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The Impact of Participation in the Food Dudes Healthy Eating Program on Dietary Habits in Fourth and Fifth Grade Students in Cache County Utah After One Year

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THE IMPACT OF PARTICIPATION IN THE FOOD DUDES HEALTHY EATING PROGRAM ON DIETARY HABITS IN FOURTH AND FIFTH GRADE STUDENTS IN CACHE COUNTY UTAH AFTER ONE YEAR

by

Amanda B. Jones

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ABSTRACT

The Impact of Participation in the Food Dudes Healthy Eating Program on Dietary Habits in 4th and 5th Grade Students in Cache County Utah after One Year

by

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Adolescents are not consuming the recommended amounts of fruits and vegetables (FV). An overall decrease in diet quality is seen as adolescents get older, with decreases in fruit and vegetable intake and increases in energy dense food intake. The aim of this study was to test whether or not the Food Dudes (FD) healthy eating program helps to prevent decreases in fruit and vegetable intake and increases in energy dense foods during the transition from elementary school into middle school.

Past FD studies supported the use of repeated tasting, rewards, and role modeling to encourage children to eat more fruits and vegetables at school with data from studies of young children. A review of available literature on effectiveness of these techniques in adolescents found evidence that the program may also be effective for adolescents.

Participants were 4th and 5th graders (n=874) from 6 elementary schools, recruited during the 2011-2012 school year. Treatment group was assigned by school and included a prize condition, a praise condition, and a control. Students were followed into the 2012-

2013 school year when the 5th grade cohort entered middle school. During 2012-2013 an additional control group was recruited from three middle schools (n = 154).

Results showed short term success at increasing FV intake and that the program had some long term success preventing large drops in FV intake. A small to medium positive correlation was seen between energy dense snack foods and total FV intake (r ranging from .125 to .355, $p<0.01$). This suggests that increases in total FV intake was not associated with decreases in intake of less healthy foods and that increases in one food are associated with increases in other foods.

The results of this study suggest that the FD program may play a role in helping to maintain lunch time FV intake during the transition into middle school. The results for the impact on total FV intake and total diet were less conclusive due to problems in the self-reported data. Future studies on this topic should look for a better method for tracking changes in total FV intake and total diet.

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PUBLIC ABSTRACT

The Impact of Participation in the Food Dudes Healthy Eating Program on Dietary Habits in 4th and 5th Grade Students in Cache County Utah after One Year

Amanda Jones

Adolescents are not meeting the recommended daily intake of fruits and vegetables (FV). The Food Dudes Healthy Eating Program (FD), developed by researchers in the UK, has previously been shown to increase lunch time and overall FV intake in elementary school aged children. The aim of this study was to test if participation in the FD program during late elementary school could prevent decreases in FV intake and increases in junk food intake during the transition from elementary school into middle school.

A decrease in average lunchtime FV intake was seen at the beginning of the transition into middle school. Students who had participated in the FD program during elementary school, however, had a less drastic decrease in lunchtime FV intake than those who had not participated. By the end of the school year average lunchtime FV intake was even higher than it had been when it was first assessed, prior to the transition into middle school. Stabilizing FV intake did not, however, appear to have an impact on the intake of junk food.

Accurately measuring total FV intake and junk food intake was problematic during this study. The changes in lunchtime FV intake may not accurately reflect what was happening to total FV intake and junk food intake, so it is critical that future studies find more accurate methods of obtaining total dietary intake from adolescents.

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Amanda B. Jones

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CHAPTER 1

INTRODUCTION AND BACKGROUND

ABSTRACT

Obesity and chronic disease are serious problems in the US affecting even young children. Eating patterns established early in life contribute to risk of obesity and related diseases. The health benefits of diets rich in plant based foods include decreased risk of chronic disease and obesity, but American children are consuming far less than the recommended intake of fruits and vegetables (FV). Increasing childhood FV intake is an important strategy for preventing chronic disease and obesity. School-based nutrition interventions have been targeted as a cost effective way to reach large numbers of children. Although many of these interventions have had statistically significant results, few have shown clinically significant results. The Food Dudes Healthy Eating Program is one program that has shown both statistically and clinically significant results. The FD program uses repeated tasting, peer modeling, and rewards to encourage children to eat more FV at school. Utah State University (USU) researchers have successfully adapted the FD program for use in US schools. This study looks at the impact of the Food Dudes program on total FV intake, energy dense food intake, and success at preventing a drop in diet quality during the transition to middle school and adolescence. The study seeks to answer the question: Does participation in the FD program help to offset the decrease in total FV intake and the increase in energy dense food commonly seen during the transition from 5th grade (elementary school) into 6th grade (middle school)? Specific aims to help answer this question included examining differences in lunch-time intake of FV and total (school + home) intake of FV and energy dense foods by grade (4^{th} vs. 5^{th}

graders in Fall 2011) and condition (control, FD praise, FD prize) over time, and examine cross-sectional associations between FV intake and energy dense food intake among 4th, 5th, and 6th graders.

INTRODUCTION

Obesity and chronic disease has become a modern plague of the US and many other developed countries, striking even the youngest members of the population. Although levels of childhood overweight and obesity have plateaued over the past decade, childhood obesity is still one of the greatest health concerns facing the nation today. Approximately 1 in 3 US children qualify as overweight and 16.9% are considered obese (1). It has been estimated that upwards of 70% of obese children go on to become obese adults, and childhood obesity is also associated with increased risk for chronic disease during childhood and into adulthood (2).

Eating patterns are established early in life and contribute to risk of obesity and related diseases. For example, diets rich in plant-based foods may help decrease the risk of childhood obesity (3, 4) as well as the risk of chronic diseases including cardiovascular disease and some types of cancer (5). However, in spite of health initiatives and national advertising campaigns promoting increased FV intake, American children consume far less than the recommended intake of fruits and vegetables (6). Increasing national FV consumption is one strategy for obesity and chronic disease prevention. Millions of research dollars have been invested into developing interventions to help increase children's FV intake, some more successful than others.

Given that 32 million children participate in the National School Lunch Program each year (7), school-based nutrition interventions have been targeted as a cost effective way to target large numbers of children. Many of these school-based intervention studies have reported modest levels of statistical success; however, few have produced clinically significant increases in FV consumption. In a review of 21 school-based intervention studies aimed at increasing FV intake, the average increase in total daily FV intake was only .25 portions (1/8 cup) (8). However, the Food Dudes Healthy Eating Program is one intervention that has reported clinically significant and relatively consistent results in increasing children's FV consumption (9, 10).

The Food Dudes (FD) program has been implemented with great success in many primary schools throughout the UK and Ireland and in 2006 the program received a World Health Organization Best Practice Award (11). The program uses a combination of repeat tasting, role modeling, and rewards to increase FV intake in elementary school age children. Children participating in the intervention had a clinically significant increase in FV intake during the intervention and maintained higher levels of fruit and vegetable intake upon follow up than those in the control group. In a 2004 study, which included 3 primary schools in England and Wales, the estimated increase in total daily FV intake was 153 g or 2.54 portions for 4-7 year olds and 131 g or 2.18 portions for 7-11 year olds immediately following the intervention (9).

Other studies of the FD program have shown increases in FV consumption to be maintained upon long term follow-up (10-12). In a study of the program adapted for Irish schools, at 12 months post-intervention there was a slight decrease from the immediate post-intervention levels, but intake was still significantly higher than at baseline (10). A 2012 evaluation of the FD program by Upton et al. found a statistically significant increase in lunch time fruit and vegetable intake at 3 months post intervention, but increases were not found to be maintained at 12 months post intervention (13). In reviewing the literature, the FD program has proven most successful in increasing the FV consumption of those who had the lowest levels of consumption to begin with, (9, 11, 14).

A research team at Utah State University that includes both registered dietitians and psychologists has been working to implement the FD program in U.S. schools since 2010. The team has successfully implemented and previously reported on a single school pilot study of the program (14). They have also done an experimental intervention that involved six schools and followed children over 1 y post intervention.

The purpose of this current project is to follow 4th and 5th grade students who participated in the six school study in 2011-2012 into the 2012-2013 school year. Fourth grade students were followed into the fifth grade at their respective elementary schools, and fifth grade students were followed into sixth grade at three Cache County Middle schools where additional students who had not previously participated in the study were recruited from physical education (PE) classes as a control group.

Plate waste photo analysis (PWPA) will be used to give an objective measure of lunch time FV intake. A food frequency style questionnaire (FVSQ) about fruit, vegetable, beverage, and snack intake will be used to assess total FV intake and overall total diet. This is significant because the original FD studies only gave estimated impacts of the program on total FV intake (9). Another study by Taylor et al. used food diaries to look at the impact of the FD program, but there were only 34 participants in the study (15). This will be the first large scale study to look at the impact of participation in the FD program on total FV intake. The data from the FVSQ will also be used to assess the impact participation in the FD program on intake of less healthy, energy dense foods. To our knowledge this has not been evaluated in any other study.

Of particular concern to the population of this study is the impact of the transition into adolescence. Data from both cohort and cross-sectional studies show that FV intake decreases and energy dense food intake increases during the transition into middle school and adolescence (16-19). This study seeks to answer the question: Does participation in the FD program help to offset the decrease in total FV intake and the increase in energy dense food commonly seen during the transition from elementary school (5th grade) into middle school (6th grade)?

BACKGROUND AND LITERATURE REVIEW

Importance of Fruit and Vegetable Consumption

<u>Protection against obesity</u>

Diets rich in plant-based foods, particularly FV, are believed to protect against obesity. In support of this theory, many studies have shown that on average persons who consume a vegetarian diet are leaner than their non-vegetarian peers (20, 21). The low energy density and high fiber content of most FV are believed to decrease hunger, increase satiety, and decrease overall caloric intake and are cited as potential mechanisms for their protective effect against overweight and obesity (22). Data on the specific influence of FV consumption on body weight in a non-vegetarian population, however, is currently limited, especially for children.

Reviews of studies on the impact of FV on weight management have shown contradictory results finding overall insufficient evidence of a protective effect of FV consumption on childhood obesity risk (4, 23). The studies were limited since most did not account for potential confounders and often depended on self-reported height, weight, and FV consumption. A 2011 study by Matthews et al. found an inverse association between vegetable intake and BMI, but no association between fruit intake and BMI (3). The results of this study are of interest because height and weight were measured and recorded by researchers rather than self-reported, and some attempt was made to control for potential confounders including gender, type of school, and soda intake.

Influence on Total Diet

FV consumption may play an important role in dietary patterns by displacing less healthy foods in the diet. Data on this effect in children is limited. A weight loss study was conducted by Epstein et al. in which 41 children ages 8-12 with BMI percentile scores above the 85% were randomly assigned to one of two 24-mo family-based behavioral treatments. All children were placed on the same diet plan, however one treatment targeted increasing intake of fruits, vegetables, and low fat dairy products while the other treatment targeted reducing intake of high energy dense foods. The group targeted to increase healthy food intake had a significantly greater reduction in zBMI and percent overweight than the group that was targeted to reduce intake of high energy dense foods only (24).

Results of another experimental study published by Looney and Raynor in 2012 found that increasing fruit, vegetable, and low-fat dairy alone does not significantly influence intake of high energy dense, less healthy foods or decrease overall caloric intake. In this study, 80 overweight children between the ages of 4 and 9 were recruited and randomly assigned into one of three family-based intervention groups for 6 mos. One group received increased feedback and growth monitoring of changes in height, weight and BMI, another group received growth monitoring and were encouraged to cut back on snack foods and sugary drinks, and the other group received growth monitoring and were encouraged to increase consumption of FV and low-fat dairy. No relationship was found between increasing FV intake and consumption of snack foods and sugary drinks (25).

Chronic disease prevention

Results of a review of intervention studies on the relationship of FV consumption and weight management in adults were also inconclusive, but suggested that some FV may increase satiety, leading to an overall lower calorie intake (22). As evidenced above, the data on the influence of fruit and vegetable intake on risk of overweight is complicated and often contradictory. Adding to the complexity, studies often depend entirely on self-reported data which can be difficult to accurately collect from children. Although the exact relationship between FV consumption and overweight and obesity is difficult to quantify, there is convincing evidence that higher FV consumption protects against obesity-related chronic diseases including stroke, hypertension, and heart disease (5).

