

## **Fruit and Vegetable Plate Waste Among Students in a Suburban School District Participating in the National School Lunch Program**

**Kellyn M. Handforth, MPH; Mary Beth Gilboy, PhD, MPH, RD, LDN;  
Jeffrey Harris, DrPH, MPH, RD, LDN; Nicole Melia, RD, LDN**

### **ABSTRACT**

#### **Purpose/Objectives**

The purpose of this project was to assess fruit and vegetable plate waste, examine patterns of selection and consumption of specific fruit and vegetable subgroups, and analyze for differences across gender, grade level, and school.

#### **Methods**

A previously-validated digital photography method was used to collect plate waste data from 693 trays at two elementary schools, one middle school, and one high school in a suburban school district. Post-consumption photographs were compared to photographs of pre-portioned standard servings. Fruit and vegetable consumption was estimated to the nearest 10%. Differences in consumption across grade level, gender, and school were ascertained using the Kruskal-Wallis Test with post hoc Mann-Whitney U Tests.

#### **Results**

The rate of consumption differed across grade levels. Elementary and middle school students consumed significantly less of the selected whole fruits compared to high school students ( $p=0.014$ ). High school students consumed significantly more of the selected cut up fresh fruit compared to elementary school students ( $p=0.001$ ). This study shows that some categories were readily selected and consumed, and a few were highly wasted. Cut fresh fruits, canned fruits, and fruit juices were highly selected and consumed. Potato products were moderately selected and highly consumed. Whole fruits and raw vegetables were highly selected, but often wasted. Cooked vegetables and dried fruits had low rates of both selection and consumption.

#### **Applications for Child Nutrition Professionals**

Whole fruits should be replaced with cut fresh fruits at elementary and middle schools. Greater variety of fruits and vegetables should be introduced to improve selection and consumption. School nutrition professionals should reduce or remove highly processed potato products because they may compete with selection and consumption of healthier vegetable options. Further research is needed to identify student preferences for healthy vegetables. Taste-testing, school gardens, and other educational initiatives may increase consumption, and reduce overall waste.

**Keywords:** Plate waste; Healthy Hunger Free Kids Act of 2010; fruits; vegetables; foodservice; nutrition

## INTRODUCTION

The National School Lunch Program (NSLP) is one of the largest federally assisted meal programs in the United States, operating in over 100,000 schools, and serving an estimated 31 million students each day (United States Department of Agriculture [USDA] Food and Nutrition Service [FNS], 2013). Participating students consume up to 47% of their daily calories at school, which demonstrates the NSLP greatly contributes to overall diet and food acceptance (Briefel, Wilson, & Gleason, 2009). Prior to 2012, the NSLP followed the 1995 Dietary Guidelines for Americans, and lunch could consist of any three to five food groups, including 2 oz. meat or meat alternative, 1 serving grain, 8 oz. dairy, and one serving fruit (½ cup), and one serving of vegetable (¾ cup) (Child Nutrition and WIC Reauthorization Act, 2004). In 2012, new federal standards were implemented as a part of the Healthy, Hunger-Free Kids Act of 2010 (HHFKA). These standards aligned the NSLP with the 2005 Dietary Guidelines for Americans (Healthy, Hunger-Free Kids Act, 2010). Under the HHFKA, the NSLP established weekly offerings of dark green and orange vegetables and legumes, portion sizes of a half-cup or greater for fruits and vegetables, and a requirement that students must take at least one fruit or vegetable as a component of a NSLP meal (USDA-FNS, 2012). The requirements for dark green and orange vegetables are particularly important because, in years prior, children were frequently consuming processed potato and tomato products that were high in calories, fat, and sodium (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009). Consuming these products on a regular basis increases the risk for obesity and chronic disease (Kimmons et al., 2009).

The updated NSLP guidelines were met with support, but also criticism. Initially, there was concern that the fruit and vegetable requirements would increase plate waste among students (Byker, Farris, Marcenelle, Davis, & Serrano, 2014). Recent studies have shown the guidelines increase student selection of fruit and vegetables without significantly increasing waste (Cohen, Richardson, Parker, Catalano, & Rimm, 2014; Schwartz, Henderson, Read, Danna, & Ickovics, 2015). However, these studies assert that fruit and vegetable plate waste remains a major problem with up to 75% of vegetable selections and 40% of fruit selections being discarded by students.

