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New Fruit and Vegetable Offerings and Challenges Increased Lunch-Time Fruit and Vegetable Consumption among Fourth-Graders

Cory Ann Hansen
Utah State University

NEW FRUIT AND VEGETABLE OFFERINGS AND CHALLENGES INCREASED LUNCH-TIME FRUIT AND VEGETABLE CONSUMPTION AMONG FOURTH-GRADERS

by

Cory Ann Hansen

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Approved:

Heidi Wengreen, Ph. D. Major Professor	Tamara S. Vitale, MS Committee Member
Ray Reutzel, Ph. D Committee Member	Byron R. Burnham, Ed. D Dean of Graduate Studies

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ABSTRACT

New Fruit and Vegetable Offerings and Challenges

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Consumption among Fourth-Graders

by

Cory Ann Hansen, Master of Science

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Major Professor: Dr. Heidi Wengreen
Department: Nutrition and Food Sciences

Facilitating nutritional improvement in schools is an important strategy for reversing the alarming trends of overweight and undernourishment currently observed among children in the United States. Compared to national recommendations, many people overconsume calories while simultaneously underconsuming essential vitamins and minerals. One contributing factor is a low intake of nutrient-dense foods, such as fruits and vegetables, and a high intake of energy-dense foods, such as soda, chips, and candy. Prior studies have demonstrated that elementary students do not consume adequate levels of fruits and vegetables during school lunch. The objective of this study was to determine if school-based interventions can increase fruit and vegetable consumption among fourth-graders who participate in the National School Lunch Program. Three different interventions were implemented, including fruit and vegetable "Challenges," offering a new variety of fruits and vegetables on the school food service

fruit and vegetable bars, and classroom nutrition education. Parental consent was obtained from the 75 fourth-graders who took part in the study. To assess food intake of the study subjects, digital photographs of students' school lunch trays were taken pre- and post-consumption and then analyzed to determine amounts of fruits and vegetables selected and consumed. Data were collected during baseline and each of the interventions. Differences in mean intake across time were examined and paired t-test analyses were used to assess if observed differences were statistically significant. Compared to baseline intakes, the variety intervention significantly increased mean fruit and vegetable consumption ($p<0.001$). The "Challenges" also increased mean intakes; however, the increase was not significant on all measured days ($p=0.014$ to 0.824). The education intervention was not associated with a significant increase in fruit and vegetable consumption ($p=0.642$). Additionally, mean fruit and vegetable intake achieved between 17% to 56% of minimum national recommendations on any given day. In light of these findings, although offering new fruit and vegetable varieties may be difficult due to time and money constraints, the results were dramatic enough to encourage schools to continually strive to offer new varieties of fruits and vegetables.

(155 pages)

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CHAPTER I

INTRODUCTION AND BACKGROUND

Abstract

The simultaneous occurrence of overweight and undernutrition is a significant problem in the United States that continues to worsen. Due to the significant health consequences of this type of malnutrition, it is important to consider effective ways to alleviate its prevalence, especially among children. Schools are one place where interventions are currently taking place and should continue to be studied and improved. Nutritional improvement may result via interventions that encourage children to consume more nutrient-dense foods, such as fruits and vegetables, and less energy-dense nutrient-poor foods, such as desserts, chips, and sodas. Although many programs are in place in the United States aimed at achieving this goal, the effectiveness of many of these programs is unknown and overall obesity trends among youth are worsening. This study implemented and tested the effectiveness of 3 nutrition interventions aimed at increasing consumption of fruits and vegetables among fourth-graders. Intake levels were measured by means of plate waste data collection. Results were evaluated to determine whether the interventions resulted in significant improvements in fruit and vegetable intake among fourth-graders. Background, hypotheses, methods and statistical procedures are included. This work was funded by the Carol M. White Physical Education Grant.

Introduction

The prevalence of overweight is considered an epidemic in the US (1-2). The associated causes and consequences are widespread, complicated, and difficult to address. Reversing the trends of overweight and obesity among the nation's youth and adults is the goal of many research projects, campaigns, and policies at both local and national levels. Yet, despite these efforts, overweight and obesity rates continue to climb.

One major contributing factor to the alarming rates of obesity in the US is the energy-dense, as opposed to nutrient-dense diets of many Americans (3-10). Energy-dense diets consequently lead to high calorie intakes and weight gain, yet inadequate nutrient intakes. For example, an energy-dense diet that may be high in candy and soda and low in fruits and vegetables may meet or exceed calorie needs and simultaneously be low in fiber and certain essential vitamins and minerals. As a result of such high-calorie and low-nutrient diets, the US population has earned a reputation of being overfed and undernourished.

Since the malnutrition plaguing many in the US likely stems from both overconsumption of calories and underconsumption of nutrients, it seems appropriate that interventions aim to reverse this energy-dense eating pattern. Aiding people in the consumption of nutrient-dense foods, which are high in vitamins and minerals and low in calories relative to weight, may be helpful in reversing the current epidemic of overweight and undernourishment.

Since the high incidence of overweight and obesity blanket all age groups in the US including youth, one key venue to implement programs emphasizing the importance

of nutrient-dense foods may be the National School Lunch Program, which currently provides meals to an average of 29 million youth on any given school day (11). Improving the nutrient density of meals provided in schools may help reverse the overfed and undernourished trend observed among youth. Although there are many nutritional issues of interest, increasing youth's consumption of school lunch fruits and vegetables (FV), which are nutrient-dense due to their low calorie content relative to vitamins and minerals, is one step towards more nutrient-dense school lunches.

The objective of the research presented in this thesis project was to assess the effectiveness of 3 interventions aimed at increasing consumption of FV offered as part of meals provided by the National School Lunch Program among fourth-graders. The interventions were: (1) Team Nutrition FV challenges that rewarded students for consuming FV on the daily FV bar, (2) offering new varieties of FV, and (3) nutrition education in the classroom. This project was supported by the Carol M. White Physical Education Grant awarded to the Cache County School District, which is comprised of 19 schools including 12 elementary schools in northern Utah. Collaboration between the Cache County School District and Utah State University Dietetics program faculty and students was developed to accomplish the nutritional objectives of this grant.

Background

The ever-increasing rates of overweight and obesity among youth and adults are a significant epidemic in the US. Despite excessive amounts of time and money dedicated to its prevention, the problem has prevailed for decades (1-2). Currently, 66% of US

adults are overweight and 32% are obese (2). Additionally, 18% of young people are overweight (2).

The causes of overweight and obesity are complex. Many factors have been blamed including inactivity, poor food choices, high fat diets, high sugar diets, low nutrient intakes, parents, schools, and even a ubiquitous "obesogenic" environment that encourages sedentary pastimes and high-calorie eating. However, the simple fact that people lack energy balance is at the heart of the issue. Americans consume more calories (2) and move less (12-20) than they have in the past, which creates a positive energy balance and inevitably leads to weight gain.

Related to the epidemic of overweight and obesity is poor compliance to national dietary guidelines. People are consuming diets that do not conform to a healthy pattern as defined by the US Department of Agriculture's (USDA) publications of the Food Guide Pyramid and MyPyramid (21) as well as the Dietary Guidelines for Americans (22). While average calorie intakes exceed recommendations, certain healthy food groups and nutrients are often inadequate (3-7). Overall, fat, sugar and calorie intakes are up while dairy, fruit, and vegetable intakes are down (8-10).

This issue of being overfed and undernourished raises concern for many reasons. Current research generally agrees that national recommendations for weight maintenance and food intakes, especially FV (22-25), should be followed to maximize good health and quality of life (26-27), decrease risk of chronic diseases (26-44), extend life expectancy (45-48), and decrease healthcare and economic costs (49-55). Taking into consideration the global costs of obesity and undernutrition, the gravity of the situation is nearly impossible to ignore. Consideration of ways to treat and prevent obesity are of great

importance, especially among youth who are already suffering from obesity-related health conditions once thought applicable only to adults (47, 56).

One proposed avenue to improve malnutrition often associated with overweight and obesity is to encourage nutrient-dense diets, which focus on calorie control and nutrient adequacy. The more nutrients and the fewer calories a food contains, the higher the nutrient density (57). As a result, a nutrient-dense diet is high in vitamins and minerals and low in calories, which may be one solution to the issue of overconsumption of calories and underconsumption of nutrients observed in the US.

Fruits and vegetables are examples of nutrient-dense foods because they are high in many nutrients such as vitamins, minerals, and fiber and low in calories. Thus, increasing FV consumption represents one dietary modification that will improve the nutrient density of many typical American diets In light of current research, effective interventions intended to improve FV intakes include strategies aimed at making these behaviors habitual (58), serving meals in a buffet rather than a la carte style (59), improving planning and cooking habits (60), encouraging education, and properly catering interventions to meet varying needs among socioeconomic status (61-62), ethnicity (20), age (63-64), and gender (65).

Another proposed answer to the nation's malnutrition is concentrating more heavily on interventions aimed at youth. Although not all interventions aimed at youth are successful, research shows youth interventions are promising. A younger population may be able to develop healthier habits more readily (66-68) and then maintain those habits (69-70) as well as a healthy weight (71-73) into adulthood.

If children do not receive effective interventions and develop appropriate lifestyle habits, they may be more likely to become overweight or obese and maintain their high weight into adulthood. (71, 73-74). Overweight youth are also at an increased risk for chronic disease including hypertension (74), cardiovascular disease (75), and insulin resistance (76-77). As a result, it seems absolutely necessary and appropriate to reach out to youth and help them make healthy decisions now and in the future.

National School Lunch Program

Since about 9 out of every 10 students in kindergarten through grade 12 are enrolled in public schools (78), school-based interventions may be effective ways to reach youth. In schools, students have the opportunity to make food decisions at school breakfast and lunch, learn about health in classrooms, and observe eating habits from their peers, teachers, and other school personnel. Thus, school lunch should provide students with good nutrition and be representative of nutritionally balanced meals so that youth may become more conditioned to consuming and understanding proper nutrition.

The National School Lunch Program (NSLP) (11), which was authorized in 1946 and is administered by the USDA Food and Nutrition Service, provides financial assistance and commodities to public and private nonprofit schools serving lunches that meet required nutritional standards according to recommendations of the Dietary Guidelines for Americans (22). In the 2004-2005 school year, the NSLP was operating in 90% of public schools (94,622 schools) with enrollments of almost 49 million students (11). Over 29 million lunches were served each day, which demonstrates a participation rate of about 59% (11). On a typical school day, about 60% of participants were receiving free

or reduced price lunches (11). Higher school lunch participation rates were seen among younger children (11). First and second graders had the highest participation rate at 69% (11). They were followed in descending order by grades three and four (66%), five and six (63%), seven and eight (47%), nine and ten (45%), and eleven and twelve (35%) (11).

NSLP nutrition requirements state that school meals must meet at least one-third of the Recommended Dietary Allowances of protein, vitamin A, vitamin C, iron, calcium, and calories (79). Additionally, the lunches cannot have more than 30% of the calories coming from fat or 10% of the calories coming from saturated fat (79). Although these requirements have improved the nutritional content of school lunches immensely, there is still room for improvement. For example, even if schools are complying with these requirements, there are still nutrition concerns and inadequacies that can occur. No limits are currently in place regarding the amount of calories, sodium, trans fats, and added sugars present in school lunch. Additionally, since the calorie recommendation is set as a minimum, menu planners may plan meals with too many calories. Menu planners may intentionally add excess calories so that the amount of fat remains below 30% of the calories. Since the fat requirement is simply based upon percentage of calories coming from fat rather than grams of fat, high calorie meals are easier to fit into the NSLP nutrient requirements. Although requirements help ensure nutritional adequacy, they may also result in inappropriately high-calorie meals being served to a population already at risk for overweight and obesity.

While federal law requires schools to ensure their menus meet NSLP guidelines, this is not well enforced. Unfortunately, a large proportion of schools still do not meet these requirements. According to the second School Nutrition Dietary Assessment Study,

which was conducted in the 1998-1999 school year and provided nationally representative information on the nutritional quality of meals served in public schools that participated in the NSLP, an average of 33% of calories in elementary school lunches came from fat and about 12% of calories came from saturated fat (80). Additionally, only 20% of schools kept calories from fat under the recommended 30%, and only 14% kept calories from saturated fat under the recommended 10% (80). However, school lunches did provide more than one-third of the Recommended Dietary Allowances for all targeted nutrients (80).

Nevertheless, it should be noted that simply providing a meal adequate in nutrients does not guarantee consumption of those nutrients. Even if nutritionally optimal, if the meals are not prepared and served in a manner enticing to students, nutritional inadequacies may still exist. To properly nourish students, quality meals must be offered and students must then choose to consume them. Thus, creating menus that please the tastes of students in addition to delivering proper nutrition is necessary. National data from 1991-92 indicated that about 12% of calories from food served to students under the NSLP went uneaten (81). A more recent study conducted among 160 students in 2 US elementary schools found that about 25% of calories served were wasted (82). Yet another study conducted at 2 urban southern US schools found that overall food waste averaged 12.9% (83). This study also found that 25% or more of the students did not consume at least 75% of one-third the Recommended Dietary Allowance for thiamin, vitamin B-6, ascorbic acid, iron, and magnesium at either school or of niacin and vitamin A at 1 of the schools (83).

Overall, when compared to non-NSLP participant meals, the NSLP provides meals that are higher in fat and saturated fat, but also higher in most nutrients. Gordon et al. (84) found that students who participated in the NSLP had better nutrient intakes than students who ate elsewhere, including students who brought lunch from home, students who ate from vending machines, and students who ate off campus, such as at grocery stores and fast food restaurants. More specifically, NSLP participation was associated with higher lunch intakes of vitamin A, calcium, iron and magnesium (84). Additionally, participation in the School Breakfast Program, which is another food program administered by the USDA and available to children in schools, was associated with higher breakfast intakes of calcium, riboflavin, phosphorus, and magnesium (84). However, Gordon et al. (84) also found that NSLP participation was associated with higher percentage of calories from fat and saturated fat as well as lower intakes of vitamin C.

Data from the 1994-1996 Continuing Survey of Food Intake by Individuals also found similar results, such as greater intakes of vitamin B6, vitamin B12, thiamin, riboflavin, calcium, phosphorus, magnesium, and zinc and less added sugar (13.2% of calories vs. 22.9%) among NSLP-participants as compared to non-participants (85). Additionally, compared to non-participants, NSLP-participants consumed more servings of vegetables (1.3 versus 0.6) and milk (0.8 versus 0.2 servings) and less soda (0.2 versus 0.4) and fruit drinks (0.1 versus 0.3) (85). However, both total fat and saturated fat intakes from all foods consumed at lunch were higher among NSLP-participants (37 and 15% of calories, respectively) than non-participants (32 and 11% of calories, respectively) (85). Overall, despite a higher fat content, the NSLP provides relatively

healthy meals to students when compared to most of the lunches consumed by non-NSLP participants.

Nevertheless, improvement may still be observed in school lunch. To achieve improved nutrition among children in schools, it is necessary to evaluate the reasons for students consuming and not consuming school lunch as well as ways to improve school lunch and then make the necessary changes wherever practical and possible.

A nationally representative study of 6556 students revealed many issues related to school lunch participation (86). It found that *meal price was the single most important predictor of participation. Of the students approved for free meals, 85% received school lunch on a typical school day. In contrast, only 58% of students not approved for either free or reduced price meals consumed school lunch. This study also found higher participation rates among younger students and in schools without a la carte options and where faculty and staff ate in the same dining area as students. Additionally, students whose parents considered the School Lunch to be more nutritious than lunch at home were more likely to participate. However, students whose parents indicated that nutrition was the primary consideration in choosing where their child consumed lunch participated less frequently. If the student, as opposed to his parents, decided where the student ate lunch, participation decreased. Students whose parents had higher educational levels were less likely to participate.*

Amount of time allowed to eat lunch is another factor involved with school lunch satisfaction and consumption rate. *This may be especially important in schools where recess follows lunch and students do not devote sufficient time to meals in order to consume adequate nutrients (87). In a study of high school students in Cincinnati,* 83% of students surveyed reported time to eat lunch was too short and 62% reported that wait in lines was too long (88).

In light of these findings, attention should be paid to issues that can improve school lunch participation rates, namely, addressing time constraints, keeping costs down, modifying or eliminating a la carte, including faculty and staff in the dining area, and improving the nutrition and performance of school lunch menus and then marketing that improvement to students as well as parents.

Improving School Lunch Menus

Analyzing food consumption and waste patterns is one way to understand how well menus are accepted and define where changes are needed. Connors' and Rozell's (89) study of patients in an acute care hospital demonstrated how improving a menu's performance by analyzing waste led to decreased waste and increased consumption of the menu's offerings, and therefore, nutrients. The study consisted of 2 one-week long plate waste studies occurring at the beginning and end of a 1-year period. The first phase evaluated 383 trays and the second evaluated 467 trays (89). *In the first phase, 2 entrees, 4 starches, all of the vegetables, sliced wheat bread, and skim milk scored below acceptable minimum consumption levels* (89). *As a result, menu*

changes were made accordingly; red potatoes, macaroni and cheese, and dinner rolls replaced noodles, rice, au gratin potatoes, and sliced whole wheat bread, and spinach was eliminated from the menu. In the second phase all entrees, 7 vegetables, and the dinner roll were consumed in acceptable quantities, but skim milk, green beans and tossed salad continued to score low. Thus, testing a menu's performance and then making necessary changes is an important step in planning nutritious menus that are also well-accepted.

Much research has been conducted in schools to help with the issue of creating nutritious, well-accepted meals. According to a review of food waste in schools by Buzby and Guthrie (81), possible causes of waste included wide variation in student appetites and energy needs, differences between meals served and student preferences, scheduling constraints that interfered with meal consumption or resulted in meals being served when children are less hungry, and availability of substitute foods from competing sources.

Similarly, Marlette et al.'s study (90) of 743 sixth-graders in 3 middle schools found that food type and preparation and the purchase of competitive foods, which are defined as any foods sold at school that are not part of the NSLP (i.e. a la carte, snack bars, vending machines, and fundraisers) (91) impacted food acceptance and waste in schools. More specifically, among fruit offerings, the frozen fruit juice bar had the highest acceptance, followed in descending order by applesauce, pears, whole apples, and oranges. Of the

grain offerings, biscuits were accepted by the highest percentage of students, followed in descending order by taco shells, saltine crackers, Spanish rice, buns and spaghetti. Of the vegetable offerings, mashed potatoes had the highest acceptance, followed by fries, corn, salad and green beans, and then boiled potatoes. Also, chocolate milk had a much higher acceptance than white milk. Additionally, the purchase of competitive foods, which are generally higher in fat and calories, led to significantly greater waste of fruits, grain products, meats, and mixed dishes (90). A study of sixth-graders at 3 public schools in Kentucky also found that competitive food purchasers increased their school lunch waste, which resulted in lower intakes of calcium and vitamin A from the school lunch; and competitive foods supplied more than one-third of total energy for the meal (92). Thus, limiting the availability of competitive foods may reduce waste and improve nutrient intake.

Another strategy aimed at decreasing waste and improving nutrient intake is the addition of salad bars to school lunches. In the past 10 years, they have become more common in many public schools (93). However, few studies have been conducted to verify whether they actually lead to increased consumption of FV by the students. Adams et al. (93) conducted a plate waste study to analyze whether the presence of salad bars compared to pre-portioned FV servings impacted FV consumption in elementary students. They evaluated a total of 294 students in 2 elementary schools with salad bars and 2 elementary schools with pre-portioned servings. They found that the presence of a salad bar alone was not sufficient to increase FV intake. However, FV consumption was positively related to the number of FV items offered at salad bars. Since item variety is

usually higher in salad bars, they may be a step in the right direction and only need small changes in order to be more beneficial to student health. As an added benefit, the study found that although the amount of food taken by students from the higher variety salad bar was less, they still consumed more FV overall. This means that high variety salad bars may be an effective way to increase FV consumption while simultaneously decreasing waste (93).

Similarly, Meyer et al. (94) found that variety of food offered was the best predictor of food satisfaction. Additional variables in his study that highly correlated with overall satisfaction included attractiveness of food on the serving line, staff smiling and greeting students, quality of food choices, choices that allow students to meet cultural and ethnic preferences, courteousness of the staff, and quality of ingredients (94).

Despite this supportive research for menus to offer students a variety of healthy choices and limit availability of competitive foods, the means to implement these menus is not always available. One major barrier to proper menu planning is linked to the USDA commodities program, which supplies food items to the NSLP. Under this program, the USDA buys millions of pounds of high-fat, high-cholesterol products, such as beef, pork, milk, and other meat and dairy products every year and then distributes them at very low cost to schools participating in the NSLP (56). Healthier foods such as vegetables, fruits, and nuts receive minor if any federal support making their costs relatively higher (56), which makes it financially difficult to plan and serve healthier, lower fat meals. For example, since the government subsidizes hamburger meat and not veggie burgers, it costs a school district more than twice as much to provide a high-fiber,

low-fat, cholesterol-free veggie burger than it does to provide a higher-fat, fiber-free hamburger (56).

Overall, research is supportive that a combination of efforts at the local and national level is critical to successfully create well-accepted menus. It should be a high priority to identify areas of concern and possible avenues of change, such as offering a greater variety of choices (92-93), reducing and/or modifying availability of competitive foods *(94),* modifying food type and preparation (94), increasing low-fat and decreasing higher-fat entrée offerings (95)*, offering* attractive food (93), and addressing the commodities program.

Team Nutrition

Team Nutrition (TN) is an example of one program targeting the current problem of obesity and malnutrition among youth (96). Team Nutrition is an educational and promotional initiative developed by the USDA to change children's eating behavior through social marketing techniques and assist schools in meeting the requirements of the NSLP and School Meals Initiative. It provides a broad array of free resources designed to educate teachers, students, and parents about the importance of choosing healthy foods. It is available to all schools in the US and over 30,000 schools throughout the country have already adopted some aspects of TN. Several Cache County schools are members of TN, although there has been limited implementation of these resources to date. Perhaps the biggest barrier to more effective resource implementation is the need for increased coordination and effort from a variety of different people, including principals, administrators, food service personnel, teachers, parents, and the community

as a whole. According to a pilot study of TN, coordinators stated it was challenging to obtain adequate time and dollars to implement a comprehensive version of TN (97). Many reported that the amount of time required for classroom education imposed strain on teachers (97). The workload for food service personnel was also increased (97). Obviously, it is difficult to implement big changes in schools. Nevertheless, a change toward improved nutrition is absolutely critical.

Team Nutrition's mission is "To improve the health and education of children by creating innovative public and private partnerships that promote food choices for a healthful diet through the media, schools, families and the community." The goals corresponding with the achievement of this mission are to bring about increased intakes of fruits, vegetables, and whole grains, increased variety in food selection, increased consumption of lower fat foods, and increased levels of activity. TN has also factored a Social Learning Theory (SLT) component into these goals and mission. SLT utilizes multiple channels to reach children and elicit changed behaviors. These multiple channels include the communities, schools, classrooms, cafeterias, media, and homes of children.

In order to test the effectiveness of its proposed interventions, a process evaluation of a TN pilot study was conducted (97). The project targeted students in kindergarten to grade 4 in 7 districts and 19 schools across the nation and systematically documented the implementation experience. The schools were assigned to either the TN implementation group or the control group. The study consisted of 2 TN implementation phases. Data were collected immediately following implementation of Phases I and II as well as 6 months later on the Phase I group. Each phase was 8 to 10 weeks long. Each

implementation school was required to hold 2 school-wide cafeteria events, 3 parent contacts, 2 chef events, 1 district-wide community event, and 1 media event. Between 12 to 33 hours of nutrition education occurred in each of the student's classrooms. The study found that even with a very short start-up period, schools were able to implement most components of the multi-channel nutrition intervention, and school teachers, administrators and foodservice professionals expressed support for and satisfaction with TN in general (97).

