DISSERTATION

IT'S NOT HEALTHY IF THEY DON'T EAT IT: SCHOOL LUNCH PLATE WASTE AND STRATEGIES TO INCREASE VEGETABLE CONSUMPTION

Submitted by

Stephanie Laine Smith

Department of Food Science and Human Nutrition

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Doctoral Committee:

Advisor: Leslie Cunningham-Sabo

Garry Auld
Mary Harris
Kathleen Kelly

ABSTRACT

IT'S NOT HEALTHY IF THEY DON'T EAT IT: SCHOOL LUNCH PLATE WASTE AND STRATEGIES TO INCREASE VEGETABLE CONSUMPTION

Children's overall health depends, in part, upon food intake that provides sufficient energy and nutrients to support optimal growth and development. Recognizing the important role schools can play ensuring children are well nourished throughout the school day, new nutrition standards for the National School Lunch Program (NSLP) were implemented which place greater emphasis on nutrient-rich fruits and vegetables. To implement the new standards, it is important for school nutrition programs to know what choices students are making, determine students' level of satisfaction with school meals, and then determine what strategies to use to increase consumption of the additional healthful offerings.

The reported study was conducted in two phases with elementary and middle school students from one Northern Colorado School District. The first was a formative assessment designed to 1) evaluate food choices and consumption patterns of elementary and middle school students who participate in the NSLP through plate waste assessment; 2) compare students' average nutrient intake from lunch to NSLP standards; and 3) determine middle school students' satisfaction with school lunch using two validated surveys. Plate waste from elementary and middle school students' (grades 1-8) lunch trays was measured in fall 2010 using a previously validated digital photography method. Percent waste was estimated to the nearest 10%, for the entrée, canned fruit, fresh fruit, vegetable, grain, and milk. Univariate ANOVA determined differences in the percentage of waste between schools, grades, and genders. Daily nutrient intake was calculated using the district's menu analysis program and percent waste. Plate waste

was estimated from 899 lunch trays; 535 elementary and 364 middle school students. Only 45% of elementary and 34% middle school students selected a vegetable. Elementary students wasted more than one third of grain, fruit, and vegetable menu items. Middle school students left nearly 50% of fresh fruit, 37% of canned fruit and nearly a third of vegetables unconsumed. Less than half of students met the national meal standards for vitamins A and C, or iron. Results from the formative assessment revealed few students' lunch consumption met the previous or strengthened NSLP lunch standards. Due to the relatively low intake of vegetables, intake of vitamins A and C were of particular concern.

We also surveyed students from three Northern Colorado middle schools to determine their level of satisfaction with the school lunch experiences using two validated surveys; the *Middle/Junior High School Student Participation Survey* and the *Middle/Junior High School Non-Student Participation Survey,* both developed by the National Food Service Management Institute. Responses from both surveys indicated there are opportunities to gain and retain more students in the lunch program by improving factors related to food quality such as flavor, aroma, visual appeal, and freshness of foods served. By administering these two surveys, school nutrition professionals have an opportunity to learn about their students' preferences and can then prioritize/strategize how best to meet them.

The second phase of this project was an intervention to determine how subtle changes to the cafeteria environment, specifically targeting vegetable intake, affect middle school student selection and consumption of vegetables among middle school students participating in the NSLP. During the 2-year intervention, 2 of 4 participating middle schools (grades 6-8) were randomly assigned as either treatment schools (TS) or control schools (CS). Each semester of the school year was treated as a discreet phase, with one new environmental change added each

semester. In fall of 2011, treatment schools received new tray line signs with student-suggested names and pictures specific for each vegetable item on the menu (e.g., Super-Power Cauliflower). In spring 2012, cafeteria staff added a verbal prompt, asking students without vegetables on their tray if they would like fresh or hot vegetables. In fall 2012, a garden seasoning blend was positively taste-tasted with students, and then added to the California blend (broccoli, cauliflower and carrots) and steamed garden blend (broccoli, zucchini, peppers, beans, cauliflower). In spring of 2013, changes, including signage, verbal prompting, placement, serving container, and increased number of servings offered, were made to the way in which fresh (raw) vegetables were presented and served in the control schools with no changes to the treatment schools. Daily average vegetable servings per meal data were obtained from food production records. Analysis of variance (ANOVA) was conducted to determine differences in vegetable servings per meal pre and post treatment and between schools. Percent vegetable waste, estimated to the nearest 10%, was measured once per month in each school. Two-way analysis of covariance, with gender and grade as covariates, was conducted to determine differences in vegetable waste between treatment and control schools at baseline and two follow-up time points after the intervention was implemented each school year. Statistical significance for all analyses was set at $p < 0.05$.

There was no change in the average vegetable servings chosen in the treatment schools, but a significant decrease occurred in the control schools ($p<0.03$). When vegetable servings were examined by type (fresh versus hot), per meal fresh vegetable servings significantly increased in one treatment school ($p<0.001$). Vegetable waste was high, averaging greater than 50% at 4 of 6 measurement time points across both years in all schools. During both school years, vegetable waste decreased significantly in both treatment and control schools, and the

difference between groups was not significant. Additionally, no gender difference in vegetable waste was observed. However, there was a consistent and significant difference in vegetable waste between grades, with 6th and 7th-grade students wasting significantly more vegetables than 8th-grade students.

Due to their simplicity and low cost, environmental changes have been proposed as options for encouraging students to take and eat more vegetables with lunch. This study suggests middle school students may respond to subtle environmental changes designed to encourage selection of vegetables. However, the strategies used in this project did not have an impact on vegetable waste, most likely because the strategies used did not address vegetable preferences which has been found to be a strong predictor of intake.

Continued efforts to increase the overall selection and consumption of school lunch-served fruits and particularly vegetables, should be a priority for future school based research. A combination of behavioral economics strategies and other interventions such as providing experiential nutrition education and cooking and gardening programs for students, marketing healthy choices, providing opportunities for student involvement in menu development, and creating opportunities for students to try new fruits and vegetables may be more effective together than any single intervention.

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CHAPTER 1: INTRODUCTION

Project Rationale

The overall health of children depends, in part, upon food intake that provides sufficient energy and nutrients to support optimal growth and development.[1] Yet the diets of most American children are not consistent with recommendations of the 2010 Dietary Guidelines for Americans,[2] American Academy of Pediatrics,[3] or Healthy People 2020,[4] particularly for fruits and vegetables. Vegetables contribute significant amounts of many nutrients, such as fiber and potassium, currently under-consumed by American children; their consumption is associated with reduced chronic disease risk; and they displace more energy dense foods in U.S. diets.[5,6,7] Despite these national-level recommendations, consumption continues to fall short for all age groups.[8,9] The percentage of individuals not meeting current intake/consumption recommendations is highest for children and adolescents aged 9-18 years old; over 95% of youth in these age groups do not meet current vegetable recommendations.[6, 8]

Nearly 55 million U.S. children ages 5-19 spend the majority of their day in school.[11] Through federally assisted NSLP and School Breakfast programs (SBP), schools provide 1-2 meals daily and students who participate in NLSP consume up to 35% of their daily energy intake from foods obtained and consumed at school.[12] Students who participate in both the NLSP and SBP consume up to 47% of their daily energy intake from such foods,[12] placing schools in a position to significantly influence children's food choices on a daily basis.

Given the potential impact schools have on food choices, in 2009 the Institute of Medicine (IOM) recommended new meal standards that closely aligned with the Dietary Guidelines for Americans.[13] In 2010, national legislation directed the United States Department

of Agriculture (USDA) to update school meal regulations and align them with the IOM's recommendations.[14] The final school meal standards, released in 2012, limit calories and provide minimum and maximum amount of energy for each age group. The standards also require a serving of fruit and serving of vegetables daily with a weekly requirement for vegetable subgroups (dark green and orange vegetables and legumes).[15] The previous standards required only a fruit or a vegetable and no requirement for vegetable subgroups.[16] Students are required to take a minimum of a fruit or vegetable, whereas, the previous guidelines allowed them to refuse both, if desired.[15] At Houston-area elementary and intermediate schools, researchers observed an increase in fruits and vegetables taken by students with lunch but not the proportion of vegetables consumed after implementing the new guidelines.[17] Results from other investigations indicate a significant amount of fruit and vegetable waste, as high as 75% at middle schools following implementation of the new guidelines.[18,19] Therefore, it remains to be determined if the new meal standards help students improve their dietary intake at school.

The Offer Versus Serve (OVS) provision of the NSLP meal regulations requires all five components to be made available, however, students are only required to take three of them, including either a fruit or a vegetable.[15] This provides students with choice and flexibility but creates a situation where lunches they actually choose and consume may not meet the standards for key nutrients. *It is important for school nutrition programs to know what choices students are making and how much of the school meal they are consuming. Are students selecting, and more importantly, consuming lunches that meet the recommendations specified in the school meals standards based on the HHFKA mandate?* If not, school food authorities must determine how to encourage students to select and consume the additional vegetable and fruit offerings.

If the environment can be altered to encourage selection of more vegetable options, with very little capital investment from the school or district, the changes are more likely to be sustainable.[20,21] Behavioral economics provides a set of tools for encouraging healthier eating behaviors in schools. Behavioral studies of food choices suggest that subtle changes in the food environment may offer novel ways for improving diets and health.[20] By applying these concepts to school meal programs, schools may be able to nudge students toward more healthful options while still providing them with choices.[22]

Choice architecture factors such as spatial arrangements, social atmosphere, the presence and level of distractions, payment options or even lighting are aspects of the environment that have been shown to influence people's food choices and how much they eat.[23] Specific examples of nudges that have been successfully applied in school cafeterias include moving fruit selections or the salad bar to more visible, heavily trafficked areas; displaying healthful foods at eye level or in front of less healthful selections making them easier for students to access; employing a small rewards program for eating fruit or vegetables; and restricting the use of student prepaid debit accounts to federally reimbursable food items and requiring cash for desserts, chips and soda.[20,21,24] For USDA and state agencies, which devote considerable resources to child nutrition programs, findings from behavioral economics research can offer alternative strategies for increasing program effectiveness and increasing the diet quality of program participants while providing them with choices.

The specific aims of this project were to: 1) evaluate food choices and consumption patterns of elementary and middle school students who participate in the National School Lunch Program (NSLP); 2) compare students' average nutrient intake from lunch to NSLP standards; 3) determine middle school students' satisfaction with school lunch; and 4) determine whether

subtle changes in the cafeteria environment affect middle school student selection and consumption of vegetable side items.

Hypotheses

To evaluate food choices and consumption patterns of students who participate in the NSLP, a formative assessment was completed of students' food choices, lunch plate waste, and satisfaction with school lunch. Because these studies, described in chapters 3 and 4, were formative, and therefore exploratory, hypotheses were not developed. For the intervention study described in chapter 5, we hypothesized that subtle, targeted changes in the cafeteria environment would produce higher selection and consumption of vegetables among middle school students participating in the NSLP.

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CHAPTER 2: LITERATURE REVIEW

Health Benefits of Fruit and Vegetable Consumption

Health and nutrition experts have long recognized fruits and vegetables as an important part of a healthy diet. Fruits and vegetables are key sources of a number of essential vitamins and minerals under consumed in the U.S., including folate, magnesium, potassium, and vitamins A, C, and K.[1] More recently, fruits and vegetables have been recognized as sources of phytochemicals, such as polyphenolics, especially antioxidants.[2] Additionally, fruits and vegetables are recommended as an important source of dietary fiber.[2] While fruits and vegetables are often good sources of these key nutrients, the overall nutritional contribution of specific fruits and vegetables can vary widely.[2,3] Fruit and vegetable content of phytochemicals and antioxidants also varies greatly.[3] For this reason, population-based dietary guidance has historically recommended people eat a variety of fruits and vegetables daily. In fact, the 2010 DGA defines an optimal diet as one that includes 2 cups of fruit and 2 ½ cups of vegetables each day and has weekly contributions from the vegetable subgroups; dark green vegetables, red and orange vegetables, beans and peas, starchy vegetables and all other vegetables.[4]

Fruit and vegetable intake has been associated with numerous positive health outcomes; these include reduced risk for chronic disease. Both clinical trials and epidemiological studies support a dietary pattern high in fruit and vegetables to reduce the risk of cardiovascular disease (CVD).[5,6,7,8] Results from the first Dietary Approaches to Stop Hypertension Trial (DASH), demonstrated that following a dietary pattern rich in fruits and vegetables, significantly lowered blood pressure, a risk factor for cardiovascular disease.[6] The DASH eating pattern has also been associated with lower blood cholesterol levels and improved insulin action.[9,10] There is also

strong evidence epidemiological evidence of a protective role for fruits and vegetable in the prevention of CVD.[11,12] In a population-based cohort study in the Netherlands, higher consumption of fruit and vegetables was protective against CHD incidence.[8] The risk of CHD was 34% lower for participants with a high intake of total fruits and vegetables compared with participants with a low total fruit and vegetable consumption. Hu examined results from a number of prospective cohort studies of CVD and consumption of fruit, vegetables, nuts and whole grains and determined high consumption of these foods is associated with a significantly lower risk of coronary heart disease and stroke.[12]

Most vegetables and fruits, when prepared without added fats or sugars, are relatively low in calories. Replacing higher calorie, energy-dense foods with fruits and vegetables, which are less energy dense, may help adults and children achieve and maintain a healthy weight.[13,14] Verrnamecelli et al. tested the impact of increased fruit and vegetable consumption and emphasized substituting fruit and vegetables for high-fat, high-energy foods in a 3-month randomized trial.[13] Results indicated the intervention was associated with reduced dietary energy density and the change in vegetable intake was significantly related to reduction in body weight. However, simply advising people to eat more fruits and vegetables has not been found to reduce body weight.[15] Therefore, interventions that lower dietary energy density by means of increasing fruit and vegetable intake and decreasing consumption energy-dense foods may be an effective strategy for reducing childhood obesity.[12, 14]

Dietary Recommendations for Fruits and Vegetables

While the 1980 and 1985 DGA did not contain a specific guideline for fruit and vegetable intake, eating a diet rich in fruits and vegetables was suggested throughout both sets of DGA as a way for Americans to meet the guidelines.[16] In 1990, fruits and vegetables received a more

specific guideline of "Choose a diet with plenty of fruits, vegetables and grain products."[17] All future revisions of the DGAs have included a guideline specifically encouraging all Americans to increase fruit and vegetable intake. The 2010 DGA were even more specific regarding vegetable intake, recommending weekly contributions from the vegetable subgroups; dark green vegetables, red and orange vegetables, beans and peas, starchy vegetables and all other vegetables.[4] The proposed recommendations from the 2015 Dietary Guidelines Advisory Committee (DGAC) continues the emphasis on increasing fruit and vegetable intake. According to their recently published report, fruit and vegetables were the only foods that were consistently associated with a positive impact on cardiovascular disease, body weight, type 2 diabetes, cancer, congenital anomalies, and bone health.[18]

Healthy People 2010 included two objectives related to fruit and vegetable intake; 1) increase the proportion of persons aged 2 years and older who consume at least two daily servings of fruit; and 2) increase the proportion of persons aged 2 years and older who consume at least three daily servings of vegetables, with at least one-third being dark green or orange vegetables. Building on the 2010 objectives, Healthy People 2020 designated total vegetable intake for individuals 2 years and older as a Leading Health Indicator objective.[19] Leading Health Indicators are a subset of objectives to communicate high-priority health issues. The Healthy People 2020 goal for total vegetable intake for all Americans is 1.14 cup equivalent per 1,000 calories. While not designated as an LHI, Healthy People 2020 also calls for an increase in the contribution of dark green vegetables, red and orange vegetables, and beans and peas to the diets of those aged 2 years and older. Healthy People 2020 also recommends an increase in the contribution of fruits to the diets of the population aged 2 years and older, specifically aim for .90 cup equivalent per 1,000 calories.

As a result of these federal level recommendations and objectives, considerable resources have been allocated toward increasing American's fruit and vegetable consumption. Programs such as USDA's Fresh Fruit and Vegetable Program,[20] Team Nutrition,[21] the National School Lunch Program (NSLP), [22] School Breakfast Program,[23] and Fruits and Veggies More Matters,[24] have all worked toward increasing Americans fruit and vegetable intake. Despite these well-known federal-level recommendations and considerable effort to increase American's fruit and vegetable intake, consumption has continued to fall short for all age groups.[25–27] The percentage of individuals not meeting current recommendations is highest for children aged 9-13 and 14-18 years old; over 95% of the children in these age groups do not meet current vegetable recommendations.[26,28] The high percentage of school aged children not meeting the federal recommendations is concerning because several studies have shown that children's intake of fruits and vegetables tracks into adolescence.[27, 28] Adolescence may be a particularly critical time to influence fruit and vegetable intake because nutrient needs are high to support rapid growth.[31] Additionally, dietary patterns developed during childhood and adolescence may persist into adulthood.[32]

Contribution of School Meals

Schools can play an important role helping children meet current dietary recommendations and ensure they are well nourished throughout the school day. Nearly 55 million U.S. children ages 5-19 spend the majority of their day in school.[33] Through the federally funded NSLP and School Breakfast Program, schools provide 1-2 meals daily and sometimes snacks. Students may consume up to 47% of their daily energy intake at school,[22,23] placing schools in a position to influence children's food choices on a daily basis and potentially shape lifelong eating habits. In fact, several studies have reported that students who participate in the

NSLP have better nutrition intakes at lunch and consume a greater variety of dairy, fruits, vegetables, and whole grains thank students who bring lunches from home.[33, 34]

Given the potential impact school meals may have on children's nutrition, several federal policy and regulatory changes have been aimed at helping schools create a more healthful school food environment. Foremost among these was passage of the Child Nutrition and WIC Reauthorization Act in 2004, which made it mandatory for every U.S. school district participating in the NSLP and/or School Breakfast Program to create a local school district wellness policy.[36] In their 2005 report, *Preventing Childhood Obesity: Health in the Balance*, the Institute of Medicine (IOM) recommended schools serve as a primary setting for implementing strategies to improve children's eating behavior.[37] In 2007, the IOM issued guidelines regarding appropriate nutrition standards for the availability, sale content and consumption of foods and beverages in schools, specifically those offered in competition with federally reimbursable meals and snacks.[38] These standards include setting limits on the amount of fat, saturated fat, trans fat, added sugar, sodium and total calories in any food sold at school outside of the meal program. The report also recommended limiting the sale of foods of minimal nutritional value in high schools and only after school.

In 2010, the IOM published recommendations for revised nutrition standards and meal requirements for the NLSP and School Breakfast Programs that are closely aligned with the 2010 Dietary Guidelines for Americans.[39] The Healthy, Hunger-Free Kids Act of 2010 required USDA to update federal requirements for the content of school lunches based on the IOM's 2010 recommendations.[40] In 2012, USDA issued the new standards which: 1) required NSLP lunches to include both fruit and vegetable choices and increased the amount of fruits and vegetables served; 2) emphasized whole-grain rich foods; 3) required only low fat and nonfat milk; 4)

limited calories and reduced saturated fat and sodium.[41] A summary of these changes for school lunches is provided in Table 2.1.

USDA required implementation of these new standards for all schools for the 2012-2013 school year. The new regulations also allowed "offer versus serve" fruit and vegetable serving options. Although students may decline two of the five lunch components, they must select at least one serving of fruit or vegetables as part of their meal. While these policy recommendations were positive steps toward improving student wellness, taken in totality, they represented significant changes schools must make in their overall environment. The Healthy Hunger Free Kids 2010 also did not directly address strategies to improve consumption, leading to questions of whether increased fruit and vegetable availability translates to increased intake or increased waste.

