

2018

Evaluation of a School-Based Fruit and Vegetable Intervention Using a Digital Photography Method

Natalie Ruth Weisfeld
University of Rhode Island, nweisfeld@my.uri.edu

Follow this and additional works at: <https://digitalcommons.uri.edu/theses>

Recommended Citation

Weisfeld, Natalie Ruth, "Evaluation of a School-Based Fruit and Vegetable Intervention Using a Digital Photography Method" (2018). *Open Access Master's Theses*. Paper 1260.
<https://digitalcommons.uri.edu/theses/1260>

This Thesis is brought to you for free and open access by DigitalCommons@URI. It has been accepted for inclusion in Open Access Master's Theses by an authorized administrator of DigitalCommons@URI. For more information, please contact digitalcommons@etal.uri.edu.

EVALUATION OF A SCHOOL-BASED FRUIT AND VEGETABLE
INTERVENTION USING A DIGITAL PHOTOGRAPHY METHOD

BY

NATALIE RUTH WEISFELD

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

IN

NUTRITION AND FOOD SCIENCES

UNIVERSITY OF RHODE ISLAND

2018

MASTER OF SCIENCE THESIS

OF

NATALIE RUTH WEISFELD

APPROVED:

Thesis Committee:

Major Professor Geoffrey W. Greene

Linda Sebelia

Catherine English

Adam Moore

Nasser H. Zawai
DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND
2018

ABSTRACT

Objective: The primary objective is to use digital photography of food to assess if a policy, systems, and environment (PSE) intervention increases the amount and variety of healthful fruits and vegetables consumed at lunch by low-income 5th graders.

Design: Quasi-experimental design.

Participants/Setting: The sample consisted of low-income 5th grade students in the Providence School District, n = 130 (treatment school, n=75, control school, n=55).

Intervention: Both the treatment and control students were assessed at baseline and post intervention to determine amount consumed and variety of fruit and vegetable using a digital photography of food method. Within the treatment school, four out of the six classrooms agreed to participate in the 8-lesson *Student's Take Charge* in-class intervention.

Main Outcome Measures: Consumption of healthful fruits and vegetables (excluded French fries, tomato sauce, and fruit juice) in cups and variety from digital photographs.

Analyses: Consumption differences were assessed using the Mann-Whitney U for between group changes and Wilcoxon signed-rank test for within groups. Pearson chi-square compared variety.

Results: There was a difference between groups for change in consumption of fruit ($p < 0.01$); within group analyses showed the treatment group decreased ($M = 0.12$ cups, $SD = 0.46$, $p = 0.02$) while the control group had a non-significant increase ($M = 0.12$ cups, $SD = 0.49$, $p = 0.20$). There were no differences between or within groups for vegetable consumption ($p > .05$). Within treatment group variety of fruits decreased (Baseline: 59.3% with 1 or 2 fruits; Follow-up: 30.9%), and within the control group, variety of fruits increased (Baseline: 11.7% with 1 or 2; Follow-up: 33.3%). Variety of vegetables decreased in the treatment group (Baseline: 49.4% with 1 or 2; Follow-up: 8.6%), and variety of vegetables was minimal at both time points within the control group (Baseline: 6.7%; Follow-up: 8.3%). Although at baseline treatment children were more likely to have at least one fruit (59%) or vegetable (49%) than children in the control school (fruit 12%, vegetables 7%; $p < .001$), at follow-up most students in both groups had no fruit (67-

69%) or no vegetables (91-92%) on their trays ($p>.05$).

Conclusions and Implications: The intervention was not successful in increasing consumption or variety of fruits and vegetables. The observed decrease in fruit consumption in the experimental group may be associated with different fruit options on observation days. Future research should explore changes in the eating environment to increase availability of preferred healthful fruit and vegetable options.

ACKNOWLEDGMENTS

First and foremost, I would like to express my sincere gratitude to my committee members, Dr Geoffrey Greene, Linda Sebelia, Dr. Cathy English, and Dr. Adam Moore, for continuous support and advice throughout this process. Dr. Greene, thank you for the countless hours that you spent meeting with me, reading drafts, running data, and guiding me. I cannot express how thankful and appreciative I am for your patience and willingness to help. Linda, thank you for providing me with endless opportunities that I never imagined were possible. You have been a mentor to me for the last six years, and I am honored to have been able to work with you. To Cathy, you too have been there for the last six years and have helped me transition into the young professional I am today, thank you. Thank you to the staff at SNAP-Education for opening your doors and welcoming me as one of your own. It has been a privilege to work with all of you and complete my thesis in the area that I love the most, community nutrition. Thank you Joanna for allowing me the opportunity to evaluate *Student's Take Charge*, and to Kate for your continuous feedback and encouragement throughout the Master's program.

I cannot forget my family, as they have helped me become who I am today. Thank you to my Mom and Dad for allowing me to receive the education that I did, and for inspiring me to be the best version I can be of myself everyday. I would not be where I am today if it was not for your guidance throughout these 25 years of life. Thank you for connecting me with the core Jewish values of chesed (kindness), tzedakah (charity), and tikkun olam (to repair the world). Thank you to my sister for being my friend and shoulder to lean on, I could not have done this without your support, and to my brother for being you. To my aunts, uncles, cousins, and friends in Texas, I love y'all. Thank you for understanding my absence these last two years, and for being my cheerleaders throughout it all.

And to my alma mater, thank you for allowing me the chance to find my passions in life. Rhody, Rhody, Rhody! Rams, Rams Rams!

PREFACE

This thesis was prepared in manuscript format following the author guidelines for *The Journal of Nutrition Education and Behavior*. After submitting this thesis, the manuscript may be submitted for publication.

TABLE OF CONTENTS

| | |
|--|------------|
| ABSTRACT..... | ii |
| ACKNOWLEDGMENTS..... | iv |
| PREFACE..... | v |
| TABLE OF CONTENTS..... | vi |
| LIST OF TABLES AND FIGURE..... | vii |
| MANUSCRIPT..... | 1 |
| INTRODUCTION..... | 2 |
| METHODS..... | 3 |
| RESULTS..... | 10 |
| DISCUSSION..... | 13 |
| IMPLICATIONS FOR RESEARCH AND PRACTICE..... | 17 |
| TABLES/FIGURE..... | 19 |
| REFERENCES..... | 30 |
| APPENDICES..... | 34 |
| A. LITERATURE REVIEW..... | 34 |
| B. TREATMENT SCHOOL CAFETERIA LAYOUT..... | 54 |
| C. CONTROL SCHOOL CAFETERIA LAYOUT..... | 55 |

LIST OF TABLES AND FIGURE

| TABLE | PAGE |
|---|------|
| Table 1: Students Take Charge Lessons and Groups Exposed..... | 19 |
| Table 2: Steps for Data Analysis of Consumption..... | 20 |
| Table 3: Demographics of Low-income Fifth Grade Participants Two Providence Public School..... | 21 |
| Table 4: Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up..... | 22 |
| Table 5: Variety of Fruits and Vegetables At Baseline and Follow-up by Group..... | 23 |
| Table 6: Change in Variety of Fruits and Vegetables Within Groups from Baseline to Follow-up..... | 24 |
| Table 7: Experimental Hypothesis Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up..... | 25 |
| Table 8: Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up Without Pre-plated Items..... | 26 |
| Table 9: Variety of Fruits and Vegetables at Baseline and Follow-up Without Pre-plated Items by Group..... | 27 |
| Table 10: Change in Variety of Fruits and Vegetables Within Groups from Baseline to Follow-up Without Pre-plated Items..... | 28 |
| Figure 1: Number of Children Who Consumed Fruits Offered by Both Schools at Both Times..... | 29 |

MANUSCRIPT

**“Evaluation of a School-based Fruit and Vegetable Intervention Using a Digital
Photography Method”**

By

Natalie R. Weisfeld¹

Geoffrey Greene PhD, RD, LDN²

Linda Sebelia MA, MS, RD, LDN³

Cathy English PhD, RD, LDN⁴

Adam Moore PhD⁵

Prepared for submission to the *Journal of Nutrition Education and Behavior*

¹ Department of Nutrition and Food Sciences, Fogarty Hall, University of Rhode Island, Kingston RI 02881 (nweisfeld@my.uri.edu)

² Department of Nutrition and Food Sciences, Fogarty Hall, University of Rhode Island, Kingston RI 02881 (gwg@uri.edu)

³ Department of Nutrition and Food Sciences, Fogarty Hall, University of Rhode Island, Kingston RI 02881 (sebelia@uri.edu)

⁴ Department of Nutrition and Food Sciences, Fogarty Hall, University of Rhode Island, Kingston RI 02881 (cathy@uri.edu)

⁵ School of Education, Chafee Hall, University of Rhode Island, Kingston RI 02881 (adam_moore@uri.edu)

INTRODUCTION

Children age 9-13 years old are not meeting the minimum recommendations for fruit and vegetable (FV) consumption based on the 2015-2020 Dietary Guidelines for Healthy Americans¹. Low FV intake and lack of variety have been associated with higher body weight in children²⁻⁵. It is important for children to consume healthful fruits and vegetables⁵. Healthful fruits and vegetables are those low in saturated fat, sodium, and high in fiber, and excludes items such as French fries, fruit juices, and tomato sauce^{5,6}. Thirty one percent of children age 10-17 in the United States were overweight or obese in 2011-2012⁷. The prevalence was slightly lower at 28.3% of all children in Rhode Island being overweight or obese and increased with 38.6% Hispanic children being overweight or obese^{3,7}. The Rhode Island Supplemental Nutrition Assistance Program Education (SNAP-Ed) has developed “Students Take Charge!” (STC), a policy, systems, and environment (PSE) program focusing on empowerment and a healthy lifestyle. STC is an in-class PSE curriculum for 5th grade students. Although process data from the pilot year of STC indicated that students had an increased FV consumption, outcome analyses failed to find any dietary changes in FV consumption^{8,9}.

The lack of effect of STC on intake may be related to the use of a two-item FV survey to measure consumption⁸. Measurement of intake is difficult in children and particularly challenging among 5th graders in low-socioeconomic populations^{10,11}. Digital photographic methods such as the Digital Photography of Food Method (DPFM) have been validated to objectively measure consumption, but until now have not been used to assess the effectiveness of PSE interventions in low-income schools¹²⁻¹⁴.

The primary aim of this study was to use DFPM to determine if the STC

intervention increased the amount of healthful fruits and vegetables consumed at lunch by low-income 5th graders in an intervention school more than a control school. The secondary aim of this study was to determine whether the STC intervention increases the variety of healthful fruits and variety of vegetables chosen at lunch in the intervention school more than control school.

METHODS

Design

The PSE intervention, “Students Take Charge!” (STC) utilized a 2x2 quasi-experimental design. STC is a research study that was piloted in the previous year and modified based on feedback reported by Lepe et al. in their process evaluation⁹. The current STC classroom-based program consisted of eight lessons taught by SNAP-Education educators. The objective was to empower low-income elementary students to increase FV consumption and to choose a variety of FVs. Table 1 provides a brief outline of the lessons and the activities by group. Both the intervention and control students were assessed pre and post school lunch meal at baseline and post intervention by DPFM to determine the amount of healthful fruit and vegetables consumed; variety of healthful fruits and vegetables was determined by the pre-meal DPFM at baseline and follow-up. DPFM allows for objective measurement of consumption and variety of FVs without relying on self-report. Within the treatment school, four out of the six classrooms agreed to participate in the in-class intervention. Two classrooms within the treatment school declined to participate in the education component, but were exposed to environmental changes such as the recipe day in the cafeteria and promotional posters. The treatment group with education received an 8-lesson curriculum, selected a recipe for a fruit or

vegetable item for school lunch, and participated in organizing an all-school taste testing during school lunch on recipe day. The two classrooms that did not participate in the education, participated in taste testing a recipe in the cafeteria and were assessed using DPFM at the two time points. The control school did not receive any intervention. Demographic information was collected from the students in the treatment group with education and the control school only. Demographic information was not collected for the treatment group without education.