To measure the effects of TN among students, survey items and observational measures were used to assess changes associated with TN messages to eat more fruits, vegetables and grains, less fat, and more variety (97). Telephone interviews with parents of fourth graders showed that 23% of parents reported participating in a school or community event. The most frequently attended activities typically took place before or after usual work hours, such as a chef breakfast at school, or events in which their children participated, such as nutrition skits performed during a Parent/Teacher Organization meeting. Overall, TN had positive impacts on the students. The results of the outcome evaluation showed that TN modestly increased the skill-based knowledge and motivation to eat healthier among fourth graders (97).

More specifically, TN produced statistically significant increases in the number of correct responses to nutrition skills questions even after controlling for other potential explanations, such as general changes over time. The only exception occurred in Phase I of TN implementation with respect to items, which asked students how the balanced diet concept applies to behavior. Overall, the impact was small, an increase of less than 1

additional item answered correctly. The largest improvement occurred for questions asking students to apply their knowledge of the Food Guide Pyramid to behavior.

The study also showed positive and significant impacts of TN on motivation to make healthier food choices. The pattern was consistent across all 3 impact measures, which included Phases I and II of implementation and the 6-month follow-up of Phase I. Improvement was observed in the "cognitive rules" scale items, which asked students to indicate both their willingness to make the healthier food choice and an understanding of what that required.

In general, there were some, but not consistently, positive impacts across the different measures of eating behavior. The results from analyses of student self-reports were the most uniform. TN students were significantly more likely than comparison schools to report improved quality of diet when asked about usual food choices, food choices in the last 2 weeks, and yesterday's choices. The degree of change was modest and comparable to that observed for nutrition skills and motivation. In contrast, the self-reported behavior changes were not statistically significant at the 6-month follow-up for Phase I students.

Data from cafeteria observations were also included in the study. Fourth-graders' food choices and consumption were measured for up to 3 matched pairs of days before and after TN. The focus of these observations was on behaviors that TN was expected to affect, such as increased grain consumption and selection of lower-fat milk. Positive TN impacts were found in the amount of grains consumed from school lunches as well as in the diversity of food items and food groups tasted. The size of such changes was relatively small. Modest shifts in the proportion of students who made healthier food

choices were observed. TN effects on the selection and consumption of fruits, vegetables, and low fat milk improved, but did not achieve statistical significance.

TN impacts on students were also measured by asking parents to describe the degree of any change in their children's nutrition awareness and eating behaviors. Based on parent's perceptions, TN produced statistically significant increases in nutrition awareness. More specifically, parents of students from TN schools perceived that their fourth-graders talked more about nutrition at home and showed a greater interest in food shopping. However, perceived changes in eating behaviors were not significantly different than reports from parents of control students. This pattern of results was similar to the ones associated with other outcome measures of knowledge and behavior. Statistically significant TN impacts were more consistently observed for knowledge and motivation than for behavior changes.

Finally, the study also included preliminary analyses of TN impacts across different intervention experiences. First, this analysis considered TN as a whole and students were categorized as either participating or not participating. Second and third, the cumulative number of elements a student experienced and the relative effectiveness of exposure to specific intervention elements were analyzed. The available elements were student exposure to at least 1 TN public service message, student receipt of TN classroom education, student participation in TN cafeteria events, student participation in TN community activities, parent participation in any TN or any other nutrition events at school, and parent participation in any TN or any other nutrition activities at home. In all 3 analyses, TN had a small, but statistically significant and positive impact on self-

reported eating behaviors. However, these effects were attenuated and no longer statistically significant at the 6-month follow-up.

In summary, it should be noted that TN impacts were more consistently statistically significant for knowledge and motivation rather than for behavior changes. However, the more exposure to TN events that students received, the more their nutrition behavior improved. TN exposure occurred in a variety of ways including in classrooms, cafeterias, physical education classes, after-school activities, assemblies, communities, and the radio. As students increased their participation in TN activities in this study, their mean scores on the self-report scales of nutrition behavior increased fairly consistently, which supports the social marketing approach of TN. Eating behavior is most effectively influenced by reaching students through multiple channels and broad environmental changes. Overall, the data from the TN Pilot Study support the need for future research and interventions to be based on broad, multiple-channel nutrition education efforts (97).

Hypotheses

The following hypotheses were examined among fourth-graders at 2 elementary schools in the Cache County School District:

1. Fourth-graders consume fewer fruits and vegetables than recommended.
2. Challenging students to eat more FV and then rewarding them is associated with increased consumption of FV.
3. Offering a new variety of FV during lunch is associated with a greater consumption of FV.
4. Classroom nutrition education is associated with FV consumption.

Methods

All protocols and procedures were reviewed and approved by the Utah State University (USU) Institutional Review Board and the Cache County School District (CCSD) to ensure the protection of participants. All fourth-graders at 1 school in the CCSD were selected to participate in this study. This school was selected due to the high willingness and enthusiasm of the school foodservice manager, principal, and fourth-grade teachers to help with the project. Letters of information were sent home with these students allowing them and/or their parents to opt the students out of the study without penalty if they chose to do so. As a result, data were collected from 98.7% (n=75) of students. Data were collected from January to May of 2007. This consisted of 9 days of data collection, which included 2 baseline days and 1 to 2 days during each of 4 intervention phases. Baseline data were defined as data collected during the first wave of data collection, which was prior to all interventions.

Data collection consisted of a visual plate waste study designed to assess food consumption with special interest paid to intake of the FV offered as part of the school lunch FV bars. These FV bars, which are offered in addition to the choices on the main serving line, permit students to take as much or as little FV as they desire as opposed to the main serving line where servings are portioned prior to serving. Information regarding lunchtime food intake was obtained by photographing each student's lunch tray and corresponding identification number before and after consumption. The identification numbers were used in order to maintain confidentiality and photographs did not include any identifying information. The identification numbers were assigned by the

school district and no identifying information was available to USU researchers as per the protocol provided by the Institutional Review Board.

Trained researchers assessed mashed potato intake, which was served in standard amounts from the school lunch serving line, according to a 6-point rating scale with 20% increments and FV from the FV bar to the nearest quarter cup. Intakes during each intervention were compared to intakes at baseline. Five waves of data collection were conducted, which included a baseline measure, 2 separate FV challenges, a new variety intervention and a classroom education intervention. Data were also collected by observation on gender and ethnicity (white vs nonwhite), and the number of students receiving free, reduced, and regular price lunches was provided by the district. Means and paired t-tests were used to examine differences between FV consumption at baseline and during each intervention.

References

1. Wang Y, Beydoun MA. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiol Rev.* 2007;29:6-28.
2. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://www.cdc.gov/nccdphp/dnpa/obesity/trend/. Accessed November 30, 2007.
3. United States Department of Agriculture. Agricultural Research Service. Food and Nutrient Intakes by Children 1994-1996, 1998. Available at:

http//:www.barc.usda.gov/bhnrc/foodsurvey/home.htm. Accessed November 30, 2006.

4. Lambert N, Plumb J, Looise B, Johnson IT, Harvey I, Wheeler C, Robinson M, Rolfe P. Using smart card technology to monitor the eating habits of children in a school cafeteria: 3. The nutritional significance of beverage and dessert choices. *J Hum Nutr Diet*. 2005;18:271-279.
5. Campaign for Better Health. Healthy Kids, Healthy Families. Available at: http://www.betterhealthcampaign.org/community-programs/get-involved-in-your-community/healthy-kids-healthy-families. Accessed December 30, 2007.
6. Bray GA, Nielsen SJ, Popkin BM. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. *Am J Clin Nutr*. 2004;79:537-543.
7. Yamamoto JA, Yamamoto JB, Yamamoto BE, Yamamoto LG. Adolescent calorie/fat menu ordering at fast food restaurants compared to other restaurants. *Hawaii Med J*. 2006;65:231-236.
8. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://apps.nccd.cdc.gov/brfss/Trends/trendchart_c.asp?state_c=UT&state=US&qkey=10150&SUBMIT1=Go. Accessed November 30, 2006.
9. Centers for Disease Control and Prevention. Prevalence of fruit and vegetable consumption and physical activity by race/ethnicity—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:301-304.
10. Knol LL, Haughton B, Fitzhugh EC. Dietary patterns of young, low-income US children. *J Am Diet Assoc*. 2005;105:1765-1773.

11. United States Department of Agriculture. National School Lunch Program. Available at: http://www.fns.usda.gov/cnd/lunch/. Accessed November 30, 2007.
12. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance System, 2001. Available at: http//:apps.nccd.cdc.gov/YRBSS/index.asp. Accessed November 30, 2006.
13. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L. Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: differences by race, ethnicity, and gender. *J Sch Health*. 2002;72:413-421.
14. Centers for Disease Control and Prevention. Healthy People 2010. Physical Activity and Fitness. Available at: http://www.healthypeople.gov/document/html/volume2/22Physical.htm#_Toc490380 80. Accessed December 30, 2007.
15. Atienza AA, Yaroch AL, Masse LC, Moser RP, Hesse BW, King AC. Identifying sedentary subgroups: The National Cancer Institute's Health Information National Trends Survey. *Am J Prev Med*. 2006;31:383-390.
16. Hu FB. Sedentary lifestyle and risk of obesity and type 2 diabetes. *Lipids*. 2003;38:103-108.
17. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003;289:1785-1791.
18. Arluk SL, Branch JD, Swain DP, Dowling EA. Childhood obesity's relationship to time spent in sedentary behavior. *Mil Med*. 2003;168:583-586.

19. Lowry R, Wechsler H, Kann L, Collins JL. Recent trends in participation in physical education among US high school students. *J Sch Health*. 2001;71:145-152.

20. The Henry J. Kaiser Family Foundation. Kids and Media @ the New Millenium. Available at: http://www.kff.org/entmedia/1535-index.cfm. Accessed January 1, 2008.

21. US Department of Agriculture. MyPyramid. Available at: http://mypyramid.gov/. Accessed November 30, 2007.

22. US Department of Agriculture. Dietary guidelines for Americans. Available at: http://www.health.gov/dietaryguidelines. Accessed November 30, 2007.

23. Harriss LR, English DR, Powles J, Giles GG, Tonkin AM, Hodge AM, Brazionis L, O'dea K. Dietary patterns and cardiovascular mortality in the Melbourne Collaborative Cohort Study. *Am J Clin Nutr*. 2007;86:221-229.

24. He FJ, Nowson CA, Lucas M, Macgregor GA. Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: Meta-analysis of cohort studies. *J Hum Hypertens*. 2007;21:717-728.

25. Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Rev*. 2004;62:1–17.

26. Banegas JR, López-García E, Graciani A, Guallar-Castillón P, Gutierrez-Fisac JL, Alonso J, Rodríguez-Artalejo F. Relationship between obesity, hypertension and diabetes, and health-related quality of life among the elderly. *Eur J Cardiovasc Prev Rehabil.* 2007;14:456-462.

27. Kim JY, Oh DJ, Yoon TY, Choi JM, Choe BK. The impacts of obesity on psychological well-being: A cross-sectional study about depressive mood and quality of life. *J Prev Med Pub Health.* 2007 Mar;40(2):191-5.

28. Panagiotakos DB, Pitsavos C, Skoumas Y, Stefanadis C. The association between food patterns and the metabolic syndrome using principal components analysis: The ATTICA Study. *J Am Diet Assoc*. 2007;107:979-987.

29. McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. *J Nutr*. 2007;137:99-105.

30. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. *Am J Clin Nutr*. 2003;77:1417–1425.

31. Newby PK, Muller D, Hallfrisch J, Andres R, Tucker KL. Food patterns measured by factor analysis and anthropometric changes in adults. *Am J Clin Nutr*. 2004;80:504–513.

32. Fernandez E, Gallus S, La Vecchia C. Nutrition and cancer risk: an overview. *J Br Menopause Soc*. 2006;12:139-142.

33. Wengreen HJ, Munger RG, Corcoran CD, Zandi P, Hayden KM, Fotuhi M, Skoog I, Norton MC, Tschanz J, Breitner JC, Welsh-Bohmer KA. Antioxidant intake and cognitive function of elderly men and women: The Cache County Study. *J Nutr Health Aging*. 2007;11:230-237.

34. Drapeau V, Despres JP, Bouchard C, Allard L, Fournier G, Leblanc C, Tremblay A. Modifications in food-group consumption are related to long-term body-weight changes. *Am J Clin Nutr*. 2004;80:29-37.

35. Whetstone LM, Morrissey SL, Cummings DM. Children at risk: The association between perceived weight status and suicidal thoughts and attempts in middle school youth. *J Sch Health*. 2007;77:59-66.

36. Young-Hyman D, Tanofsky-Kraff M, Yanovski SZ, Keil M, Cohen ML, Peyrot M, Yanovski JA. Psychological status and weight-related distress in overweight or at-risk-for-overweight children. *Obesity (Silver Spring).* 2006;14:2249-2258.

37. Datar A, Sturm R. Childhood overweight and parent- and teacher-reported behavior problems: Evidence from a prospective study of kindergartners. *Arch Pediatr Adolesc Med*. 2004;158:804-810.

38. Fuiano N, Luciano A, Pilotto L, Peitrobelli A. Overweight and hypertension: longitudinal study in school-aged children. *Minerva Pediatr*. 2006;58:451-459.

39. Jafar TH, Chaturvedi N, Pappas G. Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo-Asian population. *Canadian Medical Assoc J*. 2006; 175:1071-1077.

40. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: 26-year follow-up of participants in the Framingham heart study. *Circulation.* 1983;67:968–977.

41. Jinks C, Jordan K, Croft P. Disabling knee-pain—another consequence of obesity: results from a prospective cohort study. *BMC Public Health*. 2006;6:258.

42. Kopelman PG. Sleep apnea and hypoventilation in obesity. *Int J Obesity.* 1992;16(Suppl. 2):537–542.

43. Rochester DF, Eaton U. Current concepts in the pathogenesis of the obesity-hypoventilation syndrome. Mechanical and circulatory factors. *Am J Med.* 1994;57:402–420.

44. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *N Engl J Med.* 2003;348:1625–1638.

45. Van Baal PH, Hoogenveen RT, de Wit GA, Boshuizen HC. Estimating health-adjusted life expectancy conditional on risk factors: Results for smoking and obesity. *Population Health Metrics*. 2006;4:14.

46. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW. Body-mass index and mortality in a prospective cohort of U.S. adults. *N Engl J Med.* 1999;341:1097–1105.

47. Daniels SR. The consequences of childhood overweight and obesity. *Future Child*. 2006;16:47-67.

48. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, Hayflich L, Butler RN, Allison DB, Ludwig DS. A potential decline in life expectancy in the United States in the 21st century. *N Engl J Med*. 2005;352:1138-1145.

49. Daviglus ML. Health care costs in old age are related to overweight and obesity earlier in life. *Health Aff (Millwood).* 2005;24 Suppl 2:W5R97-100.

50. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. *Pediatrics*. 2002;109:E81-1.

51. Lewis KK, Man LH. Overweight and obesity in Massachusetts: Epidemic, hype or policy opportunity? *Issue Brief (Mass Health Policy Forum*). 2007;30:1-29.

52. Long DA, Reed R, Lehman G. The cost of lifestyle health risks: Obesity. *J Occup Environ Med*. 2006;48:244-251.

53. Anderson LH, Martinson BC, Crain AL, Pronk NP, Whitebird RR, O'Connor PJ, Fine LJ. Health care charges associated with physical inactivity, overweight, and obesity. *Prev Chronic Dis*. 2005;2:A09.

54. Finkelstein E, Fiebelkorn C, Wang G. The costs of obesity among full-time employees. *Am J Health Promot*. 2005;20:45-51.

55. Mensah GA, Brown DW. An overview of cardiovascular disease burden in the United States. *Health Aff (Millwood).* 2007;26:38-48.

56. Physicians Committee for Responsible Medicine. 2001. School Lunch Report. School lunch program fails to make the grade. Available at: http://www.healthyschoollunches.org/reports/report2003_intro.html. Accessed November 30, 2007.

57. Whitney E, Rolfes SR. *Understanding Nutrition.* 11th ed. Belmont, CA: Thomson/Wadsworth; 2008.

58. Reinaerts E, de Nooijer J, Candel M, de Vries N. Explaining school children's fruit and vegetable consumption: The contributions of availability, accessibility, exposure, parental consumption and habit in addition to psychosocial factors. *Appetite*. 2007;48:248-258.

59. Lassen A, Hansen K, Trolle E. Comparison of buffet and a la carte serving at worksite canteens on nutrient intake and fruit and vegetable consumption. *Public Health Nutr.* 2007;10:292-297.

60. Crawford D, Ball K, Mishra G, Salmon J, Timperio A. Which food-related behaviors are associated with healthier intakes of fruits and vegetables among women? *Public Health Nutr.* 2007;10:256-265.

61. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviors and associations with food habits in different countries. *Public Health Nutr*. 2006;9:244-250.

62. Kant AK, Graubard BI. Secular trends in the association of socio-economic position with self-reported dietary attributes and biomarkers in the US population: National Health and Nutrition Examination Survey (NHANES) 1971-1975 to NHANES 1999-2002. *Public Health Nutr*. 2007;10:158-167.

63. Knol LL, Haughton B, Fitzhugh EC. Food group adherence scores assess food patterns compared to US Department of Agriculture Food Guide. *J Am Diet Assoc*. 2006;106:1201-1208.

64. Larson NI, Neumark-Sztainer D, Hannan PJ, Story M. Trends in adolescent fruit and vegetable consumption. 1999-2004: Project EAT. *Am J Prev Med*. 2007;32:147-150.

65. Perez CE. Fruit and vegetable consumption. *Health Rep*. 2002;13:23-31.

66. Sabin MA, Ford A, Hunt L, Jamal R, Crowne EC, Shield JP. Which factors are associated with a successful outcome in a weight management program for obese children? *J Eval Clin Pract*. 2007;13:364-368.

67. Palfrey JS, Hauser-Cram P, Bronson MB, Warfield ME, Sirin S, Chan E. The Brookline Early Education Project: a 25-year follow-up study of a family-centered early health and development intervention. *Pediatrics*. 2005;116:144-152.

68. Villard LC, Ryden L, Ohrvik J, Stahle A. Impact of time trends and increasing age on health behavior of Swedish school children. *Eur J Cardiovasc Prev Rehabil*. 2007;14:326-332.

69. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: The cardiovascular risk in young Finns study. *Br J Nutr.* 2005;93:923-931.

70. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The cardiovascular risk in young Finns study. *Eur J Clin Nutr*. 2004;58:1038-1045.

71. Venn AJ, Thompson RJ, Schmidt MD, Cleland VJ, Curry BA, Gennat HC, Dwyer T. Overweight and obesity from childhood to adulthood: A follow-up of participants in the 1985 Australian Schools Health and Fitness Survey. *Med J Aust*. 2007;186:458-460.

72. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: The Bogalusa Heart Study. *Eur J Clin Nutr*. 2006;60:48-57.

73. Hesketh K, Wake M, Waters E, Carlin J, Crawford D. Stability of body mass index in Australian children: A prospective cohort study across the middle childhood years. *Public Health Nutr.* 2004;7:303-309.

74. Field AE, Cook NR, Gillman MW. Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obes Res*. 2005;13:163-169.

75. Eisenmann JC, Welk GJ, Ihmels M, Dollman J. Fatness, fitness, and cardiovascular disease risk factors in children and adolescents. *Med Sci Sports Exerc*. 2007;39:1251-1256.

76. Pastucha D, Malincikova J, Hyjanek J, Horakova D, Cizek L, Janoutova G, Janout. Obesity and insulin resistance in childhood. *Cent Eur J Public Health*. 2007;15:103-105.

77. Murdock DK, Olson KJ, Juza RM, Hendricks BL. Effect of body mass index on insulin resistance and lipids in prepubertal and postpubertal chilfen: SCHOOL observations. *J Cardiometab Syndr.* 2006;1:242-247.

78. US Census Bureau. School Enrollment. Available at: http://www.census.gov/population/www/pop-profile/schenrol.html. Accessed November 30, 2007.

79. US Department of Agriculture. Food and Nutrition Service. National School Lunch Program Fact Sheet. Available at: http://www.fns.usda.gov/cnd/lunch/. Accessed November 30, 2007.

80. US Department of Agriculture. School Nutrition Dietary Assessment Study II: Summary of Findings. Available at: http://www.fns.usda.gov/oane/MENU/Published/CNP/FILES/SNDAIIfindsum.htm. Accessed November 30, 2007.

81. Buzby JC, Guthrie JF. US Department of Agriculture, Economic Research Service. *Plate waste in school nutrition programs: Final report to congress E-FAN-02.009.* Washington, DC: US Government Printing Office; 2002.

82. Whatley JE, Donnelly JE, Jacobsen DJ, Hill JO, Carlson MK. Energy and macronutrient consumption of elementary school children served modified lower fat and sodium lunches or standard higher fat and sodium lunches. *J Am Coll Nutr*. 1996;15:602-607.

83. Dillon MS, Lane HW. Evaluation of the offer vs serve option within self-serve, choice menu lunch program at the elementary school level. *J Am Diet Assoc*. 1989;89:1780-1785.

84. Gordon AR, Devaney BL, Burghartdt JA. Dietary effects of the National School Lunch Program and the School Breakfast Program. *Am J Clin Nutr*. 1995;61(1 Suppl):221S-231S.

85. US Department of Agriculture, Food and Nutrition Service, Office of Analysis, Nutrition and Evaluation, Children's Diets in the Mid-1990s: Dietary Intake and Its Relationship with School Meal Participation, CN-01-CD1, by Phil Gleason and Carol Suitor. Project Officer, Ed Herzog. Alexandria, VA; 2001.

86. Maurer K. The national evaluation of school nutrition programs; factors affecting student participation. *Am J Clin Nutr*. 1984;40:425-447.

87. Buergel NS, Bergman EA. Students consuming sack lunches devote more time to eating than those consuming school lunches. *J Am Diet Assoc*. 2002;102:1283-1286.

88. Marples C, Spillmen D. Factors affecting students' participation in the Cincinnati public school lunch program. *Adolescence*. 1995;30:745-754.

89. Connors, PL, Rozell SB. Using a visual plate waste study to monitor menu performance. *J Am Diet Assoc*. 2004;104:94-96.

90. Marlette MA, Templeton SB, Panemangalore M. Food type, food preparation, and competitive food purchases impact school lunch plate waste by sixth-grade students. *J Am Diet Assoc*. 2005;105:1779–1782.

91. US Department of Agriculture. Foods sold in competition with USDA School Meal Program: A report to congress. U.S. Department of Agriculture, 2000. Available at: http://www.fns.usda.gov/cnd/Lunch/. Accessed December 30, 2007.

92. Templeton SB, Marlette MA, Panemangalore M. Competitive foods increase the intake of energy and decrease the intake of certain nutrients by adolescents consuming school lunch. *J Am Diet Assoc*. 2005;105:215-220.

93. Adams MA, Pelletier RL, Zive MM, Sallis JF. Salad bars and fruit and vegetable consumption in elementary schools: A plate waste study. *J Am Diet Assoc*. 2005;105:1789-1792.

94. Meyer MK, Conklin MT. Variables affecting high school students' perceptions of school foodservice. *J Am Diet Assoc*. 1998;98:1424-1431.

95. Bartholomew JB, Jowers EM. Increasing frequency of lower-fat entrees offered at school lunch: An environmental change strategy to increase healthful selections. *J Am Diet Assoc*. 2006;106:248-252.

96. US Department of Agriculture. Team Nutrition. Available at: http://www.fns.usda.gov/tn/. Accessed November 30, 2007.

97. Levine E, Olander C, Lefebvre C, Cusick P, Biesiadecki L, McGoldrick D. The Team Nutrition pilot study: Lessons learned from implementing a comprehensive school-based intervention. *J Nutr Educ Behav*. 2002;34:109-116.

CHAPTER II

MALNUTRITION IN THE US: AN OVERFED AND UNDERNOURISHED NATION: A REVIEW

Abstract

Interventions aimed at improving the nutrition status among children in the United States are difficult to plan and implement. Further research that examines the effectiveness of existing interventions and planning of new interventions based on past research is needed to improve the health of the nation. Low intakes of nutrients and high intakes of calories are a significant aspect of malnutrition often associated with obesity in the United States. In general, overall intakes of nutrient-dense foods such as fruits, vegetables, whole grains, and low fat dairy products are low and intakes of energy-dense foods, such as chips, candy and soda are high. Although many interventions have been implemented in schools and other settings, the prevalence of overweight and obesity is at an all-time high and compliance to national nutrition and activity recommendations is low. The cost of obesity among youth is significant both in terms of money spent on health care as well as to individuals' mental, emotional, and physical wellbeing. This review focuses on the burden of overfed yet undernourished adults and youth.