Key Elements of the Food Dudes Program

Repeat Tasting

One of the primary elements of the FD program is to increase children's exposure to FV by encouraging repeat tasting. The idea that exposure can increase liking for a food is derived from the 'mere exposure' effect, a phenomenon first quantitatively studied by psychologist Robert B. Zajonc. Zajonc found that repeated exposure to a stimulus tends to increase an individual's liking of that stimulus (26). Experimental lab studies have demonstrated that exposure can increase liking of foods for both children and adults (27-29). According to a review by Cooke, the younger the participant the fewer exposures are necessary to increase liking with some studies showing as few as one exposure necessary for infants and up to 20 exposures necessary for 10-12 year olds (29).

The previous studies were mostly performed in laboratory settings, however, other studies have tested the effect of exposure in a more naturalistic setting. Wardle et al. published results of two studies in 2003, one in preschoolers (30) and the other in 5- to 7-y-old children (31). In the preschool study, parents were either asked to give their child a small taste of a target vegetable daily, given basic information on healthy eating, or received no intervention. Children in the exposure group experienced significantly increased liking and intake of target vegetables while children in the other groups did not (30). The study of 5- to 7-y-olds took place in a school setting. Children were randomly assigned either to an exposure group, a cartoon sticker reward group, or a control group. The exposure group was found to have a greater increase in both liking and consumption than the reward or control groups (31).

A potential confounder in testing the effect of ‘mere exposure’ is that even when children do not receive a tangible reward for tasting a target food they often receive social praise. A 2010 study by Cooke et al. of 5- to 6-y-old children attempted to control for the influence of exposure alone (32). Children were placed in one of four groups: exposure with tangible reward, exposure with praise, exposure alone, and a control group that received no intervention. The study found that exposure alone increased intake and liking of a previously disliked vegetable. Liking remained higher at follow-up than at baseline, but the increase in intake was not maintained over time. FD implements both peer models and rewards to help encourage repeat tasting in a hope of increasing and maintaining both the liking and intake of FV in children (9).

Peer Modeling

The idea that individuals can learn through modeling the behavior of others is not new, however most formal understanding of the influence of role modeling on learned social behavior comes from the work of Albert Bandura who formally introduced the Social Cognitive Theory in the 1980's. According to the social cognitive theory, people can learn not just from being taught directly but by watching the behaviors of others (33). Bandura emphasizes that modeling is more than imitation (34). An early study by Bandura in the 1960's focused on learned aggression. Bandura had young children watch adults play with an inflatable doll. Those children who watched the adults play violently and aggressively with the toy were more likely to show aggressive behavior when they were later placed in a room to play with the inflatable doll than those who had seen adult models who did not demonstrate aggressive play behavior (35). Bandura's work demonstrated that behavior could be elicited by modeling a desired response rather than by reinforcement.

Bandura's theories on observational learning have been extended and applied in many fields to help shape behavior. The FD program utilizes modeling in two ways. First, videos of and letters from preteen super heroes, the Food Dudes, are presented to the children. The FD are shown using super powers they gained from consuming FV to fight off the evil Junk Punks. Support for the use of cartoon models comes from Bandura's work on aggression, which found that cartoon models could elicit aggression almost as effectively as adult models (36) as well as a study from 1972 which found showing the popular cartoon character Popeye eating spinach before spinach was served to children was as effective as the use of a peer model (37). The FD were selected to be slightly older than the children in the intervention because of prior studies that found peer models to be most effective for children when they were slightly older than the observer (9).

The second form of modeling comes from watching the behavior of other participants. As some of the children comply with eating the required amount of FV to earn a hand stamp and reward, they become models of the desired behavior for their peers (9). When the behavior of a model is reinforced, it increases the likelihood that the observer will adopt similar behavior (34). Most nutrition studies on peer modeling have been conducted in preschool aged children. In these studies a child was selected from the group and trained to eat a novel food in order to serve as a model for the rest of the participants in their group during meal or snack time. Children in the studies were found to be more likely to imitate the behavior of peers they respect, who were generally well liked, who were slightly older, and who were less aggressive (38, 39). One study also found that they were more likely to imitate female peer models (38).

A 2008 study by Salvy et al. evaluated the effect of social context on the food choices of both overweight and normal weight children between the ages of 10 and 12 (40). For one portion of the study children were partnered with an unfamiliar peer during snack time. For both overweight and normal weight children the selection of healthy snacks was strongly related to their partner’s selection of healthy snacks. Researchers concluded that including peers in interventions to increase healthy food consumption may be useful. The study was limited because the children were paired with a single unfamiliar peer. The presence of a familiar peer or multiple peers may change the influence on snack selection.

In a review of school-based interventions Salvy et al. also recognized that peer modeling may be one potential mechanism for increased FV intake in the FD and other similar studies, but suggested that for overweight children and adolescents especially it is possible that individuals were attempting to conform to social norms and avoid the stigma associated with overweight individuals who eat unhealthy foods rather than responding to peer models (41).

Rewards

The use of rewards to encourage healthy eating is a controversial topic. While the use of rewards to reinforce behavior has been well established, concerns have been raised about potentially negative effects from offering rewards. Two main theories regarding the potential negative effects of rewards have been presented (42). The first theory is the self-determination theory. These theorists suggest that when external rewards are given for a behavior it may be detrimental to an individual’s sense of autonomy and competence and as a result may decrease intrinsic motivation to perform the rewarded behavior.

The second theory perhaps more relevant to prior nutrition studies on rewards is the over justification theory. According to proponents of the over justification theory, individuals come to more strongly associate the external reward with their behavior than their own intrinsic motivations for exhibiting the behavior (42). In this case, when rewards are removed the desired behavior may decrease or disappear altogether. Early lab based nutrition studies found this effect. However, many of these studies were conducted using foods that, though novel, were already palatable to participants; for example, sweet juice. Studies done using less palatable foods show that the risk of over justification is minimal when target food is initially disliked. This may be one reason the FD program appears to be most successful in increasing FV intake for those children who consumed the least to begin with (9, 14).

Another important aspect of rewards is the use of praise as a reward. Results of a meta-analysis on the general effect of rewards found that the use of verbal rewards did not undermine intrinsic motivation (43). The 2010 study by Cooke et al. previously mentioned in the repeated tasting section of this literature review compared the effectiveness of tangible rewards versus praise. Both the tangible reward group and the praise group significantly increased their intake of the target vegetable; however intake for the tangible reward group was significantly greater than the praise group. The tangible reward and the praise group were also found to maintain their increased intake of the target vegetable at both 1- and 3-mo follow-ups. Additionally, the study found that both tangible rewards and praise increased liking of the target vegetable with no significant difference between the two groups and that increased liking was maintained upon follow-up (32). This study suggests that both tangible rewards and praise may be effectively used to increase consumption of previously disliked FV without undermining intrinsic motivation.

Previous Studies

The UK research team behind the FD program initially tested elements of the program in a home setting. A group of children who were considered selective eaters received elements of the FD program including repeated tasting, peer modeling, and rewards for eating FV (44). The program was later broadened for usage in entire primary schools. The whole school interventions found consistent and clinically significant increases in FV intake. Short term follow-up looking at three to four months post intervention has shown significant increases in FV consumption from baseline (12, 13). Longer term follow-up done up to 12 mo post intervention has had mixed results with one study showing a slight drop in consumption, but levels still above baseline, and another study showing that increases in consumption were not maintained (10, 13). The original FD program targeted increasing children's consumption of school provided FV, a variation of the program however was introduced in Ireland where students' lunches are provided by parents. The Irish program was successful in increasing parental provision of FV as well as increasing child consumption of FV and the program has been implemented in all primary school across Ireland (10).

A research team from USU conducted a single school pilot study of the FD program adapted to the schedule of US schools. The key difference from the UK program was that repeated tasting of researcher provided FV took place during lunchtime rather than during snack time since a morning snack is not part of the typical US elementary school schedule. The US pilot study found results similar to the original UK study, showing that the greatest increase in FV consumption occurred in those students who showed the lowest baseline consumption (14). The current study builds on the work of both the UK studies and the USU pilot study. Aside from some small scale home interventions with four or five children, the FD research team has not attempted to test to what degree the individual components of the program contribute to its efficacy (9, 10, 45). One important element of the current study that has not (to our knowledge) been looked at in previous FD's research is a comparison between the use of tangible rewards and praise. This study is also the first to look at the impact participation in the FD program has on dietary habits during the transition from elementary to middle school.

Decreased Fruit and Vegetable Intake in Adolescents

Autonomy in making dietary decisions increases as children transition from childhood into adolescence, particularly with the transition from elementary school into secondary school. Cross sectional studies have also shown that diet quality decreases as children move from late childhood into adolescence. A multinational study of child and adolescent eating patterns by the World Health Organization (WHO) found that FV consumption decreases with age while soda consumption increases with age (16). Lorson et al. published a study in 2009 using the 1999-2002 NHANES data for children and adolescents age 2-18 (19). Adolescents ages 12-18 y were found to be the least likely to meet the recommendations of FV compared to all other age groups. In the 12- to18-y-old group 80.5% were not meeting the daily recommended intake of fruit and 89.5% were not meeting the daily recommended intake of vegetables, compared to 74.1% and 83.8% for the 6- to 11-y-old group and 50.2% and 78.3% for the 2- to 5- y-old group.

A cohort study by Lytle et al. followed 291 students from Minnesota from 3rd grade to 8th grade. Individual 24-h recalls were collected from students during 3rd grade, 5th grade, and 8th grade. The percentage of students consuming FV was found to drop significantly between 5th grade and 8th grade, from 55.9% to 37.1% for fruit consumption ($p<0.05$) and 49.5% to 41.6% for vegetables ($p<0.05$). Soda consumption also significantly increased between 3rd grade and 5th grade and again between 5th grade and 8th grade (18). A Texas study also found that children in higher grades showed greater consumption of less healthful foods and decreased consumption of healthier foods

(17). One of the aims of this current study is to see if participation in the FD program during elementary schools helps to mediate the level of decrease in FV consumption during the transition from elementary school into middle school.

OBJECTIVE

Does participation in the FD program help to offset the decrease in FV intake and the increase in energy dense food commonly seen during the transition from 5th grade (elementary school) into 6th grade (middle school)?

SPECIFIC AIMS

SA1. Examine differences in lunch-time intake of FV and total (school + home) intake of FV and energy dense foods by grade (4th vs. 5th graders in Fall 2011) and condition (control, FD praise, FD prize) over time.

- The time effects we are interested in include baseline to the end of the phase 1 intervention; baseline to the end of the phase 2; baseline to the end of the follow-up 1; baseline to the end of the follow-up 2.
- Lunch time FV intake will be assessed by digital photo observations. Total FV intake will be assessed by a questionnaire and concentrations of skin carotenoids. Total intake of energy dense foods will be assessed by a questionnaire.

SA 2: Examine cross-sectional associations between FV intake and energy dense food intake among 4th, 5th, and 6th graders.

REFERENCES

1. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. J Am Diet Assoc 2010;303:242-9.

2. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJ. Health consequences of obesity. Arch Dis Child 2003;88:748-52.
3. Matthews VL, Wien M, Sabate J. The risk of child and adolescent overweight is related to types of food consumed. Nutr J 2011;10.
4. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. Nutr Rev 2004;62:365-74.
5. Boeing H, Bechthold A, Bub A, Ellinger S, Haller D, Kroke A, Leschik-Bonnet E, Muller MJ, Oberritter H, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. Eur J Nutr 2012;51:637-63.
6. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371-9.
7. National school lunch program: Participation and lunches served. http://www.fns.usda.gov/pd/slsummar.htm (accessed 2013).
8. Evans CE, Christian MS, Cleghorn CL, Greenwood DC, Cade JE. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. Am J Clin Nutr 2012;96:889-901.
9. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. Eur J Clin Nutr 2004;58:510-22.
10. Horne PJ, Hardman CA, Lowe CF, Tapper K, Le Noury J, Madden P, Patel P, Doody M. Increasing parental provision and children's consumption of lunchbox

fruit and vegetables in Ireland: the Food Dudes intervention. Eur J Clin Nutr 2009;63:613-8.