Research Question/Hypothesis

All students were from the fifth grade, and all comparisons are baseline to follow-up:

- i. Primary: Students in the intervention group will increase the amount of healthful FVs consumed at lunch more than students in the control group.
- ii. Secondary: Students in the intervention group will increase the variety of healthful FVs selected at lunch more than students in the control group.
- iii. Exploratory: Within the intervention school, the four classes that participated in the STC intervention will increase the amount of healthful FVs consumed at lunch more than the two classes that did not receive the intervention.

Subjects

Providence, Rhode Island is a diverse city¹⁵. Approximately 179,219 people live in the city of Providence, with 23.4% of the population being under 18 years old¹⁵. As of April of 2010, 49.8% of the population was white, 16.0% black or African American, 1.4% American Indian and Alaska Native, 6.4% Asian, 0.1% Native Hawaiian and Other Pacific Islander, 6.5% are two or more races, 38.1% are Hispanic or Latino, and 37.6% were white alone not of Hispanic decent¹⁵. Approximately 29.1% of persons are living in

poverty, and the median household income is \$37,501 as of 2015¹⁵. Providence Public School District's (PPSD) 22 elementary schools adopted a no-fee meal policy as part of a Community Eligibility Provision's pilot program in 2016^{16,17}. All students attending PPSD elementary schools have the opportunity to select a school lunch at no cost¹⁷.

Primary and secondary aims included subjects from control and intervention schools, and the exploratory aim only included 5th graders from the intervention school. The intervention school had six, 5th grade classrooms, four of which agreed to have their students participate in the school-based intervention, n=75. DPFM data from the other two classrooms were collected, n=34. These students were exposed to the school-wide taste testing on recipe day and signage promoting FV but did not receive the in-class education, STC. The control school had three 5th grade classrooms that were assessed within two weeks of the intervention school data collection points, n=55. Each classroom had around 25 students however due to absences every student's tray was not photographed, resulting in an overall analytical sample of 164 students. Only students with four pictures, two at baseline pre and post meal, and two at follow-up pre and post meal were included for hypotheses 1 and 3, and only students with one baseline pre-meal photo and one follow-up pre-meal photo were included for hypothesis 2. For hypothesis one, n=75 from the treatment school with education and n=55 from the control school. For hypothesis two, n=81 from the treatment school with education and n=60 from the control school. For the exploratory hypothesis, n=75 from the treatment school with education and n=34 from the treatment school without education group.

Student Eating Environment

Students had access to FV via two avenues in the cafeteria: on the tray line and in

the garden carts. Providence Public School District (PPSD) schools provide students with a garden cart in all cafeterias. The garden cart is a salad bar that consists of an assortment of FVs available to the students without any restriction on quantity. Students were free to select how much and how many FV they would like from these carts. The garden cart placement is different from school to school.

The intervention school had an open-floor plan with a stand-alone garden cart, away from the cafeteria line. Within the treatment school, students enter the cafeteria and follow the tray line to receive their entrée, and a pre-plated fruit or vegetable, depending on the menu for that day, from the cafeteria staff. Once the students received their meal tray, they were able to walk to the garden cart where they served themselves fruits or vegetables. The control school had a closed-floor plan with the garden cart, attached to the end of the line in the cafeteria. Within the control school, students entered the tray line to receive their entrée and pre-plated FVs from the cafeteria staff, and then walked by the garden cart to self-serve FVs on their way out of the service area. Refer to Appendix C and D for placement of garden cart and cafeteria set up of the treatment school and control school.

Procedure

For the STC program, key stakeholders identified two schools in the PPSD. Once the two schools agreed, they were randomly selected as the treatment or control. Students in both schools completed demographic surveys at the same time as the intervention school and were assessed using digital photography during meals at pre and post intervention. This study was approved by the University of Rhode Island Institutional Review Board.

Data collection

The data collection procedures were the same for all three aims. Students were assigned a unique ID number. The students' numbers were then placed on an index card attached to a lanyard with a colored sticker that correlated to their classroom number. The ID sheets and lanyards were locked in a secure cabinet in Room 300 at URI College of Continuing Education (CCE) in Providence, RI.

The research photographers were Registered Dietitians, graduate students, and undergraduate students, all who attended training prior to data collection on DPFM procedures. The procedures were based on Masis et al., Foodwise Project, for data collection methodology¹⁸.

A fixed method was developed and included four cellular phone tripods. The tripods were 14 inches from the table, and a cellular phone was attached and placed at a 45-degree angle. All persons involved were trained on how to prepare the tripod and phone prior to data collection consisting of a written explanation as well as 1-2 verbal meetings prior to data collection, and an overview prior to data collection while at the school. Practice photographs were taken during training and feedback provided until assessors were proficient. The cellular phone cameras were all calibrated prior to data collection in order to insure consistency of the quality of photo and size.

For the intervention group and 2 non-participating classes, data collection occurred at baseline and after the 8th STC lesson, approximately 4 months after baseline. The control group data were collected within a 2-week period of intervention group data. At both baseline and follow-up, photos using the DPFM method were taken before eating ("pre-meal") and after eating ("post-meal").

On each day of data collection, SNAP-Ed researchers confirmed enrolled students in each classroom and assigned ID numbers to new students. Each student was given his or her unique lanyard prior to going to the cafeteria for lunch. The research photographers explained the data collection process to the students. The students were then read a script to explain the data collection process. The same protocol was conducted on subsequent days until all classrooms had data collected.

In the cafeteria in both schools, students are seated by classroom and each classroom was assigned two tables. There were two research photographers per table; each photographer photographed the student's tray across from him/her until the entire tables' photographs were collected. Researchers were given a diagram to help follow protocol as well as the layout of each cafeteria.

During data collection, lists of FVs available to the children were collected each day. The "garden cart" was photographed each day, and the foodservice staff provided a list of pre-plated FVs. In addition each item was referenced according to size (i.e. pieces, 1 whole, or converted to cups compared to a reference photo plated on a scale).

Intervention

STC was an 8-lesson PSE (policy, systems, and environment) intervention focused on fruit and vegetable intake with 5th grade students in the PPSD. The curriculum included 8 lessons (see Table 1). STC encouraged the consumption of healthful fruits and vegetables. The curriculum did not include French fries or juice as part of a healthful diet. This program allowed students to "have a say" in what they are being served in-school, and allowed them the opportunity to try fruits and vegetables in a different way.

Data Analysis

FVs served were identified. Items that were pre-plated followed standardized recipes with standardized portions, and items chosen from the “garden cart” were identified as whole pieces of fruit or vegetables, prepackaged portions in cups, or, for salad items, in relation to a weighed measure and converted to cups. For the purposes of this study, French fries, fruit juice, and tomato sauce were excluded⁶. The visual estimation for consumption is based on the protocol of the FoodWise Project (outlined in Table 2)¹⁸. Separate sums were calculated for fruits and vegetables; the sum of items per plate (pre-plated and garden cart) were calculated and defined as amount.

The dependent variable for the primary hypothesis was calculated by subtracting the amount of FVs recorded from pre-photo minus the amount in post-photo from both intervention and control schools. This difference was defined as the amount of fruits and amount of vegetables consumed by the student. Students missing pre meal or post meal photos at either time point were excluded.

The secondary hypothesis was analyzed using the variety of fruits selected and variety of vegetables selected for each subject from both the intervention and control schools. The investigator used the pre-meal photo to count the number of fruits (variety) and the number of vegetables (variety). Each different fruit or vegetable was identified as 1 in variety. The total number of different fruits added together is variety of F, and the total number of different vegetables added together is variety of V. The number of students n=141 is greater than the number of students for the primary hypothesis (n=130) due to missing post photos. Eleven children’s trays were missing from post-meal assessment due to children leaving prior to data collection.

Within the intervention school, the exploratory hypothesis looked at the amount

of fruit and amount of vegetables consumed by the four 5th grade classes with education compared to the classes that did not receive education. The same method to assess consumption for the primary hypothesis was used.

Statistics

Continuous data were assessed for normality; consumption data were not normally distributed (kurtosis > 2) thus non-parametric statistics were utilized for the primary and exploratory hypotheses. Mann-whitney U was used in order to analyze between group changes, and Wilcoxon signed-rank tests were conducted for within group change. In addition, Wilcoxon signed-rank tests were used to compare consumption between groups at baseline. For hypothesis two, variety, Pearson chi-square was used to analyze data. Demographic data at baseline were compared between groups using Pearson chi-square or student's t-tests.

RESULTS

There were no statistically significant differences between group by age, gender, or ethnicity ($p > 0.05$) (see Table 3). The treatment group ($n=75$) comprised of 47.9% female, 52.1% male, 70.5% Hispanic, and 29.5% non-Hispanic. The control group ($n=55$) comprised of 45.8% female, 54.2% male, 60.9% Hispanic, and 39.1% non-Hispanic. The total sample ($n=130$) had 47.0% female, 53.0% male, 66.4% Hispanic, and 33.6% non-Hispanic.

The primary hypothesis of this study was to see if the treatment group with education increased the amount of cups of fruits and amount of cups of vegetables consumed at lunch more than the control group from baseline to follow-up. Data analysis protocol for defining consumption can be seen in Table 2. At baseline, both groups had a

low intake of fruits and vegetables; the treatment group consumed an average of 0.26 cups of fruit and 0.03 cups (~1/2 tablespoon) of vegetables and the control school consumed an average of 0.11 cups of fruit and 0.04 cups of vegetables. As shown in Table 4, there was a significant difference between groups ($p < 0.01$) for fruit consumption with the control school increasing fruit consumption more than the treatment school. There was a significant decrease of 0.12 ± 0.46 cups within the treatment school ($p = 0.02$); the control school increased fruit consumption by 0.12 ± 0.49 cups but this was not statistically significant ($p = 0.2$). There were no significant differences between ($p = 0.13$) or within groups (treatment school; $p = 0.41$, control school; $p = 0.71$) from baseline to follow-up for vegetable consumption. The treatment school had a non-significant increase in vegetable consumption by 0.01 cups while the control school had a non-significant decrease in vegetable consumption by 0.01 cups from baseline to follow-up.

The secondary hypothesis of this study was to see if the treatment group increased the variety of fruits and vegetables at lunch more than the control school from baseline to follow-up. Variety is defined as the number of different items on the tray for fruits and number of different items for vegetables. At baseline, there was a statistically significant difference in fruit variety between the treatment and control school ($X^2 = 33.29$, $p < 0.001$); a smaller proportion of treatment students had no fruit on their trays (40.7%) than control students (88.3%) (see Table 5). At follow-up, there were no statistically significant differences for fruit variety ($X^2 = 0.22$, $p = 0.90$), 68.1% had no fruits on their trays. At baseline, there was a difference between schools in variety of vegetables ($X^2 = 30.73$, $p < 0.001$); 50.6% of treatment school participants had no vegetables on their tray

compared to 90.3% of control school students. At follow-up, there was no difference in vegetable variety, 91% of participants had no vegetables on their tray ($X^2=1.52$, $p=0.47$). The treatment group decreased variety of fruits from baseline to follow-up, but there was no change in the control group (Table 6). The control group increased variety of vegetables but there was no change in the treatment group. A substantial proportion of students 27 to 60% of students had no fruit on their trays at either time point and 48 to 88% of students had no vegetables on their trays at baseline and follow-up.

The exploratory group in the treatment school did not receive formal education, but were exposed to the recipe tasting and the posters around the school. Comparing students in the two classes that did not receive education to the four classes that did, there were no differences between groups for fruit ($p=0.32$) or for vegetables ($p=0.37$) as seen in Table 7. As reported above, the treatment group decreased fruit consumption with no change in vegetable consumption. There were no changes within the exploratory group, students consumed 0.27 cups of fruit at baseline, 0.30 cups of fruit at follow-up, and 0 cups of vegetables at both time points.

