously on computers. Raters were blinded to time-point and study hypotheses. Ten percent of trays were double rated at each time point and interrater reliabilities (assessed via intraclass correlation [ICC]) were excellent (ICC=0.89–0.95).[20] Raters indicated which FVs were selected (number and types; excluding juice). Raters also assessed if the FVs selected were from the salad bar (self-serve), pre-cupped, or served by the cafeteria staff. Raters estimated % of each FV left on the plate in 20% increments. Visual stimuli (pie charts) on a validated tick sheet assisted raters in making judgments.[22–24] FV waste assessments were only made if there was appropriate evidence of a FV (e.g., cup, peel, or other evidence); otherwise, raters did not assume consumption (e.g., could have been shared, discarded, or brought out of the cafeteria).

For served/pre-portioned FV, standard portions sizes were applied (e.g., ½ cup for fruit, legumes, dark green, starchy and other vegetables; ¾ cup for red/orange vegetables; 2 cups of leafy greens in entrée salads), as observed in the photographs.[25] Because of the variable reference portions from salad bars, raters were carefully trained to visually assess portion sizes and volume (to the nearest ¼ cup) for different servings of salad bar FVs available using reference photographs of standard portion sizes (e.g., ¼– ¾ cup) as a guide. This method for estimating volume and waste for salad bars has been previously validated, and resulted in excellent interrater reliabilities (ICC=0.91) and accuracy for both determination of the starting portions (ICC=0.74) and waste (ICC=0.98) across vegetables.[26]

Measures

Demographics—Grade (as reported by students) and gender (as observed by staff) were obtained from labels affixed to trays.

FV Selection and Waste—For each data collection time point, the number (variety) and portion (cups) of FVs selected and percent (in 20% increments) and volume (in cups) of FVs wasted were assessed. FV consumption (cups) was calculated from these data (starting portion – wasted portion).

Surveys—Five items related to salad bars were included as part of a student post-survey implemented to 4th and 5th grade students from all 18 schools that received salad bars. Students reported frequency of salad bar usage and rated on a Likert-type scale from 1 (Strongly Disagree) to 5 (Strongly Agree) how much they liked the salad bar (“I like my school’s salad bar”); perceptions of choice (“I like being able to choose my own fruits and vegetables from the salad bar”); and variety (“I like the types of fruits and vegetables offered on the salad bar”). One open-ended item sought other comments or suggestions about their school salad bar.

Data Analyses

Descriptive analyses examined frequencies for categorical variables and means and standard deviations for continuous variables. Baseline differences in mean FV selection (number and cups) and consumption (% wasted and cups consumed and wasted) between the randomly selected schools were examined with t-tests. FV waste was examined continuously, consistent with prior investigations.[27] Differences in mean selection (number and cups), waste (% and cups), and consumption (cups) of fruit, vegetables, and total FVs from baseline to post were analyzed using a generalized linear model (GLM) with time as a covariate, controlling for school. Survey responses were examined with frequencies; open-ended items were qualitatively examined for themes. SPSS software (version 24.0, IBM) was used, with $P < .05$ indicating significance.

RESULTS

Participants

Overall, 282 plates were observed at baseline and 443 at post. More plates were rated at post due to increase in research staffing, yet % of students rated per grade was comparable at both time points ($\chi^2(4) = 1.08$; $P = 0.90$). (Table 1). Selected schools were similar: both were Title I; >95% of students participated in NSLP; 100% of students were eligible for free meals; and >95% of students were African American (<1% Hispanic). Surveys were returned from 1193 4th and 5th grade students from 15 (of 18) schools (60% response rate from schools that administered the surveys). Three schools did not administer their surveys for unknown reasons.

FVs Selected, Wasted, and Consumed

Table 2 presents which FV were available on rating days, and specifically notes which FVs were offered as self-serve on the salad bar at each school. Salad bar offerings were similar across schools (e.g., shredded vs petite carrots). At baseline, students in School A selected significantly more fruit (M = 0.98; SD = 0.18) than School B (M = 0.86; SD = 0.41); $P = 0.001$. School A also had lower % vegetable waste (M = 46.2, SD = 42.0) than B (M = 57.7; SD = 36.9); $P = 0.029$. Thus, school was entered as a covariate in models.