Introduction

Facilitating nutritional improvement in schools may be an important aspect of improving health in the US and reversing the alarming trends of obesity currently observed. Despite a growing knowledge about nutrition and the variety of programs in

place to fight this epidemic, the prevalence of obesity continues to rise among children, adolescents and adults living in the US. Even though the majority of people exceed their caloric intake recommendations as set forth by the US Department of Agriculture, they still fail to meet vitamin and mineral recommendations. Such unhealthy dietary habits may be associated with numerous problems, including a lengthy list of premature chronic diseases (1), impaired mental performance among children (2), and a decreased quality of life (3-4). The National School Lunch Program (NSLP) (5) and Team Nutrition (6) are 2 examples of ongoing programs available to public schools with goals to help reverse these trends of unhealthy living. By implementing changes in food service and adding a nutrition education component to classroom curriculum, these programs hope to initiate positive changes in students' dietary habits, which may then be maintained lifelong.

Background

An Overfed Nation

Prevalence of Overweight and Obesity

The ever-increasing weight status of US residents is indicative of an epidemic of obesity and its related consequences. Although one national health objective for the year 2010 is to reduce the prevalence of obesity among adults to fewer than 15% (7), current data indicate that the situation is actually worsening rather than improving. During the past twenty years, there has been a dramatic increase in obesity. According to the Center for Disease Control's (CDC) Behavioral Risk Factor Surveillance System (BRFSS) (8),

which uses standard procedures to collect data through a series of monthly telephone interviews with US adults, in the year 1991, only 4 US states had obesity prevalence rates of 15% to 19% and no states had rates at or above 20%. Nine years later, 22 sates had obesity prevalence rates greater than 20%. By 2005 only 4 states maintained obesity prevalence rates less than 20% while 17 states had prevalence rates equal to or greater than 25% and 3 states had prevalence rates equal to or greater than 30% (8). Currently, 66% of US adults are overweight and 32% are obese (9). According to a review by Wang (10), these trends may indicate that 75% of adults will be either overweight or obese, and 41% will be obese by the year 2015. These increasing numbers portray obesity as a growing problem in the US that needs to be addressed.

Unfortunately, the nation's youth are not immune. According to the National Health and Nutrition Examination Surveys (NHANES) (5), the percentage of young people who are overweight has more than tripled in the past 3 decades. NHANES data from 1976-1980 indicated 6% of children aged 6 to 17 years were overweight, compared to 11% in 1988-1994, and 18% in 2003-2004 (5). Additionally, 34% of children and adolescents are currently at risk of becoming overweight (10).

The Centers for Disease Control and Prevention (CDC) defines overweight among children as a body mass index (BMI) at or above the 95th percentile of the CDC's BMI-for-Age growth charts (11). Being at risk of becoming overweight is defined as a BMI between the 85th and 95th percentiles (11).

Utah has certainly not escaped the obesity trends. The prevalence of overweight and obesity among Utah adults has increased 112% over 14 years, an increase greater than the national increase of 103% (12). According to the Utah Department of Health

(12), the percentage of Utah children in kindergarten through eighth grade who were overweight in 2002 ranged between 7.0 to 20.6, with the highest prevalence found among seventh-grade boys. Among fourth-graders, the population studied here, 13.4% of girls and 14.6% of boys were overweight. According to data from 2003, 11.3% of Utah's public high school students were at risk of becoming overweight and 7.0% were already overweight (12). Overall, all age groups in Utah and the US are suffering from increasing rates of overweight and obesity and the impact on individual health as well as the nation is great.

Impact of Overweight and Obesity

Increasing rates of overweight and obesity raise concern for many reasons including increased healthcare and economic costs as well as individual implications for health and quality of life (3-4). Being overweight or obese increases the risk of many diseases and health conditions, including hypertension (13-14), dyslipidemia (13), insulin-resistant diabetes (13-14), cardiovascular disease (15), osteoarthritis (16), sleep-breathing abnormalities (17-18), some cancers (19), and life expectancy (20-21). All of these problems can be observed in the obese adult population and some are observed among overweight and obese youth.

Many obesity-related health conditions once thought applicable only to adults are now being seen in children and with increasing frequency. Mechanisms in the human body that eventually lead to heart attacks, strokes, and metabolic, digestive, respiratory, skeletal, and psychosocial disorders are often initiated during childhood (22). According to the CDC, an estimated 60% of overweight 5- to 10-year-olds have at least one risk

factor for heart disease, such as raised blood pressure or insulin levels (23). Examples of other obesity-related health conditions currently observed in children include hypertension, hardening of the arteries, nonalcoholic fatty liver disease, polycystic ovary disorder, disordered breathing during sleep, non-insulin dependent diabetes mellitus, insulin resistance (24) and various other biomarkers indicative of chronic disease risk (22, 25-26). Non-insulin dependent diabetes, which is often called "adult" onset diabetes, is now diagnosed in children as young as 3 and around 40% of all newly diagnosed cases occur in children (27).

Additionally, a higher prevalence of reported fractures, musculoskeletal discomfort, impaired mobility, and lower extremity malalignment is also found among overweight as compared to normal weight children (28). To further compound the issue, these orthopedic difficulties may affect the likelihood that children will engage in physical activity and perpetuate the cycle of excess weight gain in children (28).

Perhaps one of the more shocking results of this increasing prevalence of childhood obesity is the effect of obesity on longevity. As a result of the nation's declining health and increasing obesity, a reverse in the modern era's steady increase in life expectancy during the past 2 centuries may soon be observed as today's children are no longer expected to live a longer life than their parents (22, 29).

Many research projects have attempted to estimate the economic costs that overweight and obesity have incurred in the US. Colditz's (30) review of studies reporting the economic costs of obesity and inactivity revealed that direct costs of obesity, which was defined as direct costs resulting from the treatment of morbidity, total about 70 billion dollars annually and that the direct costs of inactivity and obesity

combined account for about 9.4% of the national health care expenditures in the US. When indirect costs such as lost productivity (work days lost) and forgone earnings caused by premature mortality are also included in estimates of the cost of obesity, the large numbers are even more astounding. In 2006 health care spending and lost productivity from cardiovascular disease alone, which is often associated with overweight and obesity, exceeded 400 billion dollars in the US (31). A nationally representative study of US adults aged 18 to 64 years old estimated the costs of obesity (excluding overweight) at a firm with 1000 employees to be 285,000 dollars per year. The study also discovered that although those with grade-III (BMI > 40) obesity represented only 3% of the employed population, they accounted for 21% of the costs due to obesity (32). Another study of the US population aged 40 years and older found that physical inactivity, overweight, and obesity were associated with 23% of health plan health care charges and 27% of national health care charges (33). A study in the state of Massachusetts estimated that medical expenditures for obese people were 25% to 27% higher than normal weight people, and 44% higher among people who are very obese (34). Overall, the expenses of obesity and overweight are staggering and should not be ignored when calculating the burden of obesity on the US.

Increased health care expenses are also observed among the nation's youth. Analysis of data from the National Hospital Discharge Survey from 1979 to 1999 of youth illustrates these increased costs (35). The study analyzed the changes in obesity-associated diseases and economic costs in youth 6 to 17 years of age (35). Obesity-associated hospital costs were estimated from the discharges with obesity listed as a principal or secondary diagnosis (35). From 1979-1981 to 1997-1999, the percentage of

discharges with obesity-associated diseases, including diabetes, gall bladder disease, and sleep apnea increased two- to fivefold, which translated into a threefold increase in hospital costs (35). Additionally, these overweight youth may become overweight adults and further increase the costs of health care spending in the adult population (36).

Although less quantifiable, another important cost of obesity includes psychosocial impacts. The psychosocial impact of being an overweight child is a growing concern. Research shows that overweight children may be more likely to have behavior problems (37), emotional and weight-related distress (38), depression (38), and even suicidal thoughts and actions (39). As these costs of obesity are summed, the gravity of the situation is nearly impossible to ignore. The direct and indirect costs for the nation and individual, both financially and socially, are great.

Causes of Overweight and Obesity

The causes of obesity are diverse and complicated. Many factors have been blamed including inactivity, poor food choices, high fat diets, high sugar diets, low nutrient intakes, parents, schools, and even the "obesogenic" environment. Although the causes of obesity and how to prevent it are complex, the simple fact that people lack energy balance is at the heart of the issue. In other words, Americans are consuming more energy than they are using.

According to NHANES data, the average adult total calorie consumption increased by 181 calories per day from 1977-78 to 1994-96, which equates to an average weight gain of over 18 pounds per year (12). Average child and adolescent total calorie consumption increased by 64 calories per day in the same time period (12). To further compound the

issue, these weight gain estimates do not include that which may be incurred from decreased activity. In addition to gaining weight from overeating, Americans may also be gaining weight because they are expending fewer calories due to less activity.

This society of elevators, escalators, drive-thrus, and remote-controls caters to the inactivity of the nation. The number of trips the average American adult takes on foot each year decreased 42% between 1975 and 1995 (12). Among American children, walking trips decreased 37% in the same time period (12). According to the National Personal Transportation Survey data, the proportion of students walking or biking to school decreased from 40.7% in 1969 to 12.9% in 2001 (40). Currently, only 10% of public school students walk to school and the most common means of transportation to school is by car, which means most children are not even walking to a bus stop (12). According to the 2005 CDC Youth Risk Behavior Surveillance System, only 35.8% of youth met the current physical activity recommendation of being active for 60 minutes on most days (41).

The trend of inactivity prevails in Utah as well. Although Utah is ranked third in the nation for adults achieving the recommended amount of physical activity, 44.5% still do not get the recommended amount (12). According to the 2005 CDC Youth Risk Behavior Surveillance System, only 35.6% of youth met the recommendation (41). Thus, in addition to higher calorie intakes, inactivity is also contributing to the positive energy balance of the nation.

Excessive amounts of time spent viewing television is a related issue to the inactivity and poor health of the US. A study from the 2003 Health Information National Trends Survey (42), which created 8 subgroups with varying levels of inactivity, found that the

highest inactivity subgroup consisted of individuals who watched 4 or more hours of television per day. Data from the Health Professionals' Follow-up Study (43) demonstrated that increased television watching was strongly associated with obesity and weight gain, independent of diet and exercise. The study also found prolonged television watching to be associated with a significant increase in the risk of type 2 diabetes. Men who watched television more than 40 hours per week had a nearly threefold increase in the risk of type 2 diabetes compared with those who spent less than 1 hour per week watching television.

The Nurses' Health Study (44) also found that time spent watching television was positively associated with risk of obesity and type 2 diabetes. In their multivariate analyses that controlled for the effects of age, smoking, exercise levels, dietary factors, and other covariates, each 2-hour per day increment in television watching was associated with a 23% increase in obesity and a 14% increase in risk of diabetes. Additionally, each 2-hour per day increment spent sitting at work was associated with a 5% increase in obesity and a 7% increase in diabetes. In contrast, standing or walking around at home for 2 hours per day was associated with a 9% reduction in obesity and a 12% reduction in diabetes. Each hour per day of brisk walking was associated with a 24% reduction in obesity and a 34% reduction in diabetes. The study estimated that in their cohort, 30% of new cases of obesity and 43% of new cases of diabetes could be prevented by adopting a relatively active lifestyle, which was defined as fewer than 10 hours per week of television watching and at least 30 minutes per day of brisk walking (44). Overall, these studies support an important link among television viewing, sedentary lifestyles, and obesity.

This link between obesity and inactivity also exists in the youth population. A study of 9- to 12-year-old military dependents found significant relationships between childhood obesity and computer usage, television watching, and total hours in sedentary behavior (45). Another study analyzed data from the nationally representative 1999 Youth Risk Behavior Survey of high school students and found that watching television more than 2 hours per day was associated with being overweight and sedentary among White females, and with being overweight among Hispanic females and White males. However, no significant associations were found among Black females or Hispanic males, and television viewing among Black males was associated with greater participation in physical activity (46). Thus, it may be critical to consider cultural factors when defining the impact television viewing has on physical activity levels. Nevertheless, most ethnicities may adopt more active lifestyles if they decrease television viewing time.

Television viewing rates in the US are very high. Among American adults, the average male watches 29 hours of television per week and the average female watches 34 hours per week (12). According to the Kaiser Family Foundation Study (47), 33% of younger children devoted 3 hours of time to television viewing on a typical day. According to the 1999 Youth Risk Behavior Survey of high school students (46), television viewing on an average school day exceeded 2 hours per day among 43% of students. A national survey found that 56% of children 8 to 16 years of age have a television in their bedrooms (12). In Utah about 38.2% of public high school students watch 3 or more hours of television per day on an average school day (12).

In addition to television viewing contributing to inactivity, it may also contribute to worse eating habits. In part, this may be due to advertisement exposure. Powell et al's study (48) of almost 100,000 children and adolescents found that between 89.4% and 97.8% of food-product advertisements viewed by children were high in fat, sugar, or sodium. On average, nearly 50% of total calories among the products advertised came from sugar (48). A total of 97.6% of cereal advertisements seen by children aged 2 to 11 years were for high-sugar cereals (48). Overall, this overwhelming majority of poor nutritional food advertisements seen on television by American children and adolescents seems inappropriate.

Whether these advertisements or other factors are to blame, some studies show an association between television viewing and poorer eating habits and obesity. The 1999 Youth Risk Behavior Survey of high school students found that watching television more than 2 hours per day was associated with eating insufficient fruits and vegetables among White females and males (46). A study by Vereecken et al. (49) concluded that high television viewing rates among adolescents was associated with not only increased consumption of less healthy food options such as sweets and soft drinks, but also decreased consumption of fruits and vegetables. A study in Australia (50) found similar results among children in grades five and six where increased television viewing led to increased consumption of and more positive attitudes about junk food. Overall, television viewing may be a contributing factor to an environment that promotes poor health by encouraging both a sedentary lifestyle and less healthy food choices.

Despite these issues of poor health and inactivity observed in the nation's youth, many schools still do not provide adequate physical education (PE) classes. In 1994,

only 17% of middle and junior high schools and 2% of senior high schools required daily physical education for all students (51). National surveys of high school students indicated that only 49% of students were enrolled in PE and only 27% had PE on a daily basis (52). According to Nader's review (53) of data from the National Institute of Child and Human Development Study of Early Child Care and Youth Development Network, which included third graders at 684 elementary schools in 10 sites around the US, children averaged 2.1 PE lessons per week and only 5.9% of children had daily PE. It seems this lack of PE enrollment may be exacerbating the issues of inactivity among the nation's youth.

An additional issue is that the simple act of schools offering regular PE classes does not guarantee sufficient amounts of quality physical activity among the students. Nader's review (53) of third-graders also found that during an average PE lesson, children accrued only 4.8 minutes of very active and 11.9 minutes of moderate to vigorous physical activity, which was 15% and 37% of the lesson time, respectively. According to data from the national school-based Youth Risk Behavior Surveys in 1991, 1993, 1995, and 1997, the prevalence of students who attended PE daily, and the prevalence of students who were physically active more than 20 minutes in an average PE class both decreased significantly among nearly all demographic subgroups (54).

In straightforward terms, many Americans eat too much and exercise too little, which contributes to the energy imbalances that precede weight gain. The US may benefit substantially by becoming more active and decreasing food intake in order to achieve and maintain a healthy weight.

Poor Food Choices

In addition to trends of overweight and obesity, poor compliance to national dietary guidelines also contributes to the nation's epidemic of malnutrition. Many people are not consuming appropriate varieties and quantities of foods in order to comply with a healthy diet as defined by the US Department of Agriculture's (USDA) publications of the Food Guide Pyramid and MyPyramid (55) and the Dietary Guidelines for Americans (56). While average caloric intake often exceeds recommendations, certain healthy food groups that provide essential micronutrients are often inadequate.

The average American is consuming too much high-fat and high-sugar food and too few fruits, vegetables, whole grains, and milk products. According to data from the 1994-1996 Continuing Survey of Food Intake by Individuals, only 2% of US children met recommendations for all 5 major food groups in the food guide pyramid (57). Additionally, only 14% ate the recommended amount of fruits, 20% ate the recommended amount of vegetables, 17% ate the recommended amount of meat, 23% ate the recommended amount of grains, and 30% consumed the recommended amount of milk (57). On average, teenagers are barely consuming 1 cup of milk per day (58). Instead, between 56% to 85% of children, depending on age and gender, are consuming soda on any given day (57).

Related to this poor compliance to national food group recommendations is a poor compliance to sugar and fat recommendations. Data from the 1994-1996 Continuing Survey of Food Intake by Individuals showed that added sugars contributed 20% of

overall calorie intakes among school children, which is double the maximum recommendation (57). Absolute mean intakes of added sugars ranged from 19 teaspoons for females aged 6 to 8 years to 36 teaspoons per day (3/4 cup) for males aged 14 to 18 years (57). Over 66% of children ate more than the recommended amount of saturated fat and total fat (57).

Other studies have also observed poor dietary habits among youth. Lambert et al's study (59) that monitored food choices of nearly 1000 boys aged 7 to 16 years in a school cafeteria found that buns (defined as iced buns, iced donuts, jam donuts, large muffins, and flapjacks) and cookies were over 10 times more popular than fresh fruits and yogurts and that sugary soft-drinks were over 20 times more popular than fresh fruit drinks and milk combined. Another study by Lambert et al. (60) of 30 boys aged 8 to 11 years over 78 days for a total of 1909 meals found that the cohort was clearly choosing meals containing higher than the recommended maximum amounts for sugar and lower than the recommended minimum amounts of fiber, iron and vitamin A. However, protein and vitamin C contents of meals chosen were well above minimum requirements. Over the 1909 meals, the 8 nutrient requirements studied were met 41% of the time. According to Bray et al.'s analysis (61) of USDA food consumption tables from 1967 to 2000, the consumption of high-fructose corn syrup (HFCS), which is high in sugar and low in nutrients, increased more than 1000% between 1970 and 1990. A conservative estimate of HFCS consumption indicated a daily average of 132 calories for all Americans aged 2 years and older.

Analysis of calorie and fat consumption patterns among adolescents at various types of restaurants also support a poor compliance to dietary guidelines. In Yamamoto et al's

study (62), 104 adolescents were asked to order a dinner meal from 10 restaurant menus and then provide an estimate of how much they would actually consume. The meals averaged 1114 calories and 53 grams of fat and ranged from a mean of 800 calories and 34 grams of fat to 1656 calories and 93 grams of fat depending on the restaurant (62). National recommendations advise between 2000 and 2800 calories per day for moderately active adolescents, with older males needing closer to 2800 and younger females closer to 2000 (55). Fat recommendations are to include between 20% and 35% of calories from fat (56). In this study adolescents consumed between 40% and 55% of their daily calories and averaged 43% of calories from fat in a single meal (62).

A study of 2,748 low-income US children found that virtually all children studied could benefit by reducing added sugars and discretionary fat and increasing low-fat, low-sugar options from the vegetable, fruit, meat, and milk food groups (63). In this study, diets were evaluated and assigned a Healthy Eating Index score (64), which is a measure developed by the USDA for assessing how well a diet conforms to the recommendations of the Food Guide Pyramid (55) and the Dietary Guidelines for Americans (56). A diet with a score greater than 80 is considered "good," one with a score of 51-80 is considered "fair," and one with a score of less than 51 is considered "poor." In this study, each child was placed in 1 of 8 different eating patterns based upon his or her dietary habits. Since 73.4% of the 4- to 8-year old children fit into the “Light Eaters” eating pattern, it seems fitting to report their results in greater detail. On average, these children consumed approximately 40% of their energy from discretionary fat and added calories, which is about 30% more than the maximum recommendation. Additionally, they rarely consumed the minimum number of recommended servings from Food Guide Pyramid

food groups. Their overall Healthy Eating Index score of 66, which is considered "fair," was weighted down the most by poor compliance to fruit, vegetable, and saturated fat recommendations. Simply stated, the results showed children were not following balanced and moderate diet patterns consistent with national recommendations.

Intakes of fruit and vegetables (FV), which are of particular interest in many studies, have been consistently below recommendations in almost every observation. According to the CDC's 2002 Behavioral Risk Factor Surveillance System (65), 77% of people aged 18 and older were not consuming the recommended minimum 5 servings of FV per day. Casagrande et al.'s analysis (66) of 1988-1994 and 1999-2002 NHANES data estimated that 27% to 28% of US adults met USDA guidelines for fruit intake, 32% to 35% met guidelines for vegetable intake and 11% met guidelines for fruits and vegetables combined.

Data from the 2005 Behavioral Risk Factor Surveillance System also demonstrated inadequate fruit and vegetable intake (67). Depending on ethnicity, between 19.5 (white non-hispanic) to 27.1% (multiracial, other) of people in the US met the recommendation to consume at least 5 servings of FV per day (67). Only 32.6% of adults consumed fruit 2 or more times per day and 27.2% of adults consumed vegetables 3 or more times per day (68). Overall, these studies spanning from 1988 to 2005 show that among a majority of Americans, FV consumption has never been adequate.

Among Utah residents, 79% of adults are not consuming minimum FV recommendations (65). Between 30% and 34.9% met recommendations for fruit consumption and 20% to 24.9% met recommendations for vegetable consumption (68). Additionally, the average Utah adult consumed fewer FV in 2003 compared to 1998 (12).

In 1998, 26.7% of Utah adults ate 5 or more servings of FV per day compared to 20.6% in 2003 (12).

Overall, fat, sugar and calorie intakes are up while dairy, fruit, and vegetable intakes are down. This prevalence of excessive high-calorie foods and inadequate high-nutrient foods is contributing heavily to the malnutrition status of the nation.

Inadequate Nutrient Intakes

Between these low intakes of fruits, vegetables, and low fat dairy products and high intakes of high-fat and high-sugar foods, it is difficult to achieve minimum nutrient recommendations, especially without exceeding calorie needs. Data from the 1976-1980 NHANES showed that as the proportion of daily energy intake from fats, sweets, and alcohol increased, total daily energy intake also increased, while intakes of micronutrients and foods from the major food groups decreased (69). Another study of the same data concluded the only eating pattern to provide mean amounts of all key vitamins and minerals at levels greater than or equal to recommendations was a pattern that included all food groups, namely dairy, meats, grains, fruits, and vegetables (70).

A more specific study by Larson et al. (71) found that calcium intakes were significantly and inversely related to consumption of soft drinks and fast food among adolescent males and to fast food among adolescent females. In addition, the 1994-1996 Continuing Survey of Food Intake by Individuals found that mean intakes of vitamin E, folate, zinc and calcium and median intakes of vitamin A and magnesium among children were inadequate (57). Affenito et al.'s (72) analysis of 3-day food records collected in the National Heart, Lung, and Blood Institute Growth and Health Study found that a

substantial percentage of girls had intakes below the estimated average requirement for vitamin E (81.2% to 99.0%), magnesium (24.0% to 94.5%), and folate (46.0% to 87.3%) and that intakes of vitamins A, D, and C; calcium; and magnesium decreased as girls aged. Additionally, there was an increasing proportion with intakes below the EAR for vitamins A, C, B-6, and B-12 as the girls aged. Overall, these studies may suggest that in addition to fatty and sugary foods contributing excessive amounts of fat, sugar and calories to diets, they may also displace healthier foods, namely, fruits, vegetables, and low-fat dairy products and the nutrients they contain.

Impact of Poor Nutrition

Poor compliance to health recommendations such as those found in the US Department of Agriculture's publication of MyPyramid (55) may be taking a toll on the nation's overall health. In general, the recommendations in MyPyramid are consistent with recommendations to control obesity and diabetes, heart disease and stroke, hypertension, cancer, and osteoporosis as proposed by the Dietary Approaches to Stop Hypertension Eating Plan, the American Heart Association, the American Cancer Society, the Clinical Guidelines on Overweight and Obesity, the American Diabetes Association, the National Cholesterol Education Program, the National Committee on High Blood Pressure, and the American Institute for Cancer Research (73). Despite this wide agreement on dietary recommendations, which encourage high intakes of fruits, vegetables, whole grains, and low-fat dairy products and low intakes of saturated and trans fats and sugar, Americans continue to struggle following the guidelines and many may be suffering negative health consequences due to their dietary decisions.