Due to the significant differences at baseline for both fruit and vegetable variety, further tests were conducted excluding pre-plated items from both the consumption and the variety variables. Tables 8 through 10 show the consumption and variety without pre-plated items, garden cart only. Within the treatment and control school, a majority of FV consumption was of the garden cart items. The treatment school consumed a total of 0.26 cups of fruit at baseline, 0.20 cups were garden cart items, and 0.06 cups were pre-plated item, and at follow-up, 0.14 cups of fruit were consumed, 0.09 from the garden cart, and 0.06 were pre-plated. Within the control school, all fruits at baseline and follow-up were

consumed from the garden cart. Vegetables were minimally consumed at both time points, and a majority were from the garden cart as seen in Table 8. The treatment school consumed a total of 0.03 cups of vegetables at baseline, 0.03 cups were garden cart items, and 0 cups were pre-plated item, and at follow-up, 0.04 cups of vegetables were consumed, 0.02 from the garden cart, and 0.02 were pre-plated. All vegetable consumption from the control school were garden cart items. Variety decreased in groups when pre-plated items were excluded (Table 9). At baseline, only 16.3% of the total sample had at least one fruit on their tray, and 19.9% at follow-up; only 5.7% of the total sample had at least one vegetable on their tray from the garden cart at baseline, and 6.4% at follow-up. At baseline, variety of fruits and vegetables without pre-plated items did not differ between schools (vegetable: $X^2=0.01$, $p=0.94$; fruit: $X^2 = 2.30$, $p=0.13$). At follow-up, variety of vegetables without pre-plated items and variety of fruits without pre-plated items also did not differ (vegetable: $X^2 = 0.86$, $p=0.35$; fruit: $X^2 = 3.83$, $p=0.05$). Excluding pre-plated items, there are no within group changes (Table 10).

The decrease of fruit consumption by the treatment school can be seen in Figure 1. At both schools the only fruits served both at baseline and follow-up were oranges, apples, and pears. The greatest differences were for oranges. At baseline in the treatment school 11 students consumed all or a portion of an orange but only 4 students consumed oranges at follow-up. In the control school, 1 student consumed all or a portion of an orange at baseline and 5 at follow-up.

In addition to oranges, pears and apples (see Figure 1), there were other FVs provided at different time points. The treatment school did not provide bananas at baseline or follow-up. Although the control school did not provide bananas at baseline

the school provided them at follow-up (n=13). The pre-plated items were also not consistent at baseline or follow-up within or between schools. This is illustrated by changes in pre-plated fruit items in the treatment school. Blueberries (n=6) and a frozen peach cup (n=6) were pre-plated at baseline accounting for a total of 4.4 cups of fruit consumed. At follow-up, pre-plated applesauce (n=8) and a strawberry cup (n=2) were provided and students consumed a total of 3.9 cups of these pre-plated fruits.

DISCUSSION

This study found that students consumed an average of 0.03 cups (~1/2 tablespoon) of vegetables during school lunch, and consumption appeared to be affected by options available during mealtime. Consumption was slightly better for fruit averaging 0.20 to 0.21 cups. To our knowledge, this is the first PSE intervention to be assessed using a DPFM method. Although the hypothesis that the PSE intervention would improve consumption was not supported, this study aids in understanding the school lunch environment and how it plays a role in eating behavior.

There was a significant change in fruit consumption between groups but no between-group change in vegetable consumption. However, the difference in fruit consumption ± 0.12 cups was small and, as described below, was likely due to changes in fruit offered at different time points. Mean consumption of fruit at baseline was higher at the treatment school than the control school, but this was reversed at follow-up. Perry et al. assessed change in FV consumption and found that children increased their daily FV consumption by 1/3 cups after receiving a nutrition intervention, but this study did not assess change related to school lunch^{2,19,20}. Studies in the school lunch environment continue to find FVs to be the most wasted items²¹. Within the literature and consistent

with this study, students have higher intake of fruits than vegetables^{1,20,22}. Hubbard and colleagues used DPFM to assess the impact of implementing Smarter Lunchroom strategies in a Massachusetts Residential school²³. Students increased fruit consumption by 0.18 cups and vegetables by 0.07 cups, demonstrating effectiveness of this intervention²³. Implementation of Smarter Lunchroom strategies should be considered for future development of STC. However, it is important to note that the STC student sample is Hispanic and lower income than the schools studied within the literature^{14,23-25}. Lower income populations are known for having a lower intake of FVs than their higher income counterpart^{1,7}.

Although this study looked at fruit and vegetable consumption separately, a majority of the literature combines FVs into one variable. For comparative purposes, we combined fruits and vegetables; students consumed 0.24 cups of FVs on average at baseline and 0.23 cups of FVs at follow-up. Martin et al. assessed FVs combined, and found that students selected an average of 1.10 cups of fruits and/or vegetables at lunch, and wasted 0.40 cups ($p < 0.005$) on average, consuming 0.70 cups at school lunch²⁶. Consumption of FV in STC was lower than found by Martin et al. Amin and colleagues assessed the NSLP environment in two Northeastern elementary schools in a sample of third, fourth, and fifth graders, 84-90% white, and 40-60% of children qualified for free or reduced lunch. The researchers evaluated 944 trays using DPFM before and after implementing the 2012 NSLP guidelines. They found that consumption of FVs averaged from 0.48 cups to 0.54 cups before implementation, and 0.42 cups to 0.47 cups after implementation²⁵. Amin and colleagues included fruit juice and mixed dishes in the total consumption of FVs, which may explain the large consumption of FVs compared to this

study. Consumption of FVs varies in children regardless of intervention, but the current study found lower consumption than generally reported in the literature.

The decrease in fruit consumption may be partially explained by different items provided at the different time points. The types of fruits served at baseline and follow-up were not consistent. Children selected and consumed canned fruit in juice in the treatment school at baseline, however canned fruit in juice was not an option at that school at follow-up, which accounted for some of the decrease. The pre-plated item at follow-up for the treatment school was applesauce or strawberries, and students consumed 0.5 cups less of these pre-plated items than the canned fruit in juice offered at baseline. At the control school, bananas were not provided at baseline but were provided at follow-up. Children appeared to choose and consume bananas frequently. A study within a Farm to School participating Wisconsin school found that canned fruits in juice were wasted less than whole fruits, while cooked vegetables were wasted more than raw²⁷.

Although there were no statistically significant differences in variety from baseline to follow-up between groups, it is important to note that 61% of the total sample did not have a fruit on their tray at baseline, 69% did not have a vegetable at baseline, 68% did not have a fruit at follow-up, and 92% did not have a vegetable at follow-up. According to the NSLP guidelines, a reimbursable meal should include three food groups, with one being a ½ cup portion of an F or V. However, this study only assessed the consumption of healthful FV, excluding French fries, tomato sauce, and fruit juice. This was not able to assess NSLP compliance. Tabak et al. surveyed school foodservice workers finding that most reported that they were not aware of the current NSLP guidelines, and those that were aware struggled to enforce them²⁸. Research by Amin et

al found that 15.7% of trays did not have an FV on them when students were not prompted to select one²⁵. The current study found a greater proportion of students without healthful FV at both time points (73%). It is important to note that the NSLP considers French fries a vegetable whereas this study excluded French fries from FV consumption and variety due to the STC curriculum encouraging healthier FV choices. A study by Hakim et al. suggests students will select more if they are given an active role in deciding what they will eat, and allowed to choose food according to their preferences²⁹. Many studies have suggested that since the 2012 update of the NSLP school guidelines consumption of FV have decreased^{25,30}.

This study found that variety was very low; 59.6% of students from both schools, and 83.0% of students from both schools did not have a fruit or a vegetable on their tray at either time point. The majority of fruit and vegetable items were from the garden cart that were actively selected by the student. Pre-plating items is not enough to get children to consume FVs. Fruit consumption increased by 0.05 cups when items were pre-plated, and only 0.01 cups when vegetables were pre-plated. Consistent with the literature, this study shows that low-income minority children selected and consumed less fruits and vegetables than their higher income counterpart from the literature^{22,31}. This suggests that action needs to be taken at the school foodservice level in order to get children to consume more FVs,

There were no differences within the treatment school comparing students in the four classrooms with education to students in the two classrooms that did not choose to participate. However, the non-participating classes did not consume any vegetables at either time point. The treatment school group without education may have selected fruit

at a greater frequency than vegetables³².

Strengths and Limitations

A strength of this study is that, to the author's knowledge, this is the first PSE intervention to be assessed using a digital photography method. The study sample is mostly Hispanic, low-income, and from urban areas. This study focused on healthful FV and excluded French fries, tomato sauce, and juice from total FV consumption. However, there were several limitations. The sample size was small, and photographs were taken over multiple days at baseline and follow-up. The items being served at each school were not identical at both time points. Only 3 items, orange, pears, and apples, were consistent from baseline to follow-up. Another limitation is the definition of variety. In this study, variety was defined as different types of fruits and vegetables where as the NSLP and the Dietary Guidelines defined variety by subgroup of fruits and vegetables^{33,34}. Other limitations include items missing from photos, students being absent, or withdrawing from school prior to follow-up data collection.

IMPLICATIONS FOR RESEARCH

Although this study did not find significant increases in FV intake associated with the PSE intervention, it is important to note that although these schools are participants in the NSLP, only a small proportion of students had a healthful fruit or a vegetable on their tray. Only 12% of students had 1 or 2 fruits at both time points, and 5% had 1 or 2 vegetables at both time points. In the future, it is recommended that PSE interventions include a component for school foodservice workers. If healthful items are not being provided to the children, they can't consume them. Pre-plating items did not appear to increase FV consumption in this study. Further action is recommended such as allowing

active choice, implementing Smarter Lunchroom strategies, and allowing students to have a choice in the selection of FVs^{23,29}. The allowance of active choice may also increase variety selected by students. Making preferred FVs accessible to the children is important to encourage consumption^{23,29,35}.

TABLES

Table 1: Students Take Charge Lesson Plan and Activities by Group

| STC Lesson | Topic | Group | | |
|---------------------|---|-------|---|---|
| | | T | C | E |
| Photo Collection | | ✓ | ✓ | ✓ |
| Demographic Surveys | | ✓ | ✓ | |
| Lesson 1 | MyPlate/Fruits & Veggies you Enjoy | ✓ | | |
| Lesson 2 | Variety of FVs and their Function/Overcoming Barriers to Eating FVs | ✓ | | |
| Lesson 3 | Amounts of F&V/Recipe Reading (25-30 min) | ✓ | | |
| Lesson 4 | Go, Slow, Whoa/Role-playing interviewing adult about favorite Fruit or Veg recipe (25-30 min) | ✓ | | |
| Lesson 5 | Healthy Snack/Taste Tasting & Discussions on slogans/persuasive messages (25-30 min) | ✓ | | |
| Lesson 6 | Winning Recipe Announced/Make Posters (25-30 min) | ✓ | | |
| Lesson 7 | Making Requests & Practice Polling (25-30 min) | ✓ | | |
| Recipe Tasting Day | | ✓ | | ✓ |
| Lesson 8 | Overview of STC and Recap | ✓ | | |
| Photo Collection | | ✓ | ✓ | ✓ |

T=Treatment Group With Education

C=Control Group

E=Treatment Group without Education

✓=Group Exposed

Table 2: Steps for Data Analysis of Consumption

| | |
|---------------|--|
| Step 1 | The FVs consumed are assessed based on a percentage that is missing from the pre-photo (i.e. pre-plated 4 oz. cup of berries, 25% left in post-meal photo = 1 oz. berries at post, 4oz-1oz = 3 oz. consumed). |
| Step 2 | The graduate student researcher will then use the known pre-plated portions, or reference photos from the “garden cart” to analyze amount on the tray. |
| Step 3 | The graduate student researcher will use the post-meal photo to analyze the amount consumed. This will be done by referencing the pre-meal photo and using the criteria from the FoodWise project to estimate the amount left on the tray. |
| Step 4 | Consumption will be calculated by subtracting the amount in the pre-meal photo and post-meal photo. |

Table 3: Demographics of Low-income Fifth Grade Participants Two Providence Public Schools

| Categorical Variables | Treatment (n=75)^a | Control (n=55)^a | Total (n=130)^a | <i>t</i> |
|------------------------------|-------------------------------------|-----------------------------------|----------------------------------|-----------------|
| Age (years) | 10.51 ± 0.60 | 10.58 ± 0.81 | | 0.62 |
| Gender | | | | χ^2 |
| Female | 36 (47.9%) | 25 (45.8%) | 61 (47.0%) | |
| Male | 39 (52.1%) | 30 (54.2%) | 69 (53.0%) | 0.92 |
| Total | 75 (57.7%) | 55 (42.3%) | 130 (100%) | |
| Ethnicity | | | | |
| Hispanic | 53 (70.5%) | 33 (60.9%) | 101 (66.4%) | |
| Non-Hispanic | 22 (29.5%) | 22 (39.1%) | 51 (33.6%) | 0.29 |
| Total | 75 (57.9%) | 55 (42.1%) | 130 (100%) | |

a. Not all students responded to every question.