Waste of fruits and vegetables is often a concern given their relatively high cost and low consumption rates. Results from a number of investigations indicate a significant amount of fruit and vegetable waste, as high as 75% at middle schools following implementation of the new guidelines.[39, 40] Cohen et al. found middle school students discarded roughly 60-75% of the vegetables on their trays.[42,44] This level of waste is similar to that reported in a recent study of Boston-area middle schools where students were throwing away 75% of the vegetables they selected for lunch.[45] Hakim and Meissen noted a range of vegetable waste of 59-71%. [46] At Houston-area elementary and intermediate schools, researchers observed an increase in fruits and vegetables taken by students with lunch but not the proportion of vegetables consumed after implementing the new guidelines.[47] Swartz and colleagues observed increased fruit selection, (54% to 66%), but a drop in the proportion of students who chose a vegetable (68% to 52%), however, students selecting vegetables ate 20% more of them.[48] The results from these studies

indicate there may still be high levels of vegetable waste, depending on the geographic area, and may warrant more attention. Therefore, it remains to be determined if the new meal standards help students improve their dietary intake at school.

Table 2.1: Previous (prior to January 2012) and Current NSLP Regulatory Requirements (after January 2012) for Grades K-12. Amount of Food per Week (Minimum per Day)

Food Group	Previous Requirement	Current Requirement
Fruit and Vegetables	½ - ¾ cup of fruit and vegetables combined per day	¾ - 1 cup of vegetables Plus ½ - 1 cup of fruit per day
Vegetables	No specifications as to the type of vegetable subgroup	Weekly requirement for: • dark green • red/orange • beans/peas (legumes) • starchy • other (as defined in 2010 Dietary Guidelines)
Meat/Meat Alternate	1.5-2oz equivalent (daily minimum)	Grades: K-5: 1 oz. equivalent daily (8-10 oz. per week) Grades 6-8: 1 oz. equivalent daily (9-10 oz. weekly) Grades 9-12: 2 oz. equivalent daily (10-12 oz. weekly
Grains	8 servings per week (minimum of 1 serving per day)	Grades: K-5: 1 oz. equivalent daily (8-9 oz. per week) Grades 6-8: 1 oz. equivalent daily (8-10 oz. weekly) Grades 9-12: 2 oz. equivalent daily (10-12 oz. weekly
Whole Grains	Encourage	All whole grains must be whole grain rich
Milk	1 cup Variety of fat contents allowed; flavor not restricted	1 cup Must be fat-free (unflavored/flavored) or 1% low fat (unflavored)
Other Specifications: Daily Amount Based on the Average for a 5-Day Week		
Min-Max calories	785 min with 825 as optional for grades 7 and 8	Grades K-5: 550-650 Grades 6-8: 600-700 Grades 9-12: 750-850
Saturated fat (%of total calories)	< 10% of total calories	< 10% of total calories
Trans fat	No limit	Zero grams per serving

Source: The USDA[41]

School-Based Interventions to Promote Fruit and Vegetable Intake

Evans et al. conducted a meta-analysis, aimed at quantifying the impact of school-based interventions on fruit and vegetable intake, of 21 school-based interventions in children aged 5-12 in 10 countries, finding no change in vegetable intake.[49] The studies included in the review used a number of strategies such as classroom based curricula, social marketing, home-based projects, and free fruit and vegetable distribution. While this meta-analysis reviewed studies conducted in elementary school children, this review highlights the challenges encountered when trying to change vegetable consumption in children. The HEALTHY study implemented changes likely to reduce the risk of overweight, obesity, and type 2 diabetes in 42 middle schools across the US, over five semesters.[50] Changes were made to the total school food environment including cafeteria meals, after-school snacks, a la carte venues, vending machines, fundraisers, classroom parties and celebrations with increasing fruit and vegetable consumption as one of the strategies targeted. At the conclusion of the study, no measureable change in vegetable intake was observed. Similar to the HEALTHY study, the TEENS (Teens Eating for Energy and Nutrition at Schools) was a school-based intervention study to evaluate the effectiveness of classroom, school wide, and family programs with one of the primary goals to increase fruit and vegetable intake among middle school students.[51] Based on 24-hour recalls, students in the TEENS intervention schools did not significantly increase their fruit and vegetable intake at the end of the 1-year intervention.

More recently, school garden-based nutrition education programs have shown promising results as a means of increasing vegetable preference and consumption.[52–54] A review of garden-based youth nutrition programs suggests they have the potential to improve students' vegetable preferences and promote improved fruit and vegetable intake.[54] Ratcliffe et al. observed an

increase in vegetable preference, consumption, and variety of vegetables eaten among middle school students who participated in garden-based nutrition education.[53] Also, a meta-analysis examining the efficacy of garden-based nutrition education programs found gardening increased vegetable consumption in children, whereas the impacts of just nutrition education programs were marginal to non-significant.[52]

Behavioral Economics – A Different Approach

The previously discussed school-based interventions, particularly school garden-based education programs, utilized multiple strategies, requiring extensive resources and cooperation from multiple stakeholders. The discipline of *behavioral economics* provides a set of tools for encouraging healthier eating behavior in schools that can be of low or no cost to the school nutrition program and without the conscious knowledge of participants.[55,56] Behavioral studies of food choices suggest that subtle changes in the food environment may offer novel and sustainable ways for improving diets and health. These subtle changes can also be thought of as elements of *choice architecture*—the context in which individuals make decisions.[55] A *nudge* is any aspect of choice architecture that alters an individual's behavior in a predictable manner without eliminating or forbidding any options.[57] By applying these concepts to school meal programs, the inadvertent signals that school cafeterias may send that trigger less nutritious eating can be identified and altered, without resorting to the draconian measures of banning foods that have been deemed unhealthy.[55] Another advantage of leveraging behavioral economics to alter choice architecture in a school cafeteria, thereby nudging students toward the more healthful choice, is that it may require only slight modifications to current cafeteria environment and can be made with very little investment.

Choice architecture factors such as *spatial arrangements, social atmosphere, the presence and level of distractions, payment options or even lighting* are aspects of the environment that have been shown to influence people's food choices and how much they eat.[55] Specific examples of nudges that have been successfully applied in a school cafeteria setting include *moving fruit selections*[56,57] *or the salad bar* to more visible, heavily trafficked areas; displaying *healthful foods at eye level* or in front of less healthful selections making them easier for students to access; *using verbal prompts to encourage a healthier choice*,[56,58] and *restricting the use of student prepaid debit accounts* to healthier foods and *requiring cash for desserts, chips and soda*. For the United States Department of Agriculture, state agencies and school food authorities, which devote considerable resources to child nutrition programs, findings from behavioral economics research can offer alternative strategies for increasing program effectiveness and increasing the diet quality of program participants while providing them with a variety of choices.[59]

Summary

The health benefits of a diet rich in fruits and vegetables for all age groups are well established. As a result, federal dietary recommendations, such as the Dietary Guidelines for Americans and Healthy People 2020, continue to place a great deal of emphasis on promoting fruit and vegetable intake among Americans. Yet, American's fruit and vegetable intake, particularly for adolescents, continues to fall short of recommendations. School-based nutrition education programs using a variety of educational tools and strategies, many requiring extensive time and resources to execute, have shown mixed results at best. In an effort to encourage greater fruit and vegetable intake from school lunches, the USDA revised the NSLP guidelines to put more fruits and vegetables on students' trays. However, school food authorities are concerned

the additional servings will be simply discarded by students and increase waste. Thus, the principles of behavioral economics were used to guide the development of the cafeteria strategies described in this middle school intervention to try to increase vegetable intake.

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CHAPTER 3: FOOD CHOICE, PLATE WASTE AND NUTRIENT INTAKE OF ELEMENTARY AND MIDDLE-SCHOOL STUDENTS PARTICIPATING IN THE US NATIONAL SCHOOL LUNCH PROGRAM[1]

Summary

Objective: To 1) evaluate food choices and consumption patterns of elementary and middle school students who participate in the National School Lunch Program (NSLP) and, 2) compare students' average nutrient intake from lunch to NSLP standards.

Design: Plate waste from elementary and middle school students' lunch trays was measured in fall 2010 using a previously validated digital photography method. Percent waste was estimated to the nearest 10%, for the entrée, canned fruit, fresh fruit, vegetable, grain, and milk. Univariate ANOVA determined differences in percent waste between schools, grades, and genders. Daily nutrient intake was calculated using the district's menu analysis and percent waste.

Setting: Elementary and middle schools in northern Colorado (U.S.)

Subjects: Students, grades 1-8

Results: Plate waste was estimated from 899 lunch trays; 535 elementary and 364 middle school students. Only 45% of elementary and 34% middle school students selected a vegetable. Elementary students wasted more than a third of grain, fruit, and vegetable menu items. Middle school students left nearly 50% of fresh fruit, 37% of canned fruit and nearly a third of vegetables unconsumed. Less than half of students met the national meal standards for vitamins A and C, or Fe.

[1] Published in *Public Health Nutrition*. 2014, 17(6):1255-1263

Conclusions: Few students' lunch consumption met previous or new, strengthened NSLP lunch standards. Due to the relatively low intake of vegetables, intake of vitamins A and C were of particular concern. Effective behavioral interventions, combined with marketing, communications and behavioral economics, will likely be necessary to encourage increased vegetable intake to meet the new meal standards.

Introduction

The overall health of children depends, in part, upon food intake that provides sufficient energy and nutrients to support optimal growth and development.[1] Yet diets consumed by most United States (U.S.) children are not consistent with the Dietary Guidelines for Americans.[2] Children's consumption of fruits, vegetables, whole grains and low-fat and fat-free dairy are substantially less than current recommendations, resulting in shortfall intakes of several key nutrients in particular, calcium, potassium, fibre, magnesium and vitamin E.[3] Additionally, intakes of discretionary calories from solid fats and added sugars considerably exceed recommendations.[3]

More than 55 million U.S. children ages 5-19 years spend the majority of their day in school.[4] Through the federally assisted National School Lunch Program (NSLP) and School Breakfast programs (SBP), schools provide up to two meals and often snacks daily. In 2011, the NSLP served lunch to more than 31 million children each day.[5] Students who participate in both the NLSP and SBP may consume up to 47% of their daily energy intake from school meals/snacks, placing schools in a position to significantly influence children's food choices and diet quality on a daily basis.[6]

Under the previous standards, enacted by the Child Nutrition and WIC Reauthorization Act of 2004 (CNR)[7] of national child nutrition programs, school lunches were planned to provide

children with one-third of the recommended dietary allowance (RDA) of protein, calcium, iron, and vitamins A and C from 5 required meal components: 2oz. meat/meat alternate, 8 oz. milk, 1 serving of grain (whole grains are encouraged), and 2 servings (total of 3/4 cup) of fruit or vegetable.[8] According to the Third School Nutrition Dietary Assessment Study,[9] over 85% of U.S. public schools offered lunches that met the standards for these key nutrients. However, fewer than one-third of these schools offered lunches that met the standard of less than 30 percent of calories from fat or less than 10 percent from saturated fat.[10]

Recognizing there were still improvements to be made, in 2009 the Institute of Medicine (IOM) recommended new meal standards that closely aligned with the Dietary Guidelines for Americans.[11] In 2010, national legislation directed the United States Department of Agriculture (USDA) to update school meal regulations and align them with the IOM's recommendations.[12] The final school meal standards, released in 2012, limit calories and provide minimum and maximum amount of energy for each age group.[13] The standards also require a serving of fruit and serving of vegetables daily with a weekly requirement for vegetable subgroups (dark green and orange vegetables and legumes). The previous standards required only a fruit or a vegetable and no requirement for vegetable subgroups.[8] Students will also be required to take a minimum of a fruit or vegetable, whereas, the previous guidelines allowed them to refuse both, if desired. Fifty percent of grain foods must be whole grains. The new meal standards should help students improve their dietary intake at school, if the additional components are chosen and consumed. The Offer Versus Serve (OVS) provision of the NSLP meal regulations requires all five components to be made available, however, students are only required to take three of them. This provides students with choice and flexibility but creates a situation where lunches they actually choose and consume may not meet the standards for key nutrients.[14]

To implement the new standards, it is important for school nutrition programs to know what choices students are making and determine how to encourage students to select the additional vegetable and fruit offerings. Therefore, the purpose of this study was to: 1) evaluate consumption patterns and food choices (via plate waste) of northern Colorado elementary and middle school students who participated the NSLP and, 2) compare students' average nutrient intake from lunch to the 2004 (CNR) lunch standards and the new (Healthy Hunger-Free Kids Act, HHFKA) school meal standards.

Methods

Subjects

Students from three elementary schools and two middle schools in one northern Colorado district participated in this study in fall of 2010. The district's population of more than 15,000 students was 77% White, 18% Hispanic, 1.2% Asian, and 0.9% African American. Approximately 35% of students were eligible to receive free or reduced price meals and 49% of all students ate lunch at school. Average daily school lunch participation was 70% for elementary schools and 57% for middle schools. Elementary school participants were children in grades 1 through 5 and middle school participants were in grades 6 through 8.

Up to 185 students at each school were randomly selected using the district's cashiering and account management system (WinSnap, version 2.6.4 2010, SLTech, Santa Monica, CA) from those who regularly participate in the NSLP. Use of this database also allowed selection of similar numbers of boys and girls and students in each grade level. Cafeteria managers flagged selected students in the point-of-sale system so that cashiers were alerted when a selected student purchased a NSLP lunch.

At no time were individual students associated with particular lunches and no personal identifying information about students was collected other than gender and grade. No photographs of students were taken as part of this research. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the [name of the ethics committee removed for blinding].

Procedure

Elementary and secondary lunch menus for October and November 2010 (the months corresponding to plate waste assessment) were obtained from the district. The district used a 4-week cycle menu. Menus were analyzed by district nutrition services staff using Nutrikids menu planning and nutrient analysis software (LunchByte Systems, Inc., v12.0, Rochester, NY) which provided daily and monthly averages (based on portion values) for energy, protein, fibre, sodium, vitamins A and C, calcium, iron, total and saturated fat. All schools utilized the OVS provision.

Plate Waste Measurement

Plate waste measures were conducted over five days in each elementary school and four days in each middle school using a previously validated digital photography method.[15-17] A digital camera (Fuji FinePix Z10fd, 7.2 MP with optical zoom, Tokyo, Japan) was mounted on a tripod 26 inches above lunch trays and angled down at approximately 45 degrees. Five servings of each pre-portioned menu item (entrees, fruits, vegetables, and breads) were obtained from the cafeteria each day, arranged on trays, and photographed. These reference photographs were used for comparison to the post-consumption photographs of each student's tray. After photographing the reference foods, they were packed in a cooler and taken back to a lab and weighed on a calibrated digital scale (A&D, SK-2000D, Seoul, Korea). The average weight of the five portions

for each food item was recorded to the nearest 0.1 grams and served as the standard when estimating the weight of food consumed. Of the 130 food items for which five portions were collected, only eight had a standard deviation greater than 10% of the mean indicating little variation between reference samples.

As students walked through the serving line and made their selections, the district's electronic point-of-sale and account management system alerted the lunch cashier if a student had been selected to have his/her tray photographed after consumption. A research assistant obtained verbal assent from the student. On a small index card, pre-printed with the date and lunch menu, a research assistant placed a check mark by the foods selected, recorded gender and grade then affixed the card to the student's tray. When students finished eating, they took their trays to the photography station for post-consumption photographs. Trays were placed on a reference board to assure consistent position of all trays in the camera frame. Prior to taking the post-consumption picture, research assistants re-positioned remaining food items and containers on the trays to ensure all items were visible in the photograph. For example, napkins and utensils were removed and if the student had combined the waste of two or more foods, they were separated if possible. Beverage waste was poured into a liquid measuring cup and ounces remaining were recorded.

Each day of data collection, approximately 20% of post-consumption student trays were packed and carried back for weighing. The weight of each remaining (uneaten) food item was divided by the average weight of the five reference portions to calculate percent of food wasted. This number was compared to the result of visual plate waste estimation as a confirmation of observer reliability. There was 92% agreement between the weighed trays and those estimated visually from post-consumption photographs.

Data Analysis

The percentage of students selecting each menu item was calculated from the frequency and total number of students whose trays were photographed. Percent waste was estimated for menu items categorized as entrée, canned fruit, fresh fruit, vegetable, grain, and milk. The entrée was typically a combination food that included a meat/meat alternate with a grain and/or vegetable. Since it was not possible to separate the individual components, the entrée was evaluated as one item. Canned fruit and fresh fruit were evaluated and reported separately because some students selected both and wasted different amounts of each. Grains were evaluated separately only if they were offered as an individual menu item choice, such as a breadstick or dinner roll.

Two trained analysts simultaneously reviewed the post-consumption photographs alongside the reference food photographs and determined the proportion of each food item wasted to the nearest 10% increment. Differences in observations greater than 20% for any food item were resolved by reviewing photographs of similar weighed trays alongside the reference tray photographs and student tray in question. Consensus was reached when estimates from each observer were within 10% of each other and the average was recorded.

Percent of each food item wasted was entered into an Excel spreadsheet and imported into Statistical Package for the Social Sciences (SPSS), version 9.2, 2008 for Windows (SPSS, Inc., Chicago, IL). Descriptive statistics (frequency, mean and standard deviation (SD) were calculated for percent waste of each food item. Univariate analysis of variance (ANOVA) was conducted to determine differences in percent plate waste between genders, schools, and grades. Differences were determined to be statistically significant at $p \leq 0.05$. The percent of each food item consumed was determined based on the percent wasted and merged with the school

district's nutrient analysis data using Statistical Analysis Software (SAS), version 9.2 for Windows (SAS Institute, Inc., Cary, North Carolina). Average lunch nutrient intake per student for energy, protein, fibre, sodium, vitamins A and C, calcium, iron, total fat, and saturated fat was calculated by multiplying the percent consumed by the nutrient values for each food item. Percentages were used to describe the proportion of students meeting or exceeding the 2004 CNR meal standards[8] and the HHFKA meal guidelines.[13] The final HHFKA school meal nutrition recommendations direct districts to use a food-based menu planning approach and recommend specific nutrient targets for energy, percent of energy from saturated fat, and Na.[13] Since the HHFKA final meal standards did not provide nutrient targets for total protein, calcium, iron, vitamins A and C, and dietary fiber, the recommendations from IOM[11] were used.

Results

The characteristics of the participating schools are provided in Table 3.1. Elementary schools B (ES B) and C (ES C) had a higher percentage of students who qualify for free and reduced priced meals than elementary school A (ES A). ES B scheduled recess before lunch for grades 3-5 only and ES C scheduled recess after lunch. All elementary schools provided 20 minutes per grade for the students to eat lunch.

Table 3.1: School Characteristics

	Elementary Schools			**Middle Schools**	
	A	**B**	**C**	**A**	**B**
Percent eligible for free/reduced price lunches	35	60	64	49	30
NSLP Participation (percent)	63	75	77	74	66
Recess before lunch	Yes	Grades 3-5	No	N/A	N/A
A la carte foods	No	No	No	Yes	Yes
Lunch length (minutes/grade)	20	20	20	30	30

NSLP, National School Lunch Program

The two middle schools (MS A and MS B) had 49% and 30% of students who qualify for free and reduced priced lunches respectively. They had similar cafeteria layouts, each with three tray lines from which students could purchase lunch. Both schools had limited availability of a la carte items, such as baked chips, small cookies, bottled water and fruit soda. The schools differed in their lunch schedules. MS A had three 30-minute lunch periods, one for each grade. MS B had two 30-minute lunch periods, with the 7th grade divided between the lunch periods.

A total of 899 students, 535 elementary students and 364 middle school students participated in this study. Of the elementary school students, 50.5% were males with 18.9%, 20.9%, 20.2%, 20.4%, and 19.6% from grades 1 through 5 respectively. Of the middle school students, 53.8% were males with 35.2%, 32.7%, and 32.1% from grades 6 through 8 respectively.

A variety of food choices were offered on the district menus. Elementary students could choose from 3 different entrees (1 hot option, a deli sandwich or a 3rd cold option, such as an entrée salad), two fruits (one canned and one fresh), a vegetable, and low fat or fat free white or fat free chocolate milk for lunch daily. MS students had a daily choice of four entrees (2 hot options, a deli sandwich or entrée salad), canned and fresh fruit, and hot and fresh vegetables. In both elementary and middle school, at least half the grain items served were whole grain and often incorporated into the entrée. Low fat white, fat free white and fat free chocolate milk were available daily at MS as well. For both ES and MS menus, the monthly average for energy was below the 2004 CNR meal standards, however, they met or exceeded guidelines for all other nutrient targets. (data not shown).

