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## Student receptivity to new school meal offerings: Assessing fruit and vegetable waste among middle school students in the Los Angeles Unified School District

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### ABSTRACT

**Objective.** We sought to characterize student receptivity to new menu offerings in the Los Angeles Unified School District by measuring the levels of fruit and vegetable waste after implementation of changes to the school lunch menu in fall 2011.

**Methods.** We measured waste at four randomly selected middle schools in the school district, using two sources: a) food prepared and left over after service (production waste); and b) food that was selected but not eaten by students (plate waste).

**Results.** 10.2% of fruit and 28.7% of vegetable items prepared at the four schools were left over after service. Plate waste data, collected from 2228 students, suggest that many of them did not select fruit (31.5%) or vegetable (39.6%) items. Among students who did, many threw fruit and vegetable items away without eating a single bite.

**Conclusions.** Our findings suggest that fruit and vegetable waste was substantial and that additional work may be needed to increase student selection and consumption of fruit and vegetable offerings. Complementary interventions to increase the appeal of fruit and vegetable options may be needed to encourage student receptivity to these healthier items in the school meal program.

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### Introduction

To stem and reverse childhood obesity, a number of policymakers and public health authorities at the federal, state, and local levels have intensified their efforts to improve the nutritional quality of school meals through the establishment of institutional policies or practices that promote healthy food procurement (Institute of Medicine (IOM), 2010; United States Department of Agriculture (USDA), 2012). These practices have included such strategies as setting upper limits for calories, sodium, and other nutrients per serving in the contracts of food services vendors; institutional procurement of healthier options such as whole grains and plant-based foods; and/or complementary approaches such as nutrition education, signage, and product placement to increase student selection of healthy food. Collectively, these institutional practices aim to improve the quality of foods served in schools,

increase food security, and positively influence student dietary intake (IOM, 2010).

The Los Angeles Unified School District (LAUSD), the second largest school district in the United States, serves more than 650,000 meals per day. With such volume and purchasing power, LAUSD has become a national leader in increasing student access to healthy foods through changes to its school meal program (Cummings et al., 2014). In the 2011–2012 school year (SY), the LAUSD Food Services Branch (FSB) launched a new menu that included more fresh fruits and vegetables, whole grains, vegetarian items, and a range of ethnic foods; it also eliminated flavored milk. These menu changes currently exceed the USDA school Final Rule on school meal nutrition standards, released in 2012 (USDA, 2012). In developing the revised menu, LAUSD held community taste tests during the summer of 2011 at its central kitchen. While taste testing results suggest that students reacted favorably to the new menu options, there were anecdotal reports that students reacted negatively when the meals were served in the actual school cafeterias (Wantanabe, 2011).

The national *Communities Putting Prevention to Work* (CPPW) program, funded by the Centers for Disease Control and Prevention (CDC), supports increasing access to healthier food options, including establishing healthy food procurement practices in schools (Bunnell et al., 2012). Despite growing support for such school-based practices

**Abbreviations:** IOM, Institute of Medicine; USDA, U.S. Department of Agriculture; LAUSD, Los Angeles Unified School District; SY, School Year; FSB, Food Service Branch in the Los Angeles Unified School District; CPPW, Communities Putting Prevention to Work; CDC, Centers for Disease Control and Prevention.

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(IOM, 2010; Story et al., 2008), limited evidence exists to support the effectiveness of such efforts for changing student food selection and eating behaviors. A key question is how students react to these changes to the menu. Few studies have examined student receptivity to school menu changes and results of such studies have been mixed. Most studies have assessed student receptivity to procurement practice changes based on older meal standards and used only one method to assess student receptivity, such as the amount of food left on students' trays (plate waste) (Adams et al., 2005; Cashman et al., 2010; Templeton et al., 2005) or administrative records of unused food (Cohen et al., 2012).