* p<.05, ** p<.01, ***p<.001

Table 4: Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up

| | Baseline | Follow-up | Within Group Change | Between Group Change (p) |
|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|---------------------------------|
| Variables | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | |
| Fruits | | | | |
| Treatment (n=75)^a | 0.26 ± 0.398 | 0.14 ± 0.285 | -0.1220 ± 0.46* | 0.009 |
| Control (n=55)^a | 0.11 ± 0.318 | 0.23 ± 0.466 | 0.1216 ± 0.49 | |
| Total (n=164)^a | 0.21 ± 0.361 | 0.20 ± 0.389 | | |
| Vegetables | | | | |
| Treatment (n=75)^a | 0.03 ± 0.211 | 0.04 ± 0.154 | 0.0073 ± 0.27 | 0.130 |
| Control (n=55)^a | 0.04 ± 0.169 | 0.03 ± 0.236 | -0.0114 ± 0.15 | |
| Total (n=164)^a | 0.03 ± 0.173 | 0.03 ± 0.172 | | |

a. Not all students participated in tray photos.

* p<.05, ** p<.01, ***p<.001

Table 5: Variety of Fruits and Vegetables At Baseline and Follow-up by Group

| Variables | Baseline Variety | | | Follow-up Variety | | |
|-------------------------------------|------------------|------------|---------------------------|-------------------|------------|------------|
| | 0 | 1 to 2 | Total | 0 | 1 to 2 | Total |
| Fruits | | | | | | |
| Treatment (n=81)^a | 33 (40.7%) | 48 (59.3%) | 81 (57.4%) | 56 (69.1%) | 25 (30.9%) | 81 (57.4%) |
| Control (n=60)^a | 53 (88.3%) | 7 (11.7%) | 60 (42.6%) | 40 (66.7%) | 20 (33.3%) | 60 (42.6%) |
| Total (n=141)^a | 86 (61.0%) | 55 (39.0%) | 141 (100%) ^{***} | 96 (68.1%) | 45 (31.9%) | 141 (100%) |
| Vegetables | | | | | | |
| Treatment (n=81)^a | 41 (50.6%) | 40 (49.4%) | 81(57.4%) | 74 (91.4%) | 7 (8.6%) | 81 (57.4%) |
| Control (n=60)^a | 56 (93.3%) | 4 (6.7%) | 60 (42.6%) | 55 (91.7%) | 5 (8.3%) | 60 (42.6%) |
| Total (n=141)^a | 97 (68.8%) | 44 (31.2%) | 141 (100%) ^{***} | 129 (91.5%) | 12 (8.5%) | 141 (100%) |

a. Not all students participated in tray photos.

* p<.05, ** p<.01, ***p<.001

Table 6: Change in Variety of Fruits and Vegetables Within Groups from Baseline to Follow-up

| | Treatment Group (n=81) | | Total |
|------------------------------------|------------------------|------------|--------------|
| | Baseline | | |
| | 0 | 1 or 2 | |
| Follow-up | | | |
| 0 Fruits | 22 (27.2%) | 34 (42.0%) | 56 (69.1%) |
| 1 or 2 Fruit | 11 (13.6%) | 14 (17.3%) | 25 (30.9%) |
| Total Variety of Fruit | 33 (40.7%) | 48 (59.3%) | 81 (100%)* |
| Follow-up | Baseline | | Total |
| | 0 | 1 or 2 | |
| | | | |
| 0 Vegetables | 39 (48.1%) | 35 (43.2%) | 74 (91.4%) |
| 1 or 2 Vegetables | 2 (2.5%) | 5 (6.2%) | 7 (8.6%) |
| Total Variety of Vegetables | 41 (50.6%) | 40 (49.4%) | 81 (100%) |
| | Control Group (n=60) | | Total |
| | Baseline | | |
| | 0 | 1 or 2 | |
| Follow-up | | | |
| 0 Fruit | 36 (60.0%) | 4 (6.7%) | 40 (66.7%) |
| 1 or 2 Fruit | 17 (28.3%) | 3 (5.0%) | 20 (33.3%) |
| Total Variety of Fruit | 53 (88.3%) | 7 (11.7%) | 60 (100%) |
| Follow-up | Baseline | | Total |
| | 0 | 1 or 2 | |
| | | | |
| 0 Vegetables | 53 (88.3%) | 2 (3.3%) | 55 (91.7%) |
| 1 or 2 Vegetables | 3 (5.0%) | 2 (3.3%) | 5 (8.3%) |
| Total Variety of Vegetables | 56 (93.3%) | 4 (6.7%) | 60 (100%***) |

* p<.05, ** p<.01, ***p<.001

Table 7 Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up within Treatment School Comparing Treatment to Non-treatment Classes

| | Baseline | Follow-up | Within Group Change | Between Group Change (p) |
|---|------------------------------------|------------------------------------|------------------------------------|---------------------------------|
| Variables | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | |
| Fruits | | | | |
| Treatment (n=75)^a | 0.26 ± 0.398 | 0.14 ± 0.285 | -0.1220 ± 0.46* | 0.322 |
| Non-treatment (n=34)^a | 0.27 ± 0.309 | 0.30 ± 0.434 | 0.0956 ± 0.44 | |
| Total (n=164)^a | 0.21 ± 0.361 | 0.20 ± 0.389 | | |
| Vegetables | | | | |
| Treatment (n=75)^a | 0.03 ± 0.211 | 0.04 ± 0.154 | 0.0073 ± 0.27 | 0.374 |
| Non-treatment (n=34)^a | 0.00 ± 0.000 | 0.00 ± 0.000 | 0.0000 ± 0.00 | |
| Total (n=164)^a | 0.03 ± 0.173 | 0.03 ± 0.172 | | |

a. Not all students participated in tray photos.

* p<.05, ** p<.01, ***p<.001

Table 8: Change in Consumption of Fruits and Vegetables in Cups from Baseline to Follow-up Without Pre-plated Items^b

| | Baseline | Follow-up | Within Group Change | Between Group Change (p) |
|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|---------------------------------|
| Variables | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | Amount Consumed (Mean ± SD) | |
| Fruits | | | | |
| Treatment (n=75)^a | 0.20 ± 0.396 | 0.09 ± 0.266 | -0.1117 ± 0.45* | 0.002 |
| Control (n=55)^a | 0.11 ± 0.318 | 0.23 ± 0.466 | 0.1216 ± 0.49 | |
| Total (n=164)^a | 0.16 ± 0.367 | 0.15 ± 0.370 | | |
| Vegetables | | | | |
| Treatment (n=75)^a | 0.03 ± 0.209 | 0.02 ± 0.086 | -0.1270 ± 0.23 | 0.217 |
| Control (n=55)^a | 0.04 ± 0.169 | 0.03 ± 0.236 | -0.0114 ± 0.15 | |
| Total (n=164)^a | 0.03 ± 0.193 | 0.02 ± 0.166 | | |

a. Not all students participated in tray photos.

b. Pre-plated refers to items plated by cafeteria staff on the tray line.

p<.05, ** p<.01, ***p<.001

Table 9: Variety of Fruits and Vegetables at Baseline and Follow-up Without Pre-plated^b Items by Group

| Variables | Baseline Variety | | | Follow-up Variety | | |
|-------------------------------------|------------------|------------|------------|-------------------|------------|------------|
| | 0 | 1 or 2 | Total | 0 | 1 or 2 | Total |
| Fruits | | | | | | |
| Treatment (n=81)^a | 64 (79.0%) | 17 (21.0%) | 81 (57.4%) | 70 (86.4%) | 11 (13.6%) | 81 (57.4%) |
| Control (n=60)^a | 54 (90.0%) | 6 (10.0%) | 60 (42.6%) | 43 (71.7%) | 17 (28.3%) | 60 (42.6%) |
| Total (n=141)^a | 118 (83.7%) | 23 (16.3%) | 141 (100%) | 113 (80.1%) | 28 (19.9%) | 141 (100%) |
| Vegetables | | | | | | |
| Treatment (n=81)^a | 77 (95.1%) | 4 (4.9%) | 81 (57.4%) | 74 (91.4%) | 7 (8.6%) | 81 (57.4%) |
| Control (n=60)^a | 56 (93.3%) | 4 (6.7%) | 60 (42.6%) | 58 (96.7%) | 2 (3.3%) | 60 (42.6%) |
| Total (n=141)^a | 133 (94.3%) | 8 (5.7%) | 141 (100%) | 132 (93.6%) | 9 (6.4%) | 141 (100%) |

a. Not all students participated in tray photos.

b. Pre-plated refers to items plated by cafeteria staff on the tray line.

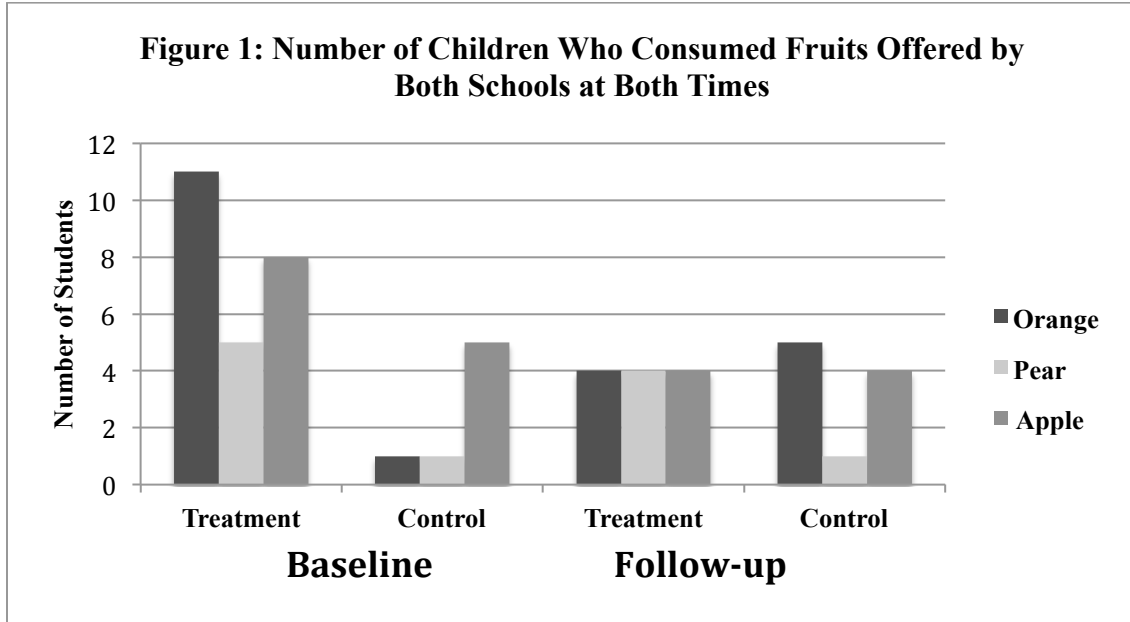
* p<.05, ** p<.01, ***p<.001

Table 10: Change in Variety of Fruits and Vegetables Within Groups from Baseline to Follow-up Without Pre-plated Items

| | Treatment Group | | Total |
|------------------------------------|-----------------|------------|------------|
| | Baseline | | |
| | 0 | 1 or 2 | |
| Follow-up | | | |
| 0 Fruits | 58 (82.9%) | 12 (14.8%) | 70 (86.4%) |
| 1 or 2 Fruit | 6 (54.5%) | 5 (6.2%) | 11 (13.6%) |
| Total Variety of Fruit | 64 (79.0%) | 17 (21.0%) | 81 (100%) |
| 0 Vegetables | 70 (86.4%) | 4 (4.9%) | 74 (91.4%) |
| 1 or 2 Vegetables | 7 (8.6%) | 0 (0%) | 7 (8.6%) |
| Total Variety of Vegetables | 77 (95.1%) | 4 (4.9%) | 81 (100%) |
| | Control Group | | Total |
| | Baseline | | |
| | 0 | 1 or 2 | |
| Follow-up | | | |
| 0 Fruit | 39 (65.0%) | 4 (6.7%) | 43 (71.6%) |
| 1 or 2 Fruit | 15 (25.0%) | 2 (3.3%) | 17 (28.4%) |
| Total Variety of Fruit | 54 (90.0%) | 6 (10.0%) | 60 (100%) |
| 0 Vegetables | 55 (91.7%) | 3 (5.0%) | 58 (96.6%) |
| 1 or 2 Vegetables | 1 (1.7%) | 1 (1.7%) | 2 (3.4%) |
| Total Variety of Vegetables | 56 (93.3%) | 4 (6.7%) | 60 (100%) |