At post when both pre-portioned and self-serve FVs were available, 46.7% of students used the salad bar, as assessed in the digital images. As shown in Table 3, introduction of salad bars increased the number of FVs selected by students (1.81 to 2.58 FVs overall; $P < 0.001$); yet, mean FV consumption decreased by 0.65 cups ($P < 0.001$). At post, students selected significantly smaller portions of FVs compared with baseline portions (2.02 cups to 1.70 cups FV overall; $P < 0.001$). There was a small increase (5.5%) in percent of fruit waste only ($P = 0.048$). Given the smaller portions selected, students wasted fewer FVs (cups) at post, compared with volume wasted at baseline. Specifically, at post children discarded 0.35 cups of vegetables (vs. 0.59 cups at baseline; $P < 0.001$) and 0.16 cups of fruit (vs. 0.23 cups at baseline; $P = 0.016$). Thus overall, the addition of salad bars increased the number of FVs selected, but decreased the overall amount of FVs consumed, compared with when FVs were pre-portioned exclusively.

Student Perceptions of Salad Bars

About 44% of 4th and 5th graders reported using the salad bar at least once per week; 16% reported daily use; and 40% reported never using the salad bar. Over half of the students agreed/strongly agreed that they like the salad bar and the types of FVs offered (61%), while 85% liked that they can choose their own FVs from the school salad bar. (Table 4)

Open-ended response were provided by 743 students. Many (31%) were specifically related to liking/loving the salad bar: "*I love love love their fruit;" "The food is good at the salad bar;" "I love our new salad bar!!;" "I like when they put fruits and vegetables in our salad bar because it makes us healthy."* Several students specifically commented on their ability to choose: "*I like it because you get to pick what you want;" "What I like about the salad bar is that you get to make your own."* Only 8% of comments specifically stated they did not like the salad bar-these comments related to dislike of the temperature (e.g., surprise at cold temperature of vegetables or dislike of FVs overall). Several comments (7%) were related to requesting different or more options on the salad bar. Of those comments, 17% requested different fruits; 7% requested different vegetables; and 4% requested additional non-FV items (eggs, meat, cheese, or croutons).

DISCUSSION

Main findings were that one month after salad bars were in operation in Title I elementary schools, students selected an overall greater number of FVs; however, students selected and consumed smaller portions of these FVs, compared to baseline, resulting in lower overall FV consumption. Further, although the percentage of fruit waste increased (by 5.5%), the overall volume of FVs that children discarded decreased (by 0.27 cups). Lastly, just under half of 4th and 5th graders reported using the salad bar at least once a week; yet 85% of students reported that they liked the ability to choose and the majority were happy their school had a salad bar.

Salad bars increased exposure to a wider variety of FVs, and students selected a greater number of FVs after their installation, consistent with one of the goals of *Eat Fresh* and the HHFKA.[14] Although the increase in exposure did not translate to increased consumption, this finding might be particularly meaningful within this population of children who have lower exposure and access to fresh FV.[16,17] Increased FV variety has been proposed as a potential mechanism through which salad bars might impact intake, supported by a prior cross-sectional study that found that students in elementary schools with salad bars that had the greatest variety of FVs offered, consumed the most FVs.[12] In contrast, however, students in the current study had *lower* FV intake at post, despite the greater variety offered and selected after salad bars were installed. Future longitudinal research should include comparison schools serving pre-portioned FVs only to further examine the relation between FV variety, serving style, and consumption.