Table 3.2 shows the number and percent of students who selected each menu item. While all students chose an entrée, less than half of ES and MS students selected a vegetable with

lunch. Students were more likely to select fruit with lunch. When canned and fresh fruit were combined, some students took both and therefore, more than 60% took at least one serving of fruit with lunch. Approximately 96% of elementary students and 82% of middle school students selected milk with their lunch, of which three-quarters was fat free chocolate.

Table 3.2: Number (percent) of elementary and middle school students who selected each menu item

	Elementary School	**Middle School**
Entrée	535 (100)	364 (100)
Canned fruit	320 (59)	189 (52)
Fresh fruit	305 (56)	142 (39)
Vegetable	243 (56)	124 (34
Milk		
Total	512 (96)	297 (82)
Chocolate[1]	417 (78)	262(72)
White[2]	95 (18)	35 (10)

[1]Fat free chocolate milk
[2]White, 1% fat or fat free white milk

The percent of each menu item wasted is provided by school, grade and gender school in Table 3.3. ES students wasted more than one-third of individual grain, canned fruit, fresh fruit and hot and fresh vegetables menu items. Significant differences ($p< 0.05$) in the percent of each menu item wasted were observed between ES A and ES B and ES C. Students from ES A had higher consumption patterns for all menu items when compared to the other two elementary schools. Fourth and 5th grade students wasted one-third to one-half less of each menu item than 1st and 2nd grade students. Males had less waste, and therefore higher consumption, for the entrée, canned fruit, fresh fruit and milk. However, these differences were significant only for the entrée (p=.001) and milk (p<.0001).

Table 3.3: Least-squared mean percent waste and SEM of each lunch menu item by school, grade level, and gender

	Percent Waste											
	Entree		Canned Fruit		Fresh Fruit		Vegetable		Grain		Milk	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Elementary Schools												
Overall	23.8	1.2	37.3	2.2	37.0	2.2	33.6	2.2	44.6	2.5	32.6	1.5
A	20.1[a]	2.1	29.6[a]	3.5	25.2[a]	3.9	24.4[a]	4.2	17.6[a]	4.1	18.2[a]	2.6
B	26.4[a]	2.1	42.0[b]	3.7	43.5[b]	4.0	33.7[a,b]	3.8	64.4[b]	4.9	33.7[b]	2.5
C	24.9[a,b]	2.1	40.5[b]	4.1	42.2[b]	3.4	42.7[b]	3.7	51.8[c]	3.8	45.9[c]	2.6
Grade level												
1	35.7[a]	2.8	48.2[a]	4.9	51.3 [a]	4.9	47.8[a]	5.5	54.7 [a]	5.8	43.0[a]	3.4
2	29.4[a,b]	2.6	41.7[a]	4.5	36.3 [b]	4.5	28.4 [b,c]	4.9	47.1[a,b]	5.5	40.4[a]	3.3
3	23.5[b,c]	2.7	41.8	4.7	41.4 [a,b,c]	5.1	40.3 [b]	4.9	47.5[a,b]	5.2	29.3[b]	3.3
4	17.8[c,d]	2.7	26.7[b]	5.3	34.2[b,c]	4.7	35.1 [b]	4.5	35.0[b]	5.4	25.4[b]	3.2
5	12.6[d]	2.7	28.0[b]	4.7	21.9	21.9	16.5)[c]	5.1	38.7[b]	5.3	25.1[b]	3.3
Gender												
Males	19.6 [a]	1.7	35.1	3.1	36.6	3.0	36.1	3.2	45.6	3.4	23.8[a]	2.1
Females	28.0[b]	1.7	39.5	3.0	37.4	3.1	31.1	3.1	43.6	3.5	41.5[b]	2.1
Middle Schools												
Overall	19.2	1.3	37.6	2.9	47.4	3.7	30.6	3.6	20.0	2.9	21.2	1.8
A	16.4 [a]	1.9	39.4	4.1	49.4	5.5	35.7	6.3	18.7	3.8	22.1	2.1
B	21.9 [b]	1.9	35.8	4.2	45.4	5.0	25.7	4.0	21.7	4.3	20.4	2.1
Grade level												
6	24.0[a]	2.3	39.3	4.8	50.2	6.4	21.5[a]	6.1	16.1	4.9	22.7	2.9
7	20.5[a]	2.3	33.1	5.2	46.2	6.4	39.0[b]	6.1	18.9	5.0	17.5	3.1
8	13.1[b]	2.3	40.3	5.1	45.8	6.5	31.6[a,b]	5.8	25.1	5.0	23.4	3.1
Gender												
Males	17.0	1.8	29.0[a]	4.0	50.1	5.3	30.7	4.8	14.5	4.2	15.8[a]	2.3
Females	21.4	2.0	46.2[b]	4.3	44.7	5.2	30.7	5.0	25.5	3.9	26.6[b]	2.7

SEM, standard error of the mean

[a,b,c,d]Mean values within a column with unlike superscript letters were significantly different ($p<0.05$).

MS students left nearly half of fresh fruit, over one-third of canned fruit and nearly a third of vegetables unconsumed. Students from MS A wasted significantly less entrée than MS B (p=.041). Additionally, there was a difference in vegetable waste between the middle schools, however, due to the low number of students who selected vegetables; this difference was not statistically significant (p=0.19). Eighth grade MS students wasted significantly less of the entrée than 6th (p=.001) and 7th grade students (p=.025). There was a significant difference in waste between MS males and females for canned fruit (p=.004) and milk (p=.002), with females wasting more than males. MS females also wasted more of individual grain foods; the difference trended toward statistical significance (p=.057)

The mean energy intake of ES students was less than both the 2004 CNR and HHFKA guidelines and therefore, very few students met the 2004 CNR or HHFKA targets (Table 3.4). This result would be expected given that the monthly menu average, based on portion values, was below the energy recommendation. The majority of ES students did not exceed the 2004 CNR and HHFKA recommended intakes for percentage of energy from total fat and saturated fat and nearly two-thirds of students met both recommendations for calcium. However, less than half of ES students met the 2004 CNR or HHFKA-recommended nutrient intakes for iron and vitamins A and C. Very few ES students met the new HHFKA recommendations for fiber and most exceeded the limit for sodium (640 mg).

Table 3.4: USDA NSLP guidelines mean of school lunch nutrient intake among ES students (n=535) and percentage meeting the 2004 CNR NSLP guidelines and the HHFKA NSLP guidelines.

Nutrient	2004 CNR Meal Guidelines	HHFKA Meal Guidelines	Mean	Percentage meeting 2004 CNR Guidelines	Percentage meeting HHFKA Guidelines
Energy (kJ)	2,778*	2,301-2,720‡†	1,791	5	11
% Energy from fat	<30	<30§	27	95	95
% Energy from Saturated fat	<10	<10†	10	87	87
Total protein (g)	>10	>15.2§	20	84	72
Ca (mg)	>286	>332§	378	63	61
Fe (mg)	>3.5	>3.4§	2.4	19	21
Vitamin A (RE)	>224	>192§	183	28	31
Vitamin C (mg)	>15	>24§	16	43	21
Dietary fibre (g)	|	>8.5§	4.4	‡	8
Na (mg)	|	640†	785	‡	10

USDA, United States Department of Agriculture
NSLP, National School Lunch Program
ES, elementary school
CNR, Child Nutrition and WIC Reauthorization Act of 2004
HHFKA, Healthy Hunger Free Kids Act of 2010
RE, retinol equivalent
*664 kcal
‡550-650 kcals
†Nutrient targets from the HHFKA final lunch meal pattern
§Nutrient targets from the 2009 IOM recommendations
|No USDA Standard

Similar to ES students, very few MS students met the 2004 CNR guidelines for energy intake, although a higher percentage met the HHFKA energy target (Table 3.5). The majority of MS students did not exceed the 2004 CNR and HHFKA recommended intakes for percentage of energy from total fat and saturated fat. In regards to calcium, approximately half the students met the 2004 CNR recommendation and slightly less than half the students met the HHFKA guideline. Less than one-third of MS students met the 2004 CNR or HHFKA recommended intakes for iron and vitamins A and C. Very few MS students met the HHFKA recommendations for fiber and average sodium intake exceeded the limit (710 mg).

Table 3.5: USDA NSLP guidelines, mean of school lunch nutrient intake among MS students (n=364) and percentage meeting the 2004 CNR meal guidelines and the HHFKA meal guidelines.

Nutrient	2004 CNR Meal Guidelines	HHFKA Meal Guidelines	Mean	Percent meeting 2004 CNR Guidelines	Percent meeting HHFKA Guidelines
Energy (kJ)	3,452*	2,510-2,989‡†	2,223	5	26
% Energy from fat	<30	<30§	28	88	88
% Energy from Saturated fat	<10	<10†	9.8	81	81
Total protein (g)	>10	>32.2§	26	84	27
Ca (mg)	>400	>440§	407	50.1	44
Fe (mg)	>4.5	>5.2§	3.1	13	7
Vitamin A (RE)	>300	>241§	171	15	22
Vitamin C (mg)	>18	>30§	15	27	19
Dietary fibre (g)	|	>8.6§	5.8	‡	6
Na (mg)	|	< 710†	1089	‡	22

USDA, United States Department of Agriculture
NSLP, National School Lunch Program
MS, middle school
CNR, Child Nutrition and WIC Reauthorization Act of 2004
HHFKA, Healthy Hunger Free Kids Act of 2010
RE, retinol equivalent
*825 kcals
‡600-700 kcals
†Nutrient targets from the HHFKA final lunch meal pattern
§Nutrient targets from the 2009 IOM recommendations
|No USDA standard

Discussion

The amount of plate waste reported in this study is consistent with amount of waste found in previous studies that examined plate waste in school lunch programs. Marlette, et al,[18] found an average percent waste of 44% for fruit, 24% for mixed dishes, 15% for milk, and 30% for vegetables among 6th-grade students. The present study found similar results in middle school students, which included 6th-grade, in which they wasted on average 43% of fruit (an average of canned and fresh), 19% of the entrée, and 31% of vegetables. Milk waste was slightly higher in the present study at 21%. However, this represents a difference of less than half an ounce of a

standard eight-ounce carton. A 2010 study of 4th-6th grade students in Louisiana reported 37% of fruits and vegetables combined.[5] This compares to overall waste of 37% of canned fruit, 37% of fresh fruit and 34% of vegetables from elementary students in the present study.

The new HHFKA school meal standards are designed to ensure school meals offered to students align with the current US Dietary Guidelines for Americans,[2] particularly with respect to servings of fruits and vegetables. The new regulations call for an overall increase in the number of fruit and vegetable servings offered to students at lunch, and in the variety of vegetables served each week.[13] Also, unlike in the past, students will be required to take a serving of fruit or vegetable with lunch. These provisions should result in students selecting more nutrient-dense lunches. However, results from the present study indicate this may not be the case. While three-quarters of all students chose fruit (canned and fresh combined) with lunch, close to 40% of these items went uneaten. Of particular concern, less than half of ES and less than 40% of MS students selected either the hot or fresh vegetables. When students did take a vegetable, more than 30% went uneaten. This result is in agreement with national data[19] which reported 96% of schools offered vegetables, however, only 51% of students consumed vegetables with lunch. Thirty-eight percent of those vegetables were categorized as starchy (French fries, white potatoes and corn) and only 6% of students chose orange or dark green vegetables. A recent study of middle school students in Texas found of those students consuming NSLP meals about 40% selected and consumed a fruit serving.[20] About two-thirds of students selected a vegetable, with only 4% choosing a dark green or orange vegetable. When students do not consume the fruit and vegetable servings offered with lunch, they are less likely to meet nutrient targets for vitamins A and C, fibre or iron, as demonstrated by the present study.

Therefore, even when school lunch menus are planned to meet the new HHFKA standards, the lunches students choose and consume may not translate into improved dietary intake.

The OVS provision of the NSLP meal regulations was implemented to provide students with choice and minimize plate waste.[14] However, the influence of OVS on student lunch intake is unclear. A recent study[21] compared fruit and vegetable intake of 4th and 5th grade students in a serve-only and an OVS school. All students at the serve-only school took fruit or vegetables with lunch; only 25-72% of OVS students chose fruit or vegetables. Students at the serve-only school wasted significantly more fruit and vegetables (43-75%) than students at the OVS school, however, OVS students still wasted 20-44% of fruits and vegetables selected with lunch. All schools participating in the current study use OVS and student consumption patterns are similar to those from Goggans et al.[21] While OVS may reduce fruit and vegetable plate waste when compared to serve-only, more needs to be done to encourage students to self-select vegetables and encourage their consumption.

Aside from the entrée, the only other menu item selected by more than 80% of ES and MS students was milk. Previous studies indicate this likely contributed to more than half of students meeting the calcium recommendation.[22,23] More than 70% of ES and MS students who took milk with lunch selected fat free chocolate milk. Data from SNDA III show most (60%) students choose flavored milk.[19] Offering fat free flavored milk is a way to help students meet the new meal standards while staying within fat and calorie targets.[14,24]

ES A students did not waste more than 30% of any menu item and therefore, had significantly better consumption of all menu items than the other two elementary schools. One possible explanation for the difference is the scheduling of recess before lunch, which has been found to influence the amount of food wasted by elementary students.[25] A Washington state

elementary school study found food waste decreased from 40.1% to 27.2% when recess was scheduled before lunch.[25] As a result, the consumption of most vitamins and minerals was significantly greater when recess occurred before lunch. ES A scheduled recess before lunch for all grades, whereas, ES B scheduled recess before lunch only for grades 3-5 and ES C's recess occurred after lunch. While it was not the purpose of the present study to determine the effect of recess scheduling on plate waste, the scheduling of recess before lunch could have had an influence on the reduced plate waste from ES A.

For the first time, the HHFKA meal standards place limits on the amount of sodium in school meals. By 2022, sodium content of American school lunches must be 53% lower than the current national average of 1377 mg for elementary school and 1520 mg for middle school.[13] Sodium reductions will occur incrementally over the next 10 years, with intent of giving schools and industry the opportunity to work together to lower sodium content of school meals. The first incremental reduction takes effect in 2014 with limits of 1230 mg for elementary and 1360 mg for middle school students.[13] While average sodium intake for both ES and MS did not exceed the incremental targets, they did exceed the final 2022 targets of 640 and 710 mg respectively. The sodium limitations could have implications for vegetable intake since any seasoning used to increased vegetable consumption will likely be sodium free. Schools will need to be innovative and partner with food industry to create lower Na products and seasonings that are acceptable to students.

Results of the present study identify the need for multi-faceted nutrition education and marketing strategies to improve students' self-selection and consumption of vegetables with school lunch. An experiential nutrition education program combining cooking in the classroom with ongoing cafeteria reinforcement, improved students' selection and consumption of fruits

and vegetables with school lunch.[26] Children's preferences are strongly linked to fruit and vegetable consumption; therefore, behavioral interventions that increase vegetable preference may also increase consumption.[27,28] A recent review of behavioral interventions to promote intake of fruits and vegetables reported seven studies conducted in children, with three demonstrating a modest (.39 servings/day) but significant increase in fruit and vegetable servings per day.[29] Age-appropriate marketing and communication strategies are another targeted approach for influencing fruit and vegetable consumption.[30] Communication campaigns may be effectively combined with behavioral interventions and provide tailored messaging at the school level, targeting intrinsic and extrinsic motivation to increase fruit and vegetable intake with school lunch.[29] A small number of studies indicate the use of behavioral economic strategies in the school cafeteria, such as food location, lighting, verbal prompts, and convenience lines may promote increased fruit and vegetable intake.[31,32] These strategies used in conjunction with traditional behavioral interventions and communication strategies may help achieve and sustain children's fruit and vegetable intake at recommended levels.

Study Strengths and Limitations

Plate waste assessment of student lunch intake is a strength of this study. Plate waste methodology overcomes the need to rely on students' memory or lack of ability to accurately estimate portion sizes; common limitations of using 24-hour recall with children.[33,34] The digital photography method used in this study has been validated by several previous studies as an accurate and convenient method to assess plate waste.[5,15-17] There was little disruption to usual lunch service, minimizing an unintended influence on plate waste. Lastly, this study provided the school district with valuable information that will help develop further improvements to the school lunch program.

There are several limitations that should be noted. The study was conducted in three elementary schools and two middle schools in Northern Colorado, with primarily white, moderate-income students, limiting generalizability. Also, plate waste was not assessed simultaneously in all schools; therefore, differences in the daily menu may have affected the difference in waste between schools.

Conclusions

The key finding from this study is that ES and MS students are not regularly selecting fruit, and particularly vegetables offered for school lunch. As a result, their lunch consumption does not meet the new national meal standards for vegetable intake and they are falling short of key nutrients including vitamins A and C. As schools implement the provisions of the new national meal standards, they will need to employ several complimentary strategies such as nutrition education, marketing communications, and behavioral economics to ensure students make the most healthful lunch choices.

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CHAPTER 4: SATISFACTION OF MIDDLE SCHOOL LUNCH PROGRAM PARTICIPANTS AND NON-PARTICIPANTS WITH THE SCHOOL LUNCH EXPERIENCE[2]

Summary

Purpose/Objectives: The purpose of this study was to determine middle school students' satisfaction with the school lunch experience, using two validated surveys; the *Middle/Junior High School Student Participation Survey* and the *Middle/Junior High School Student Non-Participation Survey,* both developed by the National Food Service Management Institute (NFSMI).

Methods: A convenience sample of students from three Northern Colorado middle schools participated in a cross-sectional survey administered during the lunch period. Those who ate lunch three or more days per week were asked to take the Participation Survey and those eating school lunch fewer than three days per week were asked to take the Non-Participation Survey. Descriptive statistics and Cronbach's alpha reliability coefficients were calculated. Analysis of variance (ANOVA) was used to determine differences in survey factor means by participants' gender, grade level, and school.

Results: Two hundred eighty-eight Participation Surveys and 185 Non-Participation Surveys were used for analyses. Participation Survey results demonstrated students perceived aspects of the foods served such as visual appeal, aroma and taste as needing improvement. Sixth-graders were more likely to agree than 8th-graders that statements relating to food preference were reasons for eating school lunch (3.47 vs. 2.51, $p<0.0001$). Similarly, more than 50% of Non-Participation Survey respondents agreed or strongly agreed with 6 of 10 food quality statements.

[2] Accepted for publication by the *Journal of Child Nutrition and Management*

Application to Child Nutrition Professionals: Responses from both surveys indicated there are opportunities to gain and retain more students in the lunch program by improving factors related to food quality such as flavor, aroma, visual appeal, and freshness of foods served. By using these two surveys, school nutrition professionals will have an opportunity to learn about their students' attitudes toward and satisfaction with the school lunch program. This will aid them in providing the best possible school lunch environment for their student customers with the most effective use of resources.

Introduction

Diets of middle school children continue to fall short of the U. S. Dietary Guidelines for Americans, particularly for fruit and vegetable intake.[1,2] Participating in the National School Lunch Program (NSLP) may help children aged 12-14 meet dietary recommendations.[3] Several studies have reported that students who participate in the NSLP have better nutrient intakes at lunch and consume a greater variety of dairy, fruits, vegetables and whole grains than students who bring lunches from home.[4,5] Unfortunately, NSLP participation declines as children progress from elementary to middle school and then declines even further when they enter high school.[6–8] Possible factors related to this decrease include growing desires of students to make their own food choices, free from parental influence:[9,10] changing food and taste preferences including a preference for familiar foods off campus, such as fast food restaurants,[10,11] cafeteria food preparation and presentation, and the school food environment.[12]

School food authorities (SFA) have sought input from students to prevent documented decreases in NSLP participation. A variety of methods are available for gathering student feedback, such as focus group discussions or student interviews, however; these may require more time and resources than school food authorities have available. Others may informally

survey students, however; it can be challenging to assure a representative sample of respondents. Also, without using a valid survey with tested questions, confidence in the validity of the results is questionable.