* p<.05, ** p<.01, ***p<.001

Figure 1



References

1. A closer look at current intakes and recommended shifts-2015-2020 Dietary Guidelines - health.gov.
<http://health.gov/dietaryguidelines/2015/guidelines/chapter-2/a-closer-look-at-current-intakes-and-recommended-shifts/#subnav-4>. Accessed January 23, 2017.
2. Mytton OT, Nnoaham K, Eyles H, Scarborough P, Ni Mhurchu C. Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. *BMC Public Health*. 2014;14(1):886. doi:10.1186/1471-2458-14-886.
3. "Rhode Island Report from the National Survey of Children's Health." NSCH 2011/12. Child and Adolescent Health Measurement Initiative, Data Resource Center for Child and Adolescent Health website. Retrieved 7/24/17 from childhealthdata.org.
4. Bertolia ML, Mukamal KJ, Cahill LE, et al. Changes in Intake of Fruits and Vegetables and Weight Change in United States Men and Women Followed for Up to 24 Years: Analysis from Three Prospective Cohort Studies. *PLoS Med*. 2015;12(9). doi:10.1371/journal.pmed.1001878.
5. Vadiveloo M, Zhu L, Quatromoni PA. Diet and Physical Activity Patterns of School-Aged Children. *J Am Diet Assoc*. 2009;109(1):145-151. doi:10.1016/j.jada.2008.10.012.
6. Vadiveloo M, Parekh N, Mattei J. Greater healthful food variety as measured by the US Healthy Food Diversity index is associated with lower odds of metabolic syndrome and its components in US adults. *J Nutr*. 2015;145(3):564-571. doi:10.3945/jn.114.199125.
7. CDC. Childhood Obesity Facts.
<https://www.cdc.gov/obesity/data/childhood.html>. Accessed December 27, 2016.
8. Goodwin J. Change in fruit and vegetable intake of elementary school students following a nutrition intervention [master's thesis]. Kingston, Rhode Island: The University of Rhode Island;2017.
9. Lepe S. Process evaluation of an EFNEP-Enhanced PSE intervention in urban schools [master's thesis]. Kingston, Rhode Island: The University of Rhode Island;2017.
10. Perez-Rodrigo C, Artiach Escauriaza B, Artiach Escauriaza J, Polanco Allue I. Dietary assessment in children and adolescents: issues and recommendations. *Nutr Hosp*. 2015;31 Suppl 3:76-83. doi:10.3305/nh.2015.31.sup3.8755.

11. Livingstone MBE, Robson PJ, Wallace JMW. Issues in dietary intake assessment of children and adolescents. *Br J Nutr.* 2004;92(S2):S213. doi:10.1079/BJN20041169.
12. Martin CK, Correa JB, Han H, et al. Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity (Silver Spring).* 2012;20 VN-r(4):891-899. doi:10.1038/oby.2011.344.
13. 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). doi:10.1016/j.jand.2014.02.029.
14. Williamson DA, Allen HR, Martin PD, Alfonso A, Gerald B, Hunt A. Digital photography: A new method for estimating food intake in cafeteria settings. *Eat Weight Disord.* 2004;9(1):24-28. doi:10.1007/BF03325041.
15. U.S. Department of Commerce. United States Census Bureau Quick Facts Providence, Rhode Island. <https://www.census.gov/quickfacts/fact/table/providencecityrhodeisland/PST045216>. Published 2015.
16. United States Department of Agriculture. National School Lunch Program (NSLP) state data on School Food Authority (SFA) certification submission progress and percent of schools dropping out of the NSLP. 2013:2012. <https://fns-prod.azureedge.net/sites/default/files/School-lunch-chart.pdf>.
17. Education RD of. National School Lunch Program. <http://www.ride.ri.gov/cnp/NutritionPrograms/NationalSchoolLunchProgram.aspx>. Published 2017.
18. Masis N, McCaffrey J, Johnson SL, Chapman-Novakofski K. Design and Evaluation of a Training Protocol for a Photographic Method of Visual Estimation of Fruit and Vegetable Intake among Kindergarten Through Second-Grade Students. *J Nutr Educ Behav.* 2017;49(4):346-351.e1. doi:10.1016/j.jneb.2017.01.004.
19. Touyz LM, Wakefield CE, Grech AM, et al. Parent-targeted home-based interventions for increasing fruit and vegetable intake in children: a systematic review and meta-analysis. *Nutr Rev.* 2018;76(3):154-173. doi:10.1093/nutrit/nux066.
20. Perry CL, Bishop DB, Taylor GL, et al. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Heal Educ Behav.* 2004;31(1):65-76. doi:10.1177/1090198103255530.
21. Byker Shanks C, Banna J, Serrano EL. Food Waste in the National School Lunch

- Program 1978-2015: A Systematic Review. *J Acad Nutr Diet*. 2017;117(11):1792-1807. doi:10.1016/j.jand.2017.06.008.
22. Rasmussen M, Krølner R, Klepp K-I, et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. *Int J Behav Nutr Phys Act*. 2006;3(1):22. doi:10.1186/1479-5868-3-22.
 23. Hubbard KL, Bandini LG, Folta SC, Wansink B, Eliasziw M, Must A. Impact of a Smarter Lunchroom intervention on food selection and consumption among adolescents and young adults with intellectual and developmental disabilities in a residential school setting. *Public Health Nutr*. 2015;18(2):361-371. doi:10.1017/S1368980014000305.
 24. 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. doi:10.1017/S1368980013001894.
 25. Amin SA. Impact of the National School Lunch Program on Fruit and Vegetable Selection in Northeastern Elementary. 2013;130(October 2015):2012-2013.
 26. Martin CK, Thomson JL, LeBlanc MM, et al. Children in School Cafeterias Select Foods Containing More Saturated Fat and Energy than the Institute of Medicine Recommendations. *J Nutr*. 2010;140(9):1653-1660. doi:10.3945/jn.109.119131.
 27. Yoder ABB, Foecke LL, Schoeller DA. Factors affecting fruit and vegetable school lunch waste in Wisconsin elementary schools participating in Farm to School programmes. *Public Health Nutr*. 2015. doi:10.1017/S1368980015000385.
 28. Tabak RG, Moreland-Russell S. Food Service Perspectives on National School Lunch Program Implementation. *Heal Behav Policy Rev*. 2015;2(5):362-371. doi:10.14485/HBPR.2.5.4.
 29. Hakim SM, Meissen G. Increasing Consumption of Fruits and Vegetables in the School Cafeteria: The Influence of Active Choice. *J Health Care Poor Underserved*. 2013. doi:10.1353/hpu.2013.0109.
 30. Wengreen H, Aguilar S, Madden G, Jones B. Do the New Nutrition Standards Help Students to Consume More Fruits and Vegetables? *J Nutr Educ Behav*. 2014;46(4, Supplement):S150-S151. doi:https://doi.org/10.1016/j.jneb.2014.04.140.
 31. Krølner R, Rasmussen M, Brug J, Klepp K-I, Wind M, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of

- the literature. Part II: qualitative studies. *Int J Behav Nutr Phys Act.* 2011;8(1):112. doi:10.1186/1479-5868-8-112.
32. USDA. National School Lunch Fact Sheet. *Office.* 2011;(1946):4-6. <http://www.ncbi.nlm.nih.gov/pubmed/21135318>.
 33. Food and Nutrition Services US Department of Agriculture. *Nutrition Standards in the National School Lunch and School Breakfast Programs. Final Rule.* Vol 77.; 2012.
 34. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015 – 2020 Dietary Guidelines for Americans. *2015 – 2020 Diet Guidel Am (8th Ed.* 2015:18. doi:10.1097/NT.0b013e31826c50af.
 35. Wansink B, Just D, Smith L. Move the Fruit: Putting Fruit in New Bowls and New Places Doubles Lunchroom Sales. *J Nutr Educ Behav.* 2018;43(4):S1. doi:10.1016/j.jneb.2011.03.013.

APPENDICES

A. LITERATURE REVIEW

Introduction

As fruit and vegetable (FV) consumption continues to be a problem with elementary aged children, collection of dietary intake data is pertinent¹. Accurate collection of fruit and vegetable dietary intake data is challenging in children due to the reliance on memory, their limited vocabulary, and the lack ability to identify foods to their food groups¹. This review will examine current research related to fruit and vegetable consumption and variety among children as well as methods to collect these data, including DPFM, will describe outcomes of the pilot *Student's Take Charge!* (STC) program, the National School Lunch Program, importance of nutrition interventions, and the student-eating environment.

Background of National School Lunch Program (NSLP)

The NSLP is responsible for feeding nutritious, well-balanced meals to more than 31 million children each day in the public school system^{2,3}. Research reports that students who participate in the NSLP and the School Breakfast Program (SBP) may consume up to 47% of their daily nutrients from these items provided by the school⁴. In 2012, the USDA made changes to the NSLP regulations⁵. With the new regulations of NSLP in 2012, the requirements for a reimbursable meal changed. The final school meal standards of 2012 limit energy and provide minimum and maximum amount of energy for each age group⁶. The standards also required a serving of fruit or a serving of vegetables daily with a weekly requirement of vegetable subgroups (variety), and students were no longer allowed to refuse fruits and vegetables^{4,6}. They had to choose at least one fruit or one vegetable. The new standards were designed to help children improve their dietary

intake⁶.

When foodservice workers were interviewed, they reported many barriers to following the new regulations such as increased labor cost, minimal understanding of the current ruling, and the lack of understanding about the new NSLP guidelines, its goals, and its need for participation/support at multiple levels on the part of parents, teachers, school staff, stakeholders, and foodservice workers⁷. Districts who had more support with NSLP tended to be districts reporting greater success with implementing the new NSLP guidelines⁷.

Fruit and Vegetable Consumption

FVs are high in fiber, water, and nutrients that are not energy dense. Consuming the recommended amounts of FVs is associated with lower total energy intake/density and increased satiety⁸. Epidemiological studies have shown a positive association between increased FV intake and decreased risk of obesity later in life⁹. Furthermore, children who consume diets rich in FVs are more likely to maintain these habits into adulthood and decrease the likelihood of excessive weight gain in adulthood¹⁰.

According to recent data, the U.S. population on average does not consume the recommended amounts for fruits and vegetables¹¹. Children, 9-13 years old consume an average of 1.1 cups of fruit a day compared to the recommendation of 1.5 – 2.0 cups¹¹. For vegetables, children ages 9 to 13 eat an average of 1.0 to 1.1 cups of vegetables a day compared to the recommendation of 1.5 to 3.0 cups per day¹¹.