Research has focused heavily on trying to define various proposed relationships between diet and health. Kant's (74) review of literature on dietary patterns in relation to health outcome found that dietary patterns characterized by fruit, vegetable, whole grain, fish, and poultry consumption generally were reported to relate to improved levels of selected biomarkers measuring disease risk and that an inverse association between healthful dietary patterns and all-cause mortality and cardiovascular disease risk is reported in most studies.

A study of over 3,000 people in Greece concluded that a dietary pattern including cereals, fish, legumes, vegetables, and fruits was independently associated with reduced levels of clinical and biological markers linked to the metabolic syndrome, whereas meat and alcohol intake showed opposite results (75). According to a review by Fernandez et al. (76), foods associated with a low risk of cancer are those typically included in the Mediterranean diet, which includes increased consumption of fruits, vegetables, cereals, whole-grain foods and fish, and reduced intake of refined carbohydrates and red meat. A US study of 1265 adults concluded that among women, intakes of fruits, vegetables and dairy products were inversely associated with blood pressure, body mass index, and waist circumference (77).

Many more studies show similar associations between dietary patters and weight status as well as body composition. Newby et al. (78) identified a consistent dietary pattern characterized by reduced-fat dairy products, cereals, and fruit that was significantly and inversely associated with an annual change in body mass index among women and waist circumference in both men and women. A 6-year follow-up study of 248 volunteers found that a self-reported decrease in the consumption of food in the fat

group or an increase in consumption in the fruit group predicted a lower increase in body weight and adiposity indicators over time (79). Additionally, increases in the consumption of whole fruit as well as skimmed milk and partly skimmed milk negatively correlated with changes in body weight, percent body fat, subcutaneous skinfold thicknesses, and waist circumference measurements (79). Overall, it seems research is supportive of national recommendations that discourage high-fat and high-sugar foods and promote fruits, vegetables, and low fat dairy products.

Of particular interest in many research projects are fruits and vegetables (FV), which are generally well-accepted components of a healthy dietary pattern. More specifically, diets high in FV are associated with a decreased risk of chronic disease (56) and may also be helpful for weight management due to their low energy density (80). According to the Melbourne Collaborative Cohort Study (81), which included more than 40,000 volunteers, vegetable and fresh fruit intakes were inversely associated with cardiovascular disease mortality among people without prior cardiovascular disease. A meta-analysis of cohort studies (82), which included 12 studies and 278,459 individuals with a median follow-up of 11 years demonstrated that increased consumption of FV from fewer than 3 to more than 5 servings per day was associated with a 17% reduction in coronary heart disease risk. A review of 250 observational studies on cancer and cardiovascular disease estimated that in the Netherlands cancer incidence could be reduced by 19% and that cardiovascular deaths could be reduced by 16% with adequate increases in FV consumption (83). Although some research shows less dramatic associations or ignores some significant potential confounding variables (84), overall it seems an increased intake of FV may be helpful for many people.

In addition to the negative health implications related to food intakes, research is also supportive of links between specific micronutrient intakes and health. Wengreen et al.'s study (85), which utilized data from the Cache County Study on Memory and Aging in Utah showed that high intakes of vitamin C, vitamin E, and carotene may delay cognitive decline in the elderly. Kimmons et al. (86), which analyzed data from the 1988-1994 NHANES to examine the association between body mass index and micronutrient status, including serum levels of total carotenoids, alpha-carotene, beta-carotene, beta-cryptoxanthin, lutein/zeaxanthin, lycopene, vitamin E, vitamin C, selenium, vitamin A, vitamin D, folate, vitamin B12, and red blood cell folate found that overweight and obese adults had higher odds of low levels for many of these nutrients compared with normal-weight adults (86). Although it is currently unknown whether these deficiencies are due to insufficient dietary intake, altered metabolic processes, or both (86). Therefore, interventions aimed at improving dietary intakes of nutrients as well as reducing overweight seem appropriate for all ages.

Although children may not immediately suffer from all of the same chronic diseases and weight gains as adults, childhood eating patterns can still have long-term health effects. For example, although heart disease generally does not become symptomatic until adulthood, risk factors associated with coronary artery and hypertensive cardiovascular disease may develop during childhood (87-91) and these risk factors are related to dietary habits (92-95). More specifically, Martin et al.'s study (96) of childhood diets found that vegetable-rich diets may be associated with a reduced risk of coronary heart disease as well as diabetes.

In addition to current dietary habits impacting chronic disease risk, the odds of dietary habits continuing into adulthood are high, which means that poor diets in childhood may likely also be observed in adulthood and further increase an individual's risk for disease. Several longitudinal studies have examined the nutrient intakes of children and compared them with intakes in subsequent years to determine whether nutrient intakes tracked over time (97-98). One study found that of preschool children consuming the highest percentage of energy from fat, 57% continued to be high consumers at age 5 to 6 years, and, of those children, 53% remained high consumers at age 7 to 8 years (98). Another study indicated that children's food choices tracked from sixth to twelfth grade (99). A study of elderly adults found that the frequency of milk consumption during childhood was the strongest predictor of current milk intake (100). Overall, improving diets of young children may lead to better food and nutrient intakes currently and into adulthood, which may lead to a decreased risk of some health diseases.

Interventions and Solutions

Nutrient Density

Energy imbalance is at the heart of the obesity problem in the US. Preventing energy imbalance requires simultaneous focus on calorie control and nutrient adequacy. In other words, there is a demand for nutrient density, which means replacing the current energy-dense diets, which are high in calories and low in nutrients, with nutrient-dense diets, which are low in calories and high in nutrients.

Nutrient density is a measure of the nutrients a food provides relative to the energy it provides. The more nutrients and the fewer calories a food contains, the higher the

nutrient density (101). For example, a nutrient-dense diet high in fruits, vegetables, low-fat dairy products, and whole grains will provide fewer calories and more vitamins and minerals than an energy-dense diet high in chips, soda, and other high-fat foods. As a result of a nutrient-dense diet being high in vitamins and minerals and low in calories, it promotes both nutritional adequacy and calorie control and may be one solution to the issue of overconsumption of calories and underconsumption of nutrients in the US.

It is important to emphasize that one major aspect of a nutrient-dense diet is minimizing energy-dense foods, as opposed to only encouraging nutrient-dense foods. In addition to an increased consumption of nutrient-dense foods, it is also critical to consume fewer energy-dense foods, which are foods that contribute energy or calories but may lack nutrients such as protein, vitamins, and minerals. However, the mere consumption of nutrient-dense foods may promote a decreased consumption of energy-dense foods. According to a study of US children and adolescents, the strongest independent negative predictor of the reported number of energy-dense foods was the amount of nutrient-dense foods consumed from the 5 major food groups (77). In other words, students who consumed more nutrient-dense foods were also more likely to consume fewer energy-dense foods, which fulfilled both aspects of a nutrient-dense diet (102).

Since nutrient-dense diets promote calorie control and nutritional adequacy, they can be very helpful for weight management. The lower total energy intakes and higher volumes of food that characterize a nutrient-dense diet aids people in consuming fewer calories overall without having to feel hungry due to small volumes of food (103). One study of 97 obese women over a 1-year period concluded that reducing dietary energy

density, particularly by combining increased fruit and vegetable intakes with decreased fat intake, was an effective strategy for managing body weight while controlling hunger (104). Providing further support to the ability of nutrient-dense diets to promote a healthy weight is a cross-sectional study of the US that found normal-weight persons had diets with a lower energy density than did obese persons (105).

In addition to healthy weight management, nutrient-dense diets are also associated with improved diet quality. A study of 7500 adults in the US found that compared with people who consumed energy-dense diets, those with nutrient-dense diets included a relatively high proportion of foods high in micronutrients and water and low in fat, such as fruits and vegetables (103). Subjects with a nutrient-dense diet also consumed fewer non-water beverages such as sweetened carbonated beverages and less fat (103). They also had higher intakes of several important micronutrients, including vitamins A, C, and B6, folate, iron, calcium, and potassium (103).

Fruits and vegetables are ideal examples of nutrient-dense foods. They are high in many nutrients and fiber, low in energy, and may be helpful for weight management (80). According to Ledikwe et al.'s (105) US study, people with a high fruit and vegetable intake had the most nutrient-dense diets and lowest prevalence of obesity. Data from the 2005 BRFSS, which related FV intakes and overweight and obesity status, found that people who were not overweight or obese (i.e., body mass index [BMI] <25) had the highest prevalence of consuming fruit 2 or more times per day (36.0%), and obese people (BMI >30) had the lowest prevalence (28.1%) (67). Similar trends were observed for vegetable consumption (67). People with a BMI less than 25 had the

highest prevalence of eating vegetables 3 or more times per day (28.9%), and overweight persons had the lowest prevalence (26.0%) (68).

Similar to these findings among adults, research also supports the role of nutrient-dense diets in achieving recommended nutrient intakes, healthy body weights and even improved school performance among children. A study of 108 8- to 11-year-old Chilean girls demonstrated a significantly positive association between energy-dense diets and obesity (106). An Australian study of 3007 children aged 2 to 18 years found that energy-dense, nutrient-poor foods contributed 47% total fat, 47% saturated fat, 54% sugar, and only 19% protein and 20-25% of selected micronutrients to the diet (107). A Taiwanese study of 2,222 elementary school children in 2001-2002 found that unfavorable overall school performance was positively associated with unhealthful eating patterns, which included high intakes of low-quality, energy-dense foods such as sweets and fried foods and low intakes of dairy products and highly nutrient-dense foods such as vegetables, fruit, meat, fish, and eggs (108). Overall, children with a greater number of unhealthful eating patterns were more at risk for unfavorable performance in school (108). Thus, it seems appropriate to promote nutrient-dense diets, especially ones incorporating a wide variety of FV, to fight the overfed and undernourished trends.

Targeting Youth

Perhaps one solution to the problem of overweight and obesity is concentrating more heavily on interventions among youth. A younger population may be able to develop healthier habits more readily, which in turn may prevent them from ever becoming overweight and obese. Additionally, targeting youth is a way to provide them with

quality diets today as well as teach healthy dietary patterns that may be maintained into adulthood.

If children do not receive effective interventions and develop appropriate lifestyle habits, they may be more likely to become overweight or obese and maintain their high weight into adulthood. According to a follow-up study of participants in the 1985 Australian Schools Health and Fitness Survey, the relative risk of becoming an obese adult was significantly greater for those who had been obese as children compared with those who had been a healthy weight (109). Another Australian study, which was a 3-year follow-up of 1438 children aged 5 to 10 years found similar results (110). Not only did the prevalence of overweight (15.0 to 19.7%) and obesity (4.3 to 4.8%) increase, only 3.8% of the overweight and obese cohort resolved to a healthy weight at the end of the 3-year period (110). For most children adiposity remained stable (84.8% remained in the same BMI category), and stability appeared to increase with age (110).

The Bogalusa Heart Study (111), which was conducted in Louisiana from 1973 to 1996, also found similar results. The BMI of 841 subjects was calculated at childhood (9-11 years) and adulthood (19-35 years) and a total of 62% of the participants in the highest BMI quartile in childhood remained in the highest BMI quartile in young adulthood (111). Additionally, from childhood to adulthood, the percentage of participants who were overweight increased from 25% to 58% and a total of 35% of the children shifted from normal weight in childhood to overweight in young adulthood (111). In the US, an 8- to 12-year follow-up study of 314 children aged 8 to 15 years at baseline found that being in the upper one half of the normal weight range (i.e., BMI between the 50th and 84th percentiles for age and gender in childhood) was a good

predictor of becoming overweight as a young adult (112). Children between the 50th and 74th percentiles of BMI were approximately 5 times more likely and those with a BMI between the 75th and 84th percentiles were up to 20 times more likely to become overweight as compared to those children with a BMI less than the 50th percentile (112).

In addition to overweight and obesity, dietary habits of childhood are also often maintained into adulthood. A 21-year follow-up study (n=1768, aged 3-18 years at baseline, n=1037 at follow-up), which was conducted in Finland, identified 2 patterns of eating among participants (113). Pattern 1 was positively correlated with consumption of traditional Finnish foods, such as rye, potatoes, milk, butter, sausages and coffee, and negatively correlated with fruit, berries and dairy products other than milk (113). Pattern 2 was characterized by more health-conscious food choices such as vegetables, legumes and nuts, tea, rye, cheese and other dairy products, and also by consumption of alcoholic beverages (113). Of the subjects originally belonging to the uppermost quintile of pattern 1 and 2 scores, 41% and 38%, respectively, persisted in the same quintile 21 years later (113). Another study, which used this same data, found that intakes of fat and vegetables in childhood were important health behavioral determinants of the quality of the adult diet (114). The study concluded that childhood diet is a significant determinant of adult diet even after 21 years (114).

Related to the importance of establishing healthy eating habits in youth is the idea that it may also be easier for a younger population to adopt healthier eating patterns. According to a study conducted in the United Kingdom of a hospital-based pediatric obesity service aimed at lifestyle modification, age was the most important predictor of larger reductions in body mass indices; younger children had the greatest reductions

(115). Another study that conducted repeated evaluations among Swedish children aged 11 to 13 years also found age to be significantly and negatively related to healthy dietary habits (116).

To further compound the issue of unhealthy diets and body weights among children and adolescents, health risks associated with obesity multiply in magnitude and severity when overweight status begins at a young age (22). Field et al found that compared with boys who had a childhood BMI below the 75th percentile, boys between the 75th and 85th percentiles of BMI as children were 4 times more likely and those at or above the 85th percentile were 5 times more likely to become hypertensive (112). Eisenmann et al.'s study (117) of 860 males and 755 females aged 9-15 years from the Australian Schools Health and Fitness Survey found significant differences according to percent body fat and fitness for cardiovascular disease risk factors, including blood pressure, triglycerides, and cholesterol: a general trend of lower blood pressure values and overall cardiovascular disease risk factors for both males and females with lower body fats and higher fitness levels was observed.

Thus, prevention strategies targeting children seem appropriate. If young children can learn to develop healthy habits in their youth, big improvements may be realized in their health and productivity as adolescents and adults. Since about 9 out of every 10 students in kindergarten through grade twelve are enrolled in public schools, this is one place where interventions should be implemented (118). In schools, students have the opportunity to make food decisions at school breakfast and lunch, learn about health in classrooms, and observe eating habits from their peers, teachers, and other school personnel. Some ideas for nutritional improvements in schools include decreasing junk

food and increasing healthy food advertisements, improving school lunches, offering healthier a la carte options, teaching healthy living in classrooms, and increasing opportunities to be active. According to the USDA,

> We have a responsibility to promote knowledge, attitudes and behaviors among our school children that will develop eating patterns that improve health, intellectual development, and overall quality of life, today and into the future. To achieve this change, students, their parents and teachers, school officials, community and business leaders, and local, State, and Federal program administrators must be actively involved in ensuring that school environments promote healthy eating patterns.

It seems absolutely necessary and appropriate to make changes to improve the malnutrition of the nation, especially its youth. Perhaps continuing to reach out to the youth will help them to make healthy decisions now and in the future, including the lifestyles they may teach their children someday.

Conclusion

The simultaneous occurrence of overweight and undernutrition is a significant problem in the US that continues to worsen. Due to the significant health consequences of this form of malnutrition, it is important to consider effective ways to alleviate its prevalence, especially among children. Schools are one place where interventions are currently taking place and should continue to be studied and improved. Nutritional improvement may result via interventions that encourage children to consume more nutrient-dense foods, such as fruits and vegetables, and less energy-dense nutrient-poor foods, such as desserts, chips, and sodas. School lunch menus must be planned in accordance with health recommendations and then evaluated and improved until they are well-accepted by a majority of students. Perhaps this will help the youth of the nation to

understand and incorporate the components of a healthy diet into their lifestyles today and in the future.

References

1. Center on Hunger, Poverty, and Nutrition Policy. Statement on the link between nutrition and cognitive development in children. Medford, MA: Tufts University School of Nutrition; 1995.
2. Pollitt E. Does breakfast make a difference in school? *J Am Diet Assoc.* 1995;95:1134-1139.
3. Banegas JR, López-García E, Graciani A, Guallar-Castillón P, Gutierrez-Fisac JL, Alonso J, Rodríguez-Artalejo F. Relationship between obesity, hypertension and diabetes, and health-related quality of life among the elderly. *Eur J Cardiovasc Prev Rehabil.* 2007;14:456-462.
4. Kim JY, Oh DJ, Yoon TY, Choi JM, Choe BK. The impacts of obesity on psychological well-being: A cross-sectional study about depressive mood and quality of life. *J Prev Med Pub Health.* 2007;40:191-195.
5. US Department Agriculture Food and Nutrition Service. National School Lunch Program. Available at: http://www.fns.usda.gov/cnd/lunch/. Accessed November 30, 2007.
6. US Department Agriculture Food and Nutrition Service. Team Nutrition. Available at: http://www.fns.usda.gov/tn/. Accessed November 30, 2007.

7. Office of Disease Prevention and Health Promotion, US Department of Health and Human Services. Healthy People 2010. Available at: http://www.healthypeople.gov/. Accessed November 30, 2006.
8. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://www.cdc.gov/nccdphp/dnpa/obesity/trend/. Accessed November 30, 2007.
9. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey. Available at: http://www.cdc.gov/nccdphp/dnpa/obesity/trend/. Accessed November 30, 2006.
10. Wang Y, Beydoun MA. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev* 2007;29:6-28.
11. Centers for Disease Control and Prevention. BMI-Body Mass Index. Available at: http://www.cdc.gov/nccdphp/dnpa/bmi/. Accessed November 30, 2007.
12. Bureau of Health Promotion. Tipping the Scales Toward a Healthier Population: *The Utah Blueprint to Promote Healthy Weight for Children, Youth, and Adults*. Salt Lake City, UT: Utah Department of Health; 2006.
13. Fuiano N, Luciano A, Pilotto L, Peitrobelli A. Overweight and hypertension: longitudinal study in school-aged children. *Minerva Pediatr*. 2006;58:451-459.
14. Jafar TH, Chaturvedi N, Pappas G. Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo-Asian population. *Canadian Medical Assoc J*. 2006;175:1071-1077.

15. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: 26-year follow-up of participants in the Framingham heart study. *Circulation.* 1983;67:968–977.
16. Jinks C, Jordan K, Croft P. Disabling knee-pain—another consequence of obesity: Results from a prospective cohort study. *BMC Public Health*. 2006;6:258.
17. Kopelman PG. Sleep apnea and hypoventilation in obesity. *Int J Obesity.* 1992;16(Suppl. 2):537–542.
18. Rochester DF, Eaton U. Current concepts in the pathogenesis of the obesity-hypoventilation syndrome. Mechanical and circulatory factors. *Am J Med.* 1994;57:402–420.
19. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *N Engl J Med.* 2003;348:1625–1638.
20. Van Baal PH, Hoogenveen RT, de Wit GA, Boshuizen HC. Estimating health-adjusted life expectancy conditional on risk factors: results for smoking and obesity. *Population Health Metrics*. 2006;4:14.
21. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW. Body-Mass Index and mortality in a prospective cohort of U.S. adults. *N Engl J Med.* 1999;341:1097–1105.
22. Daniels SR. The consequences of childhood overweight and obesity. *Future Child.* 2006;16:47-67.
23. Centers for Disease Control and Prevention. Healthy School Lunches. 2003. Available at: http://www.healthyschoollunches.org/reports/report2003_intro.html. Accessed November 30, 2007.

24. Murdock DK, Olson KJ, Juza RM, Hendricks BL. Effect of body mass index on insulin resistance and lipids in prepubertal and postpubertal children: SCHOOL observations. *J Cardiometab Sydr.* 2006;1:242-247.

25. Mitsnefes M, Kartal J, Khoury P, Daniels S. Adiponectin in children with chronic kidney disease: Role of adiposity and kidney dysfunction. *Clin J Am Soc Nephrol*. 2007;2:46-50.

26. Paradis V, Champault A, Ronot M, Deschamps L, Valla DC, Vidaud D, Vilgrain V, Belghiti J, Bedossa P. Telangiectatic adenoma: An entity associated with increased body mass index and inflammation. *Hepatology*. 2007;46:140-146.

27. Campaign for Better Health. Available at: http://www.betterhealthcampaign.org/community-programs/get-involved-in-your-community/healthy-kids-healthy-families. Accessed November 30, 2007.

28. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, Brady S, Reynolds JC, Calis KA, Yanovski JA. Orthopedic complications of overweight in children and adolescents. *Pediatrics*. 2006;117:2167-2174.

29. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, Hayflich L, Butler RN, Allison DB, Ludwig DS. A potential decline in life expectancy in the United States in the 21st century. *N Engl J Med*. 2005;352:1138-1145.

30. Colditz GA. Economic costs of obesity and inactivity. *Med Sci Sports Exerc*. 1999;31(11 Suppl):S663-S667.

31. Mensah GA, Brown DW. An overview of cardiovascular disease burden in the United States. *Health Aff (Millwood).* 2007;26:38-48.

32. Finkelstein E, Fiebelkorn C, Wang G. The costs of obesity among full-time employees. *Am J Health Promot*. 2005;20:45-51.

33. Anderson LH, Martinson BC, Crain AL, Pronk NP, Whitebird RR, O'Connor PJ, Fine LJ. Health care charges associated with physical inactivity, overweight, and obesity. *Prev Chronic Dis*. 2005;2:A09.

34. Lewis KK, Man LH. Overweight and obesity in Massachusetts: Epidemic, hype or policy opportunity? *Issue Brief (Mass Health Policy Forum*). 2007;30:1-29.

35. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. *Pediatrics*. 2002;109:E81-1.

36. Daviglus ML. Health care costs in old age are related to overweight and obesity earlier in life. *Health Aff (Millwood).* 2005;24 (Suppl 2):W5R97-100.

37. Datar A, Sturm R. Childhood overweight and parent- and teacher- reported behavior problems: Evidence from a prospective study of kindergartners. *Arch Pediatr Adolesc Med.* 2004;158:804-810.

38. Young-Hyman D, Tanofsky-Kraff M, Yanovski SZ, Keil M, Cohen ML, Peyrot M, Yanovski JA. Psychological status and weight-related distress in overweight or at-risk-for-overweight children. *Obesity (Silver Spring).* 2006;14:2249-2258.

39. Whetstone LM, Morrissey SL, Cummings DM. Children at risk: The association between perceived weight status and suicidal thoughts and attempts in middle school youth. *J Sch Health*. 2007;77:59-66.

40. McDonald NC. Active transportation to school: Trends among U.S. schoolchildren, 1969-2001. *Am J Prev Med*. 2007;32:509-516.

41. Centers for Disease Control and Prevention. Youth Risk Behavior Survey. Available at: http://apps.nccd.cdc.gov/yrbss/SelectLocyear.asp?cat=6&Quest=Q80. Accessed November 30, 2007.

42. Atienza AA, Yaroch AL, Masse LC, Moser RP, Hesse BW, King AC. Identifying sedentary subgroups: The National Cancer Institute's Health Information National Trends Survey. *Am J Prev Med.* 2006;31:383-390.

43. Hu FB. Sedentary lifestyle and risk of obesity and type 2 diabetes. *Lipids*. 2003;38:103-108.

44. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003;289:1785-1791.

45. Arluk SL, Branch JD, Swain DP, Dowling EA. Childhood obesity's relationship to time spent in sedentary behavior. *Mil Med*. 2003;168:583-586.

46. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L. Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: Differences by race, ethnicity, and gender. *J Sch Health*. 2002;72:413-421.

47. The Henry J. Kaiser Family Foundation. Kids and Media @ the New Millenium. Available at: http://www.kff.org/entmedia/1535-index.cfm. Accessed January 1, 2008.