Supported in part by CPPW, this study sought to examine student receptivity to school meals offered by the LAUSD in SY 2011–2012 that met the 2012 USDA school meal nutrition standards. It builds on current evidence by using both administrative records and plate waste data to provide a more comprehensive picture of student receptivity to new menu offerings. While food waste represents only one of several dimensions of student receptivity, it is a plausible and reliable proxy measure of student reactions to school menu changes. Because previous research suggests that plant-based options are the food category most frequently wasted by youth (Marlette et al., 2005; Regeer et al., 1996), this study focused its analysis on describing fruit and vegetable waste.

## Methods

To characterize student receptivity to adopted school meal changes in the LAUSD, we measured leftover fruit and vegetable items at four randomly selected middle schools, using two sources: a) food prepared and left over after service (production waste); and b) food selected but not eaten by students (plate waste).

Current USDA policy promotes the “offer versus serve” concept, where students are required, for purposes of government reimbursement, to choose at least three of five food components from a variety of categories (meat/meat alternate, grains, fruits, vegetables, and low-fat (1%) or fat-free milk). During any given lunch period, LAUSD schools offer multiple options for each of the categories (e.g., two entrées, two vegetable items, two fruit items). Therefore, we attempted to capture information about a) whether students selected the fruit and vegetable items and b) the extent to which students consumed these items.

## Sample

Simple random sampling using a random number generator was used to select four of the 75 middle schools served by the FSB (Table 1). Plate waste studies are notoriously labor intensive, disruptive of school lunchtime routine and expensive to conduct. To ensure variability of student demographic characteristics within the study budget and thereby minimize type I error, the investigators emulated sample sizes used in recent literature (Cohen et al., 2012, 2013; Nozue et al., 2010; Yon et al., 2012) by including four schools in the study. Selected schools were comparable with estimates of the LAUSD student demographics for the 2011–2012 school year, which showed that 72.3% of students were Hispanic, and 76.7% were eligible for free/reduced price lunch (California Department of Education, 2014). All selected schools agreed to participate, in part due to district leadership, which heavily supported participation. Plate waste data collection took place each day, for five consecutive days (Monday through Friday) at each school in November or December of 2011. At each school, all lunch periods were observed. Waste data were collected only for

students who chose to eat in the primary eating areas immediately adjacent to the cafeteria food line.

## Data collection: Food production records

Food production records were abstracted from administrative databases housed at the LAUSD. Data on food production are recorded by staff working in the school cafeteria and reported to the FSB using a standardized template. The following data fields were requested from LAUSD for this study: school, service date, service period (breakfast, snack or lunch), and a description and number of each food item (e.g., entrée, side, drink) projected, prepared, added, served and left over.

## Data collection: Plate waste of food served

The goal of the plate waste assessment was to measure the amount of fruit, vegetable, and milk waste that remained on students' trays after they finished their school lunch. This analysis focuses on fruit and vegetable waste only. Prior to the first lunch period, the plate waste evaluation team obtained and recorded information from the cafeteria manager about the day's fruit and vegetable menu choices, including the names of the food items served (stock description) and their mean weights (5 samples for each item were weighed) as served (including container weight). Any entrée with more than 50% vegetables by weight (according to the school food service director) was included as a vegetable choice.

When students entered the lunch line, a unique, arbitrary study identification number was placed on each tray and a member of the evaluation team observed and recorded the students' sex and race/ethnicity (coded as African American, Asian/Pacific Islander, Latino, white, or other). As students left the cafeteria they were instructed (through signage and public announcements) to leave all remaining/uneaten food items on their tray and deposit their tray at one of two staffed stations at opposite ends of the primary eating area. Once the majority of students had dropped off their trays, one team member at each station visually inspected each tray and recorded: the assigned identification number; the number of items that the student took (based on the presence of packaging or waste); and the amount of waste. Based on visual inspection, fruit and vegetable waste was recorded as: a) no evidence of the food component on the plate (i.e., that the student had not selected that food item); b) none (wrapper only or fruit residues (e.g. apple core)); c) one-quarter remaining; d) one half remaining; e) three quarters remaining; or f) all remaining. Using the study identification numbers, the demographic data observed at the start of the lunch period were linked with the observed plate waste data recorded at the end of the lunch period. Protocol for the collection of plate waste was comparable to previous studies (Cohen et al., 2012, 2013).