The smaller FV portions selected with the salad bars could suggest student interest in trying the FVs, yet reluctance to commit to a larger amount. Additional strategies to reinforce these tasting attempts might be needed, as prior studies have demonstrated that small reinforcements (e.g., verbal praise) are associated with increased FV intake[28] and lower FV

waste.[27] Given that children consumed more FVs when they were served by cafeteria staff in a larger portion, additional student training and monitoring by the cafeteria staff during lunch might be needed to ensure students select portions consistent with NSLP reimbursable meal guidelines. (Although mean portion was above the ½ cup guideline). In a related study conducted in elementary schools with salad bars also operating under the "Serve" model, 22% of students took no fruit and 39% took no vegetable, eliminating the chance for intake of these foods (yet also potentially reducing waste, although this was not examined).[29] Thus finding a balance between promoting autonomy and ensuring exposure (to provide the opportunity for consumption) might be important.

Findings add to the handful of reports investigating the effects of school salad bars. For example, a prior cross-sectional study using weighed plate waste and conducted in elementary schools serving primarily Latino students found no differences in FV consumption in schools with salad bars compared to those without them.[12] Importantly, this prior study was conducted in schools were salad bars had been installed for >10 years, with no baseline assessment. In a recent cross-sectional study, middle and high school students in schools *without* salad bars reported greater fruit consumption (via 24-hour recalls) compared with students in schools with salad bars.[30] These findings are similar to the current study which did not support an increase in FV consumption with salad bars, and are in contrast to the single prior prospective report of increased FV intake after salad bars were installed in elementary schools.[2] Thus there remains a lack of consistent evidence and a great need for additional rigorous, longitudinal investigations with objective assessments of intake to determine the impact of school salad bars.[10] There is also a need for empirical investigations of the impact of adjunctive strategies (e.g., salad bar marketing[31] and cafeteria tastings[27,28]) on dietary consumption patterns. These investigations are particularly needed under the newer NSLP meal standards.

When available, fewer than half of students selected a FV from the salad bar on rating days (based on rater assessments); and 40% of 4th and 5th graders reported never using the salad bar. Interestingly, 61% of 4th and 5th graders stated that they liked their school salad bar and the FVs on the salad bar, and 85% stated that they liked the ability to choose. Surveys were only administered to 4th and 5th grade students, thus younger students perceptions were not assessed. Importantly, salad bars in this district were offered in addition to pre-portioned FVs on the serving line. This design increased variety and choice, yet precluded the ability to isolate presentation methods; this design also resulted in FV familiarity (e.g., of canned and/or heated FVs) competing with salad bar FVs. For example, on process surveys, students reported being surprised that FVs were cold in the salad bar (potentially reflecting lower exposure to raw FVs in this low-income district). Of note, canned FVs (particularly canned corn) were the most frequently selected items in a prior investigation of selection patterns from school salad bars.[32] There remains a great need to further understand what guides students' FV selection patterns and what factors translate these choices into consumption, within a policy that requires students to take at least one fruit or vegetable.

Limitations include lack of comparison schools (without salad bars), and inability to match students at each time point. Findings might not be generalizable to all 17 schools with salad bars, as two were randomly selected. The percentage of trays assessed was higher at post.

However, participation rate is similar to other plate waste investigations.[33] Menus at post were not identical, although FVs offered on the salad bar at both schools were similar. Further, starting portions for pre-portioned FVs, observed in the "pre-consumption" images, were estimated based on meal standards (not weighed). Thus while there was likely some variation in starting portions, consistent volume parameters were applied at both time points; prior studies[34,35] found little variation in initial serving sizes for served foods.

Strengths of this study are the target population of students at high risk for obesity and food insecurity and use of objective dietary intake assessment methods. Further, this investigation addresses gaps identified by Adams and colleagues[10] to objectively examine the effects of introducing salad bars on dietary intake patterns in schools where they had not existed previously. This is the first longitudinal study to objectively examine the impact of salad bars on elementary students' dietary intake. It is also the first to apply digital imagery plate waste procedures to self-serve salad bars, using validated methods to estimate both the starting portion and the waste from each fruit and vegetable. Additional research is needed to understand the role of school salad bars, in addition to contextual factors, socioeconomic, and environmental and behavioral mechanisms that might explain and positively impact the relation between salad bars and dietary intake within the NSLP.