There are significant financial and health costs associated with plate waste. A recent study showed that plate waste accounted for approximately 26% of the foodservice budget in Boston public schools (Cohen, Richardson, Austin, Economos, & Rimm, 2013). Earlier studies reported up to 37% of calories on students' plates are wasted at school mealtimes, with girls wasting more than boys, younger children wasting more than older children, and fruits and vegetables being the most highly wasted categories (Buzby & Guthrie, 2002). This level of fruit and vegetable waste among children is concerning because fruits and vegetables are part of a healthy diet that reduces the risk for obesity and chronic disease (USDA, 2015a; USDA, 2015b). Because fruit and vegetable plate waste negatively impacts foodservice costs and student health, it is important to examine the level of waste under the new NSLP guidelines.

This project assessed fruit and vegetable plate waste in a southeastern Pennsylvania school district, examined patterns of selection and consumption of specific fruit and vegetable subgroups, and analyzed for differences across gender, grade level, and school. In addition, this paper outlines research-based strategies for foodservice staff to reduce fruit and vegetable plate waste by increasing consumption among students.

## METHODS

### Study Site

Researchers gained approval to conduct a district-wide plate waste study from the University's Institutional Review Board, and the school district's foodservice department. The study was conducted at two elementary schools, one middle school, and one high school within a southeastern Pennsylvania school district. The observed district had a foodservice garden that provided produce to six schools in the district, and eleven satellite schools outside the district. In the observed district, 85.6% of residents were White, 8.4% were Asian, 3.3% were Hispanic, and 2.8% were Black (Federal Education Budget Project [FEBP], 2012). The per capita income for the district was \$48,473, compared to \$27,824 for the state of Pennsylvania, and \$27,915 for the United States. Eleven percent of families qualified for free or reduced meals.

### Plate Waste Measurement

Plate waste data were collected on 15 non-consecutive school days in April through June, 2014. This included four days at Elementary One, four days at Elementary Two, three days at the middle school, and four days at the high school. A previously-validated digital photography method of plate waste measurement was used to collect data (Williamson et al., 2003; Swanson, 2008; Smith & Cunningham-Sabo, 2013).

Before lunch, researchers mounted a digital camera (Canon PowerShot A495) on a tripod angled downward at approximately 45°. A tray containing one pre-portioned serving of each fruit or vegetable offered that day was placed in the camera view and photographed. Researchers referred to this pre-portioned photograph later when assessing post-consumption photographs. Masking tape was placed on the table outlining the tray to ensure consistent positioning of each tray within the camera frame.

During lunch, every tray that met the NSLP standards was selected for observation. If over 20 trays met the standards during a single lunch, every other tray was selected. Students with selected trays were asked for verbal assent to participate. Students who declined to participate were not encouraged or asked again for the duration of the study day. Students were not told what was being measured. Assenting students' trays were tagged with a number. Each number matched a number on a preprinted index card, kept by the researcher. Each numbered index card listed demographic categories (gender, grade level, school) and fruit and vegetable categories (canned fruit, whole fruit, cut fresh fruit, dried fruit, fruit juice, potato product, cooked vegetable, or raw vegetable). For each tray, the researcher circled the student's demographic information, and the relevant fruits and/or vegetables on the index card. No other identifying characteristics were recorded, and students were never present in the photographs.

After lunch, assenting students returned their tagged trays with all of the remaining contents to a designated area. The researcher collected the trays and brought them to the camera station. Trays were made photo-ready by removing all excess trash and food. Fruit and vegetable items were repositioned to ensure visibility of the amount consumed. Each tray, along with its numbered index card, was placed in the camera frame and photographed.

One researcher completed a separate training process to establish validity of the visual assessment method. First, fruit and vegetable samples representing 0% consumed were pre-

portioned, photographed, and weighed. Next, several samples representing lower-standardized portions were pre-portioned, photographed, and weighed. To establish validity, the researcher compared photographs of the lower-standardized items to the pre-portioned sample for each corresponding fruit or vegetable item. The researcher estimated percentage difference with 93% accuracy to the scale.