In addition to individual-level tray data, the aggregated waste was bagged and weighted using a calibrated scale. All data were collected by trained observers using standardized forms (see Fig. 1). Two members of the team, masters-level health educators with experience working with schools, were permanent members across all schools. Between two and four additional members, trained graduate student interns or the principal investigators, were also present during data collection. The permanent members received training on the detailed study protocol from a Ph.D.-level former food service director prior to any data collection. The permanent members then trained the additional members by having them shadow them for a day prior to letting them collect plate waste data. The study protocol and all study materials were reviewed and approved by the University of California, Los Angeles and the Los Angeles County Department of Public Health Institutional Review Boards prior to field implementation.

**Table 1**

Characteristics of the four Los Angeles Unified School District middle schools that participated in the plate waste assessment, 2011.

School	Total enrollment <sup>a</sup>	Percent Hispanic <sup>a</sup>	Percentage of students eligible for free or reduced price lunch <sup>a</sup>	Percentage of students who were obese <sup>b</sup>	Number of lunches served <sup>c</sup>	Number of students observed <sup>d</sup>
A	860	87%	85%	27.2%	1602	430
B	707	38%	76%	23.4%	1158	590
C	1686	67%	73%	19.7%	1795	840
D	1724	39%	53%	15.0%	1729	368

<sup>a</sup> The Los Angeles Unified School District administrative data for 2011–2012.

<sup>b</sup> Based on State-mandated fitnessgram body composition measures for students in the 7th grade during school year 2010–2011.

<sup>c</sup> Estimated using the number of entrées served. Data extracted from five days of food production records from the Los Angeles Unified School District.

<sup>d</sup> During the five days of on-site observation of student plate waste conducted as a part of this study.

FORM 1 - Visual Food Monitoring Form – Plate Waste Evaluation

Date: \_\_\_\_\_ Day of week: Mon Tues Wed Thurs Fri (circle one) Vegetable Bag#: #1 #2 #3 (circle one)  
 Middle School: \_\_\_\_\_ Evaluator: \_\_\_\_\_ Fruit Bag#: #1 #2 #3 (circle one)  
 Time of day when weighing took place: Lunch #1: \_\_\_\_\_ Lunch #2: \_\_\_\_\_ Milk Bag#: #1 #2 #3 (circle one)

Tray #	Sex		Ethnicity/ race					Amount of Vegetables Left					Amount of Fruit Left					Amount of Milk Left				Comments			
								Vegetable(s)					Fruit(s)					Milk							
1-500	M	F	AA	API	L	W	O	0	¼	½	¾	All	0	¼	½	¾	All	0	¼	½	All				
	M	F	AA	API	L	W	O	1.						1.						1.					
	M	F	AA	API	L	W	O	2.						2.						2.					
	M	F	AA	API	L	W	O	3.						3.						3.					
	M	F	AA	API	L	W	O	4.						4.						4.					
	M	F	AA	API	L	W	O	5.						5.						5.					
	M	F	AA	API	L	W	O	6.						6.						6.					
	M	F	AA	API	L	W	O	7.						7.						7.					
	M	F	AA	API	L	W	O	8.						8.						8.					
	M	F	AA	API	L	W	O	9.						9.						9.					
	M	F	AA	API	L	W	O	10.						10.						10.					

Legend: AA=African American API=Asian/Pacific Islander L=Latino W=White O=Other  
 Recipe ingredients/product verified with cafeteria manager: \_\_\_\_\_Yes \_\_\_\_\_No  
 RENEW Plate Waste Form 11/15/11

Fig. 1. Standardized form used by observers to assess student plate waste in Los Angeles Unified School District middle schools, 2011.