The National Food Service Management Institute (NFSMI) recently developed two surveys; the *Middle/Junior High School Student Participation Survey* and the *Middle/Junior High School Student Non-Participation Survey*. The surveys are designed to assess students' perceptions about and satisfaction with school lunch that can guide improvements to school nutrition programs. Each was developed in two phases. Phase I used student and school nutrition professional focus group discussions to determine specific survey items. Phase II was a two-stage pilot test to refine and validate the surveys. Details about both phases of survey development were previously published elsewhere.[13,14] This study used the final version of both surveys to measure middle school students' satisfaction with the school lunch experience in one Northern Colorado School District.

Methods

Study Design and Cafeteria Settings

This cross-sectional student survey utilized a convenience sample to assess student satisfaction with the lunch program. Table 4.1 displays the NSLP participation of each middle school. Schools B and C had similar cafeteria layouts, each with three tray lines from which students could purchase lunch. Students from School A entered the lunch line in single file then split into two lines to purchase lunch. All three schools had a limited number of a la carte items available, such as baked chips, small cookies, bottled water and carbonated fruit-flavored beverage. The schools differed in their lunch schedules. Schools A and B had three 30-minute lunch periods, one for each grade. School C had two 30-minute lunch periods, with the 7th grade

divided between the lunch periods. Menu items were prepared onsite, and pre-portioned in individual containers with students serving themselves. The Colorado State University Institutional Review Board and school district approved this study.

Table 4.1: National School Lunch Program (NSLP) Demographics of Participating Middle Schools during school year 2010-11.

	School A	School B	School C
School enrollment	645	653	570
FRPL[1] Eligibility (percent of enrollment)			
Free	34.0	40.0	24.0
Reduced	11.0	9.3	7.1
Total free and reduced	45.0	49.3	31.0
ADP[2] (percent of enrollment)	51.7	63.1	50.1

[1]FRPL, Free and reduced price lunch
[2]ADP, Average daily participation
All program data obtained from the district Nutrition Services Department

Description of Survey Instruments Developed by NFSMI

Both the Participation and Non-Participation Surveys consisted of three sections. Section I of each survey contained 24 statements about school lunch program attributes such as food quality, menu choices and variety, service, and the dining area. On the Participation Survey, respondents were asked to use the phrase "When I eat school lunch..," before each statement and then rate their level of agreement on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree).The Non-Participation Survey asked students to use the phrase "My reason for not eating school lunch is that…" before each statement and then rate their level of agreement, also on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree 5=strongly agree). The Non-Participation Survey statements were similar to those on the Participation Survey; however, they were written in the negative. Section II of the Participation Survey asked students to select their top five factors (from 14 provided) why they

eat school lunch. The Non-Participation Survey asked students to select the top five factors (from 14 listed) that would encourage them to eat school lunch more often. Section III of both surveys asked students to provide grade level, the number of times per week they eat school lunch, and gender.

During Phase II of survey development, NFSMI conducted exploratory factor analyses on the statements in Section I of both the Participation and Non-Participation Surveys. Castillo and Lofton verified the reliability of two factors on each survey.[14] On the Participation Survey, the factor "food preference" (α=0.91) related to qualities of the food served that appeal to middle school students and "staff attentiveness" (α=0.87) related to school nutrition staff responsiveness and interaction with students. On the Non-Participation Survey, the factor "food quality" (α=0.92) related to the quality of the food served at lunch and "customer service" (α=0.80) related to the approachability of the school nutrition staff.

Survey Administration

Surveys were administered to students in the school cafeteria during a single lunch period on one day at each participating school. A survey administrator read a brief verbal assent statement explaining the purpose of the survey. The administrator also stated that participation was voluntary and would not impact their grades, and that the results were anonymous. Participant grade and gender were the only demographic characteristics collected.

For administration of the Participation Survey, district nutrition services used point-of-sale software (WinSnap, version 2.6.4, 2010, SLTech, Santa Monica, CA) to generate a list of 75-100 students (balanced by gender and grade level), per middle school, who ate the NSLP meal three or more days a week. Cafeteria managers reviewed the list to confirm the selected students did indeed eat the reimbursable lunch three or more days per week. Each selected

student was flagged in the district's database. On the day of survey administration, as students progressed through the lunch line and paid for their meal, cashiers were alerted by their point-of-sale computer when a flagged student was selected to complete the survey. At that time, the student was directed to a nearby survey administrator, who then read the assent statement and asked the student to complete the survey. Assenting students were given the survey and a #2 pencil and asked to return the completed survey to a survey administrator.

For administration of the Non-Participation Survey, students eating lunch from home were visually identified in the school cafeteria by the absence of a school lunch tray and the presence of a personal lunch bag or cooler. A survey administrator approached those students and asked if they ate the reimbursable meal less than three days a week. Students answering affirmatively were read the assent statement, given a survey and a #2 pencil and asked to return the completed the survey to a survey administrator if they agreed to complete the survey. In an effort to balance grade levels and numbers of males and females completing the Non-Participation Survey, survey administrators were asked to approach a similar number of students from each grade and gender. For both surveys, students were allowed to take the full 30-minute lunch period to complete the survey while eating their lunch.

Data Analysis

Respondents with substantive missing data, poor quality responses (i.e., those who answered all statements neutral or created an obvious pattern/design with their responses on the bubble sheet), or illegible surveys were removed prior to analyses. Each survey was individually scanned into Data Blocks software by a Sekonic Optical Mark Reader (SR-23000). Once all remaining surveys were scanned, the data were saved as an SPSS file.

Surveys were analyzed using SPSS, Version 20.0 for Windows. Descriptive statistics generated included means, standard deviations, and frequencies of total responses. Cronbach's alpha reliability coefficients were calculated to confirm the internal consistency of the factors for both surveys described above. Analysis of variance (ANOVA) was used to evaluate differences in Participation Survey factor means and Non-Participation Survey factor means by participants' gender, grade level and school. Because the Non-Participation Survey statements were written in the negative, a high mean score for any one statement would indicate a negative opinion from the students. For all analyses, statistical significance was identified at $p < 0.05$ level.

Results and Discussion

Participation Survey

A total of 298 students completed the Participation Survey. Ten of the surveys were unusable because of an obvious pattern in responses or scribbling illegibly over the response options on the survey, preventing them from being read by the optical reader. Approximately half of respondents (55%, n=158) were female and 39% (n=112), 35% (n=101), and 26% (n=75) from 6th, 7th, and 8th grade respectively. Ninety-eight percent (n=283) of respondents ate lunch at school three more days a week, indicating they were regular participants in the school lunch program.

Table 4.2 shows the mean scores for each of the statements in Section I of the survey. The three statements with the highest level of agreement to the statement "When I eat school lunch…" were "I get to socialize with my friends" followed by "The food choices change every day" and "The menu offers healthy choices." The three statements with the lowest level of agreement were "The food tastes homemade," "The staff listens to my suggestions," and "The food looks appealing." Nineteen of the 24 statements in Section I received a mean score higher

than 3, indicating agreement from respondents. This demonstrated that students who ate school lunch three or more days per week were generally positive about their school lunch experience. More than 60% (n=173) of students agreed or strongly agreed with the statements "The menu offers healthy choices" and "There are a variety of food choices," indicating most students were satisfied with the variety of foods offered on the menu.

Eleven Participation Survey statements were grouped together in a factor called food preference. These statements, which relate to aspects of the food being served, addressing qualities such as visual appeal, aroma, taste, freshness, and preparation and were highly related to each other as indicated by a Cronbach's alpha of 0.92 (Table 2). Several statements ("The food tastes good," "The food smells good," "The food looks appealing," and "The food is properly cooked") within the food preference factor showed a similar pattern of responses, with 30-50% (n=87-144) of respondents agreeing and 25% (n=72) neutral. These results indicate the majority of students perceive these aspects of the food could be improved. Since all of these statements relate to aspects of the food being served, addressing qualities such as visual appeal, aroma, and taste will likely further enhance students' school lunch experience.

Table 4.2: Participating middle school students attitudes toward school lunch (n=288)

Participation Survey Statements	Mean Score ± SD	Percent Strongly Agree + Agree
When I eat school lunch…		
Statements in the Food Preference Factor (α = 0.92)		
The menu offers healthy choices	3.67 ± 1.16	64.9
There is a variety of food choices	3.56 ± 1.16	59.5
The food is properly cooked	3.26 ± 1.16	48.8
The menu has food I like	3.24 ± 1.21	44.7
The food tastes good	3.15 ± 1.18	44.4
The food is fresh	3.14 ± 1.22	49.9
I am satisfied after I eat	3.08 ± 1.24	36.7
The food smells good	3.08 ± 1.26	41.6
The quality of the food is good	2.94 ± 1.20	34.4
The food looks appealing	2.91 ± 1.23	33.4
The food tastes homemade	2.34 ± 1.29	21.0
Statements in the Staff Attentiveness Factor (α = 0.89)		
The service is good	3.61 ± 1.19	65.7
The staff is friendly	3.40 ± 1.33	53.2
The quality of the service is good	3.37 ± 1.19	51.4
The quality of the my lunch experience is good	3.28 ± 1.25	44.7
The staff looks like they enjoy their work	2.95 ± 1.36	40.2
The staff listens to my suggestions	2.77 ± 1.32	26.8
Other survey statements		
I get to socialize with my friends	4.37 ± .93	86.2
The food choices change everyday	3.81 ± .97	69.8
I can buy other items if I don't want the meal	3.50 ± 1.26	57.0
There are enough seats in the dining area	3.45 ± 1.31	54.6
I know what is being served before I get to the cafeteria	3.24 ± 1.34	49.2
I have enough time to eat	3.19 ± 1.30	45.7
I get enough food to fill me up	3.15 ± 1.40	47.1

Statements are organized by factor with corresponding reliability (α) calculated during analysis, descending order of mean score
Survey response scale = 5 (strongly agree) to 1 (strongly disagree)

Six Participation Survey statements were grouped together in a factor called staff attentiveness. These statements relate to aspects of service such as friendliness of the staff and listening to suggestions and are highly related to each other as indicated by a Cronbach's alpha of 0.89 (Table 4.2). Several statements within the staff attentiveness factor ("The service is good," "The staff is friendly," "The quality of the service is good," "The quality of my lunch experience is good"), generally had above average levels of agreement, with mean scores for four of the six statements above three. However, the statement "The staff listens to my suggestions" had the second to lowest level of agreement on the survey. This result indicated respondents were generally satisfied with cafeteria staff performance but feel student suggestions for improvement are disregarded.

ANOVA for Participation Survey factor means between grade levels showed a significant difference for both the food preference and staff attentiveness factors, where 6th graders were more likely to agree than 8th graders that food preference (3.47 vs. 2.51, p<.0001) and staff attentiveness (3.33 vs 2.90, p=.009) were reasons for eating school lunch, (Table 4.4). ANOVA indicated staff attentiveness varied by school with school B as the least likely to agree with statements related to staff performance as a reason for eating school lunch. There was no difference in the mean factor scores for food preference or staff attentiveness between male and female respondents. No differences for food preference were found across middle schools, nor was there a significant interaction between grade, gender and school; therefore, only the main effects were explored in the analysis and reported here.

In section II of the Participation Survey, the top reasons students gave for eating school lunch were "I am hungry" (77%, n=222), "I get to sit with my friends" (63%, n=181), and "I didn't bring anything to eat" (49%, n=141)). The three least cited reasons for eating school lunch

were “My parents pay in advance” (18%, n=52), “I get to try different foods” (17%, n=49), and “I get a homemade meal” (2%, n=6).

Non-Participation Survey

A total of 295 students completed the Non-participation Survey. Fourteen of the surveys were unusable because of an obvious pattern of responses or scribbling illegibly across the response options, preventing the optical scanner from reading the survey. One-third (n=96) of Non-Participation Survey respondents answered that they ate lunch at school more than three days a week, indicating they did not meet the survey definition of non-participants in the school lunch program. These surveys were removed from the data set and the remaining 185 were used for analysis. Sixty-eight percent (n=126) of Non-Participation respondents were female, while 36% (n=67) were in 6th-grade, 27% (n=50) in 7th-grade, and 37% (n=68) in 8th-grade.

Table 4.3 shows the mean scores for each of the statements in Section I of this survey. The three statements with the highest level of agreement were “There are long lines,” “I prefer to eat what I bring from home,” and “The food does not look appealing.” The three statements with the lowest level of agreement were “I do not get to sit with my friends,” “The food served is the same every day,” and “The staff is not friendly.”

Ten Non-Participation Survey statements were grouped together in a factor called food quality. These statements which related to aspects of the food being served, addressed qualities such as visual appeal, aroma, taste, freshness, and preparation and were highly related to each other as indicated by a Cronbach’s alpha of 0.90. Within the food quality factor, more than 50% of students agreed with several of the statements such as “The food does not taste good,” “The food does not look healthy,” “The food does not look fresh,” and “The food does not look appealing.” These items are similar to those on the Participation Survey in the FP factor.

Table 4.3: Non-participating middle school students attitudes toward school lunch (n=185)

Non-Participation Survey Statement	Mean Score ± SD	Percent Strongly Agree + Agree
My reason for not eating school lunch is…		
Statements in the Food Quality Factor (α=0.90)		
The food does not look appealing	3.82 ± 1.15	67.1
The food does not look fresh	3.79 ± 1.16	65.4
The food does not look healthy	3.70 ± 1.22	58.4
The quality of the food is poor	3.58 ± 1.14	53.0
The food does not taste good	3.54 ± 1.14	58.4
The menu does not have food I like	3.43 ± 1.30	52.4
I do not like the food being served	3.40 ± 1.20	48.6
The food not properly cooked	3.32 ± 1.18	43.2
I do not recognize the food being served	3.28 ± 1.18	42.8
There is no variety of food choices	3.06 ± 1.11	33.6
Statements in the Customer Service Factor (α=0.77)		
The service is poor	3.07 ± 1.06	28.7
The staff does not speak to me	3.00 ± 1.22	30.9
The food choices offered are not the same as the menu	2.87 ± 1.31	24.9
The cafeteria does not look clean	3.00 ± 1.17	33.5
The staff is not friendly	2.74 ± 1.30	27.1
Other survey statements		
There are long lines	4.41 ± .96	87.0
I prefer to eat what I bring from home	4.06 ± 1.04	77.8
The food I like runs out before I get to the cafeteria	3.55 ± 1.17	52.5
My parents buy food for me to take to school	3.62 ± 1.30	62.4
I do not have enough time to eat	3.29 ± 1.32	45.9
I do not get enough food to fill me up	3.02 ± 1.24	36.3
There are not enough seats in the dining area	2.79 ± 1.40	32.5
The food served is the same everyday	2.64 ± 1.18	22.1
I do not get to sit with my friends	2.01 ± 1.20	14.1

Survey statements are organized by factor with corresponding reliability (α) calculated during analysis and in descending order of mean score
Survey response scale = 5 (strongly agree) to 1 (strongly disagree)

Taken together, both the Participation Survey and Non-Participation Survey results demonstrated there is room to improve aspects related to the food itself.

Five Non-Participation Survey statements were grouped together in a factor called customer service. These statements, which related to aspects of service such as friendliness of the staff and listening to suggestions, were highly related to each other as indicated by a Cronbach's alpha of 0.77. Several statements within the customer service factor ("The staff is not friendly," "The cafeteria does not look clean," "The food choices offered are not the same as the menu," and "The staff does not speak to me"), generally had low levels of agreement with one-third or fewer students agreeing or strongly agreeing with these statements. This indicated the staff may not be a primary reason for students not eating school lunch but improvements could also be made in the area of customer service.

ANOVA for Non-Participation factor means indicated a significant difference between 6^{th}, 7^{th} and 8^{th} graders' responses for the food quality factor (Table 4). There was a consistent decrease in mean scores from 6^{th} to 7^{th} to 8^{th} grade, with 8^{th} graders having the most unfavorable opinions of food quality. When comparing mean factor scores by school, respondents from school B had a less favorable view of customer service than schools A or C. There was no difference for food quality or customer service between male and female respondents, nor was there a significant interaction between grade, gender, and school. Therefore, only the main effects of the ANOVA are reported here.

In section II of the Non-Participation Survey, more than 60% of respondents said they would be more likely to eat school lunch with better tasting food, better quality food and shorter lines. These responses were consistent with those from section I of the survey in which students agreed there were long lines and food quality could be improved. The least cited reasons for not

eating school lunch were “better service” (11%, n=20), “cleaner cafeteria” (10%, n=19), and “more accurate menu” (5%, n=9).

Table 4.4: Least-squared (LS) mean factor scores and standard error of the mean (SEM) by grade, gender, and school for middle school respondents to Participation (n=288) and Non-Participation (n=185) Surveys.

	Participation Survey				**Non-Participation Survey**			
	Food Preference		Staff Attentiveness		Food Quality		Customer Service	
	LS Mean	SEM	LS Mean	SEM	LS Mean	SEM	LS Mean	SEM
Overall	3.07	.05	3.21	.06	3.48	.07	2.91	.07
Grade								
6	3.47[a]	.08	3.33[a]	.09	3.15[a]	.10	2.84	.10
7	3.24[a]	.08	3.40[a]	.10	3.48[a]	.12	2.80	.12
8	2.51[b]	.10	2.90[b]	.12	3.80[b]	.10	3.09	.10
Gender								
Male	3.09	.08	3.17	.09	3.39	.11	2.88	.11
Female	3.06	.07	3.26	.08	3.56	.08	2.94	.07
Schools								
A	3.18	.07	3.50[a]	.09	3.39	.10	2.69[a]	.10
B	2.90	.09	2.69[b]	.10	3.53	.10	3.12[b]	.10
C	3.14	.11	3.45[a]	.13	3.50	.12	2.85	.12

[a,b]Mean values within a column with unlike superscript letters were significantly different ($p<0.05$)
Survey response scale for both surveys = 5 (strongly agree) to 1 (strongly disagree)

Strengths and Limitations

A major strength of this study is that the responses to these two validated survey instruments add to the relatively limited research about middle school students’ attitudes towards and satisfaction with school lunch. The study also responded to a school district need and provided practical and useful information to the school nutrition staff about students’ school lunch perceptions.

However, the results from these surveys are not generalizable since the participants were drawn from three schools in one district. The surveys were administered in the school cafeteria during lunch, resulting in a noisy and chaotic environment with possible peer influence on the responses. Due to the participating schools' schedules, it was not possible to administer the surveys at any other time. Additionally, the number of surveys that were lost to unreadable responses, patterned response or inaccurate categorization may have biased the results. Lastly, 78% of the Non-Participation survey responses were from female students, potentially biasing the results from this survey.

Conclusions and Application

The purpose of this study was to determine middle school students' satisfaction with the school lunch program experience, using two validated survey instruments developed by NFSMI; the *Middle/Junior High School Student Participation Survey* and the *Middle/Junior High School Student Non-Participation Survey*. Students responding to the Participation Survey had the highest level of agreement with the statement "When I eat school lunch, I get to socialize with my friends" and included "I get to sit with my friends" among the top 5 reasons for eating school lunch. This result suggests that students value the time they have during to the school day to simply sit and socialize with their friends. While the school schedule is not within cafeteria staff's control, making the cafeteria as pleasant an environment as possible could help retain students in the NSLP.[15,16] Cafeteria and school staff could arrange the dining area to support social interaction among students, make students feel welcome and show a personal interest. To encourage/retain student participation, lunch staff can promote school lunch as an opportunity to relax from academics and participate in a social lunch experience.