### **Data Analysis**

To determine the level of fruit and vegetable consumption, researchers compared post-consumption photographs to the pre-portioned reference photograph for the same menu cycle day and school. For each photograph, one researcher estimated percent consumption to the nearest 10% increment. To establish interrater reliability, two researchers compared their separate estimations of 130 of the 693 photographs. Estimation disparities of more than 20% constituted disagreement between researchers. Researchers agreed on 92% of the cases. Disagreed cases were discussed until a consensus was established. SPSS version 20 for Windows was used for data entry and analyses. Frequencies and percentages were calculated for sample demographics. Medians for the portion consumed of each fruit and vegetable were reported because the data were not normally distributed and did not exhibit homogeneity of variance. Kruskal-Wallis and Mann-Whitney U tests were used to determine whether the portion consumed differed by gender, grade level, or school. Differences were found to be statistically significant at  $p < 0.05$ . Statistically significant Kruskal-Wallis test findings were followed by post hoc Mann-Whitney U tests to determine pairs of groups that were different from one another.

## **RESULTS AND DISCUSSION**

### **Student Demographics**

A total of 693 trays were observed in the study, 187 at Elementary One, 214 at Elementary Two, 163 at the middle school, and 129 at the high school. Three hundred sixty two girls and 331 boys agreed to return their trays to the researcher.

### **Student Selection of Fruits and Vegetables**

All schools served a variety of fruits and vegetables daily. Table 1 illustrates the specific offerings presented at each school. At the elementary schools, students could choose from whole fruits, cut up fresh fruit, canned fruit, or 100% fruit juice. Elementary One also served dried fruit (raisins) on two days. Vegetable options at the elementary schools included raw vegetables with dip, salad, and corn. In addition to these, French fries and tater tots were served at Elementary Two. At the middle school, whole fruits, cut fresh fruits, and canned fruits were offered. Salad bar and baby carrot sticks comprised raw vegetable options. Both potato products and cooked vegetables were served at the middle school. At the high school, a self-serve bar offered a variety of fresh fruit and vegetable options daily. Potato products like French fries, curly fries, and tater tots were also offered at the high school.

**Table 1. Fruit and Vegetable Options on Observed Days at Each School**

	<b>Elementary 1</b>	<b>Elementary 2</b>	<b>Middle School</b>	<b>High School</b>
<b>Canned Fruit</b>	Peaches Pineapple Mixed fruit	Peaches Pineapple Mixed fruit	Peaches Pineapple	–
<b>Whole Fruit</b>	Apple Banana Orange	Apple Banana Orange	Apple Banana Orange	Apple Banana Orange
<b>Cut Up Fresh Fruit</b>	Apple slices	Apple slices	Apple slices Watermelon	Apple slices Pineapple Watermelon Grapes Melon Strawberries Blueberries
<b>Fruit Juice</b>	Apple Grape Orange	Apple Grape Orange	Apple Grape Orange	–
<b>Dried Fruit</b>	Raisins	–	–	–
<b>Potato Product</b>	–	French fries Tater tots	French fries Tater tots	French fries
<b>Cooked Vegetable</b>	Crispy baked kale Corn	Corn	Steamed mixed veggies Roasted parsnips	–
<b>Raw Vegetable</b>	Baby carrots Celery sticks Salad Cucumber slices Broccoli	Baby carrots Salad	Salad bar Broccoli Cucumber slices Baby carrots	Salad bar Baby carrots Broccoli Cucumber slices

Table 2 shows the number and percentage of elementary, middle and high school students who selected fruits or vegetables and those who selected both. Many students selected only fruits (58.2%) with equal percentages selecting only vegetables (20.9%) and both fruits and vegetables (20.9%). Table 3 shows the number and percentage of students who selected, did not select, or were not offered each fruit and vegetable subtype. Cut fresh fruit was the most highly selected category by 38.2% of students. Only four students selected dried fruit out of 187 observed at Elementary One.