Variety of Fruits and Vegetables

Many epidemiological and cohort studies support the benefits of consuming adequate amounts of FVs. FVs contain nutrients essential for healthy body function and growth including Vitamin A, C, and K, potassium, magnesium, and phytonutrients, all

which are currently under-consumed in the United States today¹¹⁻¹⁴. Based on the 2015-2020 Dietary Guidelines, the U.S. population also does not meet the recommended intake for any subgroups of vegetables, indicating a lack of variety as seen in Table 1¹¹.

| Subgroup of Vegetables | | Weekly Recommendation (cups) | Weekly Average Intake (cups) |
|-------------------------------|----------------|-------------------------------------|-------------------------------------|
| Dark Green | Males | 1.5-2.5 | 0.4 |
| | Females | 1.0-2.0 | 0.4 |
| Red and Orange | Males | 4.0-7.0 | 2.1 |
| | Females | 3.0-6.0 | 2.0 |
| Starchy Vegetables | Males | 4.0-7.0 | 2.7 |
| | Females | 3.5-6.0 | 2.7 |
| Other | Males | 3.5-5.5 | 1.8 |
| | Females | 2.5-5.0 | 1.8 |

As seen in Table 1, male and female children meet less than 50% of the weekly recommended average intake of any subgroup. About one-third of the intake of fruits comes from fruit juice, and the remaining two-thirds from whole fruits (which includes cut up, cooked, canned, frozen, and dried fruits)¹¹. Potatoes and tomatoes are the most commonly consumed vegetables, with potatoes accounting for 21 percent and tomatoes 18 percent of vegetables consumed¹¹. This is of concern due to potatoes being a starchy vegetable that is often consumed in its high fat, high sodium form, French fries¹¹. Specifically, lower income Americans consume more calorically dense foods than their higher income counterparts and are at a higher risk for disparities due to limited access to resources¹⁵. This increases the risk of disease due to poor nutritional quality.

Socioeconomic Status (SES) and FV Variety/Consumption

SES during childhood has been shown to be a strong predictor of adult health outcomes¹⁶. Two common indicators used to classify adolescent SES is parental

education and parental income¹⁷. A longitudinal study with 896 adolescents found that high-income families reported greater accessibility to FV at home compared to their low-income counterparts (Healthy Eating Index (HEI) FV subscale score 5.0 vs. 4.1, $p < 0.001$)¹⁸. Results suggested a large reason low SES adolescents eat less FV than high SES adolescents is due to the decreased access in the home setting¹⁸. Likewise, this longitudinal study found that adolescents of higher education parents reported having greater preferences for FV, greater knowledge of FV recommendations, and stronger intentions to meet dietary FV guidelines¹⁸. Low SES is not only a national issue but also a local problem in Rhode Island.

Thirty-seven percent of the children living in Providence, RI live below the poverty line, 33% receive SNAP benefits (government assistance for purchasing food), and 88% are eligible for free or reduced meals¹⁹.

Access to FVs is limited for low-income families²⁰. Based on the HEI 2005, low-income families have lower component scores for total fruits and a statistically significant lower score for total vegetables ($p < 0.05$) as compared to their higher income counterparts²⁰. Specifically, low-income families have lower consumption of dark leafy greens and orange fruits and vegetables¹¹. The Dietary Guidelines report that a majority of vegetable consumption by low-income populations consists of starchy vegetables such as; potatoes, corn, and peas¹¹.

FV and Obesity

Childhood obesity has been linked to a high prevalence of metabolic syndrome in children, that rises with increased obesity²¹. Obesity is defined as being at or above the 95th percentile on the BMI-for-age growth chart by the Centers for Disease Control (CDC) for children under 18 years old^{22,23}. In Rhode Island, 28.3% of children age 10-17

are overweight or obese²⁴. Overweight and obesity prevalence in Rhode Island vary by race and ethnicity. Hispanic children from core cities are more likely to be overweight or obese when compared to non-Hispanic white children not living in a core city²⁵⁻²⁷.

Increased consumption of fruits and non-starchy vegetables is inversely related with weight change²⁸. Specifically, this study observed better weight management with the consumption of each extra daily serving of fruit, and an increase in total vegetable intake was also associated with prevention of weight gain²⁸. However, an increased intake of starchy vegetables such as corn, peas, and potatoes was associated with weight gain²⁸. One study with children at risk of obesity 8-12 years old showed that an increase in FV intake may lead to a decrease of energy dense foods leading to weight management and decreasing the incidence of obesity^{13,14}. Furthermore, children who have healthy dietary habits in adolescence, such as consuming FVs, have a higher likelihood of carrying these habits into adulthood and decreasing their risk of obesity in adulthood⁸⁻¹⁰.

School Eating Environment

There are many factors that can influence a child's meal patterns. Research conducted in elementary schools participating in the NSLP found that the classes that had recess before lunch had a higher consumption of FVs compared to students who had recess after lunch⁴. Another study found that children who received recess prior to lunch increased their fruit consumption by 5.1%²⁹ and increased their likelihood of consuming at least one fruit or vegetable by 10% compared to those who have recess after lunch³⁰. A Washington state elementary-school plate waste study found that FV food waste decreased from 40.1% to 27.2% when lunch followed recess³¹.

Research shows that there are certain foods that are typically accepted by children more than others such as bananas and French fries^{4,32-34}. With the current NSLP

guidelines, reimbursable meals are required to have at least one serving of fruit or vegetables. One study showed that pre-plated vs salad bar items are still wasted at the same frequency as salad bar items at meals³². Salad bar items are those that are self-served and self-selected by the child³². Their study found canned fruits in juice were wasted less than whole fruits, while cooked vegetables were wasted more than raw³². Providing students with a variety of choices both hot and cold may to increase school FV consumption³.

One approach to create change in in the school lunchroom is CAN (*Convenient, Attractive, Normal*) approach that has been studied by Wansink and colleagues³⁵. The strategy focuses on making food more *Convenient* in the lunchroom, this can be done by changing the location where healthier food is served or by pre-packaging items³⁵. The *Attractive* component focuses on displaying the healthier foods in more appealing ways³⁵. The last part of this strategy is *Normal*³⁵. *Normal* can be achieved by using the power of suggestion to make the healthy choice seem more socially acceptable³⁵. This can be achieved by having a standardized location on each child's tray for a fruit or a vegetable. The Smarter Lunchroom Movement is an initiative that was designed to help achieve the CAN approach^{36,37}. The Smarter Lunchroom Movement changes are simple and low-cost that can easily transform the school environment to promote healthy choices³⁶. Changes include displaying whole fruits in attractive bowls or baskets instead of hotel pans, creating descriptive names for FVs, and politely prompting students to select a fruit or a vegetable³⁷. Studies assessing the Smarter Lunchroom Movement have found that through this approach, FV sales have increased by 20% in schools³⁸.

Reporting Methods for Amount and Variety Consumed of FV

Dietary intake can be difficult to assess in children for a number of reasons. Some

common instruments include food frequency questionnaires (FFQ), 24-hour recalls, surveys, dietary records, weighed measures, visual estimation, and digital photography. This section will discuss strengths and limitations of different dietary intake tools commonly used to assess FV consumption in children.

Self-Reporting

The most common dietary intake method is self-reporting dietary intake. Self-reporting includes the use of comprehensive FFQ, 24-hour recalls, and brief surveys such as SNAP-Ed Fruit and Vegetable Checklist. In children, these methods can be difficult due to their limited cognitive ability, difficulty estimating portion sizes, reliance on caretaker to estimate portions, and limited attention span^{1,39,40}.

Comprehensive FFQs have been used in many studies, but they are long and tedious for young subjects and may require assistance by an adult. These surveys includes items from all food groups in order to capture the habitual intake of the subjects, but this increases the subject burden for studies focusing on fruits and vegetable consumption. The FFQ is a tool that obtains the average intake of items on a day-to-day basis, and therefore may not be as sensitive to change in daily consumption in cups as dietary recall based methods⁴¹. Nevertheless, FFQs can be self-completed, and are suitable for large scale studies with children⁴¹⁻⁴³. In order to obtain an FFQ from a child, participation from caregivers are often necessary due to a child's limited long-term memory¹.

Twenty four-hour recalls are considered the gold standard for self-reported intake. The 24-hour recall has a low-responder burden, and can be administered over the phone⁴². However, children ages 8 to 10 rely on the caregiver since a child may not be able to quantify food¹. Limitations to this method include dependence on the subject's memory, bias in reporting "good/bad" foods, difficulty in estimating portion size, and a

single recall is not a good measure of usual diet since it only captures one 24-hour period^{1,42,44}.

SNAP-Ed uses the SNAP-Ed Fruit and Vegetable Checklist as a self-reporting tool. This survey assesses the number of times fruits and vegetables were consumed in the previous day. This survey has been adapted from the 2-item FV screener⁴⁵. There are six different response choices ranging from “0” to “5 or more times a day”. The checklist includes five other items to assess types and quantities of FV consumed on the previous day. However, a limitation to this instrument is its lack of sensitivity to change. There were no changes from pre to post intervention in the pilot year of STC⁴⁵. Specific problems with this survey include memory required to assess previous day’s intake and confusion about classification of FVs⁴⁵. These surveys are administered in class as a group in English, which requires the subject to be literate in English to follow along. Lastly, students have difficulty accurately remembering what and how much they consumed on the previous day. As there are many limits to self-reporting, more objective measures are warranted.

Digital Photography

Digital photography provides a quick and unobtrusive method to estimate food intake in cafeteria settings⁴⁶⁻⁴⁸. The validity of Digital Photography of Foods Method (DPFM) has been established with both adults and children when compared to the gold standard, weighing of foods on a scale⁴⁸. A study compared weighed plate waste (WPW), digital photography, and digital photography with lunchroom observations to assess the reliability and validity of these methods in school-aged children⁴⁸. Reliability was acceptable for digital photography. FV consumption assessments by DPFM and WPW were highly correlated⁴⁹.

The validity has been established in a number of settings including free-living conditions, Head Start settings, school cafeterias, and children's homes^{46-48,50}. Martin et al. (2007) reviewed the digital photography method for food estimation, and found that visual estimation from photographs is valid tool for estimating nutrient intake and energy values of food with 5th grade children⁵⁰⁻⁵². Another study by Williamson et al. (2003) also showed high correlation of digital photography to weighed and visual estimation of portion sizes⁴⁸.

Evaluation of STC Pilot Program

A quasi-experimental study of a pilot STC program in Rhode Island assessed 5th graders in low-income urban schools. This study used the SNAP-Ed Fruit and Vegetable Checklist in order to assess quantity of fruits and vegetables consumed the previous day⁴⁵. Subjects in this study (n=298, n=178) were 35% white, 31% Hispanic, and 26% African American⁴⁵. At baseline, children in the treatment school reported eating fruits 2.34 ± 1.40 times the previous day, and 2.37 ± 1.51 times the previous day in the control school. At follow-up, children in the intervention school reported eating fruits 2.26 ± 1.37 times the previous day, and 2.34 ± 1.58 times a day in the control group. For vegetables, children in the treatment school reported eating vegetables 1.86 ± 1.38 times at baseline and 1.87 ± 1.46 times at follow-up. The control group reported eating vegetables 2.01 ± 1.43 times at baseline and 1.98 ± 1.59 times at follow-up. There were no significant changes in FV consumption between or within groups based on the checklist. However, process evaluation indicated that this intervention was perceived effective in increasing FV consumption by staff and students⁵³.

Overview of Literature using DPFM

Many studies have used DPFM to analyze meals in schools that participate in

NSLP. These studies include interventions with children, assessing the new NSLP guidelines, the impact of Smarter Lunchroom strategies, analysis of food choices in the lunchroom, and plate waste.

Smith et al. used the digital photography method to compare students' average nutrient intake at lunch to the updated 2012 NSLP standards⁴. Plate waste was estimated from n=899 tray photos from three elementary and two middle schools, grades 1-8, over 23 days of data collection in a cross-sectional study⁴. Tray photos were analyzed using percent increments in relation to reference photos and weighed measures. For fruit, 50% of fresh whole fruit was left uneaten, 37% of canned fruits were wasted, and 40% of total fruits including fruit juice were wasted⁴. This study found that 32% of vegetables selected were wasted, and only 45% of students selected a vegetable⁴. Although there were no statistically significant differences in FV for elementary subjects before and after 2012 NSLP standards, Smith et al. found that less than half of the students selected a vegetable, and students were more likely to select a fruit at lunch⁴. Based on the data from this study, few students' lunch consumption met previous or new NSLP standards, specifically vitamins A and C due to the relatively low intake of vegetables⁴.