48. Powell LM, Szczypka G, Chaloupka FJ, Braunschweig CL. Nutritional content of television food advertisements seen by children and adolescents in the United States. *Pediatrics*. 2007;120:576-583.

49. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviors and associations with food habits in different countries. *Public Health Nutr*. 2006;9:244-250.

50. Dixon HG, Scully ML, Wakefield MA, White VM, Crawford DA. The effects of television advertisements for junk food versus nutritional food on children's food attitudes and preferences. *Soc Sci Med*. 2007;65:1311-1323.

51. Centers for Disease Control and Prevention. Healthy People 2010. Available at http://www.healthypeople.gov/document/html/volume2/22Physical.htm#_Toc490380803. Accessed November 30, 2007.

52. US Department of Health and Human Services. *Healthy People 2010*. 2nd ed. 2 vols. Washington, DC: US Dept of Health and Human Services; 2000.

53. Nader PR. National Institute of Child and Human Development Study of Early Child Care and Youth Development Network. Frequency and intensity of third-grade children in physical education. *Arch Pediatr Adolesc Med*. 2003;157:185-190.

54. Lowry R, Wechsler H, Kann L, Collins JL. Recent trends in participation in physical education among US high school students. *J Sch Health*. 2001;71:145-152.

55. US Department of Agriculture. MyPyramid. Available at: http://mypyramid.gov/. Accessed November 30, 2007.

56. US Department of Agriculture. Dietary guidelines for Americans, 2005. 6th ed. Washington, DC: US Government Printing Office; 2005. Available at: http://www.health.gov/dietaryguidelines. Accessed November 30, 2007.

57. US Department of Agriculture, Food and Nutrition Service, Office of Analysis, Nutrition and Evaluation, Children's Diets in the Mid-1990s: Dietary Intake and Its

Relationship with School Meal Participation, CN-01-CD1, by Phil Gleason and Carol Suitor. Project Officer, Ed Herzog. Alexandria, VA: 2001.

58. US Department of Agriculture. Agricultural Research Service. Food and Nutrient Intakes by Children 1994-1996, 1998. Available at: http//:www.barc.usda.gov/bhnrc/foodsurvey/home.htm. Accessed November 30, 2006.

59. Lambert N, Plumb J, Looise B, Johnson IT, Harvey I, Wheeler C, Robinson M, Rolfe P. Using smart card technology to monitor the eating habits of children in a school cafeteria: 3. The nutritional significance of beverage and dessert choices. *J Hum Nutr Diet.* 2005;18:271-279.

60. Lambert N, Plumb J, Looise B, Johnson IT, Harvey I, Wheeler C, Robinson M, Rolfe P. Using smart card technology to monitor the eating habits of children in a school cafeteria: 2. The nutrient contents of all meals chosen by a group of 8- to 11-year-old boys over 78 days. *J Hum Nutr Diet.* 2005;18:255-265.

61. Bray GA, Nielsen SJ, Popkin BM. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. *Am J Clin Nutr.* 2004;79:537-543.

62. Yamamoto JA, Yamamoto JB, Yamamoto BE, Yamamoto LG. Adolescent calorie/fat menu ordering at fast food restaurants compared to other restaurants. *Hawaii Med J.* 2006;65:231-236.

63. Knol LL, Haughton B, Fitzhugh EC. Dietary patterns of young, low-income US children. *J Am Diet Assoc*. 2005;105:1765-1773.

64. US Department of Agriculture. Healthy Eating Index. 2005. Available at: http://www.cnpp.usda.gov/Publications/HEI/healthyeatingindex2005factsheet.pdf Accessed December 30, 2007.

65. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://apps.nccd.cdc.gov/brfss/Trends/trendchart_c.asp?state_c=UT&state=US&qkey=10150&SUBMIT1=Go. Accessed November 30, 2007.

66. Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med*. 2007;32:257-263.

67. Centers for Disease Control and Prevention. Prevalence of fruit and vegetable consumption and physical activity by race/ethnicity—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:301-304.

68. Centers for Disease Control and Prevention. Fruit and vegetable consumption among adults—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:213-217.

69. Kant AK, Schatzkin A. Consumption of energy-dense, nutrient-poor foods by the US population: effect on nutrient profiles. *J Am Coll Nutr.* 1994;13:285-291.

70. Kant AK, Schatzkin A, Block G, Ziegler RG, Nestle M. Food group intake patterns and associated nutrient profiles of the US population. *J Am Diet Assoc.* 1991;91:1532-1537.

71. Larson NI, Story M, Wall M, Neumark-Sztainer D. Caclium and dairy intakes of adolescents are associated with their home environment, taste preferences, personal health beliefs, and meal patterns. *J Am Diet Assoc*. 2006;106:1816-1824.

72. Affenito SG, Thompson DR, Franko DL, Striegel-Moore RH, Daniels SR, Barton BA, Schreiber GB, Schmidt M, Crawford PB. Longituidinal assessment of micronutrient intake among African-American and white girls: The National Heart, Lung, and Blood Institue Growth and Health Study. *J Am Diet Assoc*. 2007;107:1113-1123.

73. Krebs-Smith SM, Kris-Etherton P. How does MyPyramid compare to other population-based recommendations for controlling chronic disease? *J Am Diet Assoc.* 2007;107:830-837.

74. Kant AK. Dietary patterns and health outcomes. *J Am Diet Assoc.* 2004;104:615-635.

75. Panagiotakos DB, Pitsavos C, Skoumas Y, Stefanadis C. The association between food patterns and the metabolic syndrome using principal components analysis: The ATTICA Study. *J Am Diet Assoc.* 2007;107:979-987.

76. Fernandez E, Gallus S, La Vecchia C. Nutrition and cancer risk: An overview. J Br Menopause Soc. 2006;12:139-142.

77. McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. J Nutr. 2007;137:99-105.

78. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. *Am J Clin Nutr.* 2003;77:1417–1425.

79. Drapeau V, Despres JP, Bouchard C, Allard L, Fournier G, Leblanc C, Tremblay A. Modifications in food-group consumption are related to long-term body-weight changes. *Am J Clin Nutr.* 2004;80:29-37.

80. Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Rev* 2004;62:1–17.

81. Harriss LR, English DR, Powles J, Giles GG, Tonkin AM, Hodge AM, Brazionis L, O'dea K. Dietary patterns and cardiovascular mortality in the Melbourne Collaborative Cohort Study. *Am J Clin Nutr.* 2007;86:221-229.

82. He FJ, Nowson CA, Lucas M, Macgregor GA. Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: Meta-analysis of cohort studies. J *Hum Hypertens.* 2007;21:717-728.

83. Van't Veer P, Jansen MC, Klerk M, Kok FJ. Fruits and vegetables in the prevention of cancer and cardiovascular disease. *Public Health Nutr.* 2000;3:103-107.

84. Temple NJ, Gladwin KK. Fruit, vegetables, and the prevention of cancer: Research challenges. *Nutrition.* 2003;19:467-470.

85. Wengreen HJ, Munger RG, Corcoran CD, Zandi P, Hayden KM, Fotuhi M, Skoog I, Norton MC, Tschanz J, Breitner JC, Welsh-Bohmer KA. Antioxidant intake and cognitive function of elderly men and women: The Cache County Study. *J Nutr Health Aging.* 2007;11:230-237.

86. Kimmons JE, Blanck HM, Tohill BC, Zhang J, Khan LK. Associations between body mass index and the prevalence of low micronutrient levels among US adults. *Med Gen Med.* 2006;8:59.

87. Nicklas TA, Webber LS, Johnson CC, Srinivasan SR, Berenson GS. Foundations for health promotion with youth: A review of observations from the Bogalusa Heart Study. *J Health Educ*. 1995;26:518-526.

88. Berenson GS. Causation of Cardiovascular Risk Factors in Children: Perspectives on cardiovascular risk in early life. New York, NY: Raven Press; 1986.

89. Berenson GS, McMahan CA, Voors AW, Webber LS, Srinivasan SR, Frank GC, Foster TA, Blonde CV. Cardiovascular risk factors in children: The early natural history of atherosclerosis and essential hypertension. New York, NY: Oxford University Press; 1980.

90. Berenson GS, Arbeit ML, Hunter SM, Johnson CC, Nicklas TA. Cardiovascular health promotion for elementary school children: The Heart Smart Program. In: Williams CJ, Ernst LW, eds. Hyperlipidemia in childhood and the development of atherosclerosis. Part V. School and community-based interventions. New York, NY: Annals of the New York Academy of Sciences, The New York Academy of Sciences; 1991:299-313.

91. WHO Expert Committee. *Prevention in Childhood and Youth of Adult Cardiovascular Diseases: Time for Action.* Geneva, Switzerland: World Health Organization, 1990. WHO Technical Report Series 792.

92. National Academy of Sciences, National Research Council, Food and Nutrition Board. *Diet and Health: Implications for Reducing Chronic Disease Risk.* Washington, DC: National Academy Press; 1989.

93. Langstrom H, Jokinen E, Seppenen R, Ronnemaa R, Viikari J, Valimaki I, Venetoklis J, Myyrimnaa A, Niinikoski H, Lapinleium H, Simell O. Nutrient intakes by young children in a prospective randomized trial of a low-saturated fat, low cholesterol diet: The STRIP baby project. *Arch Pediatr Adolesc Med*. 1997;151:181-188.

94. Writing Group for the DISC Collaborative Research Group. Efficacy and safety of lowering dietary intake of fat and cholesterol in children with elevated low-density lipoprotein cholesterol. *JAMA.* 1995;273:1429-1435.

95. Copperman N, Schebendach J, Arden MR, Jacobson MS. Nutrient quality of fat- and cholesterol- modified diets of children with hyperlipidemia. *Arch Pediatr Adolesc Med*. 1995;149:333-336.

96. Martin RM, Holly JM, Middleton N, Davey-Smith G, Gunnell D. Childhood diet and insulin-like growth factors in adulthood: 65-year follow-up of the Boyd Orr Cohort. *Eur J Clin Nutr.* 2007;61:1281-1292.

97. Nicklas TA, Bao W, Webber LS, Srinivasan SR, Berenson GS. Dietary intake patterns of infants and young children over a 12-year period: The Bogalusa Heart Study. *J Adv Med.* 1992;5:89-103.

98. Singer MR, Moore LL, Garahie EJ, Ellison RC. The tracking of nutrient intake in young children: the Framingham Children's Study. *Am J Public Health.* 1995;85:1673-1677.

99. Kelder SD, Perry CL, Klepp KI, Lytle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health*. 1994;84:1121-1126.

100. Elbon SM, Johnson MA, Fischer JG. Predictors of milk consumption in older Americans. *FASEB J*. 1996;10:A725.

101. Whitney E, Rolfes SR. *Understanding Nutrition.* 11th ed. Belmont, CA: Thomson/Wadsworth; 2008.

102. Kant AK, Graubard BI. Predictors of reported consumption of low-nutrient-density foods in a 24-h recall by 8-16 year old US children and adolescents. *Appetite.* 2003;41:175-180.

103. Ledikwe JH, Blanck HM, Khan LK, Serdula MK, Seymour JD, Tohill BC, Rolls BJ. Low-energy-density diets are associated with high diet quality in adults in the United States. *J Am Diet Assoc.* 2006;106:1172-1180.

104. Ello-Martin JA, Roe LS, Ledikwe JH, Beach AM, Rolls BJ. Dietary energy density in the treatment of obesity: A year-long trial comparing 2 weight-loss diets. *Am J Clin Nutr.* 2007;85:1465-1477.

105. Ledikwe JH, Blanck HM, Kettel KL, Serdula MK, Seymour JD, Tohill BC, Rolls BJ. Dietary energy density is associated with energy intake and weight status in US adults. *Am J Clin Nutr.* 2006;83:1362-1368.

106. Lera ML, Olivares CS, Leyton DB, Bustos ZN. Dietary patterns and its relation with overweight and obesity in Chilean girls of medium-high socioeconomic level. *Arch Latinoam Nutr.* 2006;56:165-170.

107. Rangan AM, Randall D, Hector DJ, Gill TP, Webb KL. Consumption of 'extra' foods by Australian children: Types, quantities and contribution to energy and nutrient intakes. *Eur J Clin Nutr.* 2007; [Epub ahead of print].

108. Fu ML, Cheng L, Tu SH, Pan WH. Association between unhealthful eating patterns and unfavorable school performance in children. *J Am Diet Assoc.* 2007;107:1935-1943.

109. Venn AJ, Thompson RJ, Schmidt MD, Cleland VJ, Curry BA, Gennat HC, Dwyer T. Overweight and obesity from childhood to adulthood: A follow-up of participants in

the 1985 Australian Schools Health and Fitness Survey. *Med J Aust.* 2007;186:458-460.

110. Hesketh K, Wake M, Waters E, Carlin J, Crawford D. Stability of body mass index in Australian children: A prospective cohort study across the middle childhood years. *Public Health Nutr.* 2004;7:303-309.

111. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: The Bogalusa Heart Study. *Eur J Clin Nutr.* 2006;60:48-57.

112. Field AE, Cook NR, Gillman MW. Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obes Res.* 2005;13:163-169.

113. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consitent dietary patterns identified from childhood to adulthood: The cardiovascular risk in young Finns study. *Br J Nutr.* 2005;93:923-931.

114. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The cardiovascular risk in young Finns study. *Eur J Clin Nutr.* 2004;58:1038-1045.

115. Sabin MA, Ford A, Hunt L, Jamal R, Crowne EC, Shield JP. Which factors are associated with a successful outcome in a weight management program for obese children? *J Eval Clin Pract*. 200713:364-368.

116. Villard LC, Ryden L, Ohrvik J, Stahle A. Impact of time trends and increasing age on health behavior of Swedish school children. *Eur J Cardiovasc Prev Rehabil.* 2007;14:326-332.

117. Eisenmann JC, Welk GJ, Ihmels M, Dollman J. Fatness, fitness, and cardiovascular disease risk factors in children and adolescents. *Med Sci Sports Exerc.* 2007;39:1251-1256.

118. US Census Bureau. School Enrollment. Available at: http://www.census.gov/population/www/pop-profile/schenrol.html Accessed November 30, 2007.

CHAPTER III

NEW FRUIT AND VEGETABLE OFFERINGS AND CHALLENGES INCREASED LUNCH-TIME FRUIT AND VEGETABLE CONSUMPTION AMONG FOURTH-GRADERS

Abstract

Facilitating nutritional improvement in schools is an important strategy for reversing the alarming trends of overweight and undernourishment currently observed among children in the United States. Although a majority of people, including children, exceed their caloric intake recommendations as set forth by the United States Department of Agriculture, they fail to meet vitamin and mineral recommendations. One contributing factor is a low intake of nutrient-dense foods, such as fruits and vegetables, and a high intake of energy-dense foods, such as soda, chips, and candy. Many prior studies have

demonstrated that elementary students do not consume adequate levels of fruits and vegetables during school lunch, which should provide one-third of daily recommendations. The objective of this study was to determine if school-based interventions can increase the amount of fruits and vegetables consumed by fourth-graders who participate in the National School Lunch Program. Three different interventions were implemented, 1 each month from February through May of 2007. The 3 interventions included 1) a fruit and vegetable "challenge"; 2) offering a new variety of fruits and vegetables on the school food service fruit and vegetable bars; and 3) classroom nutrition education that included lessons on MyPyramid, fruits and vegetables, fitness, and healthy snacks. Parental consent was obtained from the 75 fourth-grade students attending 1 Cache County School District elementary school. To assess food intake of the study subjects, digital photographs of students' school lunch trays were taken pre- and post-consumption and then analyzed to determine amounts of fruits and vegetables selected and consumed. Differences in mean intake across time were examined and paired t-test analyses were used to assess if observed differences were statistically significant. Compared to baseline intakes, the new variety intervention significantly increased mean fruit and vegetable consumption from 0.36 to 0.47 cups ($p<0.001$). The "challenges" and education interventions were less effective. Additionally, mean fruit and vegetable intake achieved between 17% to 56% of minimum national recommendations on any given day. Although offering new fruit and vegetable varieties may be difficult due to time and money constraints, the results were dramatic enough to encourage schools to continually strive to offer new varieties of fruits and vegetables.

Introduction

The problem of obesity in the US is a difficult problem to address. Even as research has increased our understanding of possible causes and negative implications of unhealthy lifestyles and noteworthy efforts to promote better habits have been developed and implemented, the problem prevails. Thus, the search for a solution continues. Increasing consumption of FV, which are foods with a low energy density and high nutrient density, seems to be one possible target for obesity prevention efforts.

With countless youth-based FV promotional programs (1) as well as national FV-promotion programs, such as the 5 A Day campaign that encouraged people to consume at least 5 servings of FV daily, and its replacement program, the More Matters campaign, which simply encourages people to eat more FV in order to maintain a healthy weight and decrease risk for disease (2), many people likely recognize that FV are healthier choices than chips, soft drinks, and candy. However, a sound knowledge of which foods are healthy choices often does not lead to consumption of those foods (3). A study using data from the 1994-1996 Continuing Survey of Food Intakes by Individuals found that people with lower levels of education demonstrated no association with diet quality and nutrition knowledge and belief, although people with higher levels of education showed stronger associations (4). A review of studies with interventions to increase FV intake among adults with follow-up periods of at least 3 months found consistent positive results involving face-to-face education and counseling (5). A review of studies attempting to disseminate cancer control interventions that promoted healthy diets among adults found

the only beneficial strategy was the use of peer educators in the worksite, which led to a short-term increase in FV intake (6).

Among children there is some evidence in support of nutrition education exhibiting positive results. Blanchette's and Brug's review (7) of literature about potential determinants of FV intakes among 6- to 12-year old children found some evidence that knowledge of intake recommendations and FV classroom curriculum and education via computer multi-media channels had positive associations with FV intakes, although they were not primary determinants of FV intake. Another study investigating the effects of a 12-week garden-based nutrition education program among sixth-graders resulted in increased FV consumption as well as intakes of vitamin A, vitamin C, and fiber (8). A study among children aged 4-12 years found that a program consisting of classroom curriculum as well as parental involvement was effective in increasing children's fruit, juice and vegetable intake, although it was not as effective as a free FV distribution program (9). A study among 278 middle school students in 5 schools observed increased frequencies of FV intake following a 24-session curriculum professing to help students develop understandings about the interactions between biology, personal behavior, and the environment and personal agency through cognitive self-regulation skills in navigating today's complex food system and sedentary environment (10). A 12-week after school program among 56 children that utilized 5 A Day for Better Health educational resource materials and activities effectively increased fruit juice, salad, and non-fried potato consumption (11). Kalina and Arnold's (12) study of the impact of educational nutrition posters in the lunchroom found that posters displaying specific, simple, positive messages with appealing, colorful graphics about increasing fruit and

vegetable consumption significantly increased FV intake by 37% between baseline and midpoint, while posters displaying more general messages (i.e., breakfast, healthy snacking), which incorporated fruits and vegetables among other foods through appealing, colorful graphics resulted in no significant difference in fruit or vegetable consumption.

In addition to education impacting FV intakes, a plethora of research supports that FV availability, accessibility, and exposure also influence intake, perhaps even more than any other factors. A study among children aged 4-12 years found that a free FV distribution program, which increased availability, accessibility and exposure, was effective in increasing fruit, juice and vegetable intake among the youngest and the oldest, but not middle age groups involved in the study (9). Fogarty et al. (13) found similar results in a 3-year study of the impact of The National Schools Fruit Scheme (NSFS), which provides free daily fruit at school, however, fruit consumption only increased while the free fruit was offered and intake fell when the program ceased.

Jago et al.'s review (14) of studies examining associations between FV availability and consumption also found that greater availability was associated with greater consumption among children and adults. In their findings, it appeared that availability was associated with dietary psychosocial variables such as preferences and that intervention studies attempting to increase availability resulted in increased consumption. Jago et al suggested that the visual cues of available food may stimulate consumption and/or available food exposure may increase preference, which leads to increased consumption.

Blanchette's and Brug's review (7) of literature about potential determinants of FV intakes among 6- to 12-year-old children also supports an association between FV consumption and availability and accessibility as well as taste preferences. Another study of nearly 4000 adolescents from 31 public middle and high schools in Minnesota found that the strongest correlates of FV intake were taste preferences and home availability of FV, although even when taste preferences for FV were low, intake still increased if FV were available (15). A study of 12 focus groups with 92 10- and 11-year-old children also identified taste preferences and home and school availability of FV as important environmental determinants of FV consumption (16). An exploratory study of 1227 African American women found that estimates of their vegetable intake as children were significantly related to exposure and preference for FV as well as trying of new foods (17). Also supportive of the ability of exposure to influence intakes are 2 studies in which mothers used exposure techniques to increase children's acceptance of vegetables and a school-based study where large increases in liking and intake of raw red pepper were seen among 5 to 7 year olds following increased exposure (18).

In addition to the importance of environmental factors such as accessibility, availability, and exposure, research is also supportive of the impact food served from the NSLP, school snack bars or a la carte, and vending machines has on FV intakes. Blanchette's and Brug's review (7) of literature about potential determinants of FV intakes among 6- to 12-year-old children demonstrated that having a snack bar at school was associated with lower FV intakes. A study examining dietary behaviors among 598 seventh-graders' in 16 schools concluded that a la carte availability was inversely associated with fruit and combined FV consumption, snack vending machines were

negatively correlated with fruit consumption, and fried potatoes' being served at school lunch was positively associated with vegetable and combined FV intakes because fried potatoes were counted as a vegetable (19). A study comparing lunch fruit, juice, and vegetable intakes of 312 fourth-grade students who received only NSLP meals and 282 fifth-grade students who also had access to a school snack bar found that fourth-graders consumed significantly more fruits, juices, and vegetables (0.80 serving) than fifth-graders (0.60 serving). Additionally, fifth-graders who ate only snack bar meals consumed significantly less total fruits, juices, and vegetables (0.40 serving) than fifth-grade students who ate school lunch meals (0.82 serving) (20).

Various encouragement-related interventions, including encouraging implementation intentions (21-22), have also been associated with increased FV consumption (23). A study among fourth-graders found that goal setting was related to increases in fruit, 100%-juice and vegetable consumption (24). The Cafeteria Power Plus project, which observed the lunches of 1668 first- and third-grade students in 26 schools concluded that verbal encouragement by food-service staff was associated with FV intakes (25).

A study among 749 children aged 5 to 11 years that evaluated a rewards-based intervention, which also had a peer-modeling component, found that lunchtime and home consumption of FV increased substantially, especially among students who initially ate very little FV (26). A study among 188 school children demonstrated that token reinforcement, which consisted of punching holes into nametags when children ate their assigned foods and then allowing children to trade these tokens for small prizes, led to increases in FV consumption, however these increases were not maintained at a 7-month follow-up when the token reinforcement was no longer occurring (27).

Overall, research is very supportive of the ability of multi-component interventions to have the greatest influences on FV intakes (3, 5, 28). A review of literature on the school food environment with a focus on identifying effective strategies to promote FV consumption among youth in school settings found that multi-component school interventions, such as a combination of classroom-based educational/behavioral curricula, food service/cafeteria interventions, parent outreach interventions, and community intervention components, were effective in increasing fruit intake, with reported increases in consumption between 0.2 to 0.6 servings per day (29). However, impact on vegetable intake was less effective, with increases ranging from 0 to 0.3 servings per day (29).

A multi-component intervention program among 6 to 7 and 10 to 11 year olds that increased the provision of FV in schools, developed and utilized curriculum materials, and provided a range of point-of-purchase marketing materials, newsletters for children and parents, and teacher information effectively increased fruit but not vegetable consumption, even though taste preferences for FV were unchanged (30).

An intervention among 1472 10- to 11-year-old children from 62 schools in Norway, the Netherlands and Spain that combined a FV curriculum with efforts to improve FV availability at schools and at home demonstrated a 20% higher FV intake at a 1-year follow-up in the total sample (31). However, at the 2-year follow-up, a significant impact was only observed in Norwegian schools, which were the schools where the interventions were best implemented (31).