Data analysis

Food production record data and plate waste data were linked using descriptions of the food items served for the specific date and lunch service period. When discrepancies in items served were found between the two data sources, the stock descriptions from the plate waste data were used. For the purposes of the study, the analysis focused only on fruit and vegetable waste as the outcomes of interest.

For each school, production and plate waste values were pooled across the five day observation period. The number of entrées served was used as a proxy for the number of meals served. Descriptive statistics of production waste (percent of food items prepared but never served) were analyzed by food type (fruit or vegetable). Two values were calculated using the plate waste data: 1) whether or not the student took the item(s) and, 2) among students who took the item(s), the amount of food that was eaten, dichotomized as to whether the student ate any of the item(s) or threw the item(s) away without eating a single bite. Missing data, as a result of students removing identification numbers from their lunch trays or disposing of their lunch waste outside of the cafeteria, were included in the denominator when calculating percentages. Fruit and vegetable plate waste were also analyzed by race/ethnicity and sex. In addition to descriptive statistics, four simple logistic regression analyses, adjusted for school-level clustering, were performed to examine differences in consumption among sexes and race/ethnicities. The logistic regressions tested (separately) for differences between males/females and races (Latinos, African-Americans, or other) on: a) whether students selected the fruit/vegetable item, and b) whether the student ate any of the fruit/vegetable item. All analyses were performed using Stata version 12.1 (StataCorp LP, College Station, Texas).

Results

Analysis of the production data suggested that three out of the four schools prepared a lower number of vegetable items, when compared to the number of entrées and fruit items (Table 2). For example, at School A, on a day when 334 entrées (of four varieties) and 266 fruit items (of one variety) were prepared, only 42 vegetable items (of two varieties) were prepared. Analysis of the food production records

showed that 10.2% of fruit and 28.7% of vegetable items served were left over after service. Across all schools, vegetables were left over at a greater rate (range 22.0% to 34.6%) than fruits (range 5.0% to 16.4%) (Table 3). Among vegetable items, salads were prepared at the lowest quantities and left over at the highest quantities – e.g., at School B on a day when 181 meals were served, only 5 salads (of one variety) were prepared and all 5 were left over. The most frequently wasted fruit items were whole fruit (e.g., whole orange or apple), while fruit juices and fruit cups were left over at lower rates.

Plate waste data were collected for 2228 students – 35.5% of the total meals served over five days at each of the four middle schools during the study period. Plate waste data analysis suggests that many students did not select fruit (31.5%) or vegetable (39.6%) items. Of those who did, many did not eat any, with more students wasting vegetables (31.4%) than fruits (22.6%) (Table 3).

Rates of students selecting and eating fruits and vegetables differed across schools. School B had the highest rate of students selecting these items, but also high rates of wasting them (Table 3). Results of the logistic regression suggest that rates of selecting and eating items differed by sex. A greater percentage of female students selected fruit (51.0%) and vegetables (42.1%), than male students (41.7% and 32.2%,

Table 2

Number of entrées, fruit items and vegetable items prepared in four middle schools in the Los Angeles Unified School District, 2011.<sup>a</sup>

School	Number of entrées prepared <sup>b</sup>	Number of fruit items prepared	Number of vegetable items prepared
A	1700	1136	899
B	1229	974	863
C	2183	1231	1556
D	1868	1105	425

<sup>a</sup> For each school, data were extracted from production records for all lunch periods over five consecutive days in fall, 2011.

<sup>b</sup> Any entrée with more than 50% vegetables by weight (according to the school food service director) was counted as a vegetable item.