11. Lowe CFaH, P. J. 'Food Dudes': Increasing children's fruit and vegetable consumption. Cases in Public Health Communication & Marketing 2009;3:161-85.

12. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. Eur J Clin Nutr 2004;58:1649-60.

13. Upton D, Upton P, Taylor C. Increasing children's lunchtime consumption of fruit and vegetables: an evaluation of the Food Dudes programme. Public Health Nutr 2013;16:1066-72.

14. Wengreen HJ, Madden GJ, Aguilar SS, Smits RR, Jones BA. Incentivizing children's fruit and vegetable consumption: results of a United States pilot study of the Food Dudes Program. J Nutr Educ Behav 2013;45:54-9.

15. Taylor C, Darby H, Upton P, Upton D. Can a school-based intervention increase children's fruit and vegetable consumption in the home setting? Perspect Public Health 2013;133:330-6.

16. Currie C, Robert, C., Morgan, A., Smith, R., Setterbulte, W., Samdal, O., Rasmussen, V. B. Young people's health in context. Health behaviour in school-aged children. Copenhagen: WHO, 2004.

17. Perez A, Hoelscher DM, Brown HS, 3rd, Kelder SH. Differences in food consumption and meal patterns in Texas school children by grade. Prev Chronic Dis 2007;4:A23.

18. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. Am J Health Promot 2000;14:222-8.

19. Lorson BA, Melgar-Quinonez HR, Taylor CA. Correlates of fruit and vegetable intakes in US children. J Am Diet Assoc 2009;109:474-8.

20. Sabate J, Wien M. Vegetarian diets and childhood obesity prevention. Am J Clin Nutr 2010;91:1525S-9S.

21. Berkow SE, Barnard N. Vegetarian diets and weight status. Nutr Rev 2006;64:175-88.

22. 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.

23. Newby PK. Plant foods and plant-based diets: protective against childhood obesity? Am J Clin Nutr 2009;89:1572S-87S.

24. Epstein LH, Paluch RA, Beecher MD, Roemmich JN. Increasing healthy eating vs. reducing high energy-dense foods to treat pediatric obesity. Obesity (Silver Spring) 2008;16:318-26.

25. Looney SM, Raynor HA. Are changes in consumption of "healthy" foods related to changes in consumption of "unhealthy" foods during pediatric obesity treatment? Int J Environ Res Public Health 2012;9:1368-78.

26. Mere exposure effect. Elsevier's Dictionary of Psychological Theories, 2006.

27. Liem DG, de Graaf C. Sweet and sour preferences in young children and adults: role of repeated exposure. Physiol Behav 2004;83:421-9.

28. Pliner P. The effects of mere exposure on liking for edible substances. Appetite 1982;3:283-90.

29. Cooke L. The importance of exposure for healthy eating in childhood: a review. J Hum Nutr Diet 2007;20:294-301.

30. Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. Appetite 2003;40:155-62.

31. Wardle J, Herrera ML, Cooke L, Gibson EL. Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. Eur J Clin Nutr 2003;57:341-8.

32. Cooke LJ, Chambers LC, Anez EV, Croker HA, Boniface D, Yeomans MR, Wardle J. Eating for pleasure or profit: the effect of incentives on children's enjoyment of vegetables. Psychol Sci 2011;22:190-6.

33. Social learning theory. Corsini Encyclopedia of Psychology and Behavioral Science, 2010.

34. Bandura A. Observational learning. Englewood Cliffs, NJ: Prentice-Hall Inc, 1986.

35. Bandura A, Ross D, Ross SA. Transmission of aggression through imitation of aggressive models. J Abnorm Soc Psychol 1961;63:575-82.

36. Bandura A, Ross D, Ross SA. Imitation of film-mediated agressive models. J Abnorm Soc Psychol 1963;66:3-11.

37. Harris MB, Baudin H. Models and vegetable eating: the power of Popeye. Psychol Rep 1972;31:570.

38. Hendy HM. Effectiveness of trained peer models to encourage food acceptance in preschool children. Appetite 2002;39:217-25.

39. Greenhalgh J, Dowey AJ, Horne PJ, Lowe CF, Griffiths JH, Whitaker CJ. Positive- and negative peer modelling effects on young children's consumption of novel blue foods. Appetite 2009;52:646-53.

40. Salvy SJ, Kieffer E, Epstein LH. Effects of social context on overweight and normal-weight children's food selection. Eat Behav 2008;9:190-6.

41. Salvy SJ, de la Haye K, Bowker JC, Hermans RC. Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiol Behav 2012;106:369-78.

42. Cooke LJ, Chambers LC, Anez EV, Wardle J. Facilitating or undermining? The effect of reward on food acceptance. A narrative review. Appetite 2011;57:493-7.

43. Deci EL, Koestner R, Ryan RM. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychol Bull 1999;125:627-68; discussion 92-700.

44. Tapper K, Horne PJ, Lowe CF. The Food Dudes to the rescue! Psychologist 2003;16:18-21.

45. Lowe CF, Dowey, A., Horne, P. Changing what children eat. In: The Nation's Diet. London: Longman, 1998:57-80.

CHAPTER 2

EVIDENCE FOR THE EFFECTIVENESS OF THE FOOD DUDES PROGRAM IN ADOLESCENTS: A REVIEW

ABSTRACT

Americans are not eating the recommended amount of FV. Adolescents particularly struggle with poor diet quality. Studies show that FV intake decreases and consumption of less healthy foods increases during adolescence. FV intake is associated with chronic disease and obesity prevention, so increasing adolescent FV intake is an important aim.

The transition into adolescence is associated with increased levels of autonomy. Some studies suggest that increased autonomy is a risk factor for poor dietary choices, however other studies have found increased autonomy to be associated with greater self-control and an increase in health promoting behavior. Changes in the school food environment also impact young people during the transition into secondary school and adolescence.

The FD healthy eating program has been found to be an effective program for increasing FV consumption at school. The FD program uses a combination of repeated tasting, rewards, and role modeling. Studies used to support the effectiveness of the program were generally done in pre-school or early elementary age children.

Repeated tasting has been shown to increase liking for FV in adolescents, but further studies need to be done to test if this is linked to an increase in FV consumption. Using rewards to encourage increased FV intake is controversial. Although rewards can

be an effective tool, caution needs to be used to prevent rewards from backfiring and decreasing intrinsic motivation to eat FV.

Peer influences are especially important during adolescence. Peer modeling may be effective in adolescents, but it is important to also remember the importance of perceived social norms. What adolescents think their peers are doing may be more important that their actual behavior. Other literature reviewed in this study suggests that the Food Dudes program may have a positive impact on increasing adolescent FV intake.

INTRODUCTION

Americans are not eating the recommended amount of FV. Guenther et al. found that only 40% of American's were consuming an average of 5 or more servings of FV per day (1). The statistics for US adolescents are especially alarming as significant decreases in FV intake are seen during the transition from childhood (2). Increased consumption of less healthy beverages and snack foods are also seen during this transition. Data shows that this decline in FV intake during adolescence is becoming an international problem as well (3).

The health benefits of diets high in FV in preventing chronic diseases such as cardiovascular disease, hypertension, diabetes, and some types of cancer are well established (4, 5). There is also evidence that FV consumption may protect against obesity (6-8). In the US, 1 in 3 children between the ages of 2 to 18 are overweight and 16.9% are considered obese (9) and approximately 70% of those obese children will go on to become obese adults (4). A population sample of 5- to 17-y-olds found that 70% of obese children already have at least 1 risk factor for cardiovascular disease (10). Increasing FV intake is an important target for improving adolescent health.

Adolescence is a critical stage in the development of healthy eating behaviors because habits developed during this time will likely continue into adulthood (11, 12). During adolescence youth begin to develop more autonomy over their food choices and, as is the case with other behaviors during this period, the influence of parents decreases while the influence of peers simultaneously increases. One way to help combat unhealthy eating habits during adolescence may be to target children's eating habits before they enter secondary school. Upon entering middle school, children are faced with an increasing number of competitive food options as well as more independence in deciding what they will consume.

The FD healthy eating program is a school based program that has had clinically significant results in increasing children's FV intake (13). This literature review will investigate the literature on the problems related to unhealthy diets during adolescence. It will also investigate the literature behind the individual components of the FD program, repeated tasting, rewards, and role modeling, and whether or not the evidence supports the idea that participation in the FD program during elementary school could help prevent a future decline in FV intake during the transition into middle school.

FACTORS DETERMINING ADOLESCENT INTAKE OF FRUITS AND VEGETABLES

Adolescent Autonomy

The transition into middle school coincides with the transition from childhood into adolescence. Adolescence, a stage of development beginning with the onset of puberty (generally around age 12) and ending with the onset of adulthood (14), is a time of increasing independence from parental influences (15). The development of autonomy during adolescence involves finding a healthy balance between independence and dependence (14). The influence of this increasing autonomy on health related behaviors, including eating habits, is not entirely clear. Higher levels of autonomy have been found to be associated with higher levels of health promoting behavior in some adolescents (14). Other studies, however, suggest that higher levels of autonomy may be associated with a decrease in diet quality (16).

In a desire to demonstrate increasing independence many youth will rebel against parents. Some youth will deliberately develop unhealthy eating habits as a form of rebellion in an attempt to escape from parental control (17). Other youth, however, develop more self-control as they gain more independence in their decision making which may lead to healthier choices (14, 18). Stok et al. has suggested that the role autonomy plays in eating behaviors depends on the motives of autonomy (18). If the adolescent is seeking autonomy to gain social acceptance from his or her peers, it seems that may have a negative impact on eating behaviors. If the desire for autonomy comes from a desire to self-regulate, autonomy may actually play a positive role in the development of healthy eating behaviors (18).

Data on FV and Competitive Food Intake in Adolescents

Regardless of the exact role autonomy plays in the development of healthy eating behaviors, it is clear that for the majority of the youth the transition into adolescence is a time of increased risk of developing less than ideal eating patterns. A variety of studies done both in the US and internationally show that FV intake, as well as intake of low fat dairy products, decreases with age as youth transition from childhood into adolescence (3, 9, 19, 20). Along with this decrease in nutrient dense foods, there is an increase in the intake of calorie dense and nutrient empty foods and beverages, especially sugar sweetened beverages.

In a cross sectional study using data for children and adolescents age 2-18 taken from the 1999-2002 HHANES data, Lorson et al. found that adolescents ages 12-18 were the least likely to meet the recommendations for FV intake (2). In the 12- to 18-y-old group 80.5% were not meeting the daily recommended intake of fruit and 89.5% were not meeting the daily recommended intake of vegetables, compared to 74.1% and 83.8% for the 6- to 11-y-old group and 50.2% and 78.3% for the 2- to 5-y-old group (9). A multinational study conducted by the World Health Organization (WHO) shows that this phenomenon is not unique to the US (3). The WHO study also shows that adolescents have an increased intake of less healthy foods and beverages.

A cohort study by Lytle et al. followed 291 students from Minnesota schools through 3rd grade, 5th grade, and 8th grade and tracked changes in their dietary habits over time using data from self-reported 24 hour recalls (10). The percentage of students consuming FV was found to drop significantly between 5th grade and 8th grade. During 5th grade 55.9% of students self-reported eating fruit, only 37.1% reported doing so in 8th grade. During 5th grade 49.5% of students self-reported eating vegetables, this dropped to 41.6% in 8th graders. It was also found that soda consumption increased significantly between 3rd grade and 5th grade and again between 5th grade and 8th grade (10).

A cross sectional study of Texas 4th, 8th, and 11th grade students also found that children in higher grades showed greater consumption of less healthful foods and decreased consumption of healthier foods compared to their younger peers (20). The study found that over 70% of 8th and 11th graders had drunk soda or soft drinks, compared to only 61% of 4th graders. Snack consumption was found to increase linearly by grade ($P < .001$) and, compared with 4th graders, 8th and 11th graders were less likely to consume healthier food options such as yogurt, fruit, and milk and more likely to consume French fries and sweet pastries (20). The trends seen in these studies are clear; overall diet quality decreases with age during the transition from childhood into adolescence.