**Table 2.**  
*Selection of Fruits and Vegetables by Elementary, Middle, and High School Students*

	Fruit		Vegetable		Both	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<b>Elementary 1 (N=187)</b>	140	74.9	29	15.5	18	9.6
<b>Elementary 2 (N=214)</b>	122	57.0	40	18.7	52	24.3
<b>Middle School (N=103)</b>	61	37.4	45	27.6	57	35.0
<b>High School (N=129)</b>	80	62.0	31	24.0	18	14.0
<b>Total (N=693)</b>	403	58.2	145	20.9	145	20.9

**Table 3. Student Selections of Each Fruit and Vegetable Category (N=693)**

	Selected		Did Not Select		Option Not Offered	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<b>Canned fruit</b>	158	22.8	406	58.6	129	18.6
<b>Whole Fruit</b>	101	14.6	592	85.4	0	0.0
<b>Cut Fresh Fruit</b>	265	38.2	428	61.8	0	0.0
<b>Dried Fruit</b>	4	0.6	187	27.0	502	72.4
<b>Fruit Juice</b>	150	21.6	414	59.7	129	18.6
<b>Potato Product</b>	114	16.5	392	56.6	187	27.0
<b>Cooked Vegetable</b>	47	6.8	517	74.6	129	18.6
<b>Raw Vegetable</b>	154	22.2	539	77.8	0	0.0

### **Fruit and Vegetable Consumption**

Consumption medians for fruit and vegetable categories by gender, grade level, and school are shown in Table 4. Medians are reported because percentage consumption was not normally distributed. Median portion consumed for all types of fruit was 90% (n=678) and 70% for all types of vegetables (n=315).

Kruskal-Wallis tests followed by post hoc Mann-Whitney U tests were used to determine significant differences between fruit and vegetable subtypes. Whole fruit (20.0%) was found to be much less readily consumed than canned fruit (100.0%), cut fresh fruit (100.0%), or fruit juice (90.0%, p=0.001). Cooked potato products had a significantly higher median portion consumed (90.0%) than other cooked vegetables (50.0%) or raw vegetables (60.0%, p = 0.001). Kruskal-Wallis followed by Mann-Whitney U tests were also used to determine significant differences in consumption by gender, grade level and school. These significant differences are depicted in Table 4. High school students consumed a significantly higher median portion (80.0%) of the selected whole fruit than Elementary One and Two (20.0%, 0.0%) and middle school students (20.0%, p = 0.014). Elementary One had a higher median for portion consumed of raw vegetables than Elementary Two (70.0%, 25.0%), but this difference was not found to be significant. A Mann-Whitney U test found no significant differences between genders.

**Table 4 Median Portions Consumed<sup>a</sup> of Fruit and Vegetable Selections<sup>b</sup> by School, Grade Level, and Gender**

	<b>Canned Fruit (%)</b>	<b>Whole Fruit (%)</b>	<b>Cut Fresh Fruit (%)</b>	<b>Fruit Juice (%)</b>	<b>Potato Product (%)</b>	<b>Cooked Vegetable (%)</b>	<b>Raw Vegetable (%)</b>
<b>All</b>	100.0	20.0	100.0	90.0	90.0	50.0	60.0
<b>School</b>							
Elementary 1 <sup>c</sup>	90.0	20.0	90.0	80.0	-	30.0	70.0
Elementary 2	100.0	0.0	90.0	100.0	90.0	50.0	25.0
Middle School	100.0	20.0	100.0	100.0	90.0	50.0	60.0
High School <sup>c</sup>	-	80.0	100.0	-	90.0	-	80.0
<b>Grade Level</b>							
1-5	100.0	10.0	90.0	90.0	90.0	40.0	60.0
6-8	100.0	20.0	100.0	100.0	90.0	50.0	60.0
9-12	-	80.0	100.0	-	90.0	-	80.0
<b>Gender</b>							
Male	100.0	20.0	100.0	90.0	90.0	50.0	70.0
Female	90.0	25.0	90.0	90.0	90.0	45.0	50.0

<sup>a</sup>Portions consumed were estimated to the nearest 10% increment during analysis of photographs.

<sup>b</sup> Dried fruit was not included in this table because of very low sample size.

<sup>c</sup> Elementary One did not serve potato products on any of the days observed; The high school did not serve canned fruit, fruit juice, or cooked vegetables on any of the days observed.

## Discussion

Results indicate that some fruit categories are readily consumed, and a few are frequently wasted. Canned and cut fruits are highly selected and consumed. Whole fruits are moderately selected, but often wasted. This demonstrates that whole fruits contribute greatly to fruit waste in the district observed.