The statement "The staff listen to my suggestions" had the second to lowest level of agreement on the Participation Survey. This result indicated respondents feel that their input is disregarded when they provided suggestions. Wojcicki and colleagues reported higher NSLP participation when middle school students were polled about their food preferences and asked to participate in the process of implementing specific changes to the school lunch menu.[17]

Respondents to the Non-Participation Survey strongly agreed with the statement "My reason for not eating school lunch is that there are long lines." Therefore, middle school students would be more likely to eat school lunch if the lines were shorter. Shortening lunch lines may be achievable with increased efficiency through staff training and modifying the layout of food items. However, some factors influencing lunch line length, such as the school schedule, physical tray line layout, number of point of sale terminals, and number of cashiers, may be beyond on the operational control of the cafeteria staff.

Responses from both surveys indicated there are opportunities for this Northern Colorado school district to gain and retain more students in the school lunch program by improving food quality such as flavor, aroma, visual appeal, and freshness. Several previous studies have reported taste and visual attractiveness are the most important factors when students decide whether to eat school lunch[9] or what to eat for lunch.[10,17] School nutrition professionals should not only seek input from students but also involve them in the process of implementing changes to school lunch menus. This can be accomplished by establishing student advisory groups and conducting regular taste tests.[17–19] Student feedback could be considered with long-term strategic planning.

Mean scores of 6th-grade students were significantly higher than 7th and 8th grade students for the food preference factor on the Participation Survey and the food quality factor on the Non-

Participation Survey. These findings suggest that 6th graders are more likely than 7th and 8th graders to be satisfied with the food served during school lunch. This is consistent with the research findings of Roseman & Niblock[10] who also reported higher school lunch satisfaction levels among 6th-grade students. Overall, lunch satisfaction declines from 6th to 8th grade. If school nutrition professionals can identify the specific factors, such as focusing on quality and service, that would attract and keep and 8th-grade students in the NSLP, it may be possible to mitigate the decline in participation from elementary to middle school.

NFSMI recently published the *Middle/Junior High School Participation and Non-Participation Survey Guide: Internal Benchmarking for School Nutrition Programs.*[20] The guide is designed to provide school nutrition directors step-by-step instructions for administering the surveys and tabulating and analyzing the responses. Also included is additional NFSMI information about customer service and continuous quality improvement. By using the surveys in conjunction with this administration guide, school nutrition professionals will learn about student satisfaction with school lunch and how best to meet student preferences to increase student satisfaction. The information will aid school nutrition professionals with providing the best possible school lunch environment for their customers with the most effective use of resources. The data collected could also serve as a baseline for assessing effectiveness of changes to the food or school lunch environment.

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CHAPTER 5: EXPLORING ENVIRONMENTAL STRATEGIES TO INCREASE SCHOOL LUNCH VEGETABLE CONSUMPTION AMONG MIDDLE SCHOOL STUDENTS

Introduction

Children's overall health depends, in part, upon food intake that provides sufficient energy and nutrients to support optimal growth and development.[1] As such, the nutrition and health status of U.S. children has received increasing attention as an "upstream" determinant of adult health.[2,3],[4] Recognizing the important contribution optimal nutrition during childhood makes on cognitive development and health throughout the lifespan, Healthy People 2020 (HP 2020) incorporated several objectives directly related to child nutrition.[5] Total vegetable intake of 1.14 cup equivalent per 1,000 calories and an increased contribution of dark green, red and orange vegetable, beans and peas for individuals 2 years and older are among these objectives.[5] These objectives are consistent with the proposed recommendations from the 2015 Dietary Guidelines Advisory Committee (DGAC),[6] which support a dietary pattern that is higher in fruits and vegetables. According to the 2015 DGAC report, fruit and vegetables were the only food groups consistently associated with positive impacts on cardiovascular disease, body weight, type 2 diabetes, cancer, congenital anomalies, and bone health.[6] Vegetables contribute significant amounts of many nutrients, such as fiber and potassium, currently under consumed by American children; vegetable consumption is associated with reduced chronic disease risk; and they displace more energy dense foods in U.S. diets.[7] Despite these well-known national-level recommendations and considerable effort spent to increase American's vegetable intake, consumption has continued to fall short for all age groups.[8,9] The percentage of individuals not meeting current recommendations is highest for children aged 9-13 and 14-18 years old; over 95% of children in these age groups do not meet current vegetable recommendations.[8,10]

Schools can play an important role in helping children meet current recommendations and ensure they are well nourished throughout the school day. About 55 million U.S. children ages 5-19 spend the majority of their day in school.[11] Through the federally funded National School Lunch Program (NSLP) and School Breakfast Program, schools provide 1-2 meals daily and sometimes snacks. Students consume up to 47% of their daily energy intake at school,[12] placing schools in a position to influence children's food choices on a daily basis and potentially shape lifelong eating habits. Beginning in 2004, several federal policy and regulatory changes occurred which were aimed at helping schools create a more healthful school food environment for students. Foremost among these was passage of the Child Nutrition and WIC Reauthorization Act of 2004, which made it mandatory for every U.S. school district participating in the NSLP or School Breakfast Program to create a wellness policy.[13] Additionally, the Institute of Medicine (IOM) published two reports addressing childhood obesity and nutrition standards for competitive foods sold in schools.[14,15]

In 2009, the IOM published recommendations for revising nutrition standards and meal requirements for the NLSP and School Breakfast Programs to closely align with the 2010 Dietary Guidelines for Americans.[16] The Healthy, Hunger-Free Kids Act of 2010 required the USDA to update federal requirements for the content of school lunches based on the IOM's recommendations.[17] In 2012, the USDA issued the new standards which: 1) required NSLP lunches to include both fruit and vegetable choices and increased the serving sizes of fruits and vegetables; 2) emphasized whole-grain rich foods; 3) required milk be low fat or nonfat only; and 4) limited calories and reduced saturated fat and sodium. The USDA required implementation of these new standards for all schools for the 2012-2013 school year.[18] The new regulations also allowed "offer versus serve" (OVS) fruit and vegetable serving options, meaning

that while students may decline two of the five lunch components, they must select at least one serving of fruit or vegetables as part of their meal.[19] While these policy recommendations were positive steps toward improving students' lunch choices, taken in totality, they represented significant changes schools must make in their overall operation. In addition, the Healthy Hunger Free Kids Act 2010 did not directly address strategies to improve consumption, leading to questions of whether offering more fruit and vegetable servings translates to greater intake or waste.

Increasing children's selection and consumption of vegetables at school lunch may be particularly challenging. Several studies have used a variety of approaches to improve fruit and vegetable intake, often finding a significant increase in fruit consumption but no change vegetable intake.[20,21] In our examination of middle school lunch waste and nutrient intake, less than half of middle school students chose a vegetable with lunch. And those who did take a vegetable left more than a third uneaten.[22]

The discipline of behavioral economics provides a set of strategies for encouraging healthier food selection behaviors in schools that can be of low or no cost and without the conscious knowledge of participants.[23] These strategies can alter an individual's behavior without eliminating any options in the cafeteria. The simplicity of environmental changes along with the small investment in time and funds needed to implement the changes, make them an attractive option.[24] Specific examples that have been successfully applied in an elementary school cafeteria setting include *moving fruit selections or the salad bar* to more visible, heavily trafficked areas;[23] displaying *healthful foods at eye level* or in front of less healthful selections making them easier for students to access,[23] and using verbal prompts to encourage students to take a serving of fruit.[25] While these strategies have been successful in elementary school

cafeterias, a limited number of s studies have been conducted in middle schools. Therefore, the purpose of this project was to evaluate how subtle yet specific changes to the cafeteria environment, effect middle school student selection and consumption of vegetables. We hypothesized that subtle, targeted changes in the cafeteria environment would 1) increase the student selection of vegetables with lunch, and 2) increase consumption of vegetables among middle school students participating in the NSLP.

Methods

Schools and Cafeteria Settings

Students from four middle schools (grades 6-8) in one medium-sized (enrollment 16,226) Northern Colorado school district participated in this two-year project. The district's student body was predominantly White (75%) and Hispanic (20%). All four schools participated in the National School Lunch Program (NSLP) and enrollment at each school ranged from 546 to 812 students. The percentage of students eligible for free and reduced-priced meals ranged from 32.3% to 46.5% and average daily participation in the NSLP was 44.7% to 54.2%. All schools used OVS, which allows students to decline 2 of the 5 components of an NSLP lunch, [18] and charged $2.75 for lunch. Each school allotted 30 minutes for each of the three grades to eat lunch. Three of the four schools had three lunch lines with each displaying the same food options. At the fourth school, students entered a single line to choose their lunches but then paid at one of two cashier lines.

The district planned lunches for the school year using a four-week cycle menu, which remained the same throughout the two-year study. In all schools, low-fat and fat-free white, and fat-free chocolate milk were available daily. Students had a choice of four entrees (two hot options, a deli or peanut butter and jelly sandwich, or an entrée salad), canned and fresh fruit,

and cooked and fresh (raw) vegetables. The cooked vegetables included broccoli, cauliflower, black beans and corn, peppers and corn, garden blend, California blend, green beans, baked beans, baby whole potatoes, baked sweet potato, glazed carrots, and peas and carrots. The fresh vegetables were typically a small side salad or a combination of red, orange or green vegetables, such as red or green pepper strips and carrots. A limited selection of a la carte items such as baked chips, small cookies, bottled water, and carbonated fruit soda was also available. The Colorado State University Institutional Review Board (Fort Collins, CO), Thompson School District, and the principals and cafeteria managers at each school approved all procedures involving human subjects.

Study Design and Intervention

The intervention took place over four semesters in two subsequent school years. To promote vegetable selection and consumption, two of the four middle schools were randomly assigned to receive three cafeteria environment changes; 1) new tray line signs with descriptive vegetable names, 2) verbal prompts from cafeteria staff, and 3) new seasonings for selected vegetables for the first three semesters of the study (Figure 5.1). We added one new strategy each semester for the first three semesters; all were maintained in the final semester. The other two schools did not receive any changes initially, and served as control schools for the first three semesters. During the 4th semester, the manner in which fresh (raw) vegetables were promoted and served was enhanced in the control schools only (Figure 5.1). Evaluation measures included vegetable sales data from food production records and plate waste assessment.

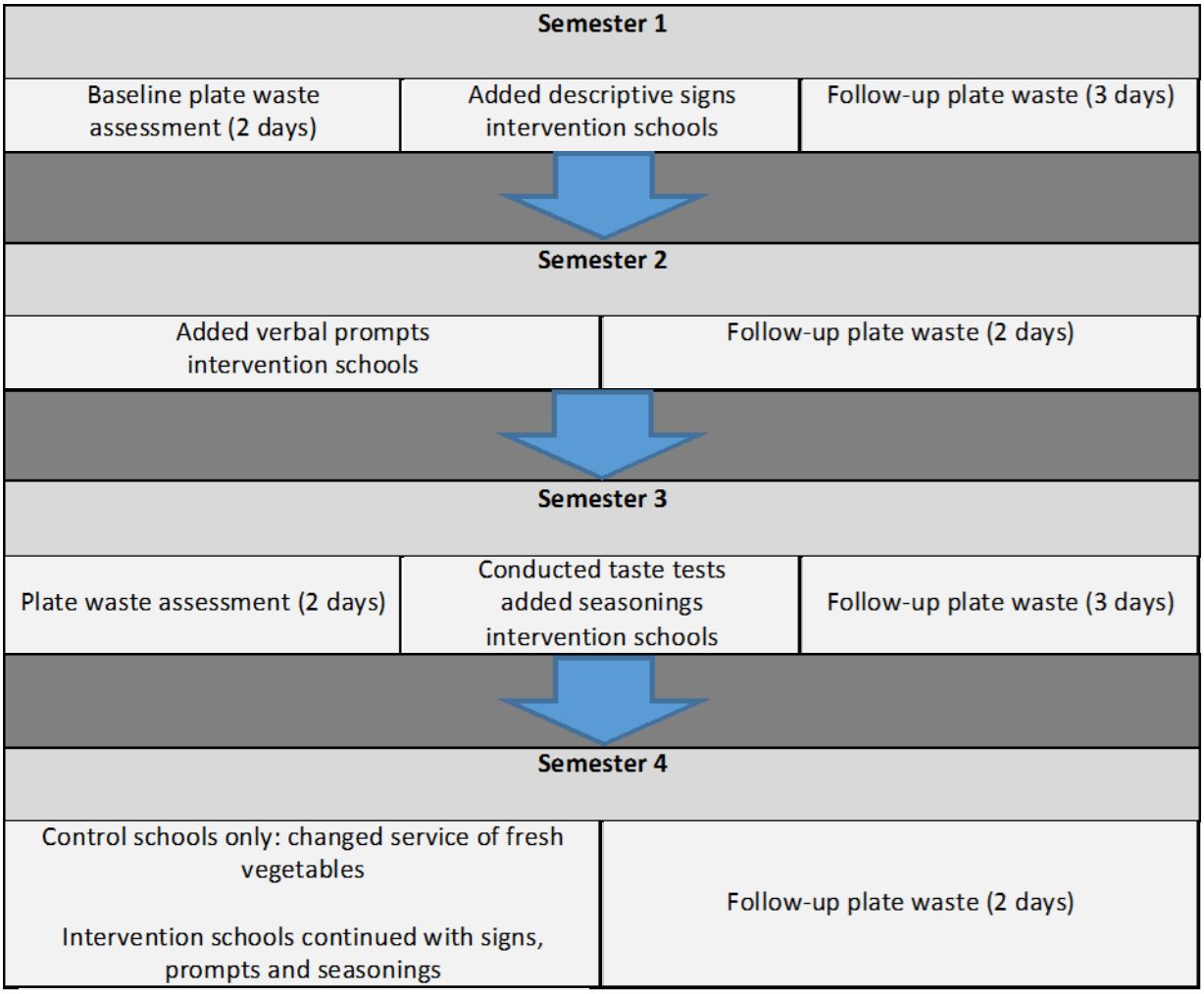

Figure 5.1: Study design showing timing of plate waste assessment and the addition of cafeteria strategies

New Tray Line Signage

In fall 2011, the treatment schools received new tray line signs specifically for the vegetable items offered. To determine descriptors for the vegetable side items that would resonate with students, three focus group discussions were conducted with students from one non-intervention school and one non-participating middle school in the same school district. A total of 24 students participated in the discussions, with 6 to 10 students per single-grade, mixed-gender group. The discussions were held during the school day, lasted 50-60 minutes, and included semi-structured, open-ended questions. The questions were designed to be

understandable at the 6th-grade level and limited to a total of 5-7 questions.[26] A single, trained moderator facilitated all three focus groups and a co-moderator took notes. After introductions and a general discussion about school lunch and the vegetables typically offered, students were guided through an activity where they provided suggestions for creative descriptors for the vegetables served at lunch. Students voted for their favorite names. Results from all three focus group discussions were compiled and final names were agreed upon by researchers and nutrition services staff. The final list of names were: lazer [sic] beans, brain boosting broccoli, home style baked beans, mellow yellow peppers and corn, sassy sweet potatoes, California veggies, roasted black beans and corn, hot and hearty veggies, fresh baby taters, super power cauliflower, power up peas and carrots, crazy-licious carrots, super garden salad, and cool and crunchy veggies. After names were selected, tray line signs were created that included the new names and photographs of each vegetable. Cafeteria staff at each treatment school were provided with the printed, full-color signs and sign holders, gave input on the best installation location for student visibility, and were instructed on posting the individual signs when each vegetable side item was served. The signs were installed in mid-October 2011, following baseline plate waste assessment and used through the remainder of the two-year intervention.

Verbal Prompts by Cafeteria Staff

In spring 2012, intervention school cafeteria staffs were trained and instructed on the use of a simple verbal prompt, asking students without vegetables on their tray if they would like a choice between fresh or hot vegetables, e.g., *"Would you like [hot vegetable of the day] or fresh vegetables?"* The implication of this statement is that students were expected to take a vegetable serving. If a student declined, he/she was not prompted further. Use of the verbal prompt began in mid-February and continued through the rest of the school year and the following year.

Change in Vegetable Seasonings

In fall 2012, we investigated the influence of seasoning on hot vegetable selection and consumption. School nutrition staff identified the California blend (broccoli, cauliflower and carrots) and steamed garden blend (broccoli, zucchini, peppers, beans, cauliflower) as vegetables on the middle school lunch menu with the lowest sales. These vegetables were chosen for flavor enhancement with a garden-seasoning blend (a no-sodium mixture of black pepper, basil, oregano, sage, garlic, onions, parsley and other ingredients). One hundred ninety-four students participated in a taste test of the garden-seasoning blend, completing a short survey asking them to rate appearance, aroma, texture, taste and overall appeal. Approximately 45% were from one treatment middle school and 55% from the other. Fifty-seven percent of participants were females, 44% were in grade 6, 28% in grade 7 and 28% in grade 8, reflecting usual participation rates. Mean responses for vegetable appearance, aroma, texture, taste and overall appeal were all between 3.5 and 4.0 on a 5-point Likert scale, indicating a moderately favorable rating. Instructions for preparing the steamed garden blend and California blend vegetables with the garden seasoning were provided to the cafeteria staff of the 2 treatment middle schools and they began using the seasoning in November 2012. New cafeteria signs were created and posted when vegetable blends with the seasonings were served.

Fresh (Raw) Vegetable Changes

We wanted to provide the control schools with a personalized intervention. Analysis of food production records, plate waste and observation from the first three semesters of the study revealed sales and consumption of raw vegetables were consistently low. Therefore, strategies to increase fresh (raw) vegetable selection and consumption were implemented February through May 2013 in the two middle schools that had served as control schools. The strategies included:

1) changing the serving container from paper tray to a clear plastic clam shell, 2) posting specific signs to promote these fresh vegetables, 3) more prominent placement on the cafeteria line, 4) increasing the number of fresh vegetable servings offered, and 5) verbal prompting from the cafeteria staff. These strategies were implemented after cafeteria staff training. No additional changes were made in the intervention schools.

Measurement and Evaluation

Daily Vegetable Sales

For each middle school, daily food production records were collected, including information on the number of students served a reimbursable meal and the quantity of food served. Since the number of meals served varied daily, the number of servings of vegetables was standardized on a per meal basis. The number of daily vegetable servings was entered into a database and the vegetable servings per meal calculated by dividing the number of vegetable servings by the number of reimbursable meals served.

Plate Waste Measurement

Plate waste was measured using a previously validated digital photography method,[22,27,28] for 7 days in each school during both study years: 2 days at the beginning of the school year, prior to implementation of any strategies; 3 days after implementation of first strategies in the intervention schools and 2 days after the second strategies were added (Figure 5.1). Based on the District's 4-week menu cycle, we measured plate waste approximately every three weeks (with the exception of winter break) during the school year. As was practicable, we measured vegetable waste during the same week on the same day at each school of each menu cycle to minimize the effect of other menu items (e.g., different entrees). On each assessment date, students were given a unique tray number; individual students were not tracked over time.

A digital camera (Fuji FinePix Z10fd, 7.2 MP with optical zoom, Tokyo, Japan) was mounted on a tripod 26 inches above lunch trays and angled down 45 degrees. Just prior to lunch service, five servings of each pre-portioned vegetable item were obtained from the cafeteria and photographed. These reference photographs were used for comparison with the post-lunch photographs of each student's tray. After photographing the reference samples of vegetables, they were packed in a cooler and taken back to the research center for weighing. The average weight of each type of vegetable was recorded to the nearest 0.10 gram using a calibrated digital scale (A&D, SK-2000D, Seoul, Korea) and served as the standard when estimating the weight of that food consumed.

Only students who took vegetables for lunch were recruited to have their tray photographed after eating lunch. As students exited the lunch line, a research assistant determined which students took vegetables and requested verbal assent from each. On a small index card, pre-printed with the date and lunch menu, a research assistant placed a check mark by all foods on the tray, recorded gender and grade, then affixed the card to the student's tray. When students finished eating they took their trays to the photography station for post consumption photographs. Other than gender and grade, no personal information was collected about the students. No photographs of students were taken.

Study staff conducted weekly, unannounced visits to the intervention schools throughout the study and to the control schools after they received the fresh vegetable changes to monitor consistent implementation of each cafeteria strategy. Observations were conducted throughout the lunch period. Any deviation from the intervention protocol was noted and discussed with cafeteria staff immediately following lunch.