**Table 3**  
Food production and plate waste for fruit and vegetable items in four middle schools in the Los Angeles Unified School District, 2011.<sup>a</sup>

School	Food type	Production waste (% of items left over)	Students selecting item (Number, %) <sup>b</sup>		Plate waste (Number, %) <sup>c</sup>	
			Selected	Did not take	Ate any	Wasted all
A	Fruit	7.0	231 (53.9)	156 (36.3)	188 (81.4)	43 (18.6)
	Vegetable	22.0	130 (30.2)	257 (59.8)	107 (82.3)	23 (17.7)
B	Fruit	13.6	321 (54.4)	195 (33.1)	239 (74.5)	82 (25.6)
	Vegetable	29.2	217 (46.0)	191 (40.5)	130 (59.9)	87 (40.1)
C	Fruit	5.0	309 (36.8)	215 (25.6)	243 (78.6)	66 (21.4)
	Vegetable	34.6	288 (34.3)	236 (28.1)	172 (59.7)	116 (40.3)
D	Fruit	16.4	153 (41.6)	135 (36.7)	115 (75.2)	38 (24.8)
	Vegetable	25.2	137 (37.2)	151 (41.0)	121 (88.3)	16 (11.7)
Summary	Fruit	10.2	1014 (45.5)	701 (31.5)	785 (77.4)	229 (22.6)
	Vegetable	28.7	772 (36.6)	835 (39.6)	530 (68.7)	242 (31.4)

<sup>a</sup> For each school, food and production waste included all lunch periods over five consecutive days in fall, 2011.

<sup>b</sup> Percentages do not add to 100% because of missing data as a result of students removing identification numbers from their lunch trays and disposing of their lunch waste outside of the cafeteria. n = 1715 for fruit waste observations and 1607 for vegetable waste observations; vegetables were not served in one school on one day.

<sup>c</sup> Of those students who selected the item.

respectively) – odds ratio for selecting fruit (male as the referent group): 1.45 (95% CI 1.05, 2.00), odds ratio for selecting vegetable (male as the referent group): 1.52 (95% CI 1.32, 1.76). Among students who selected fruit, a greater percentage of female students ate any fruit, compared to male students (odds ratio for eating any fruit (male as the referent group): 1.41 (95% CI 1.02, 1.95)) (Table 4). Overall, rates of selecting and eating fruit and vegetable items did not differ greatly across race/ethnicities. No visible patterns were seen in aggregate production or plate waste data between schools with a greater percentage of Latino students (Table 3) and none of the logistic regression odds ratios showed statistical significance (Table 5).

## Discussion

Our findings suggest that a significant proportion of students did not consume the fruits and vegetables offered as a component of their school lunch either because they did not select any fruits and vegetables or because they did not eat even a bite of them before throwing the lunch away. Production records showed that many vegetable and fruit items were prepared at lower rates. In order to avoid waste, cafeteria managers may be preparing fewer vegetable items because such items have not been previously selected by students.

**Table 4**  
Plate waste for fruit and vegetable items served in four middle schools in the Los Angeles Unified School District by sex, 2011.<sup>a</sup>

Sex	Students selecting item (Number, %) <sup>b</sup>		Plate waste (Number, %) <sup>c</sup>	
	Selected	Did not take	Ate any	Wasted all
<i>Fruit</i> <sup>d</sup>				
Male	476 (41.7)	379 (33.2)	359 (75.4)	117 (24.6)
Female	464 (51.0)	255 (28.0)	377 (81.3)	87 (18.8)
<i>Vegetable</i> <sup>e</sup>				
Male	350 (32.2)	458 (42.1)	236 (67.4)	114 (32.6)
Female	363 (42.1)	312 (36.2)	260 (71.6)	103 (28.4)

<sup>a</sup> For each school, food and production waste included all lunch periods over five consecutive days in fall, 2011.

<sup>b</sup> Percentages may not add to 100% because of missing data.

<sup>c</sup> Of those students who selected the item.

<sup>d</sup> Based on logistic regression analyses (adjusted for clustering): odds ratio (selected fruit, referent group = male) was 1.45 (95% CI 1.05, 2.00); odds ratio (ate any fruit, referent group = male) was 1.41 (95% CI 1.02, 1.95).