Several factors could contribute to fruit selection and consumption. These include ease of consumption, messiness of the food, and dental or oral conditions. Canned and cut fresh fruits are easier to eat and less messy than whole fruits. Whole fruits may be difficult to eat for students who have braces or small mouths, thus contributing to plate waste (Wansink, Just, Hanks, & Smith, 2013). A recent study showed that whole fruits were among the most frequently wasted items by middle school students (Gase, McCarthy, Robles, & Kuo, 2014). The present study found similar patterns of waste among elementary and middle school students.

Vegetable consumption differed greatly across subtypes. Cooked potato products, like French fries and tater tots, had a much higher median portion consumed (90.0%) than other cooked vegetables (50.0%) and raw vegetables (60.0%). Potato products were not served at Elementary One on the observed days, but were served at Elementary Two on three of the four days. The median portion consumed of raw vegetables was 45% higher at Elementary One than Elementary Two (70.0%, 25.0%). This disparity suggests that potato products could be competing with other vegetable options.

Cooked vegetables had low rates of selection and consumption, and offerings were limited on the observed days. Corn was the only cooked vegetable offered at Elementary Two on the days observed. Elementary One and the middle school offered greater variety, including corn and crispy baked kale at Elementary One, and corn, steamed mixed vegetables, and roasted parsnips at the middle school. Similarly, Elementary One and the middle school had a higher median portion consumed for cooked vegetables (50.0%, 50.0%) than Elementary Two (30.0%), indicating that increased variety could lead to increased consumption.

The present study was conducted in a suburban, upper-middle-class school district with 11% of students qualifying for free or reduced meals. Because the data were not normally distributed, medians from the present study were compared to means of past studies. The median portion consumed for all-types fruit (90.0%) and all-types vegetable (70.0%) were fairly consistent with other studies conducted post-implementation of the new NSLP standards. Many of these studies were conducted in low-income, urban school districts. One study conducted in an urban school district with 83% of students qualifying for free or reduced meal, found 74.3% of fruits and 63.6% of vegetables were consumed (Schwartz, et al., 2015). Another study conducted in a low-income district with 85% of students eligible for free or reduced meals found 55.2% of fruits and 41.1% of vegetables were consumed (Cohen et al., 2014). A third study conducted in an average-income district with 48.9% of students qualifying for free or reduced meals found 33% of fruits and 51.4% of vegetables were wasted (Byker et al., 2014). This relates to patterns of consumption seen in the present study because one would intuit that 67% of fruits and 48.6% of vegetables were therefore consumed. This shows that fruit and vegetable consumption may be similar across different socioeconomic backgrounds. The present study bridges this research gap because a plate waste study had not yet been conducted in an upper-middle class district post-implementation of the HHFKA.

### **Limitations**

There are a few limitations of the present study. Because the study was conducted in an upper-middle-class district with potentially lower rate of participation in the NSLP (11% free or reduced), the results may not be generalizable to the whole population. Second, although the sample size was moderate, several dependent variables (fruits and vegetables) were established, creating a small sample size in the categories. These became even smaller when assessed against the independent variables (gender, grade level, school). This created a high degree of variance and therefore less precise estimates of the parameters. Finally, although students were not told that fruit and vegetable consumption was being measured, knowledge of being observed could have changed consumption of some students.

## **CONCLUSIONS AND APPLICATION**

This study showed that students participating in the NSLP selected fruits more often than vegetables. Additionally, students consumed a higher percentage of the canned (100.0%) and cut fresh fruits (100.0%) than whole fruits (20.0%). Of fruits, cut fresh fruits were selected most often (38.2%). Potato products (90.0%) were more readily consumed than both cooked vegetables (50.0%) and raw vegetables (60.0%), but raw vegetables were selected more often (22.2%). Dried fruit was hardly selected (0.6%) or consumed (0.1%), and fruit juice had moderate to high rates of both selection (21.6%) and consumption (90.0%) in the observed sample.