Data Analysis

Differences in school enrollment and free/reduced eligibility between schools and school years were determined with chi-square analyses. Univariate analysis of variance (ANOVA) was conducted to determine differences in vegetable servings per meal pre and post treatment and between schools and clustering was accounted for at the school level Percent waste was estimated for cooked and fresh vegetables. To determine the percent of vegetables wasted from students' trays, two trained analysts independently compared the "after" lunch photographs to the reference vegetable photographs, and determined the proportion of vegetables wasted to the nearest 10% increment. Differences in observations greater than 20% for any vegetable item were resolved by reviewing the photographs of similar weighed vegetables alongside the reference vegetable photographs and the student tray in question. Consensus was reached when the estimates from each observer were within 10% of each of other and the average recorded. Two-way analysis of covariance, with gender and grade as covariates, was conducted to determine differences in vegetable waste between treatment and control schools at baseline and two follow-up time points after the intervention was implemented each school year, using SAS for Windows, 9.3. Statistical significance for all analyses was set at $p < 0.05$.

Results

Control School 1 had a significantly higher enrollment and lower free/reduced lunch price eligibility than the other three schools in each school year ($p<0.0001$) (Table 5.1). There were no other differences between schools or school years.

Table 5.1: Enrollment and Free/Reduced Eligibility Data for the Four Participating Middle Schools (School Year 2011-12/School Year 2012-13)

	Schools			
	Treatment School 1	**Treatment School 2**	**Control School 1**	**Control School 2**
School enrollment	635[a]/671[a]	613[a]/639[a]	812[b]/851[b]	546[a]/487[a]
FRPL eligibility (percent of enrollment)*	45.7[a]/52.0[a]	46.5[a]/47.6[a]	28.7[b]/32.3[b]	32.3[a]/37.5[a]
ADP (percent of enrollment)†	52.1/48.5	54.2/44.4	47.3/39.8	44.7/41.6

[a,b]Significant difference between schools (within a row), $p=0.05$
*FRLP, free and reduced price lunch
†ADP, average daily participation

New Tray Line Signs and Verbal Prompts

A total of 646 days of mean vegetable servings per lunch data was collected from food production records, representing an average of 162 days per school during school year 2011-2012. Mean vegetable servings taken per lunch differed significantly between schools ($p<0.0001$) (Table 5.2). Treatment School 1 had the lowest mean vegetable servings taken per lunch at baseline through all time periods while Control School 2 had the highest. There was no change in mean vegetable servings taken per lunch in Treatment School 1 or Treatment School 2, but there was a significant decrease in the control schools; 42% ($p=0.0007$) in Control School 1 from baseline to addition of the verbal prompts and a 13% ($p=0.04$) in Control School 2. When vegetable servings taken per lunch were examined by type (cooked vegetables or raw vegetables, Table 5.3), there was a 28% decrease ($p=0.01$) in cooked vegetables taken per lunch from baseline to addition of verbal prompts only in Control School 1. No significant change was observed in the other schools. For raw vegetables only (Table 5.4), the mean vegetable servings taken per lunch significantly increased from baseline to the addition of verbal prompts in Treatment School 2 ($p<0.001$) but not in Treatment School 1. There was a significant decrease in

selection of raw vegetables at both Control School 2 and Control School 2 (p=0.04 and p=0.02 respectively).

Table 5.2: Mean Vegetable Servings Chosen (standard error of the mean) for All Vegetables from Middle School Lunch

Time Period	Treatment School 1	Treatment School 2	Control School 1	Control School 2
Baseline (Sept to mid-Oct 2011)	.26 (.02)$_{w}$	.17 (.02)$_{x}$	.24 (.02)$^{a}_{w,y}$	.38 (.02)$^{a}_{z}$
New signs added (mid-Oct to mid-Feb 2012)	.26 (.01)$_{w}$	.19 (.01)$_{x}$	.20(.02)$^{a}_{x,y}$	.35 (.02)$^{a,b}_{z}$
Verbal prompts added (mid-Feb-April 2012)	.24 (.02)$_{w}$	.18 (.02)$_{x}$	.14 (.02)$^{b}_{x,y}$	.33 (.02)$^{b}_{z}$

[a,b]Mean values within a column with unlike superscript letters were significantly different (p=0.05)
[w,x,y,z]Mean values within a row with unlike subscript letters were significantly different (p=0.05)

Table 5.3: Mean Vegetables Chosen (standard error of the mean) Hot Vegetables only

Time Period	Treatment School 1	Treatment School 2	Control School 1	Control School 2
Baseline (Sept to mid-Oct 2011)	0.18 (.02)$_{x}$	0.11 (.02)$_{y}$	0.21 (.02)$^{a}_{x}$	0.33 (.02)$_{z}$
New signs added (mid-Oct to mid-Feb 2012)	0.19 (.01)$_{x}$	0.12 (.01)$_{y}$	0.18 (.01)$^{a,b}_{x}$	0.31 (.01)$_{z}$
Verbal prompts added (mid-Feb-April 2012)	0.16 (.01)$_{x}$	0.11 (.01)$_{y}$	0.15 (.02)$^{b}_{x,y}$	0.31 (.01)$_{z}$

[a,b]Mean values within a column with unlike superscript letters were significantly different (p=0.05)
[x,y,z]Mean values within a row with unlike subscript letters were significantly different (p=0.05)

Table 5.4: Mean Vegetables Chosen (standard error of the mean) Fresh Vegetables Only

Time Period	Treatment School 1	Treatment School 2	Control School 1	Control School 2
Baseline (Sept to mid-Oct 2011)	0.10 (.01)$^{a}_{x}$	0.07 (.01)$^{a}_{y}$	0.05 (.01)$^{a}_{z}$	0.08 (.01)$^{a}_{z}$
New signs added (mid-Oct to mid-Feb 2012	0.08 (.004)$^{b}_{x}$	0.08 (.005)$^{a}_{x}$	0.04 (.01)$^{a,b}_{y}$	0.06 (.004)$^{b}_{z}$
Verbal prompts added (mid-Feb-April 2012)	0.10 (.004)$^{a}_{x}$	0.10 (.005)$^{b}_{x}$	0.03 (.01)$^{b}_{y}$	0.06 (.004)$^{b}_{z}$

[a,b]Mean values within a column with unlike superscript letters were significantly different (p=0.05)
[x,y,z]Mean values within a row with unlike subscript letters were significantly different (p=0.05)

Vegetable waste was assessed from 1499 student lunch trays; 51.5% were from male students and with 33% from each grade. Figure 5.2 shows the mean percent vegetable waste by time and treatment versus control schools. Students in both treatment and control schools wasted 50-60% of vegetables they selected and vegetable waste decreased in both groups over time. Control School students wasted more vegetables than Treatment School students at all 3 time points. Sixth- and 7th-grade students wasted more vegetables than 8th-graders (p=.0002, p=.02

respectively). Boys and girls wasted a similar amount of vegetables; 55.5% and 54.2% respectively. Vegetable waste decreased 6% in Treatment Schools and 7% in Control Schools over time; a non-significant difference.

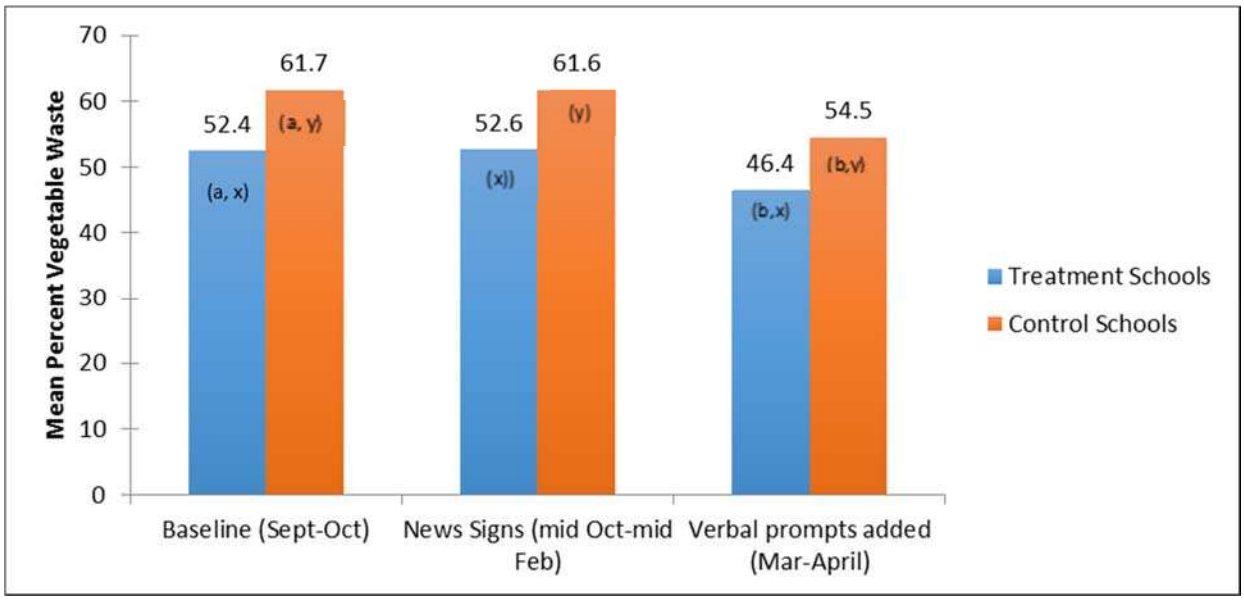

Figure 5.2: Mean Percent Vegetable Waste* at Baseline, with New Signs and with Verbal Prompts (n=1499)

*Vegetable waste measured only from students choosing vegetables with lunch

[a,b] Mean values within a treatment group with unlike letters were significantly different (p=0.05)

x,yMean values within a time point with unlike letters were significantly different (p=0.05)

Change in Vegetable Seasonings

During SY 2012-2013, the California blend and steamed garden blend were each served once during the four-week menu cycle for a total of seven occasions. Waste from each blend was measured each day they were served in the treatment schools. Waste from 118 portions of California blend were measured in Treatment School 1 and 94 portions of steamed garden blend were measured in Treatment School 2. Fewer portions of the steamed garden blend were measured because fewer students selected that vegetable with lunch. The difference in waste between the two vegetable blends was only significant at the Feb-May time point, after the seasonings were added (Fig. 5.3). While waste of both types of vegetables decreased over the course of the school year, the difference from before the seasonings were added to after was not

significant. Therefore, the addition of the seasonings to the two types of vegetables did not have the intended effect of reducing vegetable waste from either blend.

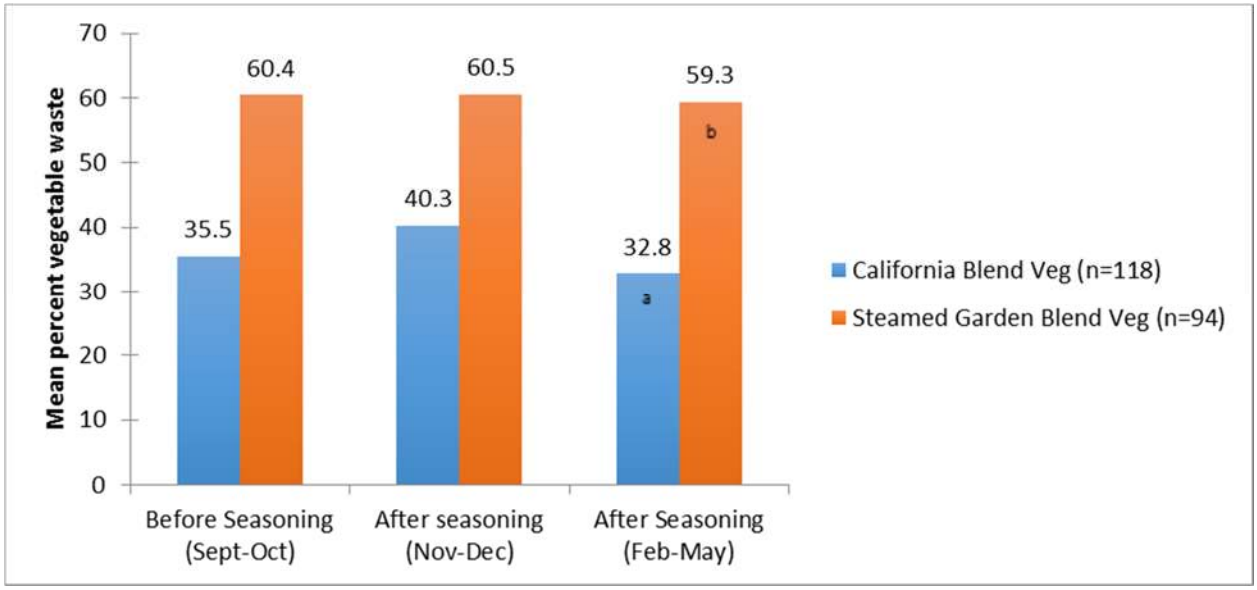

Figure 5.3: Mean Percent Vegetable Waste*, California and Steamed Garden Blend Only, Fall 2012 and Spring 2013

*Vegetable waste measured only from students selecting California Blend or Steamed Garden Blend with lunch

[a,b] Mean values within a time point with unlike letters were significantly different (p=.05)

Fresh (Raw) Vegetable Changes

Strategies to increase fresh (raw) vegetable selection and consumption were implemented February through May 2013 in the two middle schools that had served as control schools. Plate waste was assessed from 626 portions of raw vegetables during SY 2012-13. Mean percent raw vegetable waste (Figure 5.4) shows the mean percent raw vegetable waste by time and by schools receiving the raw vegetable service changes and those that did not. There was a non-significant difference in raw vegetable waste between the schools that received the changes and those that did not receive any changes at baseline. Waste decreased 8% in both schools receiving the changes and in those that did not.

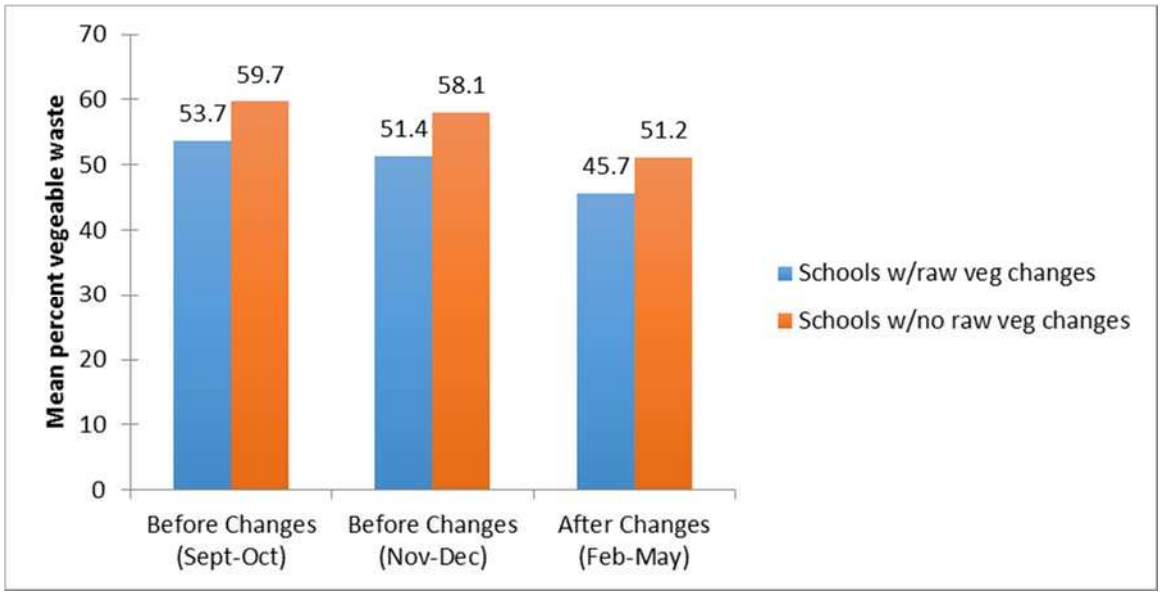

Figure 5.4: Mean Percent Waste*, Fresh (Raw) Vegetables Only, Fall 2012-Spring 2013 (n=626)
*Vegetable waste measured only from students selecting raw vegetables with lunch

Throughout the project, there was a significant difference in vegetable waste between each grade (Fig. 5.5). Sixth-grade student consistently wasted more vegetables than 7th or 8th-grade students. During SY2011-12, there was a significant difference (p<.001) between 6th-grade and 8th-grade students, with 6th-graders wasting more vegetables.

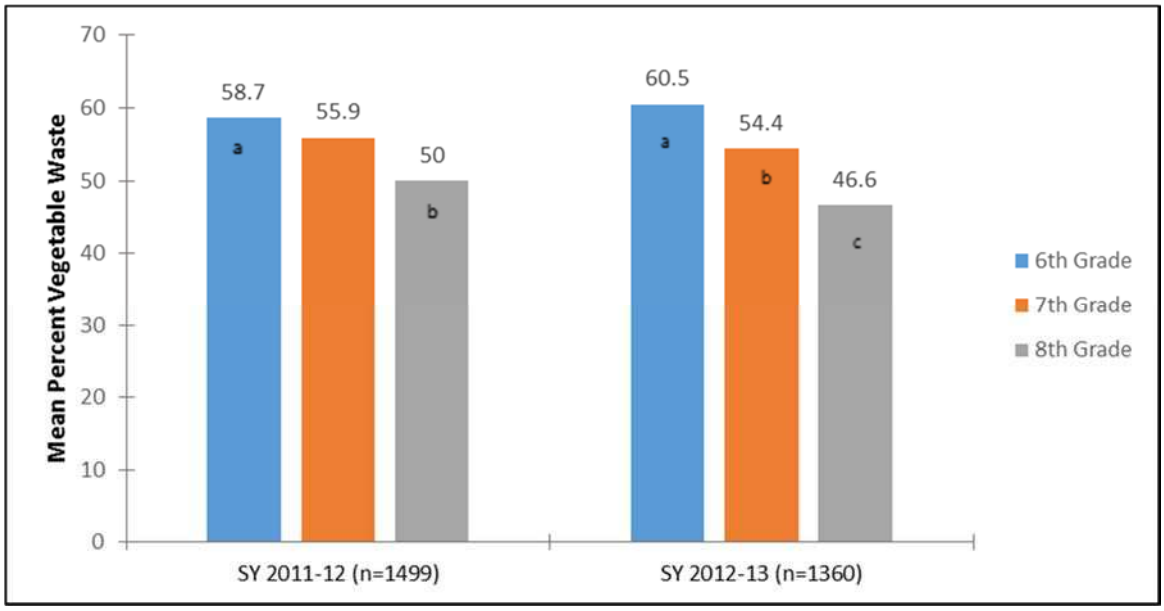

Figure 5.5: Mean Percent Vegetable Waste* by Grade Level
*Vegetable waste measured only from students selecting vegetables with lunch
[a,b] Mean values within grades with unlike letters were significantly different (p=.05)

Seventh-grade also wasted significantly more vegetables than 8th grade (p=.015). In SY2012-13, there was clear and significant decrease in vegetable waste from 6th to 7th to 8th grade. There was no significant interaction between grade and time period, indicating no relationship between the grade differences in waste and the intervention strategies.

Discussion and Conclusions

School Food Authorities (SFAs) across the U.S. are working to fully implement the revised USDA Nutrition Standards in the National School Lunch and Breakfast Programs, which took effect at the beginning of the 2012-2013 school year.[18] The Healthy Hunger-Free Kids Act of 2010 specified changes in school meal standards to align them with the 2010 Dietary Guidelines for Americans.[17] A report from the General Accounting Office states that student acceptance of the school meal changes have been challenging for some SFAs.[29] Students have expressed dislike for vegetables in some of the sub-groups. Vegetables that students are now required to take, reportedly end up in the trash.