<sup>e</sup> Based on logistic regression analyses (adjusted for clustering): odds ratio (selected vegetable, referent group = male) was 1.52 (95% CI 1.32, 1.76); odds ratio (ate any vegetable, referent group = male) was 1.22 (95% CI 0.63, 2.36).

These results are similar to those reported in other studies which have found that students are likely to waste fruits and vegetables (Cohen et al., 2013; Marlette et al., 2005), inadequately consume key recommended nutrients (Cohen et al., 2013; Cashman et al., 2010; Marlette et al., 2005; Templeton et al., 2005), and tend to opt for food items that are more highly processed, more calorie dense, or higher in saturated fat (Martin et al., 2010). In contrast to previous studies (Marlette et al., 2005; Reger et al., 1996), our results suggest that female students tended to waste less than males. Our study builds on previous work by suggesting that many students did not select fruit and vegetable items to begin with, and that food production staff may be responding to this perceived low demand.

Fruits and vegetables provide key nutrients, but increasing student consumption of fruits and vegetables is a fundamentally challenging task. Waste, per se, need not be a bad thing; some waste may be a necessary part of learning to acquire a taste for new plant foods (Edwards et al., 2010; Knaapila et al., 2011). However, in order to increase fruit and vegetable consumption, it is important that students actually select and try the fruit and vegetable choices. Results of our study suggest that

**Table 5**  
Plate waste for fruit and vegetable items served in four middle schools in the Los Angeles Unified School District by race/ethnicity, 2011.<sup>a</sup>

Race/ethnicity	Students selecting item (Number, %) <sup>b</sup>		Plate waste (Number, %) <sup>c</sup>	
	Selected	Did not take	Ate any	Wasted all
<i>Fruit</i> <sup>d</sup>				
Latino	515 (47.4)	338 (31.1)	392 (76.1)	123 (23.9)
African-American	273 (47.8)	177 (31.0)	226 (82.8)	47 (17.2)
Other race	145 (38.8)	111 (29.7)	113 (77.9)	32 (22.1)
<i>Vegetable</i> <sup>e</sup>				
Latino	373 (35.5)	448 (42.6)	257 (68.9)	116 (31.1)
African-American	197 (38.6)	199 (38.9)	134 (68.0)	63 (32.0)
Other race	136 (36.8)	116 (31.4)	100 (73.5)	36 (26.5)

<sup>a</sup> For each school, food and production waste included all lunch periods over five consecutive days in fall, 2011.

<sup>b</sup> Percentages may not add to 100% because of missing data.

<sup>c</sup> Of those students who selected the item.

<sup>d</sup> Based on logistic regression analysis (adjusted for clustering): odds ratio (selected fruit) was African-American vs. Latino 1.01 (95% CI 0.91, 1.13), Other race vs. Latino 0.86 (95% CI 0.60, 1.22); odds ratio (ate any fruit) was African-American vs. Latino 1.51 (95% CI 0.68, 3.37), Other race vs. Latino 1.11 (95% CI 0.60, 2.04).

<sup>e</sup> Based on logistic regression analysis (adjusted for clustering): odds ratio (selected vegetable) was African-American vs. Latino 1.19 (95% CI 0.81, 1.75), Other race vs. Hispanic 1.41 (95% CI 0.82, 2.41); odds ratio (ate any vegetable) was African-

many students did not select or try the plant foods being offered and that additional food environment changes may be needed to motivate students to select and consume fruits and vegetables in the school cafeteria setting.