IMPLICATIONS FOR RESEARCH AND PRACTICE

One month of exposure to salad bars within the NSLP increased the number of FV children choose, yet *decreased* FV consumption. Longer term investigations are needed to examine the sustained impact of salad bars after longer exposure. Future studies should include comparisons between schools with and without salad bars, and pairing of salad bars with additional strategies to examine their impact on dietary consumption patterns. Future research should also investigate the effects of policies and programs that capitalize on student choice and reinforce tasting attempts, given their potential to shape FV consumption patterns.

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References

1. 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]
2. Slusser WM, Cumberland WG, Browdy BL, Lange L, Neumann C. 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]
3. 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]

4. 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]
5. 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]
6. United Fresh Produce Association. Let's Move Salad Bars to Schools. http://www.unitedfresh.org/nutrition/lets-move-salad-bars-to-schools/. Accessed September 1, 2015
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. Centers for Disease Control and Prevention. Overweight and obesity: Strategies and solutions for my community. 2013. http://www.cdc.gov/obesity/strategies/communitystrategies.html. Accessed September 21, 2015
9. US Department of Agriculture. Salad Bars in the National School Lunch Program. Mar, 2013. Memo: SP 31-2013http://www.fns.usda.gov/sites/default/files/SP31-2013os.pdf. Accessed September 1, 2015
10. 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]
11. 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]
12. 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]
13. 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]
14. Healthy Hunger-Free Kids Act of 2010; One Hundred Eleventh Congress of the United States of America, 2nd Session. 2010. p. 3307https://www.govtrack.us/congress/bills/111/s3307/text. Accessed June 30, 2015
15. Hakim SM, Meissen G. Increasing consumption of fruits and vegetables in the school cafeteria: the influence of active choice. J Health Care Poor U. 2013; 24(2):145–157.
16. Sherry B, Mei Z, Scanlon KS, Mokdad AH, Grummer-Strawn LM. 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 Pediat Adol Med. 2004; 158(12):1116–1124.
17. Miech RA, Kumanyika SK, Stettler N, Link BG, Phelan JC, Chang VW. Trends in the association of poverty with overweight among US adolescents, 1971–2004. JAMA. 2006; 295(20):2385–2393. [PubMed: 16720824]
18. United States Department of Agriculture. School Meals: Community Eligibility Provision. http://www.fns.usda.gov/school-meals/community-eligibility-provision. Accessed Accessed September 8, 2014
19. 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]
20. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33(1):159–174. [PubMed: 843571]
21. Cohen JF, Richardson S, Austin SB, Economos CD, Rimm EB. School lunch waste among middle school students: nutrients consumed and costs. Am J Prev Med. 2013; 44(2):114–121. [PubMed: 23332326]
22. Comstock EM, St Pierre RG, Mackiernan YD. Measuring individual plate waste in school lunches. Visual estimation and children's ratings vs. actual weighing of plate waste. J Am Diet Assoc. 1981; 79(3):290–296. [PubMed: 7264115]