Availability of Competitive Food

One reason for these changes in eating habits upon entering adolescence could be the change in the school food environment. At the same time young adolescents are adjusting to new found autonomy and a transition to a new school environment, the school food environment also changes significantly. The transition from elementary school into middle school presents students with access to many more competitive food options. Although competitive foods are available in a significant number of elementary schools (73% of elementary schools compared to 97% of middle schools), secondary schools have been found to offer items higher in fat and calories (21, 22). Also, while only 27% of elementary schools have vending machines, they can be found in 87% of middle schools with more than 50% of middle schools having vending machines in or near the cafeteria (22).

A study of Texas middle school students found that 36 % of students purchased their lunches exclusively from snack bars and another 26% had a combination of home or school lunch and snack bar foods (23). Fifth graders who purchased their meals just from a la carte lines consumed on average .4 servings of FV compared to .82 servings for 5th graders participating in the National School Lunch Program (NSLP) (23). A cross-sectional study of Minnesota 7th graders found that students with a la carte options at their school consumed nearly a serving less of FV per day than students with no a la carte option available (3.39 vs 4.23, P=.02) (24).

The problem does not seem to be so much a lack of access to healthy choices so much as an abundance of availability of less healthy choices. A study of the influence of vending machines on the lunch time eating behaviors of Florida middle school students by Park et al. found that although healthier choices were usually available, the most common items purchased from vending machines were chips, pretzels/crackers, candy bars, soda, and sport drinks (25). This further suggests the importance of helping children develop healthy eating patterns before entering secondary school.

RESEARCH ON THE EFFECTIVENESS OF FOOD DUDES INTERVENTION COMPONENTS FOR OLDER CHILDREN

FV consumption during childhood has been found to influence adolescent fruit and vegetable consumption (12). Programs to increase intake of FV during elementary school, before the transition into middle school and adolescence, therefore may be one way to help improve trends in adolescent nutrition. School based interventions to increase FV intake have reported modest levels of statistical success; however, few have produced clinically significant results. In a review of 21 school-based intervention studies aimed at increasing FV intake, the average increase in total daily FV intake was only .25 portions (1/8 cup) (26).The Food Dudes Healthy Eating Program (FD) is one intervention that has had consistent and clinically significant results in increasing FV intake in elementary school age children both in the U.S. and abroad (13, 27, 28).

The UK research team behind the FD program initially tested elements of the FD program in a home setting (29). A group of children who were considered selective eaters received elements of the FD program including repeated tasting, rewards for tasting FV, and peer modeling (30). The program was later broadened for usage in entire primary schools. The whole school interventions found consistent and clinically significant increases in FV intake post-intervention (13, 27). A 2004 study, which included three primary schools in England and Wales, found that immediately following the intervention the estimated increase in total daily FV intake was 2.54 portions for 4- to 7-y-olds and 2.18 portions for 7- to 11-y-olds (27). The original FD program targeted increasing children's consumption of school provided FV. A variation of the program, however, was introduced in Ireland where students' lunches are provided by parents. The Irish program was successful in increasing parental provision of FV as well as increasing child consumption of FV and the program has been implemented in all primary school across Ireland (28).

A research team from USU conducted a single school pilot study of the FD program adapted to the schedule of US schools. The key difference from the UK program was that repeated tasting of researcher-provided FV took place during lunchtime rather than during snack time since a morning snack is not part of the typical US elementary school schedule. The US pilot study found results similar to the original UK study, showing that the greatest increase in FV consumption occurred in those students who showed the lowest baseline consumption (31).

The FD program uses 3 main elements to encourage behavior change towards eating more FV. These include repeated tasting, rewards, and role modeling. Much of the evidence that has been cited for the effectiveness of these methods comes from studies done in preschool or early elementary aged children. The purpose of the following sections are to review whether or not there is evidence for the effectiveness of these methods in increasing FV intake in older children and adolescents.

Repeated Tasting

It has been found that for both children and adolescents, taste is the single most important factor on consumption. Children and adolescents will eat what they like, so increasing liking for FV may be one of the most effective ways to increase consumption of these foods. Experimental lab studies have demonstrated that exposure, through repeated tasting, can increase liking of foods in both children and adults (32-34). The concept of repeat tasting to increase liking of new or previously disliked foods is derived from the “mere exposure” effect, a phenomenon first quantitatively studied by psychologist Robert B. Zajonc (35). Zajonc found that repeated exposure to any stimulus tends to increase an individual’s liking of that stimulus (35).

The majority of studies on repeated tasting have been done with toddlers, pre-school or early elementary school age children (34). These studies have found that repeated tasting can increase both liking for and consumption of previously disliked foods. A study of preschoolers by Cooke et al. found that repeated tasting increased liking and consumption of red peppers immediately post intervention (36). However, although the increase in liking was maintained upon follow-up, the increase in consumption was not. It seems possible and reasonable that this may also be applicable to older children but research testing this hypothesis is lacking.

Two recent studies by Lakkakula et al. have reported on the effectiveness of a repeated tasting intervention in older elementary school age children (37, 38). The first study included 340 4th and 5th grade students from low income elementary schools in Louisiana. Students were offered a taste of carrots, peas, tomatoes, and bell peppers once a week for 10 weeks. During tasting sessions, children were asked to complete a survey asking whether or not they had actually tried each of the FV and rate their liking of the foods. Liking for the FV was found to increase after eight to nine exposures for children who had previously disliked the foods, however no follow-up was reported assessing whether or not increases in liking were maintained over time (37). It is important to note that consumption was not measured for this study.

The second study included 379 children attending 1st, 3rd, or 5th grade at 2 low income Louisiana public elementary schools. The intervention was an 8-week program with fruits offered twice a week for 4 weeks and vegetables offered twice a week for 4 weeks on an alternating schedule. A 2-week follow-up was done at 4 mo and 10 mo post-intervention (5th graders were not included in the 10 mo follow-up). As in the other study, children were asked to self-report whether or not they had tasted the foods and to rate how much they liked each food. The children who had initially disliked a particular fruit or vegetable were found to have increased their liking by the end of the program and this increase in liking was maintained at both of the follow-ups (38). As in the first study, consumption was not measured.

These studies demonstrate that repeated tasting can be effectively used to increase liking of FV in older elementary school age children who previously disliked those foods, however, because the fifth graders were not followed into middle school it is unclear whether or not this increase in liking would be maintained during the transition into middle school. Also, since consumption was not measured for either of these studies, it remains unclear whether or not repeated tasting is actually effective at increasing consumption of FV in older children, or if it only has an effect on perceived liking of FV without actually changing consumption. Further studies are needed to understand whether or not repeated tasting is an effective tool for increasing consumption of FV in older children and whether or not that increase in consumption can be maintained during the transition into middle school and early adolescence.

Rewards

The use of rewards to encourage healthy eating is controversial. Although the use of rewards to reinforce behavior has been well established, concerns have been raised about potentially negative effects from offering rewards. Two main theories regarding the potential negative effects of rewards have been presented (36). The first theory is the self-determination theory. These theorists suggest that when external rewards are given for a behavior it may be detrimental to an individual's sense of autonomy and as a result may decrease intrinsic motivation to perform the rewarded behavior (36, 39). This may be significant for adolescents who are striving to develop autonomy. According to Deci et al. rewards may be perceived either as controlling behavior or as indicators of competence (39). This suggests that used correctly rewards could be an effective tool for shaping adolescent behavior since adolescents have a natural desire to demonstrate autonomy and competence (14), but caution must be used to make sure youth do not feel that their behavior is being overly controlled or the result could backfire.

The second theory on rewards is the over justification theory. According to proponents of the over justification theory, individuals come to more strongly associate the external reward with their behavior than their own intrinsic motivations for exhibiting the behavior (36). In this case, when rewards are removed, the desired behavior may decrease or disappear altogether. Early lab-based nutrition studies found this effect; however many of these studies were conducted using foods that, though novel, were already palatable to participants, for example sweet milk beverages (36, 40). Studies done using less palatable foods show that the risk of over justification is minimal when target food is initially disliked (41, 42). This may be one reason the FD program appears to be most successful in increasing FV intake for those children who consumed the least to begin with (27, 31).

Another important aspect of rewards is the use of praise as a reward. An early study by Birch et al. found that verbal praise negatively influenced intrinsic motivation to consume a previously unfamiliar, but generally well liked sweetened milk beverage (40). The 2010 study by Cooke et al. previously mentioned in the repeated tasting section of this literature review compared the effectiveness of tangible rewards versus praise. Both the tangible reward group and the praise group significantly increased their intake of the target vegetable; however, intake for the tangible reward group was significantly greater than the praise group. Both groups were found to maintain their increased intake of the target vegetable at both one and three month follow-ups. Additionally, the study found that both tangible rewards and praise increased liking of the target vegetable, with no significant difference between the two groups, and that increased liking was maintained upon follow-up (41). This study suggests that both tangible rewards and praise may be effectively used to increase consumption of previously disliked FV without undermining intrinsic motivation.

The studies that have been conducted testing the influence of verbal praise as a reward have largely been done in preschool or early elementary age children so it is difficult to make assumptions about the effectiveness of praise for older children and adolescents. A review by Henderlong and Lepper does give some insight on using praise as a reward for older children and adolescents (43). The review suggests that sincere praise may increase feelings of competence, however it is important that the praise be sincere. Offering praise for easy tasks may decrease feelings of competence. It is also important that praise be offered in such a way that it does not decrease perceived autonomy (43). This suggests that praise has the potential to be as effective in older children and adolescents as it has been found to be in children, but used incorrectly it risks giving the perception of taking away the young person's autonomy.

Role Modeling

The influence of peers becomes more important during late childhood and early adolescence. It is possible that the role of peer models may be even more important during this stage of development. Most current understanding on the role of modeling in learning and shaping behavior comes from the work of Albert Bandura who formally introduced the Social Cognitive Theory in the 1980's. According to the social cognitive theory people can learn not just from being taught directly, but by watching the behaviors of others (44). Bandura emphasizes that modeling is more than imitation (45). An early study by Bandura in the 1960's focused on learned aggression. Bandura had young children watch adults play with an inflatable doll. Those children who watched the adults play violently and aggressively with the toy were more likely to show aggressive behavior when they were later placed in a room to play with the inflatable doll than those who had seen adult models who did not demonstrate aggressive play behavior (46). Bandura's work demonstrated that behavior could be elicited by modeling a desired response rather than by reinforcement.

Bandura's theories on observational learning have been extended and applied in many fields to help shape behavior. The FD program utilizes modeling in 2 ways. First, videos of and letters from preteen super heroes, the FD, are presented to the children. The FD are shown using super powers they gained after consuming FV. The FD use these powers to fight off the evil Junk Punks. Support for the use of cartoon models comes from Bandura's work on aggression, which found that cartoon models could elicit aggression almost as effectively as adult models (47). In the study children were either exposed to a live actor modeling aggression, a filmed actor modeling aggression, or a cartoon modeling aggression. The levels of imitative as well as overall aggression were all found to be similar and were statistically greater than the control group that was not exposed to any kind of aggressive model (47). A nutrition-based study from 1972 also found that cartoons can be effective models of behavior (48). Showing children the popular cartoon character Popeye eating spinach before spinach was served was found to be just as effective as using a peer model to encourage spinach tasting (48).

The second form of modeling comes from watching the behavior of other participants. As some of the children comply with eating the required amount of FV to earn a hand stamp and reward, they become models of the desired behavior for their peers (27). When the behavior of a model is reinforced, it increases the likelihood that the observer will adopt similar behavior (45). Most nutrition studies on peer modeling have been conducted in preschool aged children. In these studies a child was selected from the group and trained to eat a novel food in order to serve as a model for the rest of the participants in their group during meal or snack time. Children in the studies were found to be more likely to imitate the behavior of peers they respect, who were generally well liked, who were slightly older, and who were less aggressive (49, 50). One study also found that they were more likely to imitate female peer models than males (49).