Birnbaum et al.'s (32) analysis of the Teens Eating for Energy and Nutrition at School intervention revealed that greater levels of exposure to the program led to greater intakes of FV, with students receiving interventions from peer leaders, the classroom, and

the school environment reporting the largest increases in FV consumption, followed by students exposed to classroom and environment interventions only, and then students exposed only to school environment interventions who actually showed trends toward declining fruit intake and no change in vegetable intake.

An intervention consisting of behavioral curricula in classrooms, parental involvement, school food service changes, and industry support and involvement in 20 elementary schools in Minnesota led to increased lunchtime fruit consumption (33). The Cafeteria Power Plus project, which involved a cafeteria-based intervention, including increasing the availability, attractiveness, and encouragement for FV, and special events (kick-offs, samplings, challenge weeks, theater production, and finale meal), significantly increased the fruit consumption of first- and third-grade students (25).

In light of this research, it seems appropriate that interventions to increase FV consumption include as many components as is practical, with an emphasis on long-term education, FV availability and exposure, rewards-based strategies, and eliminating or modifying the offerings in school snack bars and vending machines.

The objective of this study is to further contribute to the growing body of research trying to identify effective strategies and interventions to increase school lunch FV consumption among children by implementing 3 interventions including a rewards-based intervention, offering new varieties of FV, and classroom nutrition curriculum.

Subjects and Methods

Study Participants

All protocols and procedures were reviewed and approved by the Utah State University Institutional Review Board and the Cache County School District to ensure protection of participants. The participant schools were selected by solicitation to all Cache County School District Food Service Managers via a presentation on the proposed interventions and evaluation methods during one of their monthly manager's meetings. Following the presentation, the managers responded to a questionnaire regarding their interest in participation. Principals of all schools with food service managers willing to participate were asked for their approval of the interventions and study to take place in their schools. As a result of these procedures, 1 school was selected to participate in the study.

All fourth-grade students at the selected school were invited to participate in the study. Letters of information were sent home with all students allowing them and/or their parents to opt not to participate in the study without penalty if they chose to do so. However, all students (n=75) chose to participate.

The study population was 91% non-Hispanic white and 53% female Table 1 provides information on other demographics. Socioeconomic status was categorized based upon whether students received free, reduced or regular priced school lunch, which is determined by the US Department of Agriculture's publication of Income Eligibility Guidelines (34). These guidelines are based on the Federal income poverty guidelines and are intended to directly benefit children most in need and are revised annually to account for changes in the Consumer Price Index. For the period from July 1, 2006 to June 30, 2007, guidelines for free and reduced price meals were obtained by multiplying the year 2006 Federal income poverty guidelines by 1.30 and 1.85, respectively. Among

study participants, 68% received regular-priced lunch, 14% received reduced lunch, and 18% received free lunch.

Methods

All data collection occurred when the pre-selected school menu included a FV bar and either cubed turkey and fried steak entrée choices, which was classified as "Menu One," or chicken noodle soup and taco salad entrée choices, which was classified as "Menu Two." Table 2 lists the FV available on each day. Data were collected from students who were present at school and chose to consume school lunch on the specific days of data collection. The percentage of students providing information on any given day of data collection ranged from 69% (n=52) to 93% (n=70). Forty-four percent (n=33) of students had their lunch trays analyzed on all 9 days of data collection. In addition to analyses performed on all data collected, analyses were also performed on a subset of data, which excluded children who did not have both baseline and specified post-intervention trays available so that paired differences could be calculated.

Data Collection

A visual plate waste study was implemented to assess the food choices and consumption levels among fourth-graders. Five waves of data collection were conducted during the spring 2007 school semester, which corresponded with various interventions aimed at increasing FV intakes. Each student evaluated was randomly assigned an identification number by the school district. As the students exited the serving lines, a digital photograph was taken of the food selections made by that student as well as the identification number, which was placed on the participant's tray. The student was not

included in the photograph in order to maintain confidentiality. When each participating student was finished eating and approached the area to dispose of his or her tray contents, a second photograph of all remaining food on the tray was taken. Milk was measured and a number corresponding to the percent consumption was placed on the tray in order to be observable in the photograph. Students were offered a small incentive such as a sticker, eraser, or pencil after the second photograph was taken.

Trained observers assessed waste by viewing the photographs and using a 6-point rating scale to indicate consumption. For foods served from the FV bars, where students were permitted to take as much or little as desired, consumption was visually estimated to the nearest quarter cup for each food selected. For mashed potatoes, which were served in one-fourth cup portions from the serving line during Menu One, consumption was visually measured and assigned zero to 100% in 20% increments. All food was assessed by at least 2 trained observers, 1 of which was the same observer for all data to maintain consistency. Any discrepancies were reassessed by a third trained observer. The mode observation was used if 2 of the 3 observations were the same. The mean, rounded to the nearest interval on the corresponding rating scale, was used if all 3 observations were different. There was an exact agreement between the first 2 observers 86% of the time. However, when excluding data where zero FV were consumed, the exact agreement rate dropped to 62%. Using this same data subset, but broadening the agreement criteria to include estimates within one-quater cup (or 20% for the mashed potatoes), as opposed to only including estimates that were exactly the same, the agreement rate increased to 88%.

To compare consumption to national recommendations, the number of total FV servings consumed was calculated. Serving size parameters were reflective of those

recommended by the USDA's publication of MyPyramid for 10-year olds who are active for 30 to 60 minutes most days of the week.

Interventions

The interventions implemented included FV Challenges, offering a new variety of FV during school lunch, and classroom education. The FV Challenge, which is a free resource available through Team Nutrition, encouraged students to increase their FV intakes by allowing students to mark on a dry erase poster chart each day they consumed fruits or vegetables. Classroom teachers introduced the FV Challenges in each of the 3 classrooms and whichever classroom had the most markings at the end of the intervention period received an extra recess.

During the new FV variety intervention, Macey's Grocery Store donated bananas, kiwifruit, grapes, and pineapple, which were served on the FV bars in addition to the other typical FV offerings during school lunch and students were permitted to take as much or little as desired.

The classroom education intervention consisted of four 45–minute lessons that were planned and implemented by Utah State University Dietetic Students (see Appendix). Lesson topics included Healthy Snacking, Fitness, Fruits and Vegetables, and MyPyramid and were interactive with at least 1 activity included. Additionally, lessons were designed in a way as to be easily implemented by classroom teachers or others without a nutrition education background.

Statistical Analysis

Descriptive analyses, including means and standard deviations, were used to examine the food consumption choices of subjects. Paired student t-tests were calculated for FV intake, percent FV waste, and percent of students consuming at least some FV from the FV bars. Means that included all available data, as opposed to paired t-test means, were used to compare FV intakes to national recommendations as well as to assess consumption and waste of each FV individually. SPSS (SPSS, Chicago, IL, USA) and SAS (SAS Institute, Cary, NC, USA) software packages were used for data analysis. Bonferroni adjustments were made to p-values to adjust for multiple comparisons. Using this adjustment, p-values ≤ 0.02 were considered statistically significant (alpha = 0.05/3).

Results

To assess the effectiveness of each intervention, FV consumption was measured during each intervention and then compared to baseline consumption levels. Paired t-tests were used to calculate differences in mean FV intakes on corresponding menu days during baseline and each subsequent intervention. Table 3 shows consumption levels at baseline and during each subsequent intervention.

Fruit and Vegetable Challenge Intervention

Mixed results were observed during the FV Challenges (see table 3). During the first FV Challenge mean FV intake nearly doubled from 0.12 to 0.23 cups during Menu One (p-value=0.014). However, FV intake only increased slightly during Menu Two from 0.25 to 0.26 cups, a difference which was not statistically significant (p-value= 0.824). An average of the 2 menu days showed an increase from 0.19 to 0.25 cups, a difference which was not statistically significant (p-value=0.12). During the second FV

Challenge, mean FV intake increased from 0.13 to 0.21 cups during Menu One, a difference which approached statistical significance (p-value =0.057). Data were not available for Menu Two.

Mixed results were also observed for the FV Challenges impact on the number of students who chose to consume any FV from the FV bars (see table 4). The first FV Challenge significantly increased the percentage of students who consumed FV from the FV bar from 25% to 54% during Menu One (p-value=0.001). However, no similar difference was observed during Menu Two (p-value =0.411). An average of the 2 menu days showed an increase from 39% to 49% (p-value=0.088). During the second FV Challenge, an increase from 26% to 43% was observed during Menu One (p-value=0.038). Menu Two data were not available.

Since classroom teachers were responsible for implementing the FV challenges in their own classrooms, it was appropriate to subcategorize the data by class for some analyses (see table 5). During the first FV challenge, FV consumption during Menu One increased significantly from 0.10 to 0.36 cups in classroom 1 (p-value=0.002); no similar differences were observed among students in classrooms 2 and 3. NOTE: reader can look to table 5 for details about these results which did not reach statistical significance. Surprisingly, during Menu Two, small decreases in FV consumption in classrooms 1 and 2 and a small increase in classroom 3 were observed, although these differences did not reach statistical significance. During the second FV challenge, FV consumption increased from 0.13 to 0.27 among students in classroom 2 (p-value =0.045); no similar differences were observed among students from classroom 1 or 3. During Menu Two, when an intervention was implemented by only classroom 3, FV intake increased from 0.22 to

0.49 cups in classroom 1 (p-value=0.043), and from 0.22 to 0.60 in classroom 3 (p-value=0.021); no similar differences were observed among students from classroom 2.

New Variety Intervention

The variety intervention led to consistently significant increases in FV consumption (see table 3). Mean FV intake increased from 0.12 to 0.48 cups during Menu One and from 0.25 to 0.72 cups during Menu Two (p-value<0.001). An average of the 2 menu days also showed a highly significant increase from 0.19 to 0.62 cups (p-value<0.001).

The variety intervention also significantly increased the percentage of students who chose to consume any FV from the FV bars (p-value<0.001) (see table 4). During Menu One, the percentage of students consuming any FV from the FV bar increased from 25% to 75% (p-value<0.001). During Menu Two, the increase was from 50% to 90% of students (p-value<0.001). When the 2 menu days were averaged together, an increase of 37% to 85% of students consuming FV from the FV bar was observed (p-value<0.001).

Education Intervention

The education intervention did not lead to significant increases in FV consumption (see table 3). Only moderate increases which did not reach statistical significance in intake and percentage of students consuming any FV were observed (see table 4). Data were not available for Menu Two.

Comparison to National Recommendations

Mean FV consumption levels did not meet minimum recommendations as set forth by the US Department of Agriculture's publication of MyPyramid (see table 6). For a 10-year old, which is the mean age of study participants, who is active for 30 to 60 minutes most days of the week, MyPyramid recommends consuming 4 cups of FV per day (35). Since the National School Lunch Program requires that school lunches provide at least one-third of calorie recommendations as well as other select nutrients, school lunches should also be providing at least one-third of the recommendations for FV (36). Therefore, mean consumption of FV among all participants was compared to one-third of the recommendation set forth by MyPyramid, which is one and one-third cups. It is appropriate to note that on during Menu One mashed potatoes were also served and this intake was included in the total FV consumption. During Menu Two, the taco salad entrée had a small amount of iceberg lettuce (<1/4 cup) that was not included in total FV intake and the chicken noodle soup entrée had a negligible amount of carrots (<1/8 cup per serving) that was not included in total FV consumption.

Data from all waves of data collection showed that students achieved between 17% and 56% of national recommendations (see table 6). The highest percentage was consumed during the new variety interventions (56% and 49%). Among FV consumers only, which was defined as any student who consumed at least some FV from the FV bars, average consumption ranged from 0.47 to 0.84 cups, which is equivalent to 35% to 63% of MyPyramid recommendations (table 6).

Individual Fruit and Vegetable Consumption and Waste

FV waste was measured as the percentage of food taken from the FV bar that was not consumed. Paired t-tests were used to compare FV waste between baseline and each intervention (table 7). Compared to baseline waste, significantly more waste was observed during 4 of 6 intervention data collections days, including both days of the new variety intervention and 2 of the 3 FV Challenge days.

To analyze mean consumption and waste of each FV individually, data from all students on all days of data collection were used regardless of whether they consumed any FV or were present on both the baseline and intervention day (see figure 1). Compared to all FV offered on the FV bars, mean consumption of grapes was the highest (0.40 cups), followed in descending order by bananas (0.19 cups), kiwi, (0.15 cups), pineapple (0.15 cups), peaches (0.12 cups), mixed greens (0.11 cups), applesauce (0.09 cups), pears (0.07 cups), oranges (0.06 cups), carrots (0.05 cups), mixed fruit (0.04 cups), cauliflower (0.02), and broccoli (0.01 cups). The highest percentage of waste was seen with carrots (25%), which was followed in descending order by grapes (23%), oranges (22%), pineapple (19%), kiwi (16%), peaches (13%), applesauce (13%), broccoli (13%), mixed fruit (13%), bananas (10%), pears (8%), mixed greens (6%), and then cauliflower (0%).

Analysis of consumption and waste of mashed potatoes, which were served from the serving line as opposed to from the FV bars, is also in included in figure 1. During Menu One, each student received one-fourth of a cup of mashed potatoes. Mean consumption of the potatoes was 0.20 cups (SD=0.09) and mean waste was 19%. This placed mashed potatoes as the second highest for consumption and fourth highest for waste.

Discussion

FV consumption among fourth-graders at 1 elementary school in the Cache County School District was found to be low according to national recommendations and positively influenced by offering new varieties of FV and possibly by engaging in FV Challenges, but not by classroom education.

Although FV intakes varied with different interventions, students never met minimum national recommendations for FV. Even at their best, students were barely achieving half of recommendations, which here are defined as one-third of daily MyPyramid recommendations. This is consistent with other research among children, adolescents, and adults demonstrating that FV intakes are below recommendations (37-43).

Such low intakes raise concern because overall, research is supportive of national recommendations that promote high intakes of FV. Studies have linked inadequate intakes of FV to lower intakes of vitamins and minerals (44), an increased risk of chronic diseases (45-50), and less healthy body weight and composition (51-54). Thus, it seems appropriate that interventions aimed at improving dietary habits, including increasing FV consumption, continue.

Team Nutrition is an example of one national program encouraging healthier eating in schools (55). Some resources it provides include ways to improve school foodservice menus, activities to make healthy eating fun, and nutrition curriculum. The different TN strategies implemented in this study, namely the FV Challenges, certain

aspects of their nutrition curriculum, and enhancement of lunch menus by increasing variety, varied in their ability to increase FV consumption among fourth-graders.

The most effective method to increase FV consumption was to offer new varieties of FV. This led to consistently significant increases in FV consumption on all measured days. This finding agrees with other research demonstrating that variety is a good predictor of FV consumption (56) and student satisfaction (3, 57) with school lunch. Also related is research linking FV consumption to FV availability, accessibility, and exposure (7, 9, 13-18). Thus, making a variety of acceptable FV available and accessible to students may be a key component to achieving adequate FV intakes.

The FV Challenges, which rewarded students for consuming FV during lunch, showed inconsistent results. Out of 3 days that were measured, 1 showed a significant increase in FV consumption, 1 day approached a significant increase, and 1 day showed a highly insignificant increase. This is consistent with other research where encouragement-related interventions (21-23), including goal-setting (24), rewards-based interventions (3, 26-27, 58-59), and verbal encouragement by food-service staff (25) were associated with increased FV intakes.

One possible explanation for the wide variety of FV intake during these challenges may be the large role that teachers played. Teachers may have introduced the challenges with different levels of enthusiasm, which then influenced how serious and excited the students were about participating in the challenge. A study in 3 Cretan primary schools attempting to identify best teaching practices as they related to introducing principles of a Mediterranean diet to children through nutrition education discovered that individual teacher willingness and teaching skills were mainly

responsible for the quality of teaching and that changes in pupils' knowledge and recall of the course were related to teacher enthusiasm (60). Thus, effective nutrition interventions may require innovative, enthusiastic and highly motivated teachers.

The education intervention, during which students received weekly nutrition lessons regarding healthy snacks, physical activity, fruits and vegetables, and MyPyramid, showed no significant improvements in FV consumption. Other research relating education to FV consumption levels is mixed. Some education efforts have been positively associated with modest improvements (7-8, 30) in FV consumption and some show insignificant or no increases in FV consumption (30, 61). Overall, some research supports that while knowledge is generally improved with education, it is much more difficult to influence behavior, and that more comprehensive interventions may be necessary to induce change (3). This may be related to the nation's "obesogenic" environment in which youth are surrounded with high-calorie foods and insufficient healthy and appealing foods, such as FV, making it difficult to maintain healthy eating patterns regardless of nutritional knowledge.

In light of the FV challenges showing mixed but positive results, the new variety intervention showing strongly positive results, and the education intervention showing no impact on FV consumption, it seems appropriate to recommend that the most effective way to increase FV consumption is through continually making available new varieties of FV. Continually involving students in FV challenges may also be helpful. When comparing the results of this research to the current body of literature, it seems that to effectively increase FV consumption, interventions should be long-term, improve the

availability of well-liked FV, and be multi-component by incorporating many different avenues to reach children.

Another effective way to improve FV intakes as well as ensure that menus provide students with their intended nutrients is to test menu performance. Results from this study showed highly variable intakes and waste of the different FV offered. The FV bar selections that students consumed in highest quantities, namely grapes, bananas, pineapple, and kiwi, were all new offerings during the new variety intervention, which provides further support that new varieties support increased FV consumption.

Of the FV offered more regularly, peaches were consumed in the highest amount, followed in descending order by mixed greens, applesauce, pears, oranges, carrots, mixed fruit, cauliflower, and then broccoli. Mashed potatoes, which were served from the serving line as opposed to from FV bars were consumed in even greater amounts than all of the above FV. Schools should be made aware of their students' preferences so that the well-accepted foods can be offered more often and other foods can be replaced or prepared differently. Of the 9 menu days that were assessed, peaches were offered on 4 days, mixed greens on 1 day, applesauce on 4 days, pears on 4 days, oranges on 1 day, carrots on 7 days, mixed fruit on 3 days, cauliflower on 1 day, and broccoli on 2 days. Mashed potatoes were always offered during Menu One, which was 5 of the 9 days, and led to higher total FV intakes when compared to days not offering mashed potatoes. In light of these results, the most obvious changes that may improve FV consumption at this school would be replacing the carrots with a better accepted item and offering mixed greens more often. Additionally, it may be beneficial to assess other FV offerings in the serving line and then make appropriate changes. Although the acceptance of various FV

was similar to what has been observed in other studies (62-64), it seems assessing FV consumption patterns of schools via plate waste studies and then modifying the menu to achieve maximum intakes is a good way to achieve more acceptable FV offerings.

Since cost is also an issue with school lunch, FV waste should also be addressed. Unfortunately, significant increases in waste were observed during the new variety intervention and some of the FV Challenges. A possible explanation for waste increase during the new variety intervention may be that students had not been exposed to the FV very often, if ever. As a result, they did not know how much they would eat and placed too much on their trays. During the variety and FV Challenge interventions, waste may have increased because students who normally did not consume FV were encouraged to do so and were not conditioned to know how much they would eat. This explanation coincides with the finding that 4 of the 5 days during these interventions had significant increases in the percentage of students who consumed at least some FV from the FV bars. Perhaps if the FV were offered more frequently and the FV Challenges occurred more often, more students would be better conditioned to only take what they would consume and waste would decrease. In support of this theory is Adam et al's study (56) of salad bars compared to pre-portioned FV servings, which demonstrated that salad bars were associated with less waste. The students in this study were more conditioned to the FV offerings in their salad bars, which may be one explanation for the decreased waste observed.

In addition to food waste, other issues also make it difficult to implement effective interventions in school lunch. The NSLP does not have the financial nor human resources requisite to purchase, plan and implement the types of nutritious meals that

children should receive. One barrier is that the job positions in charge of menu-planning are not always held by people with appropriate qualifications, such as Registered Dietitians or other equivalently educated professionals. Another major barrier is linked to the USDA commodities program, which supplies food items to the NSLP. Under this program, the USDA buys millions of pounds of high-fat, high-cholesterol products, such as beef, pork, milk, and other meat and dairy products every year and then distributes them at very low cost to schools participating in the NSLP (65). Although some fresh fruits and vegetables are available through this program, the variety is limited. For the 2007 school year, the only fresh fruits available included apples, grapefruit, oranges and pears and the only fresh vegetables were potatoes (66). Other foods provided by the USDA commodities program in 2007 included higher fat and calorie items such as chicken nuggets and patties, beef, cheese, vegetable oils, and shortening. As a result, it seems the USDA commodity program should undergo change in order to better provide nutrition to a nation facing an obesity epidemic.

Additionally, although schools receive much-needed financial profits from a la carte sells, these menu items are often high in calories and low in nutrients as they are not required to meet the same dietary qualifications as the serving line, such as offering vegetables, various vitamins and minerals, and not too much fat. Although taking the a la carte serving option out of schools may lead to improved food choices among students such as increased FV and other nutrient-dense foods, it may be too financially difficult under current funding issues.

In summary, although certain barriers exist to various nutrition interventions, this research provides support that offering new varieties of FV and possibly implementing

reward-based interventions may be helpful in increasing FV consumption. In an effort to treat an overfed and undernourished nation, it may be helpful to *plan menus that meet NSLP as well as other national dietary recommendations, test menu performance, and then make necessary changes until a nutritious menu is well-accepted by school children of all ages.*

References

1. Academy for Educational Development. Center for Nutrition Available at: http://www.aednutritioncenter.org/programs/united_states. Accessed December 30, 2007.
2. Fruits and Veggies, More Matters. Available at: http://www.fruitsandveggiesmorematters.org/. Accessed December 30, 2007.
3. Levine E, Olander C, Lefebvre C, Cusick P, Biesiadecki L, McGoldrick D. The Team Nutrition pilot study: lessons learned from implementing a comprehensive school-based intervention. *J Nutr Educ Behav.* 2002;34:109-116.
4. Beydoun MA, Wang Y. Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Prev Med.* 2007; [Epub ahead of print].
5. Pomerleau J, Lock K, Knai C, McKee M. Interventions designed to increase adult fruit and vegetable intake can be effective: A systematic review of the literature. *J Nutr.* 2005;135:2486-2495.

6. Ciliska D, Robinson P, Armour T, Ellis P, Brouwers M, Gauld M, Baldassarre F, Raina P. Diffusion and dissemination of evidence-based dietary strategies for the prevention of cancer. *Nutr J.* 2005;4:13.
7. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6- to 12-year old children and effective interventions to increase consumption. *J Hum Nutr Diet.* 2005;18:431-443.
8. McAleese JD, Rankin LL. Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *J Am Diet Assoc.* 2007;107:662-665.
9. Reinaerts E, de Nooijer J, Candel M, de Vries N. Increasing children's fruit and vegetable consumption: Distribution or a multicomponent program? *Public Health Nutr.* 2007;10:939-947.
10. Contento IR, Koch PA, Lee H, Sauberli W, Calabrese-Barton A. Enhancing personal agency and competence in eating and moving: Formative evaluation of a middle school curriculum—choice, control, and change. *J Nutr Educ Behav.* 2007;39(5 Suppl):S179-186.
11. Engels HJ, Gretebeck RJ, Gretebeck KA, Jimenez L. Promoting healthful diets and exercise: Efficacy of a 12-week after-school program in urban African Americans. *J Am Diet Assoc.* 2005;105:455-459.
12. Kalina EA, Arnold CLS. Impact of nutrition education on the fruit and vegetable consumption of children. *J Am Diet Assoc.* 2006;106:A47.
13. Fogarty A, Antoniak M, Venn A, Davies L, Goodwin A, Salfield N, Stocks J, Britton J, Lewis S. Does participation in a population-based dietary intervention scheme have

a lasting impact on fruit intake in young children? *Int J Epidemiol.* 2007;36:1080-1085.