23. 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]
24. Kirks BA, Wolff HK. A comparison of methods for plate waste determinations. J Am Diet Assoc. 1985; 85(3):328. [PubMed: 3973322]
25. New Meal Pattern Requirements and Nutrition Standards, USDA's National School Lunch and School Breakfast Programs. http://www.fns.usda.gov/sites/default/files/LAC_03-06-12_0.pdf. Accessed June 30, 2015
26. Bean, MK., Raynor, H., Thornton, LM., Sova, AS., Stewart, MD., Mazzeo, SE. Reliability and validity of digital imagery methodology for measuring portions and plate waste from school salad bars. The Obesity Society Annual Meeting at Obesity Week. 2017. https://higherlogicdownload.s3.amazonaws.com/OBESITY/004d4f70-37d5-434e-b24d-08a32dfdfcd9/UploadedImages/2017ow_abstracts/11-1-Wedensday-LB-Poster-Abstracts.pdf. Accessed November 22, 2017
27. Mazzeo SE, Bean MK, Palmberg A, et al. A Pilot intervention targeting dietary intake in school cafeterias. Health Behavior and Policy Review. 2017; 4(3):256–264.
28. Lakkakula A, Geaghan JP, Wong W-P, Zanovec M, Pierce SH, Tuuri G. A cafeteria-based tasting program increased liking of fruits and vegetables by lower, middle and upper elementary school-age children. Appetite. 2011; 57(1):299–302. [PubMed: 21554910]
29. Moreno-Black G, Stockard J. Salad bar selection patterns of elementary school children. Appetite. 2018; 120(Supplement C):136–144. [PubMed: 28864255]
30. Johnson CC, Myers L, Mundorf AR, O'Malley K, Spruance LA, Harris DM. 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)
31. Spruance LA, Myers L, O'Malley K, Rose D, Johnson CC. Individual- and school-level factors related to school-based salad bar use among children and adolescents. Health Educ Behav. 2017 1090198116687713.
32. Moreno-Black G, Stockard J. Salad bar selection patterns of elementary school children. Appetite. 2018; 120:136–144. [PubMed: 28864255]
33. Thompson E, Johnson DC, Leite-Bennett A, Ding Y, Mehrotra K. The impact of multiple strategies to encourage fruit and vegetable consumption during school lunch. J Sch Health. 2017; 87(8):616–622. [PubMed: 28691175]
34. Getts KM, Quinn EL, Johnson DB, Otten JJ. Validity and interrater reliability of the visual quarter-waste method for assessing food waste in middle school and high school cafeteria settings. J Acad Nutr Diet. 2017
35. Smith SL, Cunningham-Sabo L. Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program. Public Health Nutr. 2014; 17(6):1255–1263. [PubMed: 23866827]

Table 1

Tray Characteristics from Lunches at Two Title I Elementary Schools Before and One Month After Salad Bars Were Installed.

	All Elementary Plates		*School A*		*School B*	
	Baseline n = 282 n (%)	**Post n = 443 n (%)**	**Baseline n = 148 n (%)**	**Post n = 189 n (%)**	**Baseline n = 134 n (%)**	**Post n = 254 n (%)**
Gender						
Female	149 (53%)	215 (49%)	77 (52%)	92 (49%)	72 (54%)	123 (48%)
Male	133 (48%)	228 (52%)	71 (48%)	97 (51%)	62 (46%)	131 (52%)
Grade						
1	56 (20%)	96 (22%)	28 (19%)	35 (19%)	28 (21%)	61 (24%)
2	51 (18%)	88 (20%)	25 (17%)	34 (18%)	26 (19%)	54 (21%)
3	59 (21%)	84 (19%)	32 (22%)	33 (18%)	27 (20%)	51 (20%)
4	60 (21%)	90 (20%)	28 (19%)	39 (21%)	32 (24%)	51 (20%)
5	56 (20%)	83 (19%)	35 (24%)	47 (25%)	21 (16%)	36 (14%)

Note: Total enrollment (1^{st}–5^{th} grade) of School A was 222 students; School B was 342 students.

Table 2

Fruit and Vegetables Available on Plate Waste Rating Days in Two Title I Elementary Schools Before (Baseline) and One-Month After (Post) Salad Bars were Installed.

	School A		*School B*	
Item	**Baseline**	**Post**	**Baseline**	**Post**
Fruit cocktail (canned)	X			
Grapes (fresh)	X			
Mandarin oranges (canned)	X	X	X	X
Peaches(canned)	X			
Pineapple (canned)			X	
Apple (sliced; prepackaged)	X	X	X	X
Apple (whole)				X
Applesauce			X	X
Strawberries (frozen)			X	
Clementine (whole)		X		X
Orange (whole)				X
Baked beans	X		X	
Green beans (canned/hot)	X			X
Broccoli (cooked)			X	
Corn on the cobb		X		
Corn (canned/hot)				X
Collard greens (hot)		X		
Marinara sauce (prepackaged)[c]		X		X
Cole slaw			X	
Entrée salads	X	X	X	X
Side salad	X	X	X	X
Self-serve Salad Bar Offerings				
Strawberries (fresh) [a,b]		X		X
Romaine/Spinach[a]		X		X

	School A		*School B*	
Item	**Baseline**	**Post**	**Baseline**	**Post**
Edamame[a]		X		X
Yellow peppers (rings/raw)[a]		X		X
Broccoli (raw)[a]		X		X
Grape tomatoes[a]		X		X
Shredded carrots[a]		X		
Petite carrots[a]				X

Note: At post, most fruits were pre-cupped into 4oz servings on salad bars.