Implementing changes to the school menu, as has been done by the LAUSD, is an important first step to increasing access to healthy foods. However, in order to increase student receptivity and consumption of healthy options, school-based healthy food procurement practices should be implemented with a thorough understanding of how to prime the target population to accept environmental changes (IOM, 2010). Engaging students in designing new menu options and implementing complementary interventions can help increase student demand for and consumption of more fruit and vegetable options. Potentially promising interventions include offering a greater variety of fruits and vegetables (Adams et al., 2005), increasing physical activity (e.g., recess, physical education) before lunch to increase hunger for water-rich foods (Getlinger et al., 1996; Murray et al., 2013), involving students in growing fruits and vegetables as part of school gardens (Davis et al., 2011; Gatto et al., 2012; Heim et al., 2009), infusing nutrition education materials into the school's standard curriculum (Guthrie and Buzby, 2002), implementing more health marketing campaigns that promote the appeal of new food items (Baranowski et al., 2000; Blanchette and Brug, 2005), and redesigning the placement of products to encourage consumption — for example, providing a variety of vegetables at a salad bar (Adams et al., 2005; Slusser et al., 2007) or providing healthy food at eye level (Berkeley Media Studies Group, 2006).

While similar types of food items were offered and served across the four middle schools in our study sample, rates of production and student plate waste appeared to differ between schools. More research and evaluation is clearly needed to better understand these differences and the collective impacts of school food services on students' consumption/non-consumption of fruits and vegetables so that school meal programs can help students increase consumption of healthy foods.

### Limitations

While this is one of the first studies to use food production records in conjunction with student plate waste data to get a more comprehensive picture of student receptivity to school-based healthy food procurement practices that meet the new 2012 USDA school meal standards, it is subject to limitations. First, because this study used a cross-sectional observational design, it did not assess waste patterns before school menu changes were implemented. Therefore, it is not possible to ascertain whether the plate waste patterns reported here represent an increase or decrease in overall waste from SY 2010–11 to SY 2011–12.

Second, while it would have been ideal to observe the entire population of students who obtained school lunch meals, due to resource constraints, only students who ate lunch in the cafeteria after obtaining their food were observed in the study. No information on consumption patterns is available for students who left the cafeteria after obtaining their food. Comparison between observed and unobserved students was, therefore, not possible. Plate waste data were also not collected for roughly a fifth of the students in the sample due to students removing identification numbers from their lunch trays or disposing of their lunch waste outside of the cafeteria.

Third, even though a standardized form was used for data collection, some mistakes in collecting plate waste data may have been present. For example, if whole fruit was served without a wrapper and was taken off the tray by the student, then no evidence would be left behind to indicate that fruit had ever been served, creating undercounting of the number of students selecting whole fruit. Field observations during data collection, however, suggest that only a relatively small number of students selected whole fruit and, among those who did, only a few were seen removing the whole fruit from the tray and leaving no remainder. Most students who selected a whole apple, for instance,

left the core on the tray after consuming some of it. Because the field observations were not recorded in detail on the visual monitoring form and primarily serve to provide qualitative context, the extent of this potential limitation is not quantifiable.

Fourth, based on discrepancies between food production records and the on-site recording of foods served, recording errors either on the part of the food services staff or the plate waste data collectors may have occurred. These discrepancies (6% of the items served), however, appeared to be minimal. Finally, because our plate waste assessment was limited to middle school students in LAUSD, our findings may not generalize to other student populations within the District or elsewhere in the U.S.

Taken together, the study findings and limitations support the need to further assess the collective impacts of these and other school-based healthy food procurement practices on health, including collecting more information on downstream outcomes such as body mass index.

### Conclusions

Given that children consume a substantial amount of their daily nutrients in school, school-based interventions to increase access to healthier food options are an important component of a comprehensive strategy for improving childhood nutrition. In order to ensure the effectiveness of such practices, students need to have opportunities to become receptive to menu changes and consume the healthy food being offered and served. While institutional policies to increase access to a wider range of healthy food choices are a critical first step toward achieving this, simply offering these options may not be sufficient. More research and evaluation of complementary interventions to increase consumption of healthier foods are needed to help guide these and other institutional policy and practice decisions.

### Conflict of interest statement

The authors declare that there are no conflicts of interest.

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