Another study used DPFM to examine if school meals met the School Meals Initiative and the Institute of Medicine recommendations for children⁵⁴. This cross-sectional study assessed 33 middle schools, grades 4 to 6, to assess average percent wasted⁵⁴. Data collection occurred over 3 days, and n=2049 trays were observed. Martin et al. assessed FVs as one item, and found that students selected an average of 1.1 cups of fruits and/or vegetables at lunch, consumed 0.7 cups, and wasted 0.4 cups ($p < 0.005$) on average⁵⁴. Results from this study suggest that the nutritional quality of school meals can be improved⁵⁴. Children are more likely to discard fruits and vegetables, and less likely to

discard other food categories⁵⁴. Future implications of this study include serving foods higher in nutrient density and lower in energy density⁵⁴. This can be accomplished by adding vegetables into the foods provided to the children, and increasing the variety of FVs offered at lunchtime⁵⁴.

Williamson et al. reported selection, plate waste, and changes in intake from Wise Mind and LA Health studies⁵⁵. This randomized control trial used DPFM to report these results⁵⁵. Wise Mind (n=604) and LA Health (n=2015) study focused on modifications to the school cafeteria environment to improve consumption of nutrient dense foods⁵⁵. This study did not report consumption of FV, but found that modification to the school cafeteria is feasible and has the ability to positively influence children's food consumption⁵⁵. The use of DPFM found statistically significant decreases in total fat selected at lunch (Wisemind: -60 ± 10.6 ; $p=0.03$; LA Health: -78 ± 10.4 ; $p<0.0001$) and fat intake at lunch (Wisemind: -41 ± 5.0 ; $p=0.015$; LA Health: -58 ± 8.9 ; $p<0.0001$)⁵⁵. This decrease in total fat intake may be due to the increased availability of healthier more nutrient dense items such as FVs⁵⁵. The findings of this study support the hypothesis that modifying the lunch environment can positively impact healthier choices, and supports the decision to change the NSLP guidelines to the current 2012 standards⁵⁵.

Hubbard et al. evaluated whether a Smarter Lunchroom intervention could be adapted to increase the selection of FVs for students with intellectual and developmental disabilities⁵⁶. This quasi-experimental study used baseline and follow-up intervention DPFM data⁵⁶. Data collection occurred 5 days at baseline and 5 days at follow-up. Days were matched based on menu items in order to ensure items offered were identical at both time points⁵⁶. There are a total of 644 trays analyzed and subjects, n=43, ranged from 11 to 21 years old with disabilities attending a residential school in Massachusetts⁵⁶. The 3-

month intervention occurred from March to June 2012, and capitalized on environmental changes such as moving fruits to the front of the service line and providing items in separate, attractive bowls⁵⁶. This study found that after the 3-month environmental changes, the daily consumption of total fruits increased by a mean of 0.18 cups ($p=0.008$), canned fruits increased by 0.13 cups ($p=0.02$), and whole fresh fruits increased by 0.05 cups ($p=0.38$)⁵⁶. Selection of raw vegetables significantly decreased by 0.16 cups ($p=0.001$), but intake of total vegetables increased by 0.07 cups ($p=0.14$)⁵⁶. Plate waste significantly decreased for vegetables ($p=0.03$)⁵⁶. What this tells us is that the students selected vegetables they were more likely to eat at follow-up, consumed more, and wasted less⁵⁶. The Smarter Lunchroom intervention significantly increased fruit consumption, and decreased FV plate waste⁵⁶.

Schwartz et al. found the new meal regulations increased fruit consumption and did not lead to increased plate waste.⁵⁷ This cross sectional study used DPFM to assess 12 urban, low-income, middle schools. Data was collected prior to the changing of the NSLP guidelines in spring 2012, and follow-up data was collected in spring 2013 and 2014⁵⁷. For baseline fruits, $n=269$, and $n=573$ trays for follow-up⁵⁷. For baseline vegetables, $n=344$, and $n=479$ for follow-up⁵⁷. Generalized linear regression was used to compare selection and consumption of FVs pre and post-policy implementation⁵⁷. This study used percent increment in order to interpret data and did not report consumption or selection in cups⁵⁷. The percentage of students selecting fruits significantly increased from 54% of students to 66% ($p<0.05$) and consumption of fruits remained high pre and post policy implementation⁵⁷. Furthermore, this study found that fruit consumption increased by 9% for each additional fruit that was offered at meal-time⁵⁷. Post-policy implementation, vegetable selection dropped from 68% to 52% ($p<0.05$), however,

students ate 20% ($p < 0.05$) more vegetables post-policy implementation, lowering vegetable waste⁵⁷. This study also looked into which fruits and vegetables were most popular⁵⁷. Based on baseline and follow-up data, 88% of fruit cups, 78% of bananas, 70% of oranges, 56% of pears, and 48% of apples served were consumed⁵⁷. For vegetables, 72% of potatoes (excluding fried), 65% of corn, 46% of beans, 42% of salad, and 38% of broccoli served was consumed⁵⁷. This study indicates that the NSLP updated guidelines have led to more nutritious meals and increased fruit selection without increasing plate waste of FVs⁵⁷.

DPFM is a reliable, valid tool in order to look deeper into the breakdown of school meals^{48,58,59}. Researchers have been able to use DPFM in a wide variety of settings, including the school lunchroom in order to quantify consumption of school lunch. The findings from these studies suggest the DPFM is an appropriate tool to use amongst low-income 5th graders, and is reliable and effective in the school lunch environment to assess fruit and vegetable consumption and variety^{48,58,59}.

Conclusion

Accurately measuring dietary intake in children is important due to the low intake of FVs and rising incidence of overweight and obesity^{1,11,19,45,53}. Children who do not consume the daily recommendations of FV are more likely to consume excess quantities of energy dense foods that can lead to overweight and obesity^{8,13,60}. This review found that DPFM is a valid and reliable dietary intake tool in school aged children^{46,48,50,58,61}. DPFM is accurate within the school lunchroom setting, decreases participant burden, and is effective in measuring FVs^{4,59,62}. Data shows that children consume an average of 0.4 cups of FVs at lunch, and consume a greater amount of fruits than vegetables^{3,4,46,51}. Process data from the pilot year of STC indicated that students had an increased

knowledge in nutrition and perceived making changes but outcome data failed to find changes in FV consumption. This suggests that PSE interventions may need to use objective measures such as DPFM, but no studies have used this objective method for PSE outcome evaluation^{45,53}.

Bibliography

1. Perez-Rodrigo C, Artiach Escauriaza B, Artiach Escauriaza J, Polanco Allue I. Dietary assessment in children and adolescents: issues and recommendations. *Nutr Hosp*. 2015;31 Suppl 3:76-83. doi:10.3305/nh.2015.31.sup3.8755.
2. USDA. National School Lunch Fact Sheet. *Office*. 2011;(1946):4-6. <http://www.ncbi.nlm.nih.gov/pubmed/21135318>.
3. Byker Shanks C, Banna J, Serrano EL. Food Waste in the National School Lunch Program 1978-2015: A Systematic Review. *J Acad Nutr Diet*. 2017;117(11):1792-1807. doi:10.1016/J.JAND.2017.06.008.
4. 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. doi:10.1017/S1368980013001894.
5. United States Department of Agriculture. National School Lunch Program (NSLP) state data on School Food Authority (SFA) certification submission progress and percent of schools dropping out of the NSLP. 2013:2012. <https://fns-prod.azureedge.net/sites/default/files/School-lunch-chart.pdf>.
6. Food and Nutrition Services US Department of Agriculture. *Nutrition Standards in the National School Lunch and School Breakfast Programs. Final Rule*. Vol 77.; 2012.
7. Tabak RG, Moreland-Russell S. Food Service Perspectives on National School Lunch Program Implementation. *Heal Behav Policy Rev*. 2015;2(5):362-371. doi:10.14485/HBPR.2.5.4.
8. Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Rev*. 2004;62(1):1-17.
9. Ledoux TA, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obes Rev*. 2011;12(5):e143-50. doi:10.1111/j.1467-789X.2010.00786.x.
10. Hu T, Jacobs DRJ, Larson NI, Cutler GJ, Laska MN, Neumark-Sztainer D. Higher Diet Quality in Adolescence and Dietary Improvements Are Related to Less Weight Gain During the Transition From Adolescence to Adulthood. *J Pediatr*. 2016;178:188-193.e3. doi:10.1016/j.jpeds.2016.08.026.
11. A closer look at current intakes and recommended shifts-2015-2020 Dietary Guidelines - health.gov. <http://health.gov/dietaryguidelines/2015/guidelines/chapter-2/a-closer-look-at-current-intakes-and-recommended-shifts/#subnav-4>. Accessed January 23, 2017.

12. Tufts HR, Harris CS, Bukania ZN, Johns T. Antioxidant and Anti-Inflammatory Activities of Kenyan Leafy Green Vegetables, Wild Fruits, and Medicinal Plants with Potential Relevance for Kwashiorkor. *Evidence-Based Complement Altern Med*. 2015;2015:1-9. doi:10.1155/2015/807158.
13. Epstein LH, Paluch RA, Beecher MD, Roemmich JN. Increasing healthy eating vs. reducing high energy-dense foods to treat pediatric obesity. *Obesity (Silver Spring)*. 2008;16(2):318-326. doi:10.1038/oby.2007.61.
14. Epstein LH, Gordy CC, Raynor HA, Beddome M, Kilanowski CK, Paluch R. Increasing Fruit and Vegetable Intake and Decreasing Fat and Sugar Intake in Families at Risk for Childhood Obesity. *Obes Res*. 2001;9(3):171-178. doi:10.1038/oby.2001.18.
15. Chandler I, Rosenthal L, Carroll-Scott A, Peters SM, McCaslin C, Ickovics JR. Adolescents Who Visit the Emergency Department Are More Likely to Make Unhealthy Dietary Choices: An Opportunity for Behavioral Intervention. *J Health Care Poor Underserved*. 2015;26(3):701-711. doi:10.1353/hpu.2015.0086.
16. Cohen S, Janicki-Deverts D, Chen E, Matthews KA. Childhood socioeconomic status and adult health. *Ann N Y Acad Sci*. 2010;1186:37-55. doi:10.1111/j.1749-6632.2009.05334.x.
17. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obes (Silver Spring)*. 2008;16(2):275-284. doi:10.1038/oby.2007.35.
18. Bere E, Van Lenthe F, Klepp KI, Brug J. Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat? *Eur J Public Health*. 2008;18(6):611-615. doi:10.1093/eurpub/ckn081.
19. National CDC, Disease C, Promotion H, Nutrition D, Activity P. Overweight and Obesity Rhode Island State Nutrition, Physical Activity, and Obesity Profile Rhode Island. 2012;(September).
20. Guenther P, Juan W, Lino M, Hizo H, Fungwe T, Lucas M. Diet quality of low-income and higher income Americans in 2003-04 as measured by the Healthy Eating Index-2005. *Nutr*. 2008;2. <http://ddr.nal.usda.gov/handle/10113/33312>.
21. Weiss R, Dziura J, Tamborlane W V, et al. Obesity and the Metabolic Syndrome in Children and Adolescents. *N Engl J Med*. 2004;350(23):2362-2374. doi:10.1056/NEJMoa031049.
22. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA*. 2012;307(5):483-490. doi:10.1001/jama.2012.40.
23. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts:

United States. *Adv Data*. 2000;(314):1-27.