The purpose of this study was to determine how subtle changes to the cafeteria environment, specifically targeting vegetable intake, effect middle school student selection and consumption of vegetables (not included in the entrée). Taken as a whole, the environmental strategies used in this study did not have an effect on vegetable selection or consumption. The addition of the new signs and verbal prompts did not increase vegetable servings taken by students at lunch in the intervention schools, however, they may have prevented a similar decrease in vegetables servings taken observed in the control schools. None of the cafeteria changes we implemented had a significant effect on vegetable waste.

Only two other studies have examined the effect of cafeteria changes based on behavioral economics in middle school populations. Hakim and Meissen [29] investigated the effect of

offering a vegetable choice on consumption during a month-long intervention with middle school students. They observed an 18% increase in vegetable consumption when students were allowed to select from four different vegetables on a "choice day". It should be noted that baseline consumption in this study was low, with an average vegetable consumption of just 23%. The vegetable choice intervention increased average consumption to 41%. While the result was statistically significant, students were still consuming less than half of the vegetable servings they took. Furthermore, it is difficult to compare the results of our study to Hakim and Meissen's, since their participating schools were "serve" programs, meaning students had to leave the lunch line with all components of the school lunch on their trays. The lunch programs in our study used the offer versus serve (OVS) model during both measurement years with students allowed to decline either the fruit or vegetable.

Hanks et al.[24] conducted a "smarter" lunchroom makeover in which 12 small changes to the school cafeteria were simultaneously implemented in two junior-senior high schools. Some of the changes were similar to those we used in our study; vegetables labeled with descriptive names, signs posted with color photos of vegetables and verbal prompts from the cafeteria staff. They found students were 23% more likely to take a vegetable and actual vegetable consumption increased by 25%. We implemented and measured cumulatively three changes over three semesters, which may have been too subtle to bring about significant change in selection and waste. Additionally, we included two control schools and Hanks et al noted a lack of control school as a limitation of their study.

The updated USDA meal regulations allow for OVS of fruit and vegetable serving options.[18] The participating schools in this project maintained OVS for the entire study. The USDA meal regulations also require students to take a fruit or a vegetable with their lunch but

they do not have to take both.[18] Regardless of the environmental changes to the cafeteria, students could still refuse the vegetables and have a reimbursable meal by selecting a fruit. Cohen et al examined the impact of the new school meal standards on food selection, consumption, and waste.[30] Following implementation of the new meal standards, they observed fruit selection increased by 23% but vegetable selection remained unchanged. This suggests that students used their mandatory fruit or vegetable choice to choose fruit. We did not measure fruit selection or waste in the present study, however, given the low number of students choosing vegetables with lunch, it is logical to conclude students were taking fruit instead of vegetables. Hakim et al found a 15.6% increase in vegetables consumed with a forced-choice intervention where students could choose from 4 different vegetables on "choice day". [29] However, this was implemented in a cafeteria using a serve-only service model. Regardless of their vegetable or fruit choice, students in their study were required to leave the lunch line with a full tray: milk, one fruit, one vegetable, and one entrée.

Consistent with our previous research,[22] students in this current study selected few vegetables with lunch and wasted large portions of the vegetables they did choose. We observed a 47-61% range of vegetable waste in the current study. Hakim and Meissen noted a range of vegetable waste of 59-71% [29] and Cohen et al found middle school students discarded roughly 60-75% of the vegetables on their trays.[30] This level of waste is similar to that reported in a recent study of Boston-area middle schools where students were throwing away 75% of the vegetables they selected for lunch.[31] The results from these studies indicate high levels of vegetable waste have been an on ongoing problem and may warrant more attention than what subtle environmental strategies can address. Cohen et al. noted "schools must also focus on the quality and palatability of the fruits and vegetables offered and on creative methods to engage

students to taste and participate in selection of menu items to decrease overall waste levels."[30] Experiential cooking and tasting programs, such as Cooking with Kids[32] have demonstrated a positive effect on vegetable preferences, cooking attitudes and self-efficacy in 4th-grade students.

Similar to experiential cooking programs, school garden-based nutrition education has been reported to be an effective means in increasing vegetable preferences and consumption.[33–35] A review of garden-based youth nutrition programs suggests these programs have the potential to improve students' vegetable preferences.[35] Ratcliffe et al. observed an increase in vegetable preference, consumption, and variety of vegetables eaten in middle school students who participated in garden-based nutrition education.[34] Also, a meta-analysis examining the efficacy of garden-based nutrition education programs found gardening increased vegetable consumption in children, whereas the impacts of nutrition education programs were marginal to nonsignificant.[33]

Throughout this study, 6th-grade students wasted significantly more vegetables than 7th or 8th graders. One possible reason is middle school lunches generally contain more calories than elementary school lunches. [18] Sixth-grade students may not have adapted to the larger meals and it is possible they were unable to finish everything on their tray. Eighth grade students would likely be exhibiting greater growth and therefore an increased need for more calories.

Food quality factors, such as flavor, aroma, perceived freshness, presentation, and visual attractiveness are important considerations when students decide what foods they will eat for school lunch.[36,37,38] Vegetable quality and preparation methods were not altered in our study, except for the addition of the seasoning in semester 3. In a recent survey of middle school students, we found that food quality was often cited as a reason for students not participating in the NSLP.[39] In a review of international qualitative studies investigating determinants of

children's fruit and vegetable consumption, Krolner and colleagues found children often described vegetables served in school as cold, mushy, soggy, dry and unpleasant tasting.[36] Since aspects of vegetable quality were not altered our study, this is a likely reason for a lack of significant effect of the environmental strategies on vegetable selection and consumption.

Vegetable availability and accessibility has been associated with increased consumption.[40] Terry-McElrath et al. investigated associations between school food group availability and accessibility and student fruit and green vegetable consumption in a nationally representative sample of secondary students. Availability of fruits or vegetables was defined as any school prevalence of fruits or vegetables and accessibility was indicated by the total number of school sources of fruits or vegetables. As fruit and vegetable accessibility increased, the likelihood of students consuming fruits and vegetables also increased. The presence of salad bars were significantly associated with middle school green vegetable consumption in both availability and accessibility analyses.[40] None of the participating schools in our study had salad bars, but each served two choices of vegetables daily; one hot vegetable choice and one fresh choice. While adding salad bar equipment requires a significant capital investment and would generally not be considered as a low or now cost strategy, studies have reported the introduction of salad bars increases the amount and variety of fruits and vegetables selected and consumed by students.[41–43] If an SFA can afford the capital investment, adding a salad bar may be a long-term solution with the greatest impact on vegetable consumption.

While the findings from our study are disappointing, the results are comparable to several other school-based interventions which failed to show improvements in vegetable intake. Evans et al. conducted a meta-analysis of 21 school-based interventions in children aged 5-12 in 10 countries, finding no change in vegetable intake.[20] The studies included in the review used a

number strategies such as classroom based curricula, social marketing, home-based projects, and free fruit and vegetable distribution. While this meta-analysis reviewed studies conducted in elementary school children, this review highlights the challenges encountered when trying to change vegetable consumption in children. The HEALTHY study implemented changes likely to reduce the risk of overweight, obesity, and type 2 diabetes in 42 middle schools across the US, over five semesters.[44] Changes were made to the total school food environment including cafeteria meals, after-school snacks, a la carte venues, vending machines, fundraisers, classroom parties and celebrations with increasing fruit and vegetable consumption as one of the strategies targeted. At the conclusions of the study, no measureable change in vegetable intake was observed. Larson et al. examined predictors of fruit and vegetable intake in young adulthood and concluded it is important for nutrition interventions to address individual and environmental factors throughout adolescence. They found taste preferences to be a strong predictor of intake and emphasized the importance of establishing taste preferences for fruits and vegetables early in life.[37] Experiential cooking and tasting programs have a positive effect on effect on vegetable preferences in 4th-graders and are one way in which establish vegetable preferences early, prior to middle school.[32] The present study examined changes in just a few small environmental factors; the intervention did not address individual factors such as vegetable preferences or taste. Other studies have found familiarity of taste and early exposure to vegetables plays an important role in children's acceptance.[36] Therefore, combining multiple strategies that address both environmental and individual factors, such as providing nutrition education,[21,45] the formation of student advisory groups,[45] understanding adolescent views on food and nutrition,[46] involving students in menu development,[47] taste testing vegetables, recipes, and preparation methods,[21]

may be necessary to produce a significant change in vegetable selection and consumption in this age group.

Strengths and Limitations

A primary strength of this study was that it was conducted in middle schools, an understudied setting for school-based programs. Additionally, the interventions were carried out over a semester or the entire school year, a longer period time than previous studies using behavioral economics based strategies. Plate waste was assessed with a previously validated digital photography method.

There are several limitations that should be noted. The study was conducted in four middle schools in northern Colorado with primarily white, moderate-income students, limiting generalizability. Also, plate waste was not assessed simultaneously in all schools; therefore, waste of different vegetables was measured in the treatment and control schools. Also, plate waste was assessed as repeated cross-sections and individual student consumption was not tracked over time. We were unable to control all possible variables impacting students' school lunch participation and consumption such as last minute menu changes, scheduling of field trips, weather events that caused schools to alter their lunch schedules, and so forth. Lastly, there was variation between all four middle schools in free and reduced price lunch eligibility, enrollment, and cafeteria settings limiting our ability to match treatment and control schools in all aspects of their school meal service. The schools randomized to the control condition were also more affluent, potentially biasing the results.

Conclusions and implications for future research

Continued efforts to increase the overall selection and consumption of school lunch-served fruits and particularly vegetables, should be a priority for future school based research. A

combination of behavioral economics strategies and other interventions such as, providing experiential nutrition education and cooking and gardening programs for students, marketing healthy choices, providing opportunities for student involvement in menu development, and creating opportunities for students to try new fruits and vegetables may be more effective together than any single intervention.

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CHAPTER 6: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this project was to: 1) evaluate food choices and consumption patterns of elementary and middle school students who participate in the National School Lunch Program (NSLP); 2) compare students' average nutrient intake from lunch to NSLP standards; 3) determine middle school students' satisfaction with school lunch; and 4) determine how subtle changes in the cafeteria environment, specifically targeting vegetable intake, effect middle school student selection and consumption of vegetable side items.

Discussion

Formative Assessment

The school meal standards born from the 2010 Healthy Hunger Free Kids Act were designed to ensure school meals offered to students aligned with the US Dietary Guidelines for Americans, particularly with respect to servings of fruits and vegetables.[1] The regulations called for an overall increase in the number of fruit and vegetable servings offered to students at lunch, and in the variety of vegetables served each week.[2] Also, unlike in the past, students were required to take a serving of fruit or vegetable with lunch. These provisions should result in students selecting more nutrient-dense lunches. However, our evaluation of the food choices and consumption patterns of NSLP participants, using photographic plate waste assessment revealed that students did not regularly choose fruit, and, in particular, vegetables with lunch and when these foods were selected, significant amounts were wasted. Students were more likely to choose fruit rather vegetables with lunch but, close to 40% of these items went uneaten. Of particular concern, less than half of elementary and less than 40% of middle school students selected either the hot or fresh vegetables with lunch. When students did take a vegetable, more than 30% went uneaten. This result is in agreement with national data[3] which reported 96% of schools offered

vegetables, however, only 51% of students consumed vegetables with lunch. Thirty-eight percent of those vegetables were categorized as starchy (French fries, white potatoes and corn) and only 6% of students chose orange or dark green vegetables. A recent study of middle school students in Texas documented that of those students consuming NSLP meals, about 40% selected and consumed a fruit serving.[4] About two-thirds of students selected a vegetable, with only 4% choosing a dark green or orange vegetable. When students did not choose or consume the fruit and, in particular, vegetables offered with lunch, they were less likely to meet nutrient targets for vitamins A and C, fiber, or iron. Even when school lunch menus were planned to meet the 2010 Healthy Hunger-Free Kids Act standards, the lunches students chose and consumed did not translate into improved dietary intake.

The results of our plate waste assessment underscored the need for school meal programs to utilize a variety of strategies to improve students' self-selection and consumption of vegetables with school lunch. A small number of studies have demonstrated success promoting fruit and vegetable intake with behavioral economic strategies, such as signage, food location, lighting, verbal prompts, and convenience lines.[5,6,7] Because of the relatively low cost for implementing these strategies, we chose make them the focus of a cafeteria intervention.

Cafeteria Intervention

The purpose of the cafeteria intervention was to determine how subtle changes to the cafeteria environment, specifically targeting vegetable intake, effect middle school student selection and consumption of vegetables (not included in the entrée). Taken as a whole, the environmental strategies used in this study did not have a measurable effect on vegetable selection or consumption. The addition of the new signs and verbal prompts did not increase vegetable servings taken by students at lunch in the intervention schools, however, they may

have prevented a similar decrease in vegetables servings taken observed in the control schools. None of the cafeteria changes we implemented had a significant effect on vegetable waste.

Only two other studies have examined the effect of cafeteria changes based on behavioral economics in middle school populations. Hakim and Meissen[8] investigated the effect of offering a vegetable choice on consumption during a month-long intervention with middle school students. They observed an 18% increase in vegetable consumption when students were allowed to select from four different vegetables on a "choice day". It should be noted that baseline consumption in this study was low, with an average vegetable consumption of just 23%. The vegetable choice intervention increased average consumption to 41%. While the result was statistically significant, students were still consuming less than half of the vegetable servings they took. Furthermore, it is difficult to compare the results of our study to Hakim and Meissen, since their participating schools were "serve" programs, meaning students had to leave the lunch line with all components of the school lunch on their trays. The lunch programs in our study used the offer versus serve model and students were allowed to decline either the fruit or vegetable. And, their study was of a much shorter duration; the intervention lasting for only a month whereas our intervention spanned two full school years. A study of short duration would measure impact when the cafeteria changes were novel, whereas the effect of a yearlong intervention may fade over time.

Hanks et al [9] conducted a "smarter" lunchroom makeover in which 12 small changes to the school cafeteria were simultaneously implemented in two junior-senior high schools. Some of the changes were similar to those we used in our study; vegetables labeled with descriptive names, signs posted with color photos of vegetables and verbal prompts from the cafeteria staff. They found students were 23% more likely to take a vegetable and actual vegetable consumption

increased by 25%. We implemented three changes over three semesters, which may have been too subtle to bring about significant change in the middle school students in this study. Additionally, we included two control schools, both of which had a decrease in plate waste throughout the school year similar to the two treatment schools. Hanks et al noted a lack of control school as a limitation of their study[9]. Without a control school, it is not possible to know if the observed increase in consumption (decrease in waste) was due to the smarter lunchroom makeover or is a naturally occurring phenomenon of the school meal program.

The updated USDA meal regulations allow for offer versus serve (OVS) of fruit and vegetable serving options. [2] The participating schools in this project maintained OVS for the entire study. The USDA meal regulations also require students to take a fruit or a vegetable with their lunch but they do not have to take both.[2] Regardless of the environmental changes to the cafeteria, students could still refuse the vegetables and take a fruit to have a reimbursable meal. Cohen et al examined the impact of the new school meal standards on food selection, consumption, and waste.[10] Following implementation of the new meal standards, they observed fruit selection increased by 23% but vegetable selection remained unchanged. This suggests that students used their mandatory fruit or vegetable choice to choose fruit. We did not measure fruit selection or waste in the present study, however, given the low number of students choosing vegetables with lunch, it is logical to conclude students were taking fruit instead of vegetables. Hakim et al reported a 15.6% increase in vegetables consumed with a forced-choice intervention where students could choose from 4 different vegetables on "choice day". [8] However, this was implemented in a cafeteria using a serve-only service model. Regardless of their vegetable or fruit choice, students were required to leave the lunch line with a full tray: milk, one fruit, one vegetable, and one entrée.

Consistent with our formative plate waste assessment as well as other research, students in this project selected few vegetables with lunch and wasted large portions of the vegetables they did choose.[10, 11] We observed a 47-61% range of vegetable waste in the present study. Hakim and Meissen noted a range of vegetable waste of 59-71% [8] and Cohen et al observed that middle school students discarded roughly 60-75% of the vegetables on their trays.[10] This level of waste is similar to that reported in a recent study of Boston-area middle schools where students were throwing away 75% of the vegetables they selected for lunch.[12] The results from these studies indicate high levels of vegetable waste has been an on ongoing problem and may warrant more attention than what subtle environmental strategies can address. Cohen et al noted "schools must also focus on the quality and palatability of the fruits and vegetables offered and on creative methods to engage students to taste and participate in selection of menu items to decrease overall waste levels."[10]

Experiential cooking and tasting programs, such as Cooking with Kids[13] have demonstrated a positive effect on vegetable preferences, and cooking attitudes and self-efficacy in 4th-grade students. Children's and adolescent's fruit and vegetable preferences are strong positive correlates with intake.[14–16] Similar to experiential cooking programs, school garden-based nutrition education has been reported to be an effective means of increasing vegetable preferences and consumption.[17–19] A review of garden-based youth nutrition programs suggests they have the potential to improve students' vegetable preferences and promote improved fruit and vegetable intake.[19] Ratcliffe et al. observed an increase in vegetable preference, consumption, and variety of vegetables eaten in middle school students who participated in garden-based nutrition education.[18] Also, a meta-analysis examining the efficacy of garden-based

nutrition education programs found gardening increased vegetable consumption in children, whereas the impacts of nutrition education programs were marginal to non-significant results.[17]

Taste and visual attractiveness are the most important factors when students decide what foods they will eat for school lunch.[20,16,21] Food quality includes factors such as flavor, aroma, perceived freshness, presentation, and visual appeal.[22] Vegetable quality and preparation were not altered in our study, except for the addition of the seasoning in semester three. The results of the middle school surveys administered as part of the formative assessment indicated that food quality was often cited as a reason for students not participating in the National School Lunch Program. In a review of international qualitative studies investigating determinants of children's fruit and vegetable consumption, Krolner and colleagues found children often described vegetables served in school as cold, mushy, soggy, dry and/or unpleasant tasting.[20] Since aspects of vegetable quality were not altered our study; it is possible this may be a reason for a lack of significant effect of the environmental strategies on vegetable selection and consumption.

While the findings from our study are disappointing, several other school-based interventions failed to show improvements in vegetable intake. Evans et al conducted a meta-analysis of 21 school-based interventions in children aged 5-12 in 10 countries, finding no change in vegetable intake. [23] The studies included in this review used a number of strategies such as classroom based curricula, social marketing, home-based projects, and free fruit and vegetable distribution. While this meta-analysis reviewed studies conducted in elementary school children, this review highlights the challenges encountered when trying to change vegetable consumption in children. The HEALTHY study implemented changes likely to reduce the risk of overweight, obesity, and type 2 diabetes in 42 middle schools across the US, over five semesters.[24] Changes were made to the total school food environment including cafeteria meals,

after-school snacks, a la carte venues, vending machines, fundraisers, classroom parties and celebrations with increasing fruit and vegetable consumption as one of the strategies targeted. At the conclusions of the study, no measureable change in vegetable intake was observed. Larson et al examined predictors of fruit and vegetable intake in young adults and concluded it is important for nutrition interventions to address individual and environmental factors throughout adolescence.[16] They found taste preferences to be a strong predictor of intake and emphasized the importance of establishing taste preferences for fruits and vegetables early in life.[16] Experiential cooking and tasting programs have a positive effect on effect on vegetable preferences in 4th-graders and are one way in which establish vegetable preferences early, prior to middle school.[13] Our cafeteria intervention examined changes in just a few small environmental factors; the intervention did not address individual factors such as specific vegetable preferences or taste. Other studies have found familiarity of taste and early exposure to vegetables plays an important role in children's acceptance.[20] Therefore, combining multiple strategies that address both environmental and individual factors, such as providing nutrition education,[25,26] the formation of student advisory groups,[25] understanding adolescent views on food and nutrition,[27] involving students in menu development [28], taste testing vegetables, recipes, and preparation methods,[26] may be necessary to produce a significant change in vegetable selection and consumption in this age group.