A 2008 study by Salvy et al. evaluated the effect of social context on the food choices of both overweight and normal weight children between the ages of 10 and 12 (51). For one portion of the study, children were partnered with an unfamiliar peer during snack time. For both overweight and normal weight children, the selection of healthy snacks was strongly related to their partner's selection of healthy snacks. Researchers concluded that including peers in interventions to increase healthy food consumption may be useful (51). The study was limited because the children were paired with a single unfamiliar peer; presence of a familiar peer or multiple peers may change the influence on snack selection. In a later review of school-based interventions Salvy et al. also recognized that peer modeling may be one potential mechanism for increased FV intake in the FD and other similar studies. However, they suggested that especially for overweight children and adolescents, it is possible that individuals were attempting to conform to social norms and avoid the stigma associated with overweight individuals who eat unhealthy foods rather than responding to peer models (52).

SOCIAL NORMS THEORY

Though not part of the original FD program, social norms theory is another approach for looking at the importance of peer influence. While research on the FD program has not looked at the influence of social norms, they likely play an important role. According to the social norms theory, individual behavior is strongly influenced by the individual's perception of what is the norm for their peer group. The social norms approach has been used in the past to predict and prevent behaviors such as alcohol and tobacco use among young people (53-55). Studies of both secondary school and college students have found that young people's perception of their peer's behavior and attitudes towards substance abuse is a strong predictor of their personal use of these substances (56).

More recently the social norms approach has been applied to research on nutrition-related health behaviors. Most of these studies are careful to distinguish between descriptive norms and injunctive norms. Descriptive norms are an individual's beliefs about what others do (for example, beliefs about how many FV their peers eat during the week) whereas injunctive norms are an individual's beliefs about others' attitudes toward a behavior (for example, beliefs about how their peers feel about eating FV) (57, 58). Descriptive norms have been found to be a better predictor of behavior than injunctive norms (59), particularly during the adolescent stage of development (57).

A cross-sectional study by Lally et al. of 16-19 year old students in the UK found descriptive norms to be a strong predictor of actual behavior (57). Participants answered questions about their own intake of unhealthy snacks, sugar sweetened beverages, and FV, what they believed their peers intake of these items to be (descriptive norms), and what they believed their peers attitudes about these food groups were (injunctive norms). Average perceived peer intake of snacks and sugar sweetened beverages was found to be significantly higher than the average reported actual intake, while perceived intake of FV was found to be lower than actual intake levels. Perceived intake of snacks was found to account for 21% of the variance in actual intake, perceived intake of sugar sweetened beverages was found to account for 17% of the variance in actual intake, and perceived intake of FV was found to account for 22% of the variance in actual intake. Injunctive norms were not found to have a significant influence on actual intake (57).

Similarly, a cross-sectional study by Perkins et al. on perceived intake of sugar-sweetened beverages in 6^{th}-12^{th} graders found that 76% of students overestimated the daily consumption of their peer group (58). In this study, students were asked about their personal consumption of sugar-sweetened beverages and their perceived intake of their peers. Personal consumption levels were averaged to give an estimate of average actual intake and perceived intake levels were averaged to give an estimate of overall perceived intake. Perceived intake was found to account for 34% of the variability in individual consumption, even after the actual average peer intake and variance in student characteristics were taken into account (58).

Changing perceived norms may be an important way to improve adolescent consumption of FV. Few studies have been done on the impact of targeting messages about descriptive norms to adolescents in order to manipulate eating behavior, however this tactic has been successfully used to influence tobacco and alcohol use (54, 55). A field study by Mollen et al. conducted in the cafeteria of a private east coast university in the US found that presenting descriptive norms messages promoting healthy eating increased the consumption of healthy food (59). Robinson et al. have also suggested that future nutrition interventions should utilize positive descriptive norm messages to encourage healthy eating behaviors (60). Positive messages about adolescent FV intake are an important step for future interventions to increase adolescent consumption of FV.

CONCLUSION

The transition from childhood and elementary school into adolescence and middle school is associated with decreases in FV intake. The transition into is associated with not only an increased desire for autonomy, but a food environment that promotes a variety of choices, many of which are not conducive to a healthy, balanced diet. Eating patterns from childhood have been found to carry into adolescence, so targeting children before they transition into adolescence and enter secondary school may help to prepare these children to make better food choices. There is evidence the elements of the FD program including repeated tasting, reward, and role modeling may be useful in encouraging behavior change in elementary school age children. Future research should be done to take into account the importance of social norms and help to reshape the idea that adolescents all eat unhealthy, to a more realistic image of adolescents eating a varied diet.

REFERENCES

1. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371-9.

2. Lorson BA, Melgar-Quinonez HR, Taylor CA. Correlates of fruit and vegetable intakes in US children. J Am Diet Assoc 2009;109:474-8.

3. Currie C, Robert, C., Morgan, A., Smith, R., Setterbulte, W., Samdal, O., Rasmussen, V. B. Young people's health in context. Health behaviour in school-aged children. Copenhagen: WHO, 2004.

4. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJ. Health consequences of obesity. Arch Dis Child 2003;88:748-52.

5. Boeing H, Bechthold A, Bub A, Ellinger S, Haller D, Kroke A, Leschik-Bonnet E, Muller MJ, Oberritter H, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. Eur J Nutr 2012;51:637-63.

6. Matthews VL, Wien M, Sabate J. The risk of child and adolescent overweight is related to types of food consumed. Nutr J 2011;24:10.

7. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. Nutr Rev 2004;62:365-74.

8. Evidence Analysis: Fruit and Vegetable Intake and Childhood Overweight. 2014 http://andevidencelibrary.com/evidence.cfm?evidence_summary_id=25 (accessed 21 March 2014).

9. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. JAMA 2010;303:242-9.

10. Freedman DS, Mei Z, Srinivasan SR, Berenson GS, Dietz WH. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. J Pediatr 2007;150:12-7 e2.

11. Videon TM, Manning CK. Influences on adolescent eating patterns: The importance of family meals. J Adolesc Health 2003;32:365-73.

12. Rasmussen M, Krolner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. Int J Behav Nutr Phys Act 2006;3:22.

13. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. Eur J Clin Nutr 2004;58:1649-60.

14. Spear HJ, Kulbok P. Autonomy and adolescence: A concept analysis. Public Health Nurs 2004;21:144-52.

15. Hill AJ. Developmental issues in attitudes to food and diet. Proc Nutr Soc 2002;61:259-66.

16. Bassett R, Chapman GE, Beagan BL. Autonomy and control: The co-construction of adolescent food choice. Appetite 2008;50:325-32.

17. Stevenson C, Doherty G, Barnett J, Muldoon OT, Trew K. Adolescents' views of food and eating: Identifying barriers to healthy eating. J Adolesc 2007;30:417-34.

18. Stok FM, De Ridder DTD, Adriaanse MA, De Wit JBF. Looking cool or attaining self-rule. Different motives for autonomy and their effects on unhealthy snack purchase. Appetite 2010;54:607-10.

19. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. Am J Health Promot 2000;14:222-8.

20. Perez A, Hoelscher DM, Brown HS, 3rd, Kelder SH. Differences in food consumption and meal patterns in Texas school children by grade. Prev Chronic Dis 2007;4:A23.

21. Gordon AR, Crepinsek MK, Briefel RR, Clark MA, Fox MK. The Third School Nutrition Dietary Assessment Study: Summary and Implications. J Am Diet Assoc 2009;109:S129-S35.

22. Story M. The Third School Nutrition Dietary Assessment Study: Findings and Policy Implications for Improving the Health of US Children. J Am Diet Assoc 2009;109:S7-S13.

23. 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;100:1482-6.

24. 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 Jul;93:1168-73.

25. Park S, Sappenfield WM, Huang YJ, Sherry B, Bensyl DM. The Impact of the Availability of School Vending Machines on Eating Behavior during Lunch: the Youth Physical Activity and Nutrition Survey. J Am Diet Assoc 2010;110:1532-6.

26. Evans CE, Christian MS, Cleghorn CL, Greenwood DC, Cade JE. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. Am J Clin Nutr 2012;96:889-901.

27. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. Eur J Clin Nutr 2004;58:510-22.

28. Horne PJ, Hardman CA, Lowe CF, Tapper K, Le Noury J, Madden P, Patel P, Doody M. Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention. Eur J Clin Nutr 2009;63:613-8.

29. Lowe CF, Dowey, A., Horne, P. Changing what children eat. The Nation's Diet. London: Longman, 1998:57-80.

30. Tapper K, Horne PJ, Lowe CF. The Food Dudes to the rescue! Psychologist 2003;16:18-21.

31. Wengreen HJ, Madden GJ, Aguilar SS, Smits RR, Jones BA. Incentivizing children's fruit and vegetable consumption: results of a United States pilot study of the Food Dudes Program. J Nutr Educ Behav 2013;45:54-9.

32. Liem DG, de Graaf C. Sweet and sour preferences in young children and adults: role of repeated exposure. Physiol Behav 2004;83:421-9.

33. Pliner P. The effects of mere exposure on liking for edible substances. Appetite 1982;3:283-90.

34. Cooke L. The importance of exposure for healthy eating in childhood: a review. J Hum Nutr Diet 2007;20:294-301.

35. Mere exposure effect. Elsevier's Dictionary of Psychological Theories, 2006.

36. Cooke LJ, Chambers LC, Anez EV, Wardle J. Facilitating or undermining? The effect of reward on food acceptance. A narrative review. Appetite 2011;57:493-7.

37. Lakkakula A, Geaghan J, Zanovec M, Pierce S, Tuuri G. Repeated taste exposure increases liking for vegetables by low-income elementary school children. Appetite 2010;55:226-31.

38. Lakkakula A, Geaghan JP, Wong WP, Zanovec M, Pierce SH, Tuuri G. A cafeteria-based tasting program increased liking of fruits and vegetables by lower, middle and upper elementary school-age children. Appetite 2011;57:299-302.

39. Deci EL, Koestner R, Ryan RM. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychol Bull 1999;125:627-68; discussion 92-700.

40. Birch LL, Marlin DW, Rotter J. Eating as the means activity in a contingency - effects on young childrens food preference. Child Dev 1984;55:431-9.

41. Cooke LJ, Chambers LC, Anez EV, Croker HA, Boniface D, Yeomans MR, Wardle J. Eating for pleasure or profit: the effect of incentives on children's enjoyment of vegetables. Psychol Sci 2011;22:190-6.

42. Wardle J, Herrera ML, Cooke L, Gibson EL. Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. Eur J Clin Nutr 2003;57:341-8.

43. Henderlong J, Lepper MR. The effects of praise on children's intrinsic motivation: A review and synthesis. Psychol Bull 2002;128:774-95.

44. Social learning theory. Corsini Encyclopedia of Psychology and Behavioral Science, 2010.

45. Bandura A. Observational learning. Englewood Cliffs, NJ: Prentice-Hall, 1986.

46. Bandura A, Ross D, Ross SA. Transmission of aggression through imitation of aggressive models. J Abnor Soc Psychol 1961;63:575-82.

47. Bandura A, Ross D, Ross SA. Imitation of film-mediated agressive models. J Abnorm Soc Psychol 1963 Jan;66:3-11.

48. Harris MB, Baudin H. Models and vegetable eating: the power of Popeye. Psychol Rep 1972;31:570.

49. Hendy HM. Effectiveness of trained peer models to encourage food acceptance in preschool children. Appetite 2002;39:217-25.

50. Greenhalgh J, Dowey AJ, Horne PJ, Lowe CF, Griffiths JH, Whitaker CJ. Positive- and negative peer modelling effects on young children's consumption of novel blue foods. Appetite 2009;52:646-53.

51. Salvy SJ, Kieffer E, Epstein LH. Effects of social context on overweight and normal-weight children's food selection. Eat Behav 2008;9:190-6.

52. Salvy SJ, de la Haye K, Bowker JC, Hermans RC. Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiol Behav 2012;106:369-78.

53. Perkins HW, Craig DW. The imaginary lives of peers: Patterns of substance use and misperceptions of norms among secondary school students. The social norms approach to preventing school and college age substance abuse: a handbook for educators, counselors, and clinicians. San Francisco, CA: Jossey-Bass, 2003:209-23.