24. “Rhode Island Report from the National Survey of Children’s Health.” NSCH 2011/12. Child and Adolescent Health Measurement Initiative, Data Resource Center for Child and Adolescent Health website. Retrieved 7/24/17 from childhealthdata.org.
25. Dunn C. Nutrition Decisions: Eat Smart, Move More. 2010:412. <https://books.google.com/books?id=pQ0AUIZ9tgoC&pgis=1>.
26. CDC. Childhood Obesity Facts. <https://www.cdc.gov/obesity/data/childhood.html>. Accessed December 27, 2016.
27. Ogden CLL, Carroll MDD, Kit BKK, Flegal KMM. Prevalence of childhood and adult obesity in the United States, 2011-2012. *Jama*. 2014;311(8):806-814. doi:10.1001/jama.2014.732.
28. Bertolia ML, Mukamal KJ, Cahill LE, et al. Changes in Intake of Fruits and Vegetables and Weight Change in United States Men and Women Followed for Up to 24 Years: Analysis from Three Prospective Cohort Studies. *PLoS Med*. 2015;12(9). doi:10.1371/journal.pmed.1001878.
29. Chapman LE, Cohen J, Canterberry M, Carton TW. Factors Associated with School Lunch Consumption: Reverse Recess and School “Brunch.” *J Acad Nutr Diet*. 2017;117(9):1413-1418. doi:10.1016/j.jand.2017.04.016.
30. Price J, Just DR. Lunch, recess and nutrition: Responding to time incentives in the cafeteria. *Prev Med (Baltim)*. 2015. doi:10.1016/j.ypmed.2014.11.016.
31. Smith SL, Cunningham-Sabo L. *Eat Well to Excel: Report to the Coalition of Activity and Nutrition to Defeat Obesity*. Fort Collins, CO; 2011.
32. Yoder ABB, Foecke LL, Schoeller DA. Factors affecting fruit and vegetable school lunch waste in Wisconsin elementary schools participating in Farm to School programmes. *Public Health Nutr*. 2015. doi:10.1017/S1368980015000385.
33. Byker CJ, Farris AR, Marcenelle M, Davis GC, Serrano EL. Food Waste in a School Nutrition Program After Implementation of New Lunch Program Guidelines. *J Nutr Educ Behav*. 2014;46(5):406-411. doi:<https://doi.org/10.1016/j.jneb.2014.03.009>.
34. Hakim SM, Meissen G. Increasing Consumption of Fruits and Vegetables in the School Cafeteria: The Influence of Active Choice. *J Health Care Poor Underserved*. 2013. doi:10.1353/hpu.2013.0109.
35. Wansink B. Change their choice! Changing behavior using the CAN approach and activism research. *Psychol Mark*. 2015;32(5):486-500. doi:10.1002/mar.20794.

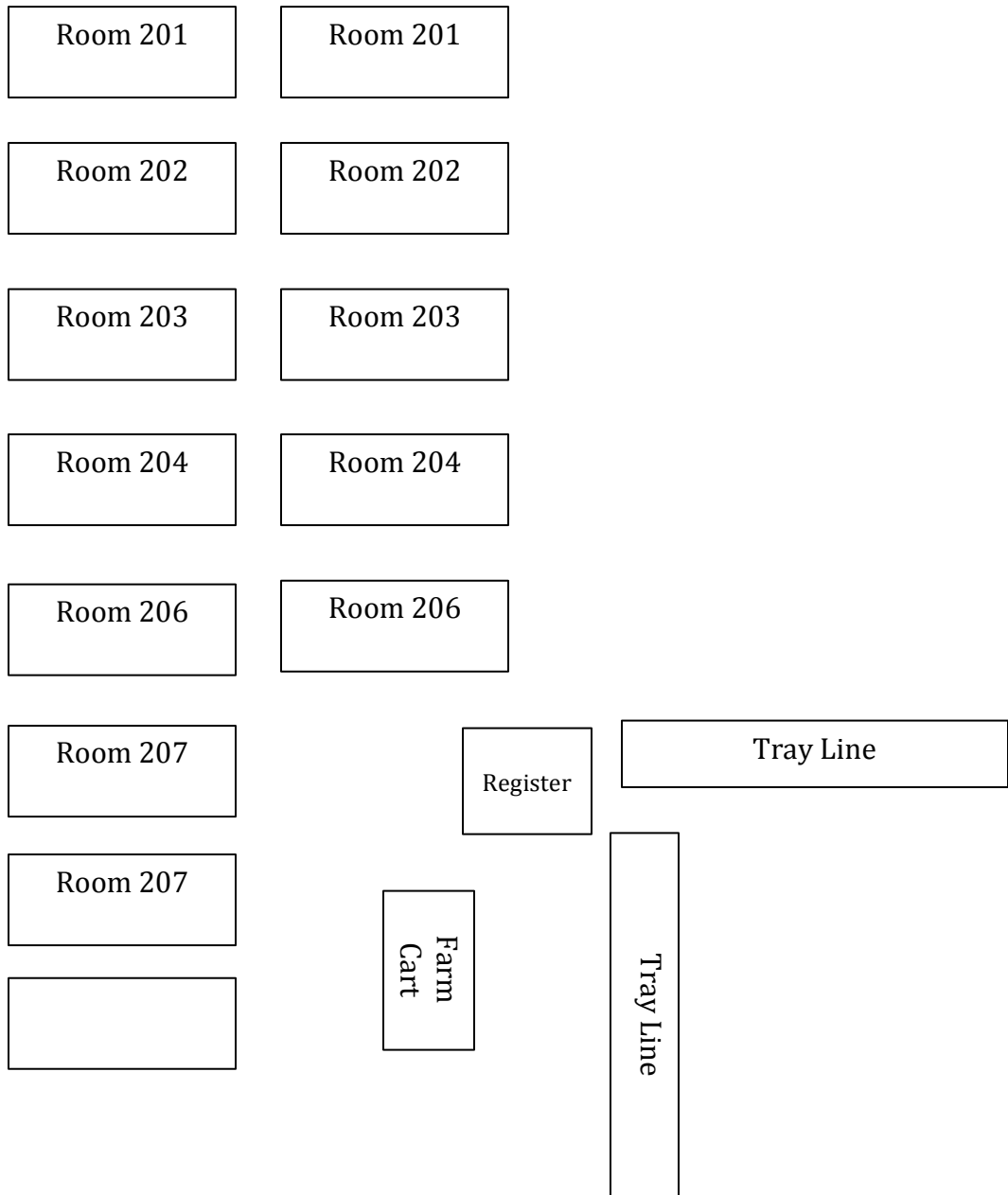
36. Wansink B, Smith LE, Just DR. Cornell's Smarter Lunchroom Initiative: Engineering Smart Selections. *J Nutr Educ Behav.* 2018;42(4):S75. doi:10.1016/j.jneb.2010.03.017.
37. Our Ideas | Smarter Lunchrooms Movement. <http://smarterlunchrooms.org/ideas>. Accessed March 22, 2016.
38. Wansink B, Just D, Smith L. What Is in a Name? Giving Descriptive Names to Vegetables Increases Lunchroom Sales. *J Nutr Educ Behav.* 2018;43(4):S1. doi:10.1016/j.jneb.2011.03.014.
39. Goris AHC, Westerterp-Plantenga MS, Westerterp KR. Underreporting and underrecording of habitual food intake in obese men: Selective underreporting of fat intake. *Am J Clin Nutr.* 2000;71(1):130-134.
40. Zegman MA. Errors in food recording and calorie estimation: clinical and theoretical implications for obesity. *Addict Behav.* 1984;(9):347-350.
41. Bingham, S.A Gill, C Welch, A Cassidy A et al. Epidemiology : Weighed Records V . 24 H Recalls , Food-Frequency. *Br J Nutr.* 1994;72:619-643. doi:10.1079/BJN19940064.
42. Wrieden W, Peace H, Armstrong J, Barton K. A short review of dietary assessment methods used in National and Scottish Research Studies. ... *Gr Monit Scottish Diet* 2003;(September):1-17. <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:A+short+review+of+dietary+assessment+methods+used+in+National+and+Scottish+Research+Studies#0>.
43. Sahota P, Rudolf MC, Dixey R, Hill a J, Barth JH, Cade J. Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. *BMJ.* 2001;323(7320):1029-1032. doi:10.1136/bmj.323.7320.1029.
44. Quittner AL, Modi AC, Lemanek KL, Ievers-Landis CE, Rapoff MA. Evidence-based assessment of adherence to medical treatments in pediatric psychology. *J Pediatr Psychol.* 2008;33(9):916-936. doi:10.1093/jpepsy/jsm064.
45. Goodwin J. Change in fruit and vegetable intake of elementary school students following a nutrition intervention [master's thesis]. Kingston, Rhode Island: The University of Rhode Island;2017.
46. Williamson DA, Allen HR, Martin PD, Alfonso A, Gerald B, Hunt A. Digital photography: A new method for estimating food intake in cafeteria settings. *Eat Weight Disord.* 2004;9(1):24-28. doi:10.1007/BF03325041.
47. Williamson, D.A., Martin, P.D., Allen, H.R., Most, M.M., Alfonso, A.J., Thomas, V. & Ryan DH. Changes in food intake and body weight associated with basic combat training. *Mil Med.* 167(3):248-253.

48. Williamson DA, Allen HR, Martin PD, Alfonso AJ, Gerald B, Hunt A. Comparison of digital photography to weighed and visual estimation of portion sizes. *J Am Diet Assoc.* 2003;103(9):1139-1145. doi:10.1016/S0002-8223(03)00974-X.
49. 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). doi:10.1016/j.jand.2014.02.029.
50. Martin CK, Nicklas T, Gunturk B, Correa JB, Allen HR, Champagne C. Measuring food intake with digital photography. *J Hum Nutr Diet.* 2014;27(SUPPL.1):72-81. doi:10.1111/jhn.12014.
51. Martin CK, Newton RL, Anton SD, et al. Measurement of children's food intake with digital photography and the effects of second servings upon food intake. *Eat Behav.* 2007;8(2):148-156. doi:10.1016/j.eatbeh.2006.03.003.
52. Martin CK, Correa JB, Han H, et al. Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity (Silver Spring).* 2012;20 VN-r(4):891-899. doi:10.1038/oby.2011.344.
53. Lepe S. Process evaluation of an EFNEP-Enhanced PSE intervention in urban schools [master's thesis]. Kingston, Rhode Island: The University of Rhode Island;2017.
54. Martin CK, Thomson JL, LeBlanc MM, et al. Children in School Cafeterias Select Foods Containing More Saturated Fat and Energy than the Institute of Medicine Recommendations. *J Nutr.* 2010;140(9):1653-1660. doi:10.3945/jn.109.119131.
55. Williamson DA, Han H, Johnson WD, Martin CK, Newton RL. Modification of the school cafeteria environment can impact childhood nutrition. Results from the Wise Mind and LA Health studies. *Appetite.* 2013;61:77-84. doi:10.1016/j.appet.2012.11.002.
56. Hubbard KL, Bandini LG, Folta SC, Wansink B, Eliasziw M, Must A. Impact of a Smarter Lunchroom intervention on food selection and consumption among adolescents and young adults with intellectual and developmental disabilities in a residential school setting. *Public Health Nutr.* 2015;18(2):361-371. doi:10.1017/S1368980014000305.
57. Schwartz MB, Henderson KE, Read M, Danna N, Ickovics JR. New School Meal Regulations Increase Fruit Consumption and Do Not Increase Total Plate Waste. *Child Obes.* 2015;11(3):242-247. doi:10.1089/chi.2015.0019.
58. Hanks AS, Wansink B, Just DR. Reliability and accuracy of real-time visualization techniques for measuring school cafeteria tray waste: Validating the quarter-waste method. *J Acad Nutr Diet.* 2014. doi:10.1016/j.jand.2013.08.013.

59. Swanson M. Digital photography as a tool to measure school cafeteria consumption. *J Sch Health*. 2008;78(8):432-437. doi:10.1111/j.1746-1561.2008.00326.x.
60. Hendrie GA, Baird D, Ridoutt B, Hadjikakou M, Noakes M. Overconsumption of Energy and Excessive Discretionary Food Intake Inflates Dietary Greenhouse Gas Emissions in Australia. *Nutrients*. 2016;8(11). doi:10.3390/nu8110690.
61. Lazarte CE, Encinas ME, Alegre C, Granfeldt Y. Validation of digital photographs, as a tool in 24-h recall, for the improvement of dietary assessment among rural populations in developing countries. *Nutr J*. 2012;11(1):61. doi:10.1186/1475-2891-11-61.
62. Amin SA. Impact of the National School Lunch Program on Fruit and Vegetable Selection in Northeastern Elementary. 2013;130(October 2015):2012-2013.

B. TREATMENT SCHOOL CAFETERIA LAYOUT

Entrance



C. CONTROL SCHOOL CAFETERIA LAYOUT