Strengths and Limitations

Plate waste assessment of student lunch intake during the formative assessment and evaluation of the intervention is a strength of this project. Plate waste methodology overcomes the need to rely on students' memory or ability to accurately estimate portion sizes; common limitations of using 24-hour recall with children.[29,30] The digital photography method used in this

study has been validated by several previous studies as an accurate and convenient method to assess plate waste.[31–33] There was little disruption to usual lunch service, minimizing any unintended influence on plate waste. Additionally, the formative assessment provided the school district with valuable information that will help develop further improvements to the school lunch program. A primary strength of the cafeteria intervention was that it was conducted in middle schools, an understudied setting for school-based programs. Additionally, the changes were carried out over a semester at a time, over the course of two school years, a longer period time than previous studies using behavioral economics based strategies.

There are several limitations of our cafeteria intervention that should be noted. The study was conducted in four middle schools in northern Colorado with primarily white, moderate-income students, limiting generalizability. Also, plate waste was not assessed simultaneously in all schools; therefore, the menus were different on measurement days in the treatment and control schools, potentially influencing vegetable selection and waste. Also, plate waste was assessed as repeated cross-sections and individual student consumption was not tracked over time. We were unable to control all possible variables impacting students' school lunch participation and consumption such as last minute menu changes, scheduling of field trips, weather events that caused schools to alter their lunch schedules, and so forth. Lastly, there was variation between all four middle schools in free and reduced price lunch eligibility, enrollment, and cafeteria settings, limiting our ability to match treatment and control schools in all aspects of their school meal service.

Conclusions

The key finding from the formative plate waste assessment was that elementary and middle school students did not regularly select fruit and particularly vegetables offered for

school lunch. As a result, their lunch consumption did not meet the school meal regulations for vegetable intake based on the Healthy Hunger Free Kids Act 2010 and they fell short of key nutrients including vitamins A and C. Respondents to both surveys indicated they would have a greater level of satisfaction with school lunch if improvements in food flavor, aroma, visual appeal, and freshness were made.

Taken as a whole, the environmental strategies used in the cafeteria intervention did not have an effect on vegetable selection or consumption. The addition of the new signs and verbal prompts did not increase vegetable servings taken by students at lunch in the intervention schools, however, they may have prevented a similar decrease in vegetables servings taken observed in the control schools. None of the cafeteria changes we implemented had a significant effect on vegetable waste.

Recommendations

As schools continue to implement the provisions of the revised national meal standards, they will need to employ several complimentary strategies such as experiential nutrition education, marketing communications, and behavioral economics to ensure students make the most healthful lunch choices. These strategies used in conjunction with traditional behavioral interventions and communication strategies may help achieve and sustain children's fruit and vegetable intake at recommended levels. Continued efforts to increase the overall selection and consumption of school lunch-served fruits and particularly vegetables, should be a priority for future school based research. A combination of behavioral economics strategies and other interventions such as providing nutrition education, marketing healthy choices, providing opportunities for student involvement, and creating opportunities for students to try new fruits and vegetables may be more effective together than any single intervention.

Communication between school nutrition professionals and students is a key factor for implementing the meal standards, encouraging vegetable intake, and improving school meal programs. To improve lunch satisfaction and encourage students to choose the additional vegetable servings, school nutrition professionals need to communicate with students to obtain their perspective about food choices and the meals served to explore the best course of action. Taking a proactive approach to see student input and address the concerns will provide student with a sense of empowerment and may have a positive impact on the decision to eat school lunch.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD LETTERS

Colorado State University
Knowledge to Go Places

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	August 26, 2010	
TO:	Cunningham-Sabo, Leslie, Food Science & Human Nutrition Melby, Christopher, Smith, Stephanie, Food Sci. & Human Nutrition	
FROM:	Barker, Janell, CSU IRB 1	
PROTOCOL TITLE:	Thompson School District Eat Well to Excel	
FUNDING SOURCE:	Coalition of Activity and Nutrition to Defeat Obesity (CanDo) : 101128	
PROTOCOL NUMBER:	10-1916H	
APPROVAL PERIOD:	Approval Date: August 24, 2010	Expiration Date: August 23, 2011

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Thompson School District Eat Well to Excel. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Research.Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Research.Colostate.edu

Barker, Janell

Barker, Janell

Includes:

Approval is for the food tray activity only; observing and photographing 1,800 food trays. Parents will be notified of the research; children will give their verbal assent to have their food tray photographed using the approved verbal script. Documentation of consent for the parents for the food tray photo is waived through 116(d). The project meets 46.404; minimal risk of the child. CONDITIONS OF THE APPROVAL: the method and any documents of alerting the parents of the research should be submitted once determined and the remaining documents and activity details must be submitted for review and approval prior to implementation (surveys, forms, interview questions). Submit these additions and changes as amendments.

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Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
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FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	August 25, 2011
TO:	Cunningham-Sabo, Leslie, Food Science & Human Nutrition Melby, Chris, Smith, Stephanie, Food Sci. & Human Nutrition
FROM:	Barker, Janell, , CSU IRB 1
PROTOCOL TITLE:	Thompson School District Eat Well to Excel
FUNDING SOURCE:	Coalition of Activity and Nutrition to Defeat Obesity (CanDo) : 101128 College of Applied Human Sciences, Agriculture Experiment Station Grant :
PROTOCOL NUMBER:	10-1916H
APPROVAL PERIOD:	Approval Date: August 24, 2011 Expiration Date: August 23, 2012

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Thompson School District Eat Well to Excel. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Barker, Janell

Includes:

Approval is to continue the study to assess the plate waste of 9,000 student food trays.

Approval Period:	August 24, 2011 through August 23, 2012
Review Type:	EXPEDITED
IRB Number:	00000202

Colorado State University
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Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011
Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	February 21, 2011	
TO:	Cunningham-Sabo, Leslie, Food Science & Human Nutrition Melby, Chris, Smith, Stephanie, Food Sci. & Human Nutrition	
FROM:	Barker, Janell, , CSU IRB 1	
PROTOCOL TITLE:	Thompson School District Eat Well to Excel	
FUNDING SOURCE:	Coalition of Activity and Nutrition to Defeat Obesity (CanDo) : 101128	
PROTOCOL NUMBER:	10-1916H	
APPROVAL PERIOD:	Approval Date: February 21, 2011	Expiration Date: August 23, 2011

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Thompson School District Eat Well to Excel. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Barker, Janell

Includes:

The amendment approval is to collect food waste from 4th graders. Parental consent is waived through 116(d); verbal assent will be obtained from the child. To conduct interviews with various groups using the approved consent form to obtain consent. Conduct anonymous surveys with middle (600) and high school (600) students using verbal assent. Parental consent is waived through 116(d). Observation of meal environment will also be conducted; not identifying any person. These are to be conducted with school approval.

Approval Period:	February 21, 2011 through August 23, 2011
Review Type:	EXPEDITED

APPENDIX B

DIGITAL PHOTOGRAPHY PLATE WASTE ASSESSMENT PROTOCOL

Overview
A variety of techniques exist to study the meal consumption of students participating in the National School Lunch and School Breakfast Programs.

Digital photography of meal trays before and after consumption allows for visual estimation of the amount of food consumed by each student by multiple evaluators. Because data is preserved in a photograph, visual estimations can be made in the lab, rather than in the cafeteria, allowing evaluators as much time as needed to carefully consider amounts consumed by each student.

For the Thompson School District (TSD) Eat Well to Excel project, plate waste data will be collected from approximately five elementary schools, two middle schools and two high schools. A representative sample of students from all grades will be randomly selected using TSD's electronic student account management system, WinSNAP.

The following protocol describes equipment and materials needed for each school, camera station set-up, data collection methods and data analysis procedures.

Equipment and Materials
- Digital Cameras – 2 (Fuji FinePix Z10fd, 7.2 MP, 3x Optical Zoom)
- Camera batteries (fully charged) and battery charger
- 4MB SD card, blank
- Tripod with full-rotating head mount
- Calibration board
- Portable table
- Digital clock
- Protractor
- Step stool
- Power strip and extension cord
- Pre-printed index cards and masking tape
- Clipboard
- Ziploc bags and cooler (for transport of reference tray foods and serving samples)
- Measuring glass for milk and other beverages in opaque containers
- Bucket (for disposing of excess beverages)
- Sharpie markers
- Disinfecting wipes and paper towels
- Trash can (from cafeteria)

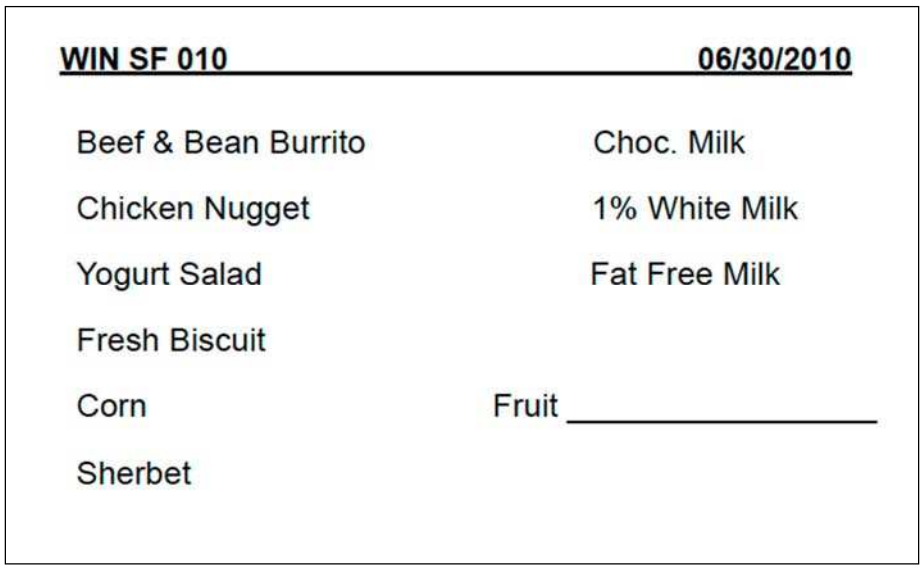
For now, all materials will be stored with the study coordinator, Stephanie Smith. By fall, a suitable and secure location will be identified for storage within the FSHN Department in the Gifford Building.

Station and Camera Set-Up

1. Ensure a fully charged camera battery and blank 4MB SD memory card are loaded into the compartment on the bottom of the camera. Use a separate SD card for each school.
2. Check the camera's shooting mode. The shooting mode should be set to AUTO.
3. Attach the tripod mounting plate to the bottom of the camera then secure the camera onto the tripod.
4. Adjust the tripod head mount so that the camera lens is 26.5 inches above the tray at a 45° angle. Ensure the camera is level by aligning the mark on the head mount with the red reference line (marked on a small piece tape affixed to the bottom of the mount). Tripod legs do not need to be extended.
5. Set the tripod on the table and place the calibration board flush with the tripod legs and aligned with the foam buttons on the tripod feet.
6. Look through the camera's LCD panel (using the step stool, if necessary) and adjust the zoom so that the border of the calibration board is at the edge of the top and right side of the frame (see Figure 1.)
7. Take a couple of test pictures to determine if the flash is needed for the lighting conditions.
8. Plug-in the camera battery charger; keep extra batteries charged for quick battery changes, if needed.
9. Position a trash can near the end of the table for students to dispose of their trash after the post consumption photographs have been taken.

Figure 1. – Sample positioning of test tray and zoom

Measurement Procedures
At least one day before the assigned measurement day, obtain a copy of the menu from TSD Nutrition Services. Print a set of index cards for data collection with the day's menu and pre-determined ID codes. See example below.



On the day of measurement, arrive at least 30 minutes before the first lunch service to set up the photography station (as outlined above) and ensure all equipment is working properly. Check-in with the cafeteria manager and obtain a copy of the day's production record. Ask the cafeteria manager to assemble test trays of that day's menu items. Five to 10 portions of each menu item are needed for the test trays. The number of portions depends upon whether the food are pre-packaged or scooped by the servers. Place the test tray in the upper right corner of the calibration board as shown in Figure 1. On a pre-printed index card, check-off the menu items and place the card on the tray. Look through the camera's LCD panel and ensure all food items are adequately visible. Photograph the test trays then pack all foods into Ziploc bags and the cooler to carry them back to the lab for weighing. An average of the 5-10 weights will be the standard used when estimating the amounts offered to and consumed by students.

At least three study volunteers are needed during data collection: One person to check off the student's food selections and affix the index card to the tray, one person to monitor the cafeteria and direct students with ID cards on their trays to the photography station, and one person to the position the trays on the calibration board and operate the camera.

Once the lunch period begins, students will move through the cafeteria line and fill their trays as usual. As they pay for their meal, TSD's electronic account management system will alert the cashier if a student has been selected to have his/her tray photographed. The student will verbally acknowledge their willingness to participate and have their tray photographed after they've eaten. If he/she agrees to participate, a study volunteer will assign a participant identification code and check-off the foods and beverages selected on an index card pre-printed with the date, meal and day's menu and affixes it on the tray. The student takes his/her tray to a table and eats as usual.

After finishing their meals, students are reminded by a study volunteer to bring their tray to the photography station. Students place their tray in the upper right corner of the calibration board as pictured in Figure 2. To determine beverage consumption, pour any remaining liquid into a measuring cup, record the amount on the beverage waste form. Dispose of any trash not related to food eaten such as napkins and utensils. Look through the LCD panel and ensure all waste is adequately visible. Reposition items if needed. Take the post-consumption photograph. Discard the waste in the trash can at the end of the table. Pour the liquid from the measuring cup into a bucket. Wipe the measuring cup with a paper towel.

To check intra-observer reliability, at least 10 post-consumption trays will be packed and brought back to the lab for weighing. Weights will be compared to the weights derived from visual estimation of the photographs.

At the end of the meal period and after all selected student trays have been photographed, dispose of any remaining trash and discard the beverage waste where directed by custodians. Wipe down the calibration board and table with disinfecting wipes. Ensure the SD card from the camera is labeled with the school and date.

Figure 2. – Sample post-consumption photograph

Weighing Reference Servings of Foods
Bring the cooler filled with reference servings of menu items back to CSU-Gifford Building. Weigh each sample on an electronic scale in the Foods Lab and record the weight in grams. Once all samples of a menu item have been weighed, calculate the average weight and record on the "Weight of Reference Servings" form. This average will be used to calculate the amount of food each student consumed after visual estimation of percentage waste has been recorded from each photograph.

Photograph Analysis
Prior to analyzing the photographs, each .jpg file will need to be renamed with the student ID code corresponding to the code on the index card and "post" to distinguish from the test tray photographs. For example, for the photograph in Figure 2, the file name should be GFSF025Post.jpg. The will make the file easy to locate for later use and the computer.

For photograph analysis, select a student ID number and open the test tray photographs and post photographs together. Arrange them side by side on the screen. The wide screen monitors in the Gifford Graduate Student Computer Lab work well for this purpose. Check that food items in the photograph match those checked off on the index card. Record the foods on the "Photographic Plate Waste Analysis" data form along with student ID number, date, school, grade and evaluator name. Carefully examine the test tray and post photographs and record the amount of food left for each item to the nearest 10%. Do not rush. The advantage of using digital photography is the evaluator can take as much time as needed to examine the photographs. Repeat this procedure until the test tray/post photographs of all student trays have been evaluated and the percentage of waste recorded on the data collection form.

After all waste data is recorded; it will be entered into an Excel spreadsheet where the actual amount of food consumed is calculated based on the weights of the reference servings.

APPENDIX C

MIDDLE SCHOOL PARTICIPATION AND NON PARTICIPATION SURVEYS

National Food Service Management Institute
The University of Mississippi

Middle/Junior High School Student
Participation Survey

Completely fill in the circle of your answer. Use a #2 pencil.

Correct ●●● Use No. 2 Pencil Only *Incorrect* ⊗⊙⊘

We want to know what you think! This survey is your chance to let us know how we are doing. Please take a few minutes to offer feedback on the quality of your lunch experience at the school cafeteria.

SECTION I. Your Lunch Experience

Instructions:
Listed below are several characteristics of school lunch programs. As you answer, use the phrase, **"When I eat school lunch..."** before each statement, and then rate your level of agreement by using the scale 1 (Strongly Disagree) to 5 (Strongly Agree).

	When I eat school lunch...	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1.	The food is fresh.	①	②	③	④	⑤
2.	The service is good.	①	②	③	④	⑤
3.	The food tastes good.	①	②	③	④	⑤
4.	There is a variety of food choices.	①	②	③	④	⑤
5.	The food smells good.	①	②	③	④	⑤
6.	The menu offers healthy choices.	①	②	③	④	⑤
7.	I get enough food to fill me up.	①	②	③	④	⑤
8.	I get to socialize with my friends.	①	②	③	④	⑤
9.	The staff looks like they enjoy their work.	①	②	③	④	⑤
10.	The food choices change every day.	①	②	③	④	⑤
11.	The food looks appealing.	①	②	③	④	⑤
12.	The food is properly cooked.	①	②	③	④	⑤
13.	The food tastes homemade.	①	②	③	④	⑤
14.	The staff is friendly.	①	②	③	④	⑤
15.	The staff listens to my suggestions.	①	②	③	④	⑤
16.	There are enough seats in the dining area.	①	②	③	④	⑤
17.	The menu has food I like.	①	②	③	④	⑤
18.	I know what is being served before I get to the cafeteria.	①	②	③	④	⑤
19.	I can buy other food items if I don't want the meal.	①	②	③	④	⑤
20.	I have enough time to eat.	①	②	③	④	⑤
21.	I am satisfied after I eat.	①	②	③	④	⑤
22.	The quality of the food is good.	①	②	③	④	⑤
23.	The quality of the service is good.	①	②	③	④	⑤
24.	The quality of my lunch experience is good.	①	②	③	④	⑤

National Food Service Management Institute
The University of Mississippi

Middle/Junior High School Student
Non-Participation Survey

Completely fill in the circle of your answer. Use a #2 pencil.

Correct ●●● ✎ Use No. 2 Pencil Only *Incorrect* ⊗◉✓

Your School Nutrition Program is interested in understanding why middle/junior high school students do not eat or do not eat often in the school lunch program. Please take a few minutes to offer feedback based on your own experience.

SECTION I. Reasons for Not Eating School Lunch

Instructions:
Please read the statements regarding reasons for not eating (or not eating often) school lunch. As you answer, use the phrase, **"My reason for not eating school lunch is that..."** before each statement, and then rate your level of agreement by using the scale 1 (Strongly Disagree) to 5 (Strongly Agree).

	My reason for not eating school lunch is that...	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1.	The food does not taste good.	①	②	③	④	⑤
2.	I prefer to eat what I bring from home.	①	②	③	④	⑤
3.	I do not get enough food to fill me up.	①	②	③	④	⑤
4.	There are not enough seats in the dining area.	①	②	③	④	⑤
5.	The staff is not friendly.	①	②	③	④	⑤
6.	I do not like the food being served.	①	②	③	④	⑤
7.	The food does not look healthy.	①	②	③	④	⑤
8.	My parents buy food for me to take to school.	①	②	③	④	⑤
9.	The food I like runs out before I get to the cafeteria.	①	②	③	④	⑤
10.	There are long lines.	①	②	③	④	⑤
11.	The service is poor.	①	②	③	④	⑤
12.	I do not recognize the food being served.	①	②	③	④	⑤
13.	The food served is the same every day.	①	②	③	④	⑤
14.	The staff does not speak to me.	①	②	③	④	⑤
15.	The food does not look fresh.	①	②	③	④	⑤
16.	The food choices offered are not the same as the menu.	①	②	③	④	⑤
17.	The food is not properly cooked.	①	②	③	④	⑤
18.	The cafeteria does not look clean.	①	②	③	④	⑤
19.	The food does not look appealing.	①	②	③	④	⑤
20.	There is no variety of food choices.	①	②	③	④	⑤
21.	The menu does not have food I like.	①	②	③	④	⑤
22.	I do not get to sit with my friends.	①	②	③	④	⑤
23.	I do not have enough time to eat.	①	②	③	④	⑤
24.	The quality of the food is poor.	①	②	③	④	⑤