54. Linkenbach JW, Perkins HW. Most of us are tobacco free: An eight-month social norms campaign reducing youth initiation of smoking in Montana. In: The social

norms approach to preventing school and college age substance abuse: a handbook for educators, counselors, and clinicians. San Francisco, CA: Jossey-Bass, 2003:224-34.

55. Haines MP, Barker GP, Rice R. Using social norms to reduce alcohol and tobacco use in two midwestern high schools. In: The social norms approach to preventing school and college age substance abuse: a handbook for educators, counselors, and clinicians. 2003:235-44.

56. Perkins HW. The social norms approach to preventing school and college age substance abuse: a handbook for educators, counselors, and clinicians. 1st ed. San Francisco: Jossey-Bass, 2003.

57. Lally P, Bartle N, Wardle J. Social norms and diet in adolescents. Appetite 2011;57:623-7.

58. Perkins JM, Perkins HW, Craig DW. Misperceptions of peer norms as a risk factor for sugar-sweetened beverage consumption among secondary school students. J Am Diet Assoc 2010;110:1916-21.

59. Mollen S, Rimal RN, Ruiter RAC, Kok G. Healthy and unhealthy social norms and food selection. Findings from a field-experiment. Appetite 2013;65:83-9.

60. Robinson E, Blissett J, Higgs S. Social influences on eating: implications for nutritional interventions. Nutr Res Rev 2013;26:166-76.

CHAPTER 3

THE IMPACT OF PARTICIPATION IN THE FOOD DUDES HEALTHY EATING PROGRAM ON DIETARY HABITS IN 4th AND 5th GRADE STUDENTS IN CACHE COUNTY UTAH AFTER ONE YEAR

ABSTRACT

American children are not consuming the recommended intake of FV. Diet quality decreases during adolescence with decreases in FV intake and increases in intake of less healthy food. Eating habits established during childhood carry over into adolescence, so targeting children's FV intake while in elementary school may prevent decreases in intake seen during adolescence. The purpose of this study was to answer the question: Does participation in the FD program help to offset the decrease in FV intake and the increase in energy dense food commonly seen during the transition from elementary school into middle school?

Participants were 4th and 5th graders from six elementary schools, recruited during the 2011-2012 school year (n= 874). Treatment groups were assigned by school and included a prize, praise, and control group. Students were followed into the 2012-2013 school year and the 5th grade cohort transitioned into middle school. During 2012-2013 an additional control group was recruited from the middle schools (n=154).

Lunch time FV intake was measured by plate waste photo analysis. Total FV intake and total intake of less healthy food was self-reported through a fruit, vegetable, and snack questionnaire. Skin carotenoid levels was measured as an estimate of long-term FV intake.

Participants in both FD treatment groups showed increased lunch time FV intake over the short term. Participation in the prize group appeared to mediate long term decreases in lunch time FV intake. A small to medium positive association was found between total FV intake and less healthy food intake (r ranging from .125 to .355, $p<0.01$), suggesting that increases in intake of one food are associated with increases in intake of the other foods.

This study showed that the FD program has promise in mediating drops in FV intake seen during the transition into middle school. The total diet portion of the study suggests that increasing FV intake does not directly impact intake of less healthy foods. The use of self-reported data for the total diet portion of the study makes it difficult to draw definitive conclusions. Future studies should use a more precise method to measure total diet.

INTRODUCTION

In spite of numerous health initiatives and national advertising campaigns promoting increased FV intake, American children are consuming far less than the recommended intake of FV (1). The trend becomes even more alarming as children enter adolescence. Cross-sectional and cohort studies have shown that diet quality decreases with age as children transition from late childhood to adolescence (2-5). A study of 2- to 18-y-olds using the 1999-2002 NHANES data found that 12- to 18-y-olds were the least likely age group to meet the recommended intake of FV (2).

The health benefits of diets high in FV in preventing chronic diseases such as cardiovascular disease, hypertension, diabetes, and some types of cancer are well established (6, 7). There is also evidence that fruit and vegetable consumption may protect against obesity (8-10). In the US, 1 in 3 children between the ages of 2 to 18 are overweight and 16.9% are considered obese (11) and approximately 70% of those obese children will go on to become obese adults (6). A population sample of 5- to 17-y-olds found that 70% of obese children already have at least 1 risk factor for cardiovascular disease (12).

In addition to decreased intake of FV during adolescence, data from cross sectional and cohort studies shows an increase in consumption of energy dense foods and beverages during this same time period (2-5). The low energy density and high fiber content of most FV are believed to decrease hunger, increase satiety, and decrease overall caloric intake and are cited as potential mechanisms for their protective effect against overweight and obesity (13) and may also help improve overall total diet quality. Studies on the effect of increasing FV intake on overall diet quality have had mixed results (14, 15). Looney et al. found that increasing intake of healthy foods, including FV, did not have a significant impact on the intake of less healthy foods (15). Regardless of the overall impact on total diet, it is clear that increasing FV intake is an important target for improving adolescent health.

FV intake during childhood has been found to carry over into adolescence (16), so programs targeting childhood FV intake before the transition into adolescence and middle school may be one way to improve adolescent nutrition. With more than 32 million American children participating in the National School Lunch Program (NSLP) (17), school based nutrition interventions have been targeted as a cost effective way to increase child FV consumption. Many of these school-based intervention studies have reported modest levels of statistical success; however, few have produced clinically significant increases in FV consumption. In a review of 21 school-based intervention studies aimed at increasing FV intake, the average increase in total daily FV intake was only .25 portions (1/8 cup) (18). The FD program, however, is one intervention that has had consistent and clinically significant results in increasing FV intake in elementary school age children both in the U.S. and abroad (19-21).

The FD program has been implemented with great success in many primary schools throughout the UK and Ireland and in 2006 the program received a World Health Organization Best Practice Award (22). The program uses a combination of repeat tasting, role modeling, and rewards to increase FV intake in elementary school age children. Children participating in the intervention had a clinically significant increase in FV intake during the intervention and maintained higher levels of FV intake upon follow-up than those in the control group. In a 2004 study, which included three primary schools in England and Wales, the estimated increase in total daily FV intake was 2.54 portions for 4- to 7-y-olds and 2.18 portions for 7- to 11-y-olds immediately following the intervention (20).

A research team from USU conducted a single school pilot study of the FD program adapted to the schedule of US schools (21). The key difference from the UK program was that repeated tasting of researcher provided FV took place during lunchtime rather than during snack time since a morning snack is not part of the typical US elementary school schedule. The US pilot study found results similar to the original UK study, showing that the greatest increase in FV consumption occurred in those students who showed the lowest baseline consumption (19, 21).

Past FD studies have not done a long-term follow-up to see if the increase in FV intake is maintained. The USU research team developed a 6-school group randomized control study to test the long term impact of the FD program. The 6-school study also tested the effectiveness of using praise compared to tangible prizes as a reward to encourage FV consumption. The full details of the six school study are pending publication. This paper focuses on participants who were in 4th and 5th grade at the beginning of the 6-school study and seeks to answer the following questions. Does participation in the FD program help to offset the decrease in FV intake and the increase in energy dense food commonly seen during the transition from 5th grade (elementary school) into 6th grade (middle school)? Is there a condition or grade specific difference in total lunch time FV intake at 1 y follow-up after completion of the FD program for 4th and 5th grade participants?

METHODS

Subjects

All 4th and 5th grade students attending 6 Cache County Utah elementary schools that were part of the FD study during the 2011-2012 school year were invited to participate in this study (n=874, 49.4% 4th graders). During the 2012-2013 school year for the follow-up portion of the study, all 4th graders were followed into 5th grade and a subgroup of the 5th graders was followed into the transition into 6th grade at 3 local middle schools. During the 2012-2013 follow-up portion of the study an additional 6th grade control group of students who had not previously participated in the FD study was recruited from PE classes at the three middle schools (n=154). Consent for participation in the photo analysis and food frequency portion of the study were obtained through passive consent, with a letter sent home to parents explaining the details of the study. A separate consent form was also sent home to obtain active consent for participation in the skin carotenoid scan portion of the study.

Overview of the Food Dudes Study

The study was a cluster randomized control study. Students in 1st through 5th grade were recruited from six Cache County School District elementary schools during the 2011-2012 school year. Each school was randomly assigned to one of three groups:

- FD with tangible incentives for consuming FV (Providence and Canyon Elementary)
- FD with social recognition as the only incentive (Sunrise and Park Elementary)
- Control (Birch Creek and Millville Elementary)

For the purposes of this papers, results will only be reported for 4th and 5th grade participants.

Basic Overview of Food Dudes 2011-2012: Intervention

<u>Baseline 1 (4 Days)</u>

During Baseline 1, all participants were served FV from the regularly scheduled school lunch menu. The research team insured that all participating schools served the same foods during the four days of Baseline 1 and again during Phase 2. Plate waste photo analysis (PWPA), skin carotenoid levels, and 4th and 5th grade fruit, vegetable, and snack questionnaires (FVSQ) were obtained for this phase.

<u>Baseline 2 (4 Days)</u>

Baseline 2 was identical to baseline one, except that all participants (including those who brought lunch from home) were served 60 mg portions of 1 of 4 fruits and 1 of

4 vegetables paid for and provided by the research team. The same FV were served during Phase 1. Only PWPA data was obtained for this phase.

Phase 1 (16 Days)

FD w/ Incentives

Each day before lunch participants in this group were read a letter from and/or shown a video of the FD. During lunch the same FV as were served during Baseline 2 were served to all participants (including those who brought lunch from home). Lunch room monitors observed FV consumption and children received hand stamps for consuming prescribed levels of both fruits and vegetables. After lunch, in the classroom teachers distributed FD prizes to students who had received hand stamps indicating they had consumed both fruits and vegetables.

FD w/ Praise

FD with praise was identical to FD with incentives, except that no tangible prizes were given for eating FV. Instead children received praise in the classroom for receiving hand stamps.

Control Schools

Students at control schools received the same researcher-provided FV, but did not receive any videos, letters, hand stamps, verbal praise, or prizes to encourage FV consumption.

PWPA, skin carotenoid levels, and 4th and 5th grade FVSQ were obtained for all conditions during this phase.

Phase 2 (remainder of academic year)

During phase 2 the number of days that children were required to have consumed full portions of FV before receiving a prize was increased. After three months conditions were returned to those of Baseline 1. PWPA, skin carotenoid levels, and 4th and 5th grade FVSQ were obtained during this phase.

Basic Overview of Food Dudes 2012-2013: Follow-Up

Phase 3 (3 Days)

Conditions were the same as during Baseline 1. This follow-up was completed during fall 2012. All former participants (including middle school students) had photos taken of lunch trays. New middle school recruits did not have photos taken. PWPA was obtained for all students except the middle school control group. Skin carotenoid levels and 4th and 5th grade FVSQ were obtained during this phase.

Phase 4 (3 Days)

This follow-up was completed during spring 2013 and the methods were identical to Follow-Up 1. PWPA was obtained for all students except the middle school control group. Skin carotenoid levels and 4th and 5th grade FVSQ were obtained during this phase.

Fruit, Vegetable, and Snack Questionnaire

All 4th and 5th and 6th grade participants were asked to complete three fruit, vegetable, and snack questionnaires (FVSQ) for each phase of the study they participated in (except Baseline 2). Elementary students were sent home with a food record for each of the days they would be filling out a questionnaire (generally 2 weekdays and a weekend day) and were asked to keep a record of everything they ate during that day. The next school day, after keeping the food record, the FVSQs were completed in class. During Baseline 1 the FVSQ was administered by trained FD researchers. All other times the FVSQ was administered by teachers who had been given instructions on how to administer the questionnaire. Sixth graders completed the same FVSQs as the elementary school children. They were completed during PE class or prep period under the supervision of trained FD researchers. Previous research by another USU graduate student found no significant difference between FVSQs filled out using a food record and those filled out only from memory (23), so 6th graders did not use food records to track what they ate. Providence Elementary refused to participate in the FVSQ portion of the follow-up (P3 and P4). FVSQ data from Millville Elementary during P3 were lost and teachers sent the FVSQ home with the students rather than having them complete it in class for P4, so Millville was also excluded from the FVSQ analysis during P3 and P4.