14. Jago R, Baranowski T, Baranowski JC. Fruit and vegetable availability: A micro environmental mediating variable? *Public Health Nutr.* 2007;10:681-689.
15. Neumark-Sztainer D, Wall M, Perry C, Story M. Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. *Prev Med.* 2003;37:198-208.
16. Wind M, Bobelijn K, De Bourdeaudhuij I, Klepp KI, Brug J. A qualitative exploration of determinants of fruit and vegetable intake among 10- and 11-year-old schoolchildren in the low countries. *Ann Nutr Metab.* 2005;49:228-235.
17. Haire-Joshu D, Kreuter MK, Holt C, Steger-May K. Estimates of fruit and vegetable intake in childhood and adult dietary behaviors of African American women. *J Nutr Educ Behav*. 2004;36:309-314.
18. Cooke L. The importance of exposure for healthy eating in childhood: A review. *J Hum Nutr Diet.* 2007;20:294-301.
19. Kubik MY, Lytle LA, Hannan PJ, Perry CL, Story M. The association of the school food environment with dietary behaviors of young adolescents. *Am J Public Health.* 2003l;93:1168-1173.
20. Cullen KW, Eagan J, Baranowski T, Owens E, de Moor C. Effect of a la carte and snack bar foods at school on children's lunchtime intake of fruits and vegetables. *J Am Diet Assoc.* 2000;100:1482-1486.
21. de Nooijer J, de Vet E, Brug J, de Vries NK. Do implementation intentions help to turn good intentions into higher fruit intakes? *J Nutr Educ Behav.* 2006;38:25-29.

22. Kellar I, Abraham C. Randomized controlled trial of a brief research-based intervention promoting fruit and vegetable consumption. *Br J Health Psychol.* 2005;10:543-558.

23. Steptoe A, Perkins –Porras L, Rink E, Hilton S, Cappuccio FP. Psychological and social predictors of changes in fruit and vegetable consumption over 12 months following behavioral and nutrition education counseling. *Health Psychol.* 2004;23:574-581.

24. Cullen KW, Zakeri I, Pryor EW, Baranowski T, Baranowski J, Watson K. Goal setting is differentially related to change in fruit, juice, and vegetable consumption among fourth-grade children. *Health Educ Behav.* 2004;31:258-269.

25. Perry CL, Bishop DB, Taylor GL, Davis M, Story M, Gray C, Bishop SC, Mays RA, Lytle LA, Harnack L. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health Educ Behav.* 2004;31:65-76.

26. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumptions: A peer-modeling and rewards-based intervention. *Eur J Clin Nutr.* 2004;58:1649-1660.

27. Hendy HM, Williams KE, Camise TS. "Kids Choice" school lunch program increases children's fruit and vegetable acceptance. *Appetite.* 2005;45:250-263.

28. Reynolds KD, Franklin FA, Binkley D, Raczynski JM, Harrington KF, Kirk KA, Person S. Increasing the fruit and vegetable consumption of fourth-graders: Results from the high 5 project. *Prev Med.* 2000;30:309-319.

29. French SA, Stables G. Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Prev Med.* 2003;37:593-610.

30. Anderson AS, Porteous LE, Foster E, Higgins C, Stead M, Hetherington M, Ha MA, Adamson AJ. The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables. *Public Health Nutr.* 2005;8:650-656.

31. Te Velde SJ, Brug J, Wind M, Hildonen C, Bjelland M, Perez-Rodrigo C, Klepp KI. Effects of a comprehensive fruit- and vegetable- promoting school-based intervention in 3 European countries: The Pro Children Study. *Br J Nutr.* 2007 [Epub ahead of print].

32. Birnbaum AS, Lytle LA, Story M, Perry CL, Murray DM. Are differences in exposure to a multicomponent school-based intervention associated with varying dietary outcomes in adolescents? *Health Educ Behav.* 2002;29:427-443.

33. Perry CL, Bishop DB, Taylor G, Murray DM, Mays RW, Dudovitz BS, Smyth M, Story M. Changing fruit and vegetable consumption among children: The 5-a-Day Power Plus program in St. Paul, Minnesota. *Am J Public Health.* 1998;88:603-609.

34. US Department of Agriculture. Food and Nutrition Service. Available at: http://www.fns.usda.gov/cnd/. Accessed December 30, 2007.

35. US Department of Agriculture Human Nutrition Information Service. MyPyramid. Available at: http://mypyramid.gov/mypyramid/results.html?name=undefined&age=10&gender=male&weight=70&heightfeet=4&heightinch=7&activity=low&weightN=70&heightfeetN=4&heightinchN=7&validweight=0&validheight=0&. Accessed November 30, 2007.

36. US Department of Agriculture Food and Nutrition Service. National School Lunch Program Fact Sheet. Available at: http://www.fns.usda.gov/cnd/lunch/. Accessed November 30, 2007.

37. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://apps.nccd.cdc.gov/brfss/Trends/trendchart_c.asp?state_c=UT&state=US&qkey=10150&SUBMIT1=Go. Accessed November 30, 2006.

38. Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med.* 2007;32:257-263.

39. Centers for Disease Control and Prevention. Prevalence of fruit and vegetable consumption and physical activity by race/ethnicity—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:301-304.

40. Centers for Disease Control and Prevention. Fruit and vegetable consumption among adults—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:213-217.

41. Bureau of Health Promotion. *Tipping the Scales Toward a Healthier Population: The Utah Blueprint to Promote Healthy Weight for Children, Youth, and Adults.* Salt Lake City, UT: Utah Department of Health 2006.

42. Knol LL, Haughton B, Fitzhugh EC. Dietary patterns of young, low-income US children. *J Am Diet Assoc.* 2005;105:1765-1773.

43. Lambert N, Plumb J, Looise B, Johnson IT, Harvey I, Wheeler C, Robinson M, Rolfe P. Using smart card technology to monitor the eating habits of children in a school

cafeteria: 3. The nutritional significance of beverage and dessert choices. *J Hum Nutr Diet.* 2005;18:271-279.

44. Kant AK, Schatzkin A, Block G, Ziegler RG, Nestle M. Food group intake patterns and associated nutrient profiles of the US population. *J Am Diet Assoc.* 1991;91:1532-1537.

45. Panagiotakos DB, Pitsavos C, Skoumas Y, Stefanadis C. The association between food patterns and the metabolic syndrome using principal components analysis: The ATTICA Study. *J Am Diet Assoc.* 2007;107:979-987.

46. Fernandez E, Gallus S, La Vecchia C. Nutrition and cancer risk: An overview. *J Br Menopause Soc.* 2006;12:139-142

47. US Department of Agriculture. Dietary guidelines for Americans, 2005. 6th ed. Washington, DC: US Government Printing Office; 2005. Available at: http://www.health.gov/dietaryguidelines. Accessed November 30, 2007.

48. Harriss LR, English DR, Powles J, Giles GG, Tonkin AM, Hodge AM, Brazionis L, O'dea K. Dietary patterns and cardiovascular mortality in the Melbourne Collaborative Cohort Study. *Am J Clin Nutr.* 2007;86:221-229.

49. He FJ, Nowson CA, Lucas M, Macgregor GA. Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: Meta-analysis of cohort studies. *J Hum Hypertens*. 2007;21:717-728.

50. Wengreen HJ, Munger RG, Corcoran CD, Zandi P, Hayden KM, Fotuhi M, Skoog I, Norton MC, Tschanz J, Breitner JC, Welsh-Bohmer KA. Antioxidant intake and cognitive function of elderly men and women: The Cache County Study. *J Nutr Health Aging.* 2007;11:230-237.

51. McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. *J Nutr.* 2007;137:99-105.

52. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. *Am J Clin Nutr.* 2003;77:1417–1425.

53. Drapeau V, Despres JP, Bouchard C, Allard L, Fournier G, Leblanc C, Tremblay A. Modifications in food-group consumption are related to long-term body-weight changes. *Am J Clin Nutr.* 2004;80:29-37.

54. Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Rev.* 2004;62:1–17.

55. US Department of Agriculture. Team Nutrition. Available at: https://www.fns.usda.gov/tn/. Accessed November 30, 2007.

56. Adams MA, Pelletier RL, Zive MM, Sallis JF. Salad bars and fruit and vegetable consumption in elementary schools: a plate waste study. *J Am Diet Assoc.* 2005;105:1789-1792.

57. Meyer MK, Conklin MT. Variables affecting high school students' perceptions of school foodservice. *J Am Diet Assoc.* 1998;98:1424-1431.

58. Lowe CF, Horne PJ, Hardman CA, Tapper K. A peer-modeling and rewards-based intervention is effective in increasing fruit and vegetable consumption in children. *Prev Med.* 2006;43:351.

59. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C. Effects of a peer modeling and rewards-based intervention to increase fruit and vegetable consumption in children. *Eur J Clin Nutr.* 2004;58:510-522.

60. Kafatos I, Peponaras A, Linardakis M, Kafatos A. Nutrition education and Mediterranean diet: Exploring the teaching process of a school-based nutrition and media education project in Cretan primary schools. *Public Health Nutr.* 2004;7:969-975.

61. Mangunkusumo RT, Brug J, de Koning HJ, van der Lei J, Raat H. School-based internet-tailored fruit and vegetable education combined with brief counseling increases children's awareness of intake levels. *Public Health Nutr.* 2007;10:273-279.

62. Marlette MA, Templeton SB, Panemangalore M. Food type, food preparation, and competitive food purchases impact school lunch plate waste by sixth-grade students. *J Am Diet Assoc.* 2005;105:1779–1782.

63. Edwards JS, Hartwell HH. Fruit and vegetables—attitudes and knowledge of primary school children. *J Hum Nutr Diet.* 2002;15:365-374.

64. Domel SB, Baranowski T, Davis H, Leonard SB, Riley P, Baranowski J. Measuring fruit and vegetable preferences among 4th- and 5th-grade students. *Prev Med.* 1993;22:866-879.

65. Physicians Committee for Responsible Medicine. Healthy School Lunches. Available at: http://www.healthyschoollunches.org/reports/report2003_intro.html. Accessed November 30, 2007.

66. USDA Foods Available for School Year 2007. Available at: http://www.fns.usda.gov/fdd/foods/sy07-schfoods.pdf. Accessed December 30, 2007.

Table 1. Demographics of study participants.

Demographic (n=75)	**Percent**
Race	
White, non-Hispanic	91
Other	9
Gender	
Female	53
Male	47
Lunch Price	
Free	18
Reduced	14
Regular	68

Table 2. Fruit and vegetable bar offerings.

Fruit/ Vegetable	Baseline		Challenge1		Variety		Education		Challenge2	
	One[a]	Two[b]	One	Two	One	Two	One	Two	One	Two
Carrots	X[c]	X	X	X	O	O	X	Not Available	X	X
Peaches	X	X	O	O	O	O	O		X	X
Pears	X	O	O	X	O	O	O		X	X
Mixed Fruit	O[d]	X	O	O	X	O	X		O	O
Applesauce	O	O	X	X	X	O	X		O	O
Oranges	O	O	X	O	O	O	O		O	O
Broccoli	O	O	O	X	O	X	O		O	O
Bananas	O	O	O	O	X	X	O		O	O
Kiwifruit	O	O	O	O	X	O	O		O	O
Grapes	O	O	O	O	O	X	O		O	O
Pineapple	O	O	O	O	O	X	O		O	O
Cauliflower	O	O	O	O	O	O	X		O	O
Mixed Greens	O	O	O	O	O	O	O		O	X

[a] "One" indicates Menu One

[b] "Two" indicates Menu Two

[c] "X" indicates the fruit or vegetable was offered.

[d] "O" indicates the fruit or vegetable was not offered.

Table 3. Comparisons between baseline and intervention fruit and vegetable intake.

Measure	Baseline	Intervention	Difference	T Value	P Value
	mean ± standard deviation				
Challenge 1					
Menu One (n=52)	.12 ±.22	.23 ±.26	.11 ±.30	2.6	.014
Menu Two (n=47)	.25 ±.30	.26 ±.37	.01 ±.33	0.2	.824
Combined (n=40)	.19 ±.22	.25 ±.24	.06 ±.22	1.6	.118
Variety					
Menu One (n=52)	.12 ±.22	.48 ±.40	.36 ±.40	6.3	.000
Menu Two (n=50)	.25 ±.29	.72 ±.47	.47 ±.49	6.8	.000
Combined (n=41)	.19 ±.22	.62 ±.37	.43 ±.34	8.2	.000
Education					
Menu One (n=54)	.13 ±.23	.14 ±.23	.02 ±.29	0.5	.642
Menu Two	N/A[a]	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A
Challenge 2					
Menu One (n=54)	.13 ±.23	.21 ±.32	.08 ±.31	1.9	.057
Menu Two	N/A	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A

[a] Data not available

Table 4. Comparisons between baseline and intervention percentage of all students who consumed at least some fruits and vegetables from the fruit and vegetable bars.

Measure	Baseline	Intervention	Difference	T Value	P Value
	mean ± standard deviation				
Challenge 1					
Menu One (n=52)	25 ± 44	54 ± 50	29 ± 57	3.6	0.001
Menu Two (n=47)	49 ± 51	43 ± 50	-06 ± 53	-0.8	0.411
Combined (n=40)	39 ± 40	49 ± 38	10 ± 36	1.7	0.088
Variety					
Menu One (n=52)	25 ± 44	75 ± 44	50 ± 58	6.2	0.000
Menu Two (n=50)	50 ± 51	90 ± 30	40 ± 57	5.0	0.000
Combined (n=41)	37 ± 39	85 ± 30	49 ± 43	7.3	0.000
Education					
Menu One (n=54)	26 ± 44	33 ± 48	07 ± 61	0.9	0.376
Menu Two	N/A[a]	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A
Challenge 2					
Menu One (n=54)	26 ± 44	43 ± 50	17 ± 58	2.1	0.038
Menu Two	N/A	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A

[a] Data not available

Table 5. Mean fruit and vegetable intake by classroom during the fruit and vegetable challenges.

Measure	Baseline	Intervention	Difference	T Value	P Value
	mean ± standard deviation				
Challenge 1					
Classroom 1					
Menu One (n=18)	.10 ± .21	.36 ± .28	.26 ± .31	3.6	.002
Menu Two (n=15)	.18 ± .26	.15 ± .23	.03 ± .23	0.6	.582
Classroom 2					
Menu One (n=16)	.13 ± .24	.20 ± .21	.08 ±.24	1.3	.206
Menu Two (n=15)	.33 ± .32	.32 ± .38	.02 ± .41	0.2	.876
Classroom 3					
Menu One (n=18)	.14 ± .23	.11 ± .21	.03 ± .27	0.4	.668
Menu Two (n=17)	.22 ± .30	.29 ± .45	.07 ± .33	0.9	.369
Challenge 2[a]					
Classroom 1					
Menu One (n=20)	.11 ± .22	.10 ± .17	.01 ± .25	0.2	.825
Menu Two (n=17)	.22 ± .26	.49 ± .53	.26 ± .50	2.2	.043
Classroom 2					
Menu One (n=16)	.13 ± .24	.27 ± .31	.15 ± .26	2.2	.045
Menu Two (n=16)	.31 ± .32	.36 ± .33	.05 ± .38	0.5	.628
Classroom 3					
Menu One (n=18)	.14 ± .23	.28 ± .42	.14 ± .40	1.5	.163
Menu Two (n=17)	.22 ± .30	.60 ± .66	.38 ± .61	2.6	.021

[a] Only Classroom 3 implemented the second Fruit and Vegetable Challenge during "Menu Two".

Table 6. Percentage of MyPyramid recommendations consumed.

	Baseline		**Challenge1**		**Variety**		**Education**		**Challenge 2**	
	One[a]	Two[b]	One	Two	One	Two	One	Two	One	Two
All Students										
n	59	52	57	58	60	65	62	n/a	62	n/a
FV Bar[c]	.1±.2	.3±.3	.2±.3	.2±.4	.5±.2	.7±.5	.2±.2	n/a	.2±.3	n/a
Potato[d]	.2±.1	n/a	.2±.1	n/a	.2±.1	n/a	.2±.1	n/a	.2±.1	n/a
MyPyramid[e]	25%	19%	32%	17%	49%	56%	26%	n/a	30%	n/a
FV Consumers										
n	14	43	30	23	44	59	49	n/a	26	n/a
FV Bar	.5±.2	.5±.2	.4±.2	.6±.3	.6±.3	.8±.4	.4±.2	n/a	.5±.3	n/a
Potato	.2±.0	n/a	.2±.1	n/a	.2±.1	n/a	.2±.1	n/a	.2±.1	n/a
MyPyramid	54%	35%	47%	44%	63%	61%	47%	n/a	52%	n/a

[a] "One" indicates Menu One.
[b] "Two" indicates Menu Two.
[c] Mean ± SD cups of fruits and vegetables consumed.
[d] Mean ± SD cups of mashed potatoes consumed
[e] Percent of MyPyramid recommendation consumed, which was defined as one-third the amount recommended for a ten-year old who is active for 30 to 60 minutes most days of the week.

Table 7. Percentage of fruits and vegetables taken from the fruit and vegetable bars that was not consumed.

Measure	Baseline	Intervention	Difference	T Value	P Value
	mean ± standard deviation				
Challenge 1					
Menu One (n=52)	1.6 ± 8.2	8.7 ± 18.4	7.1 ± 20.9	2.4	0.018
Menu Two (n=47)	0.5 ± 3.7	3.4 ± 16.2	2.8 ± 16.7	1.2	0.250
Combined (n=40)	0.7 ± 3.2	5.3 ± 10.5	4.6 ± 11.4	2.5	0.015
Variety					
Menu One (n=52)	1.6 ± 8.2	10.2 ± 23.5	8.6 ±25.6	2.4	0.019
Menu Two (n=50)	1.5 ± 6.0	12.8 ± 22.3	11.3 ± 20.5	3.9	0.000
Combined (n=41)	0.7 ± 3.2	9.5 ± 13.6	8.8 ± 13.7	4.1	0.000
Education					
Menu One (n=52)	1.5 ± 8.1	1.4 ± 7.6	0.2 ± 11.3	0.1	0.923
Menu Two	N/A[a]	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A
Challenge 2					
Menu One (n=54)	1.5 ± 8.1	12.4 ± 27.1	10.8 ± 29.0	2.7	0.008
Menu Two	N/A	N/A	N/A	N/A	N/A
Combined	N/A	N/A	N/A	N/A	N/A

[a] Data was not available.

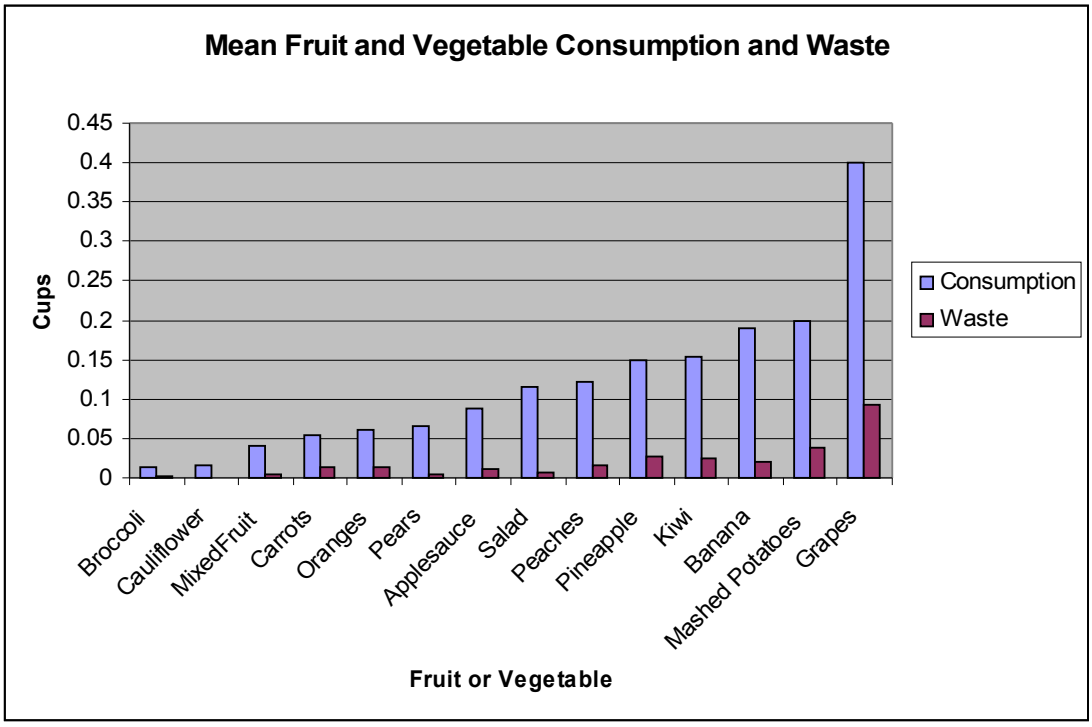

Figure 1. Mean consumption and waste of fruits and vegetables. Values represent average consumption and waste of all fruits and vegetables offered on the fruit and vegetable bars and include data from all students on all days of data collection.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

Intention of this thesis project was to gain knowledge in the field of nutrition, including the topics of obesity, fruit and vegetable (FV) intakes, and associated nutritional factors by conducting a literature review and completing a study of FV intakes among fourth-graders. The literature review revealed the ever-increasing rates of obesity and poor dietary habits among the nation's youth and adults and the associated negative impacts on health as well as possible interventions to reverse the epidemic with an emphasis on increasing FV intakes.

Based upon research findings of interventions to increase FV consumption and findings supporting that interventions aimed at youth may be effective in promoting development and then maintenance of healthy dietary habits and body weights (1-7), a plate waste study was designed and conducted among fourth-graders from 1 elementary school in the Cache County School District. The aim of the study was to investigate current FV consumption and the impact of 3 different interventions aimed at increasing FV intake, namely FV Challenges, offering new varieties of FV, and classroom education. Data regarding FV intake at baseline and during each intervention were collected. Paired t-tests were used to assess the association between each intervention and FV intake.

Although FV intakes varied throughout the study, total FV intake was consistently below minimum national recommendations, which was in aggreement with much other

research demonstrating inadequate FV intakes among all age groups in the US (8-14). Among the interventions implemented, classroom education resulted in no no association to FV intakes, FV challenges led to increased intakes that varied heavily in degree of significance, and offering new FV varieties was consistently associated with significant increases. Similar results were observed for the interventions' impact on the decisions of students to consume at least some FV from the FV bars; classroom education portrayed no association, the FV challenges led to increases, which varied in significance, and the new variety intervention was consistently associated with significant increases in the percentage of students who consumed FV from the FV bars.

Overall these results are consistent with other research, namely that FV consumption is often improved by making greater varieties of FV available (15-22) and encouraging FV consumption via rewards-based interventions (23-28). The inability of the education intervention to increase intakes is also consistent with the body of research demonstrating that dietary behaviors are often difficult to change, even with increased nutritional knowledge (29, 30). However, some research is supportive of educational interventions eliciting behavioral changes (7, 16, 31-36). Additionally, available research also shows FV consumption may be influenced by multi-component interventions (30, 37-42), strategies that aim to make these behaviors habitual (43), serving meals in a buffet rather than a la carte style (44), eliminating or modifying the availability of competitive foods in schools (19, 45, 46), modifying food type and preparation (47), *offering* attractive food (48), and properly catering interventions to meet varying needs among socioeconomic status (49, 50), ethnicity (12), age (51,52), and gender (53).

In light of this literature review and plate waste study, it seems appropriate that interventions to increase FV consumption include as many components as is practical, with an emphasis on long-term education, FV availability and exposure, rewards-based strategies, and eliminating or modifying the offerings in school snack bars and vending machines.

Conclusion

A majority of the US population struggles with overweight and obesity, which may in part be related to poor food choices, such as a low intake of nutrient-dense foods including FV and high intakes of energy-dense foods, such as soda, chips, and desserts. Among fourth-graders in this study, FV intakes were consistently inadequate and offering new varieties during school lunch was an effective way to achieve higher intakes. Thus, efforts to increase the offerings and consumption of nutrient-dense foods, such as FV, during school lunch, seem appropriate.

References

1. Sabin MA, Ford A, Hunt L, Jamal R, Crowne EC, Shield JP. Which factors are associated with a successful outcome in a weight management program for obese children? *J Eval Clin Pract.* 2007;13:364-368.
2. Villard LC, Ryden L, Ohrvik J, Stahle A. Impact of time trends and increasing age on health behavior of Swedish school children. *Eur J Cardiovasc Prev Rehabil.* 2007;14:326-332.