## **Recommendations**

The present study examined specific fruit and vegetable subtypes, which could help foodservice professionals determine where plate waste could be occurring. From this study, several interventions can be applied to reduce waste while increasing student consumption. First, school nutrition personnel should reduce or remove whole fruits at the elementary and middle school levels, replacing with cut up fresh fruits. A study of middle school students found that pre-slicing whole apples increased apple consumption by 17% (Wansink et al., 2013). Second, school nutrition personnel could offer a greater variety of fruit and vegetable options daily. Past research showed that greater variety increased consumption (Adams et al., 2005; Hakim & Meissen, 2013). The present study supports the findings of past research because the greatest variety of cooked vegetables were offered at Elementary One and the middle school, where consumption of this subtype was the highest (50.0%, 50.0%). At the elementary schools, sliced apples were the only option for cut fresh fruit, and consumption of this subtype was lower (90.0%, 90.0%) than at the middle (100.0%) and high schools (100.0%). A self-serve fruit and vegetable bar offered a wide variety of cut fresh fruits at the high school, where consumption was determined to be the highest by Kruskal-Wallis test (100.0%). Raw vegetable consumption was comparable at the high school and Elementary One, both of which offered many different types of raw vegetables (70.0% and 80.0%).

From the present study, it appears that potato products could be competing with selection and consumption of other raw and cooked vegetables. This is demonstrated by the disparity of raw vegetable consumption between Elementary One, where potato products were not offered, and Elementary Two, where they were offered most days (70.0%, 25.0%). Taking this into consideration, it may be beneficial for school nutrition professionals to reduce or remove highly-processed potato options in the interest of student health.

Not a lot is known about student preferences for raw or cooked vegetables. The present study did not examine student preferences for specific vegetable items. Following this study, another study should be conducted using the same methods to objectively determine student selection and consumption of raw and cooked vegetable menu items.

This study should observe specific vegetable types and preparations (i.e. roasted broccoli, steamed asparagus, cooked corn, raw vegetables with dip, salad with dressing). From this type of study, student selection and consumption of raw and cooked vegetables can be objectively examined. In addition to an objective follow up study, a survey tool could be used by foodservice professionals to subjectively assess student preferences for raw and cooked vegetable types, preparations, and serving sizes.

Experiential learning approaches have been shown to improve outcomes for healthy eating among students (Dudley, Cotton, & Peralta, 2015). Taste-testing, school gardens, and educational assemblies could be among these initiatives. The district observed offered taste-testing opportunities in which students were allowed to try new recipes before they were served in the cafeteria. Within the district, it had not been measured whether this initiative improved consumption. However, because the positive outcome of experiential learning is supported by prior research, it could be beneficial to implement in a district that does not currently offer taste-testing. The same is true for school foodservice gardens. A foodservice garden provided fresh produce to the observed district's lunch program, which promoted agricultural education and

interest among students. Students were encouraged to join in the Farm-to-Plate process by volunteering, touring the garden, or participating in the Adopt-A-Seedling program, a program in which elementary students planted a seedling in the garden and watched it grow over time. Past research shows that school gardens significantly increased students' consumption of fruits and vegetables (Taylor & Johnson, 2013; Davis, Ventura, Cook, Gyllenhammer, & Gatto, 2011; Heim, Stang, & Ireland, 2009). Finally, a school assembly could help inform students about the plate waste problem. At the assembly, empty trash bins could be lined up on stage to represent the weekly amount of fruit and vegetable waste. This could be done around Earth Day so that it relates to educational curriculum. These are just a few examples of experiential learning implementations that could increase consumption of fruits and vegetables among students (Dudley et al., 2015).

The present study shows that fruit and vegetable plate waste is a major problem with median values of 90.0% of fruits and 70.0% of vegetables being consumed. Fruit and vegetable plate waste increases costs for school nutrition departments and may compromise the health of children because they miss out on vital nutrients from the fruits and vegetables they do not consume. School nutrition departments should apply the aforementioned recommendations to increase consumption among students and reduce plate waste of fruits and vegetables. Further research is needed to determine student preferences for raw and cooked vegetable options.

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Handforth, Gilboy, and Harris are all associated with the West Chester University of Pennsylvania where Handforth is a Plate Waste Research Coordinator and Analyst, Gilboy is Coordinator of the Nutrition Track of the MPH Program, and Harris is Chair of the Nutrition Department. Melia is Supervisor of Foodservice at Great Valley School District in southeastern Pennsylvania.