The FVSQ used was developed by USU master's student Anne Lambert who adapted it from the Snack and Beverage Questionnaire (SNQ) of the Hutchinson Cancer Institute (23). The FVSQ included a beverage section with seven questions; a snack foods section with ten questions; a FV section with 3 questions for fruits and 8 questions for vegetables; and 2 questions specifically about lunch time FV consumption. Portion size was measured in handfuls for solid foods and in cups for beverages. A pilot version of the FVSQ was used during P1 at Sunrise and Providence and during P2 only at Sunrise. This version of the questionnaire asked about intake of each food at school and not at school, but was changed to asking about overall consumption of each food item and separate questions about school intake only for FV. Sunrise was excluded from FVSQ analyses for P1 and P2 and Providence was excluded for P1.

The measurement scale used for the beverage section of the questionnaire was modified slightly between the 2011-2012 portion of the study and the 2012-2013 follow-up, with the beverage measurement scale changing being changed from none, a few sips, 1 cup, 2 cups, 3 cups, 4+ cups to none, a few sips, ½ cup, 1 cup, 2 cups, 3+ cups (see supplemental pages for a copy of the questionnaire used during the 2012-2013 follow-up). The measurements for solid foods were converted from handfuls into cups for analysis, with one handful being considered equal to ½ cup as follows: none=0 cups, a few bites=.6 cups, 1 handful=1/2cup, 2 handfuls=1 cup, 3 handfuls=1.5 cups, and 4 or more handfuls=2 cups.

To measure energy dense food intake, responses for consumption of individual food items were categorized into sugar sweetened beverages, salty snacks, and sweet snacks. Sugar sweetened beverages included regular soda/energy drinks and fruit flavored drinks. Salty snacks included chips, French fries, popcorn, and pretzels/salty crackers. Sweet snacks included graham crackers, candy, chocolate, pastries, popsicles, and ice cream. The servings of each food item were totaled to give overall consumption levels for each category. If any food item from the category was skipped, that category was coded as missing for that day. Total fruit and total vegetable consumption were similarly calculated, with all individual questions about fruit added together to give total fruit and all individual questions about vegetables added together to give total vegetable. As with the snack categories, if any individual fruit or vegetable question was skipped, total fruit or total vegetable was coded as missing for that day.

Sugar sweetened beverage, salty snack, sweet snack, fruit, and vegetable intakes were averaged for each phase over the three days. Averages were only calculated if there were at least two valid, non-missing estimates for a category from the individual, otherwise the category was coded as missing for that phase. Average total fruit and average total vegetable intake were totaled to give average total FV intake for the phase. If either total fruit or total vegetable was missing for an individual, total FV was coded as missing for that phase. Self-reported lunch time fruit intake was averaged if it was reported for at least two days and was included only if the student also reported total fruit intake. The same method was used for lunch time vegetable intake, which was included only if the student also had reported total vegetable intake.

Photo Analysis

An objective measure of lunch time FV consumption was obtained by plate waste photo analysis (PWPA). Trained researchers took digital photos of participants' lunch trays before and after eating lunch. After photos were uploaded and another group of trained researchers then sorted the photos so before and after pairs were matched. Estimates of fruit, vegetable, and milk consumption were recorded independently by 2 different trained researchers who were blinded to each other's estimates. If the estimates matched within one piece or .13 cups of each other, the two estimates were averaged (if different). If the estimates of the two researchers did not match closely enough, a 3rd estimate was obtained by another trained researcher. If the new estimate matched either of the previous estimates within 1 piece or .13 cups, the 2 estimates were averaged. If the third estimate still did not match either of the first 2 estimates, a 4th researcher (a registered dietician) made the final decision about recording how much was consumed. Photo analysis was not completed for the 6th grade middle school control cohort.

Skin Carotenoid Scans

Skin carotenoid levels were measured for participants as an indicator of long-term FV consumption. Participants skin carotenoid levels were measured using the Pharmanex BioPhotonic Scanner, a non-invasive method of determining total carotenoid levels using resonance Raman spectroscopy (RRS) of the palm of the hand. Total carotenoid levels are known to be a biological marker of FV consumption (24). Mayne et al. conducted a validation study in adults of RRS measurement of carotenoid levels (25). The study found a significant correlation ($r=0.62$, $P=0.006$) between total carotenoid level in the skin measured by RRS and total carotenoid level in plasma. This study suggests that RRS is an effective indicator of long-term FV consumption in adults (25). A similar validation study of RRS in children conducted by USU researchers also found levels of skin and serum carotenoids to be highly correlated ($r=.62$, $P<.001$) (26). Skin carotenoid scans for this study were complete during PE class time. Height and weight were also measured at this time and were later used to calculate BMI and BMI percentile.

Statistical Analysis

Statistical analyses were done using IBM Statistical Product and Service Solutions (SPSS) version 18.0. PWPA data and FVSQ data was Winsorized to remove outliers by calculating z-scores and changing values more than three standard deviations from the mean to the highest value within three standard deviations of the mean. Scanner score data was checked for outliers and scores below 1,000 Raman counts were removed as errors, the remaining data was Winsorized to remove outliers using the same method as previously described.

The repeated measures function in SPSS was used to run mixed-design analysis of variance (ANOVA) for total FV intake from PWPA for the intervals B1 to P1, B1 to P2, B1 to P3, and B1 to P4 with condition (prize, praise, control) and grade as between subject factors. Mixed-design ANOVA was also run to compare scanner scores over the intervals B1 to P1, B1 to P2, B1 to P3, and B1 to P4. Statistical significance was determined as $P<0.05$ and partial η^2 was reported following Cohen's convention for interpreting effect size with .01=small, .06=medium, and .14=large (27). Cross sectional analysis was run at P3 and P4 on the FVSQ data for all 2012-2013 6th graders (both the 2011-2012 5th grade cohort and the new middle school control group) using one way ANOVA with condition (prize, praise, control, middle school control) as the between subject factor.

Associations between self-reported lunch time FV intake from FVSQ and lunch time FV intake from PWPA, associations between self-reported total FV intake and scanner score, and associations between lunch time FV intake from PWPA and scanner score were all examined using Spearman's rank order correlation at times B1 and P1-P4. Associations between sugar sweetened beverage intake, salty snack intake, sweet snack intake, and total FV intake from FVSQ were also examined using Spearman's rank order correlation at times B1 and P1-P4. Cohen's convention was used to assess the effect size of the correlations with 0.1=small, 0.3=medium, and 0.5=large (28).

RESULTS

Demographics

At baseline (data from B1) there were 874 participants with 49.4% 4th graders, 46.5% male (11.9% unknown), 10% overweight (46.1% unknown). Table 1 shows baseline demographics reported by condition group. Table 2 shows baseline demographics from the beginning of P3 for the 2012-2013 6th grade control cohort. BMI data was not available for the 6th grade control cohort.

Table 1 Demographics at Baseline 1 (2011-2012 School Year)

		Control (n=297)		Praise (n=241)		Prize (n=336)	
Variable		N	%	N	%	N	%
Grade							
	4	144	48.5%	114	47.3%	174	51.8%
	5	153	51.5%	127	52.7%	162	48.2%
Sex							
	M	141	47.5%	124	51.5%	141	42%
	F	118	39.7%	108	44.8%	138	41 %
	Unknown	38	12.8%	9	3.7%	57	17%
BMI							
	Overweight	31	10.4%	35	14.5%	21	6.3%
	Normal Weight	128	43.1%	144	59.8%	112	33.3%
	Unknown	138	46.5%	62	25.7%	203	60.4%

Table 2 Demographics at Phase 3 for Middle School Control Group (2012-2013 School Year)

	Middle School Control (n=154)	
Sex	N	%
M	77	50%
F	75	48.7%
Unknown	2	1.3%

Mixed-design ANOVA for PWPA

The repeated measures function in SPSS was used to run mixed-design ANOVA to compare differences in lunch time FV intake across time periods and condition (control, praise, prize) comparing between B1 to P1, B1 to P2, B1 to P3, and B1 to P4.

Baseline 1 to Phase 1

For B1 to P1 there was a significant time effect with a large effect size ($P<0.000$, partial $\eta^2=.197$) and there was a significant time by condition interaction with a medium effect size ($P<0.000$, partial $\eta^2 = .131$, see Figure 1). This suggests that the change in mean FV intake over time was associated with the intervention condition. One-way ANOVA run at B1 showed no differences in mean FV intake by condition ($P>.05$). One-way ANOVA run at P1 showed a significant difference between the mean FV intake by condition ($P<.05$) and Bonferoni post hoc comparison showed that the means for the control, praise, and prize groups were all significantly different from one another ($P<.05$). Figure 1 shows that the prize group had the greatest increase from baseline, with increases also seen for the praise group. Table 3 shows the observed mean FV intake by grade and condition.

Baseline 1 to Phase 2

For B1 to P2 there was a significant time effect with a medium effect size ($P<0.000$, partial $\eta^2= .065$) and there was a significant time by condition interaction with a small effect size ($P=.002$, partial $\eta^2= .016$, see Figure 2). This again suggests that the change in mean FV intake over time was associated with the intervention condition. One-way ANOVA run at B1 showed no significant differences in mean FV intake by condition (P>.05). One-way ANOVA run at P2 showed a significant difference in the mean FV intake by condition (P<.05). Bonferoni post hoc comparison showed a significant difference between the means for the control group and the prize group (P<.05). Table 4 shows the observed mean FV intake by grade and condition.

Baseline 1 to Phase 3

For B1 to P3 there was a significant time effect with a medium effect size (P<0.000, partial η^2= .137) and there was a significant time by grade interaction with a small effect size (P<0.000, partial η^2= .045, see Figure 3). One-way ANOVA run at B1 showed no significant differences in mean FV intake by grade (P>.05). One-way ANOVA run at P3 showed a significant difference in mean FV intake between 4^{th} and 5^{th} graders (P<.05). Table 5 shows the observed mean FV intake by grade and condition.

Baseline 1 to Phase 4

For B1 to P4 there was a significant time by condition interaction with a small effect size (P =.004, partial η^2= .047, see Figure 4) and there was a significant time by grade interaction with a small effect size (P = .042, partial η^2=.018, see Figure 5). One-way ANOVA run at B1 and P4 showed no significant differences in mean FV intake by condition (P>.05). One-way ANOVA run at B1 showed no significant differences in mean FV intake by grade (P>.05). One-way ANOVA run at P4 showed a significant difference in mean FV intake between 4^{th} and 5^{th} graders (P<.05). Table 6 shows the observed mean FV intake by grade and condition.