[a]Item offered as self-serve on the salad bar.

[b]Strawberries were cupped at School A and both cupped and self-serve at School B.

[c]Marinara sauce meets ¼ cup vegetable serving.

Table 3

Change in Fruit and Vegetable Selection, Consumption, and Waste (%) at Two Title I Elementary Schools Before and One-month After Salad Bars Were Installed.

	Baseline *n = 282*	*Post* *n = 443*	Δ[a]	
	M (SD)	**M (SD)**	***P* value**	**Model statistics**
Fruits				
Types selected (number)	.9 (.34)	1.1 (.48)	<.001	$F = 27.01$; $P < .001$
Portion selected (cups)	.96 (.17)	.64 (.29)	<.001	$F = 166.9$; $P < .001$
% waste	23.3 (36.2)	27.8 (38.0)	.048	$F = 5.97$; $P = .003$
Portion consumed (cups)	.78 (.38)	.52 (.38)	<.001	$F = 58.49$; $P < .001$
Portion wasted (cups)	.23 (.36)	.16 (.23)	.016	$F = 3.47$; $P = .032$
Vegetables				
Types selected	.9 (.47)	1.5 (.98)	<.001	$F = 42.73$; $P < .001$
Portion selected (cups)	1.06 (.47)	.69 (.40)	<.001	$F = 51.30$; $P < .001$
% waste	51.4 (40.1)	57.2 (38.8)	.133	$F = 3.85$; $P = .022$
Portion consumed (cups)	.57 (.53)	.30 (.34)	<.001	$F = 26.74$; $P < .001$
Portion wasted (cups)	.59 (.52)	.35 (.34)	<.001	$F = 20.92$; $P < .001$
Total FV[b]				
Types selected	1.8 (.56)	2.6 (1.10)	<.001	$F = 62.25$; $P < .001$
Portion selected (cups)	2.02 (.49)	1.07 (.50)	<.001	$F = 319.3$; $P < .001$
% waste	37.8 (33.2)	43.3 (32.6)	.032	$F = 2.33$; $P = .099$
Portion consumed (cups)	1.35 (.63)	.70 (.44)	<.001	$F = 117.18$; $P < .001$
Portion wasted (cups)	.68 (.61)	.41 (.40)	<.001	$F = 23.65$; $P < .001$

Note:

[a] P values represent change from baseline to post, tested with General Linear Models, controlling for school;

[b] FV=Fruits and Vegetables.

Table 4

4th and 5th Grade Student Self-reported Usage and Perceptions of Salad Bars After Partial Year Exposure; n = 1193

Item		n (%)
How often do you use the salad bar?		
	Never	457 (40%)
	Less than 1×/week	176 (15%)
	1–2×/week	203 (18%)
	3–4×/week	121 (11%)
	Every School Day	182 (16%)
I like my school's salad bar		
	Strongly Disagree	181 (16%)
	Disagree	256 (23%)
	Agree	487 (44%)
	Strongly Agree	192 (17%)
I like being able to choose my own FV[a] from salad bar		
	Strongly Disagree	67 (6%)
	Disagree	102 (9%)
	Agree	510 (46%)
	Strongly Agree	432 (39%)
I like the types of FV on the salad bar.		
	Strongly Disagree	140 (13%)
	Disagree	294 (27%)
	Agree	484 (44%)
	Strongly Agree	190 (17%)

Note: All responses provided; columns do not total n due to missing data; respondents are from 15/18 Title I elementary schools that received salad bars in 2015–16 school year;

[a]FV=Fruits and Vegetables.