3. Palfrey JS, Hauser-Cram P, Bronson MB, Warfield ME, Sirin S, Chan E. The Brookline Early Education Project: A 25-year follow-up study of a family-centered early health and development intervention. *Pediatrics.* 2005;116:144-152
4. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: The cardiovascular risk in young Finns study. *Br J Nutr.* 2005;93:923-931.
5. Venn AJ, Thompson RJ, Schmidt MD, Cleland VJ, Curry BA, Gennat HC, Dwyer T. Overweight and obesity from childhood to adulthood: a follow-up of participants in the 1985 Australian Schools Health and Fitness Survey. *Med J Aust.* 2007;186:458-460.
6. Hesketh K, Wake M, Waters E, Carlin J, Crawford D. Stability of body mass index in Australian children: A prospective cohort study across the middle childhood years. *Public Health Nutr.* 2004;7:303-309.
7. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: The Bogalusa Heart Study. *Eur J Clin Nutr.* 2006;60:48-57.
8. US Department of Agriculture. Food and Nutrition Service. Office of Analysis. Nutrition and Evaluation. *Children's Diets in the Mid-1990s: Dietary Intake and Its Relationship with School Meal Participation, CN-01-CD1, by Phil Gleason and Carol Suitor.* Project Officer, Ed Herzog. Alexandria, VA; 2001.
9. Lambert N, Plumb J, Looise B, Johnson IT, Harvey I, Wheeler C, Robinson M, Rolfe P. Using smart card technology to monitor the eating habits of children in a school

cafeteria: 3. The nutritional significance of beverage and dessert choices. *J Hum Nutr Diet.* 2005;18:271-279.

10. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://apps.nccd.cdc.gov/brfss/Trends/trendchart_c.asp?state_c=UT&state=US&qkey=10150&SUBMIT1=Go. Accessed November 30, 2007.
11. Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med.* 2007;32:257-263.
12. Centers for Disease Control and Prevention. Prevalence of fruit and vegetable consumption and physical activity by race/ethnicity—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:301-304.
13. Centers for Disease Control and Prevention. Fruit and vegetable consumption among adults—United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:213-217.
14. Bureau of Health Promotion. *Tipping the Scales Toward a Healthier Population: The Utah Blueprint to Promote Healthy Weight for Children, Youth, and Adults.* Salt Lake City, UT: Utah Department of Health; 2006.
15. Reinaerts E, de Nooijer J, Candel M, de Vries N. Increasing children's fruit and vegetable consumption: Distribution or a multicomponent program? *Public Health Nutr.* 2007;10:939-947.
16. Fogarty A, Antoniak M, Venn A, Davies L, Goodwin A, Salfield N, Stocks J, Britton J, Lewis S. Does participation in a population-based dietary intervention scheme have

a lasting impact on fruit intake in young children? *Int J Epidemiol.* 2007;36:1080-1085.

17. Jago R, Baranowski T, Baranowski JC. Fruit and vegetable availability: a micro environmental mediating variable? *Public Health Nutr.* 2007;10:681-689.
18. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6-12-year old children and effective interventions to increase consumption. *J Hum Nutr Diet.* 2005;18:431-443.
19. Neumark-Sztainer D, Wall M, Perry C, Story M. Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. *Prev Med.* 2003;37:198-208.
20. Wind M, Bobelijn K, De Bourdeaudhuij I, Klepp KI, Brug J. A qualitative exploration of determinants of fruit and vegetable intake among 10- and 11-year-old schoolchildren in the low countries. *Ann Nutr Metab.* 2005;49:228-235.
21. Haire-Joshu D, Kreuter MK, Holt C, Steger-May K. Estimates of fruit and vegetable intake in childhood and adult dietary behaviors of African American women. *J Nutr Educ Behav.* 2004;36:309-314.
22. Cooke L. The importance of exposure for healthy eating in childhood: A review. *J Hum Nutr Diet.* 2007;20:294-301.
23. de Nooijer J, de Vet E, Brug J, de Vries NK. Do implementation intentions help to turn good intentions into higher fruit intakes? *J Nutr Educ Behav.* 2006;38:25-29.
24. Kellar I, Abraham C. Randomized controlled trial of a brief research-based intervention promoting fruit and vegetable consumption. *Br J Health Psychol.* 2005;10:543-558.

25. Cullen KW, Zakeri I, Pryor EW, Baranowski T, Baranowski J, Watson K. Goal setting is differentially related to change in fruit, juice, and vegetable consumption among fourth-grade children. *Health Educ Behav.* 2004;31:258-269.
26. Perry CL, Bishop DB, Taylor GL, Davis M, Story M, Gray C, Bishop SC, Mays RA, Lytle LA, Harnack L. A randomized school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health Educ Behav.* 2004;31:65-76.
27. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumptions: A peer-modeling and rewards-based intervention. *Eur J Clin Nutr.* 2004;58:1649-1660.
28. Hendy HM, Williams KE, Camise TS. "Kids Choice" school lunch program increases children's fruit and vegetable acceptance. *Appetite.* 2005;45:250-263.
29. Levine E, Olander C, Lefebvre C, Cusick P, Biesiadecki L, McGoldrick D. The Team Nutrition pilot study: Lessons learned from implementing a comprehensive school-based intervention. *J Nutr Educ Behav.* 2002;34:109-116.
30. Beydoun MA, Wang Y. Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Prev Med.* 2007; [Epub ahead of print].
31. Pomerleau J, Lock K, Knai C, McKee M. Interventions designed to increase adult fruit and vegetable intake can be effective: A systematic review of the literature. *J Nutr.* 2005;135:2486-2495.

32. Ciliska D, Robinson P, Armour T, Ellis P, Brouwers M, Gauld M, Baldassarre F, Raina P. Diffusion and dissemination of evidence-based dietary strategies for the prevention of cancer. *Nutr J.* 2005;4:13.
33. McAleese JD, Rankin LL. Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *J Am Diet Assoc.* 2007;107:662-665.
34. Contento IR, Koch PA, Lee H, Sauberli W, Calabrese-Barton A. Enhancing personal agency and competence in eating and moving: Formative evaluation of a middle school curriculum—Choice, Control, and Change. *J Nutr Educ Behav.* 2007;39:S179-186.
35. Engels HJ, Gretebeck RJ, Gretebeck KA, Jimenez L. Promoting healthful diets and exercise: efficacy of a 12-week after-school program in urban African Americans. *J Am Diet Assoc.* 2005;105:455-459.
36. Kalina EA, Arnold CLS. Impact of nutrition education on the fruit and vegetable consumption of children. *J Am Diet Assoc.* 2006;106:A47.
37. Reynolds KD, Franklin FA, Binkley D, Raczynski JM, Harrington KF, Kirk KA, Person S. Increasing the fruit and vegetable consumption of fourth-graders: Results from the high 5 project. *Prev Med.* 2000;30:309-319.
38. French SA, Stables G. Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Prev Med.* 2003;37:593-610.
39. Anderson AS, Porteous LE, Foster E, Higgins C, Stead M, Hetherington M, Ha MA, Adamson AJ. The impact of a school-based nutrition education intervention on

dietary intake and cognitive and attitudinal variables relating to fruits and vegetables. *Public Health Nutr.* 2005;8:650-656.

40. Te Velde SJ, Brug J, Wind M, Hildonen C, Bjelland M, Perez-Rodrigo C, Klepp KI. Effects of a comprehensive fruit- and vegetable-promoting school-based intervention in 3 European countries: The Pro Children Study. *Br J Nutr.* 2007; [Epub ahead of print].
41. Birnbaum AS, Lytle LA, Story M, Perry CL, Murray DM. Are differences in exposure to a multicomponent school-based intervention associated with varying dietary outcomes in adolescents? *Health Educ Behav.* 2002;29:427-443.
42. Perry CL, Bishop DB, Taylor G, Murray DM, Mays RW, Dudovitz BS, Smyth M, Story M. Changing fruit and vegetable consumption among children: The 5-a-Day Power Plus program in St. Paul, Minnesota. *Am J Public Health.* 1998;88:603-609.
43. Reinaerts E, de Nooijer J, Candel M, de Vries N. Explaining school children's fruit and vegetable consumption: the contributions of availability, accessibility, exposure, parental consumption and habit in addition to psychosocial factors. *Appetite.* 2007;48:248-258.
44. Lassen A, Hansen K, Trolle E. Comparison of buffet and a la carte serving at worksite canteens on nutrient intake and fruit and vegetable consumption. *Public Health Nutr.* 2007;10:292-297.
45. Kubik MY, Lytle LA, Hannan PJ, Perry CL, Story M. The association of the school food environment with dietary behaviors of young adolescents. *Am J Public Health.* 2003;93:1168-1173.

46. Cullen KW, Eagan J, Baranowski T, Owens E, de Moor C. Effect of a la carte and snack bar foods at school on children's lunchtime intake of fruits and vegetables. *J Am Diet Assoc.* 2000;100:1482-1486.

47. Marlette MA, Templeton SB, Panemangalore M. Food type, food preparation, and competitive food purchases impact school lunch plate waste by sixth-grade students. *J Am Diet Assoc.* 2005;105:1779–1782.

48. Meyer MK, Conklin MT. Variables affecting high school students' perceptions of school foodservice. *J Am Diet Assoc.* 1998;98:1424-1431.

49. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviors and associations with food habits in different countries. *Public Health Nutr*. 2006;9:244-250.

50. Kant AK, Graubard BI. Secular trends in the association of socio-economic position with self-reported dietary attributes and biomarkers in the US population: National Health and Nutrition Examination Survey (NHANES) 1971-1975 to NHANES 1999-2002. *Public Health Nutr.* 2007;10:158-167.

51. Knol LL, Haughton B, Fitzhugh EC. Food group adherence scores assess food patterns compared to US Department of Agriculture Food Guide. *J Am Diet Assoc*. 2006;106:1201-1208.

52. Larson NI, Neumark-Sztainer D, Hannan PJ, Story M. Trends in adolescent fruit and vegetable consumption. 1999-2004: Project EAT. *Am J Prev Med.* 2007;32:147-150.

53. Perez CE. Fruit and vegetable consumption. *Health Rep.* 2002;13:23-31.

APPENDIX

NUTRITION EDUCATION LESSON OUTLINES

Healthy Snack Curriculum

Objectives:
Fourth-graders will demonstrate knowledge of the following:
- The difference between a healthy and unhealthy snack choice.
- Why snacks are important.
- The ability to name a snack that combines at least two of the food groups.

Materials:
- Paper
- Container
- 2 balls

- Ask the students, "Does anyone know why snacks are important?"
    - They help be less hungry between meals
    - They can help us consume our recommended food group servings
    - They give us energy

- **Activity**: Ask the students, "What kinds of snacks do you enjoy?" Then, have each student write one of his or her favorite snacks on a piece of paper and put it in a container. With everyone standing, pull a paper from the container and read the snack aloud. If students think it is a healthy snack, they should jump in place. If not, they should drop to the floor.
    - List some of the healthy snacks they mentioned. Ask what those snacks have in common.
    - When is a good time to have a snack?
        - Before doing a physical activity
        - Between meals, when you feel hungry.
    - Why eat nutritious snacks instead of "others" snacks like chips and soda?
- We should think of snacks as mini-meals, so they should be just as healthy as our regular meals. Snacks are a good time to eat fruits and vegetables.
- It is a good idea to pick a snack that has foods from at least two of the food groups, sort of like combination foods that we talked about when we learned about MyPyramid.

- **Activity**: *Intercepting Nutritious Snacks*. Ask the students, "What is a fun and healthy snack from each food group?" This is a time for you to get creative. Divide the students into two groups, each group should form a circle. One student should be in the middle of the circle. The students must pass the ball around the circle (not to the person next to them), but before they can pass it, they have to say a healthy snack. The student in the middle should try and intercept the ball as it is being passed around the circle. When the student intercepts the ball, have him/her rotate to the outside of the circle so another student has a chance in the middle.
    - What does the ball symbolize? *A healthy snack*

    - Why is the person in the middle trying to get the ball? They are trying to get a nutritious snack. By choosing and eating nutritious snacks, you can score for good nutrition.
- We should avoid snacks that come from the "others" group. Why? Because they contribute few nutrients.

- **Activity**: Give each student a picture of a basic food from a food group. Direct the students to combine with other students to make a combination snack that would taste good and be fun to eat. Let the kids be creative! Create a "you pick" card, so that individual can be whatever snack food they want. Examples may include:
    - A peanut butter banana with raisins on it
    - Ants on a log (celery with peanut butter and raisins)
    - A sandwich (peanut butter and jelly or ham and cheese)
    - A string cheese and a piece of meat
    - Cheese and crackers
    - Cheese and an apple

Fitness Curriculum

Objectives:

- Fourth-graders will demonstrate the following abilities:
    - Verbalize why daily exercise is important.
        - It helps prevent disease.
        - Promotes lean body mass and bone growth.
        - It is fun.
        - It helps you feel happy and stress less.
    - Verbalize activities that can aid in being physically fit.
        - Playing tag
        - Playing sports
            - Soccer
            - Basketball
            - Baseball
            - Gymnastics
            - Football
        - Dancing
        - Running
        - Gardening/vigorous yard work
        - Walking the dog
        - Hiking
        - Water skiing/snow skiing
    - Understand it is important to balance physical activity with food consumption to achieve a healthy weight.
    - Track physical activity for one week after they receive the curriculum and bring the tracker back for the next lesson.
    - Understand and incorporate the motto "Move more, sit less."

Materials:

- Slips of paper with the names of physical activities
- CD with dance music
- CD player
- Copies of the fitness tracker sheet
- Dry-erase marker to make lists on the board.

- What do you think of when you think of the word exercise?
    - Breathing hard
    - Sweating
    - Playing sports
    - Getting tired
    - Anything that gets you moving

    - Playing (may want to emphasize this concept since sometimes exercise is considered a less fun concept)
- Exercise is anything that helps us move more and sit less. What are some activities that help us do this?

    - **Activity**: Charades. Choose one child at a time to act out one of the following motions. Have the students draw the following activities out of a container or envelope.
        - Playing tag
        - Playing sports
            - Soccer
            - Basketball
            - Baseball
            - Gymnastics
            - Football
        - Dancing
        - Running
        - Gardening/vigorous yard work
        - Walking the dog
        - Hiking
        - Water skiing/snow skiing
- Do you know how much exercise we should get every day? 60 minutes! What kinds of things take that long? That is often as much as two episodes of your favorite TV show, or one hour.
- To help remind you to do more physical activity, let's use the motto "Move more, sit less." Have the class repeat the phrase.
- Exercise is important, but we don't necessarily have to do it all at the same time. You can do lots of small things during the day that will add up. What can you do to make your day more active, to move more and sit less?

    - **Activity**: Go through main activities in the day and list what you could do to incorporate physical activity. Have one (or many) of the students contribute ideas to their daily schedule and discuss ways to incorporate activity as you list them. Here is a sample list with some sample ideas of what could be done to increase activity.
        - Get dressed: Do 10 jumping jacks before and after you put on your clothes, put on some music and dance around as you are getting ready
        - Eat breakfast: Skip when you take your dishes to the sink
        - Brush teeth: calf raises, stretch, arm circles
        - Go to school: If you live close enough, ride your bike or walk, ask mom to drop you off farther away from the door so you can walk.
        - Recess: Play an active game instead of sitting
        - Go home: Ride bike or walk

        - Go to the store with a parent: Ask parent to park a little farther away so you can walk; take the stairs instead of the elevator; walk next to the cart instead of riding inside of it.
- All of these are ways we can "Move more and sit less." (Have class repeat).
- What are some things you like to do that are less active?
    - Play video games
    - Checkers or board games
    - Computer games
    - Watch TV/movies

- **Activity**: What can you do to make some of your favorite games more active? Take the list of things they like to do that are less active, split them into groups, give one activity to each group and give them a couple of minutes to come up with a way to incorporate exercise into that activity or at least make it more active. Have them share it with the class.
- Why is exercise important for our bodies?
    - Helps prevent disease
    - Makes us feel happy and stress less
    - Helps us sleep better at night
    - Gives us stronger muscles and bones
    - It is fun
- What are some other things that will help us when we exercise?
    - Eat foods before, during, and after we exercise so we have more energy.
        - Our bodies are just like cars that need gas to run. You wouldn't go on a long trip without putting gas in the car, would you? Just like a car cannot run without gas, our bodies cannot run without food.
        - Bring snacks that are small that you can eat while you are exercising if you are going to do it for a long time.
        - If you get side aches or feel sick when you eat before you exercise, don't eat so close to exercise time.
        - Eating foods that have protein and carbohydrate in them will give us energy longer. Ask them to list examples.
            - String cheese
            - Yogurt
            - Half of a sandwich
            - Glass of milk and a banana
    - Stay hydrated (drink enough water)
        - Helps you not to get tired
        - Helps keep muscles from cramping
    - Eat snacks to have energy
    - Exercise with a buddy—family member, friend, pet
    - Music
- Introduce the fitness tracker sheet and ask for a commitment from them that they will exercise this week. Have each of them set a personal goal and write it down. Tell

them you will do it, too and ask them to bring the tracker back next week. Talk about the tracker at the next lesson and see how they did. See how many total minutes of physical activity the class was able to get. Remind them to "move more and sit less"

- Exercise can be easy! To show you how easy it is, even when it's cold outside, let's make a dance together.
- **Activity**: Put on some exercise music and have everyone form a circle. Go around the circle and have each child, one at a time, show a dance move. Everyone will then repeat that dance move.
- When you are done (and hopefully out of breath), emphasize that exercise can be easy and fun. Remind them to fill out their fitness tracker.

MyPyramid Curriculum

Objectives:

- Fourth-graders will be able to demonstrate knowledge of the following:
    - Identify all food groups
    - Identify which foods belong to which food group
    - State recommended consumption amount for each food group
    - Identify combination foods and the food group of each ingredient

Materials:

- Picture cards from the five food groups
- MyPyramid for kids poster
- Pictures of combination foods such as sandwiches, tacos
- "Others" foods such as cookies, soda pop, cake and chips

Getting started activity:

Have students stand with room to move. Explain to the students that when a food group is called, they need to do a special movement. Call out the food group and movement (You can write the food group and the movement on the board).

- Grains: jump SIX times
- Vegetables: Hop THREE times
- Fruits: Turn TWO times
- Milk: Stomp THREE times
- Meat & beans: Touch the ground TWO times
- "others": fall to the ground ONCE

Repeat the activity a few times. Call the movements faster and faster

Discussion:

Ask the students why you had them do each movement for the number of times indicated

- Grains: We need at SIX ounces of grains every day
- Vegetable: we need THREE cups of vegetables each day (cooked = ½ cup, raw = 1 cup)
- Fruit: we need TWO cups of fruit each day
- Milk: we need THREE cups of milk or dairy each day
- Meat & beans: We need TWO servings of meat or beans (about 5 oz)

Food group relay

Divide students into five teams by counting off from one to five.

Assign the team names:

- Grains Giants
- Vegetables Vikings
- Fruits Falcons
- Milk Chargers

- Meat Titans

Place a pile of food picture cards about 10 yards from the starting line

Have the first person run to the food picture cards, find a food from their food group and run back to their team. The next person in line then does the same thing. Continue with the game until the pile of food picture cards is gone.
Ask each group to stand and share the pictures of food that are in their food group.

Review the five food groups
Review each food group, what the health benefit is and the number of servings from each group required.

Group	**Servings**	**Health benefits**
Grains	6 oz	Carbohydrates provide energy and aid digestion
Vegetables	3 cups	Vitamins from vegetables help you see and keeps your skin healthy
Fruits	2 cups	Vitamins that help your body heal cuts and bruises and fight infections
Milk	3 cups	Calcium builds strong bones and healthy teeth
Meat & beans	2 (5 oz)	Protein builds strong muscles and helps you grow

Discussion
How the five food groups work together to create a balanced, nutritious diet?

- Each group has different nutrients that our body needs
- When we choose foods from all five food groups we will get the nutrients we need to grow and stay healthy and also have the energy that we need

Combination foods

- Pizza – show the picture of a slice of pizza. Ask the students what food group pizza would this food belong to.
  Explain that it has at least three food groups
  Cheese – from the milk group
  Tomato sauce – from the vegetable group
  Crust – from the grains group
- Taco—show the picture of a taco. This type of food has four food groups
  Cheese – milk group
  Chicken, beef or beans – from meat & beans group
  Lettuce and tomato—from vegetable group
  Taco shell – from grains group

Explain to students that combination foods help us to eat a variety from the food groups. When we eat these types of foods we can count them toward our recommended servings.

We can also use combination foods to eat more vegetables by putting them on our sandwiches and tacos.

"Others"
Discussion:
Why weren't there any foods like soda, cookies or potato chips in the relay?
What is the "others" category and why isn't there a food group?

Explain:

- These types of foods don't really belong in any of the foods groups because they do not provide us the nutrients to stay healthy.

- They are called "others" because they should only be eaten occasionally and should not replace eating nutritious foods.

- It is okay to eat small amounts after we have eaten foods from the five food groups

- "Others" foods usually have a lot of calories (energy) and if we eat too many "others" foods it is harder to balance our 'energy in' with our 'energy out' for a healthy weight.

- Students in this age group understand the difference between a "want" and a "need" and you can use this example to explain that our bodies don't really need the "others" foods to keep it healthy and these foods should be limited in our diet.

Fruit and Vegetable Curriculum

Objectives:

- Fourth-graders will be able to:
    - Identify characteristics of fruits and vegetables that they find appealing.
    - Name at least one fruit or vegetable that they would like to eat again.
    - Use adjectives to describe the characteristics of at least three fruits and vegetables.

Materials:

- Rate the Taste Worksheet for each student
- Taste testing supplies (small plate for each student, paper towels, utensils or toothpicks)
- Cup of water for each student
- Cleaning supplies
- Variety of bite-size fruits and vegetables for tasting, including fresh, canned, dried and/or frozen products
- Thesaurus

- Introduce the concept of consuming a variety of fruits and vegetables. Ask the students:
    - Do you eat many different kinds of food each day?
    - Do you eat many different fruits and vegetables each day?
    - Do you like to try new fruits and vegetables? Why or why not?
    - Is it important to eat different fruits and vegetables? Why?
- Brainstorm words to describe fruits and vegetables. As a class, review the definition of an adjective and brainstorm adjectives that may be used to describe fruits and vegetables. (Examples may include how they taste, look, smell, or feel). Write the adjectives on the board.

Activity: Students sample an array of fruits and vegetables, one at a time, using safe food handling techniques. After each sample is tasted, each student rates the food and then uses adjectives to describe the food using the Rate the Taste Worksheets. Then, the students write down their favorite fruit or vegetable. Following the tasting, each student will share his or her descriptions of the foods as well as his or her favorite fruit or vegetable. Provide students with a thesaurus to aid in thinking of unique adjectives for each food.

- Lead a class discussion about the students' experiences.
    - Did you try a fruit or vegetable you had never tasted before?
    - Were you surprised by the way it tasted?
    - Will you eat fruits or vegetables more often in the future? Why or why not?

- Will you ask your parents to buy any of the fruits and vegetables that we tasted today? Why or why not?
- What did we do to make sure the food we tasted today was safe?
- Ask which fruit or vegetable was each student's favorite and why.

Rate the Taste Worksheet

Name_____ Date_____

Did you like the fruits and vegetables that you tasted? Write adjectives to describe how the food tasted looked, smelled, and felt. Try not to use the same adjective over and over. Then circle or color the picture that shows how much you liked each food. When you are done write the name of your favorite fruit or vegetable on the back.

Sample 1

Name of this food: _____

Adjectives for this food: _____ _____ _____

Sample 2

Name of this food: _____

Adjectives for this food: _____ _____ _____

Sample 3

Name of this food: _____

Adjectives for this food: _____ _____ _____

Sample 4

Name of this food: _____

Adjectives for this food: _____ _____ _____

Sample 5

Name of this food: _____

Adjectives for this food: _____ _____ _____

Sample 6

Name of this food: _____

Adjectives for this food: _____ _____ _____

My Favorite Fruit or Vegetable: _____