Table 3 Pairwise Comparison of Observed Mean Lunchtime FV Intake for Baseline 1 to Phase 1

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	.3907	.38101	132
		Phase 1	.4134	.29584	132
	5	Baseline 1	.4541	.39860	148
		Phase 1	.5215	.41051	148
	Total	Baseline 1	.4242	.39100	280
		Phase 1	.4705	.36443	280
Praise	4	Baseline 1	.4641	.37994	106
		Phase 1	.6139	.40377	106
	5	Baseline 1	.4405	.38639	113
		Phase 1	.5954	.39937	113
	Total	Baseline 1	.4519	.38258	219
		Phase 1	.6044	.40069	219
Prize	4	Baseline 1	.4212	.35613	171
		Phase 1	.7941	.35212	171
	5	Baseline 1	.4153	.37720	160
		Phase 1	.8154	.38157	160
	Total	Baseline 1	.4183	.36592	331
		Phase 1	.8044	.36625	331
Total	4	Baseline 1	.4225	.37066	409
		Phase 1	.6245	.38500	409
	5	Baseline 1	.4357	.38674	421
		Phase 1	.6531	.41674	421
	Total	Baseline 1	.4292	.37873	830
		Phase 1	.6390	.40142	830

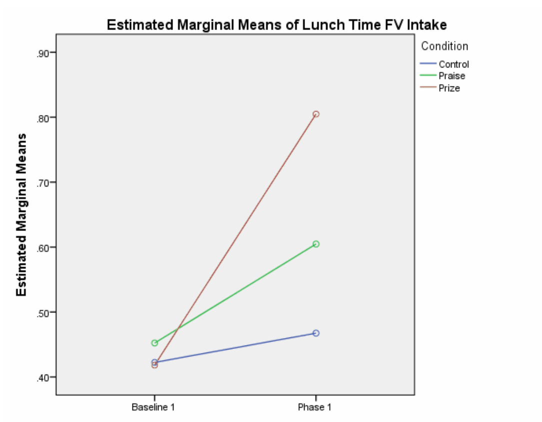

Figure 1 Time by Condition Interaction Plot B1 to P1

Table 4 Pairwise Comparison of Observed Mean Lunchtime FV Intake for Baseline 1 to Phase 2

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	.3809	.37692	140
		Phase 2	.2038	.30456	140
	5	Baseline 1	.4517	.39995	150
		Phase 2	.3293	.35548	150
	Total	Baseline 1	.4175	.38995	290
		Phase 2	.2687	.33721	290
Praise	4	Baseline 1	.4704	.37213	95
		Phase 2	.3556	.36980	95
	5	Baseline 1	.4685	.38130	98
		Phase 2	.3309	.33559	98
	Total	Baseline 1	.4694	.37584	193
		Phase 2	.3431	.35214	193
Prize	4	Baseline 1	.4223	.35044	155
		Phase 2	.4047	.35538	155
	5	Baseline 1	.4232	.38791	146
		Phase 2	.3618	.34918	146
	Total	Baseline 1	.4227	.36847	301
		Phase 2	.3839	.35245	301
Total	4	Baseline 1	.4191	.36609	390
		Phase 2	.3206	.35245	390
	5	Baseline 1	.4453	.39036	394
		Phase 2	.3417	.34775	394
	Total	Baseline 1	.4323	.37847	784
		Phase 2	.3312	.35003	784

Figure 2 Time by Condition Interaction Plot B1 to P2

Table 5 Pairwise Comparison of Observed Mean Lunchtime FV Intake for Baseline 1 to Phase 3

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	.3911	.37917	133
		Phase 3	.2689	.28012	133
	5	Baseline 1	.4579	.40769	118
		Phase3	.2181	.29795	118
	Total	Baseline 1	.4225	.39346	251
		Phase 3	.2450	.28917	251
Praise	4	Baseline 1	.4581	.36157	105
		Phase 3	.3063	.28658	105
	5	Baseline 1	.4301	.35780	93
		Phase 3	.1172	.23586	93
	Total	Baseline 1	.4449	.35916	198
		Phase 3	.2175	.27980	198
Incentives	4	Baseline 1	.4230	.35865	166
		Phase 3	.4446	.34755	166
	5	Baseline 1	.5230	.33224	28
		Phase 3	.2198	.33293	28
	Total	Baseline 1	.4374	.35589	194
		Phase 3	.4122	.35361	194
Total	4	Baseline 1	.4216	.36626	404
		Phase 3	.3508	.32048	404
	5	Baseline 1	.4547	.38015	239
		Phase 3	.1791	.28314	239
	Total	Baseline 1	.4339	.37153	643
		Phase 3	.2870	.31795	643

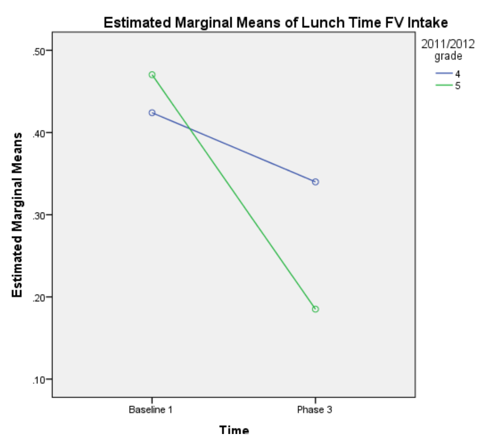

Figure 3 Time by Grade Interaction Plot B1 to P3

Table 6 Pairwise Comparison of Observed Mean Lunchtime FV Intake for Baseline 1 to Phase 4

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	.3798	.36639	65
		Phase 4	.3903	.32876	65
	5	Baseline 1	.4886	.41430	41
		Phase 4	.5000	.45580	41
	Total	Baseline 1	.4219	.38736	106
		Phase 4	.4327	.38458	106
Praise	4	Baseline 1	.5012	.31618	30
		Phase 4	.3055	.27984	30
	5	Baseline 1	.6010	.47800	20
		Phase 4	.4648	.41515	20
	Total	Baseline 1	.5411	.38756	50
		Phase 4	.3692	.34553	50
Incentives	4	Baseline 1	.4380	.31909	75
		Phase 4	.4079	.34339	75
	5	Baseline 1	.4217	.39902	7
		Phase 4	.7789	.35778	7
	Total	Baseline 1	.4366	.32378	82
		Phase 4	.4395	.35790	82
Total	4	Baseline1	.4269	.33832	170
		Phase 4	.3831	.32766	170
	5	Baseline 1	.5148	.43020	68
		Phase 4	.5184	.43878	68
	Total	Baseline 1	.4520	.36813	238
		Phase 4	.4217	.36706	238

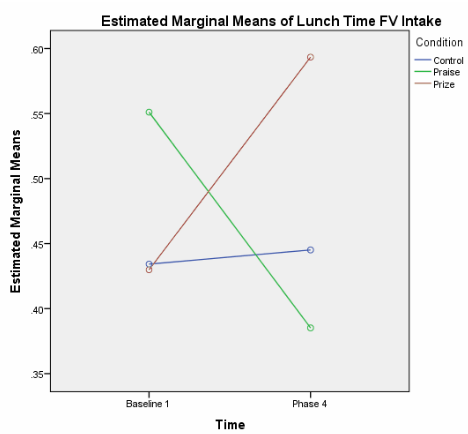

Figure 4 Time by Condition Interaction Plot B1 to P4

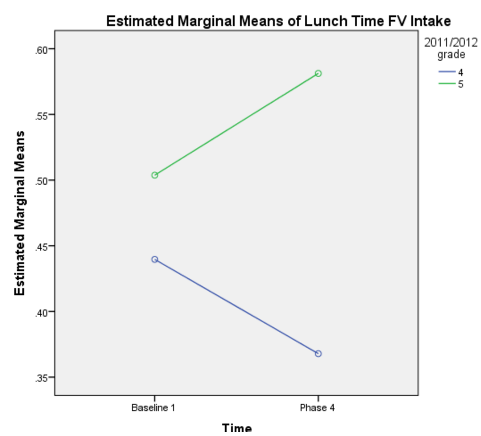

Figure 5 Time by Grade Interaction Plot B1 to P4

Repeated Measures for Scanner Scores

Baseline 1 to Phase 1

For B1 to P1 there was a significant time effect with a medium effect size ($P<0.000$, partial $\eta^2 = .108$) and there was a significant time by condition interaction with a small effect size ($P=.008$, partial $\eta^2 = .021$, see Figure 6). One-way ANOVA run at B1 showed a significant difference in mean scanner score between control and praise condition and between prize and praise condition ($P<.05$). One-way ANOVA run at P1 showed no significant difference mean in scanner score by conditions ($P>.05$). Table 7 shows the observed mean scanner score by grade and condition.

Baseline 1 to Phase 2

For B1 to P2 there was a significant time by condition interaction with a medium effect size ($P<0.000$, partial $\eta^2 = .093$, see Figure 7). One-way ANOVA run at B1 showed a significant difference in mean scanner score between control and praise condition and between prize and praise condition ($P<.05$). One-way ANOVA run at P2 showed a significant difference in mean scanner score between praise and prize conditions ($P<.05$). Table 8 shows the observed mean scanner score by grade and condition.

Baseline 1 to Phase 3

For B1 to P3 there was a significant time by condition interaction with a small effect size ($P=.028$, partial $\eta^2 = .026$, see Figure 13) and there was a significant time by grade interaction with a small effect size ($P=.001$, partial $\eta^2 = .038$, see Figure 14). One-way ANOVA run at B1 showed a significant difference in mean scanner score between control and praise condition and between prize and praise condition ($P<.05$). One-way

ANOVA run at P3 showed a significant difference in mean scanner score between praise and prize conditions ($P<.05$). One-ANOVA run at B1 and P3 showed no significant difference in mean scanner score by grade. Table 9 shows the observed mean scanner score by grade and condition.

Baseline 1 to Phase 4

For B1 to P4 there was a significant time by condition interaction with a small effect size ($P = .001$, partial $\eta^2 = .051$, see Figure10). One-way ANOVA run at B1 showed a significant difference in mean scanner score between praise and control conditions ($P<.05$). One-way ANOVA run at P4 showed no significant difference in mean scanner score by condition ($P>.05$). Table 10 shows the observed mean scanner score by grade and condition.

FVSQ P3 and P4 ANOVA

One-way ANOVA was run to test differences in sugar-sweetened beverage, salty snack, sweet snack, total fruit, total vegetable, total FV, lunch fruit, and lunch vegetable intake between 6th graders in the control, praise, prize, and middle school control groups. Descriptive statistics with the number of participants and the mean and standard deviation by group are listed in Table 11. Significant differences between the means were found for total fruit, total vegetable, and total FV at P3 and only for total fruit at P4 ($P<0.05$). Bonferoni post hoc analysis found a significant difference between the middle school control and praise group for total fruit at P3 ($P<0.05$), a significant difference for total vegetable between the middle school control and control group ($P<0.05$) and between the middle school control and praise group ($P<0.05$) at P3, a significant difference for total FV between the middle school control group and the praise group at P3 ($P<0.05$), and a

Table 7 Pairwise Comparison of Observed Mean Scanner Scores for Baseline 1 to Phase 1

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	22912.0350	8361.35917	60
		Phase 1	24707.8333	7428.40514	60
	5	Baseline 1	24559.6538	7898.09878	78
		Phase 1	25735.5885	8736.66847	78
	Total	Baseline 1	23843.2978	8114.21503	138
		Phase 1	25288.7384	8180.83688	138
Praise	4	Baseline 1	20507.0183	9595.26560	71
		Phase 1	23838.2676	8109.38705	71
	5	Baseline 1	19632.0298	8970.31141	84
		Phase 1	23038.4595	8343.04102	84
	Total	Baseline 1	20032.8310	9241.70932	155
		Phase 1	23404.8232	8219.90398	155
Incentives	4	Baseline 1	23382.3011	7985.72147	90
		Phase 1	25258.5044	7914.75809	90
	5	Baseline 1	21724.1822	6773.41503	73
		Phase 1	22801.6260	8619.60079	73
	Total	Baseline 1	22639.7080	7490.65347	163
		Phase 1	24158.1847	8302.90190	163
Total	4	Baseline 1	22330.8937	8686.79485	221
		Phase 1	24652.7258	7837.73241	221
	5	Baseline 1	21917.4843	8209.66762	235
		Phase 1	23860.1072	8627.36780	235
	Total	Baseline 1	22117.8428	8437.49305	456
		Phase 1	24244.2491	8254.61953	456

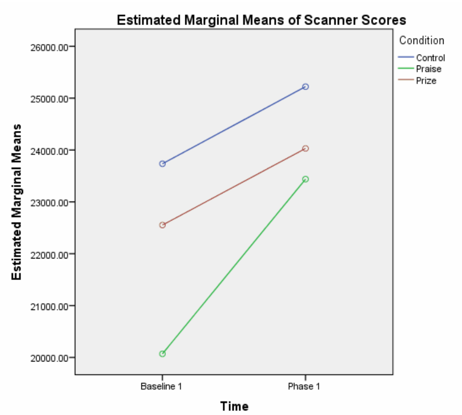

Figure 6 Time by Condition Interaction Plot B1 to P1

Table 8 Pairwise Comparison of Observed Mean Scanner Scores for Baseline 1 to Phase 2

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	22340.4576	7759.33771	59
		Phase 2	21723.3237	7551.07763	59
	5	Baseline 1	25103.7530	8173.03142	83
		Phase 2	23868.2386	9764.34805	83
	Total	Baseline 1	23955.6232	8092.03468	142
		Phase 2	22977.0415	8945.79074	142
Praise	4	Baseline 1	20117.9274	9530.03965	62
		Phase 2	24395.3823	8521.12488	62
	5	Baseline 1	19654.0048	8833.99670	83
		Phase 2	23451.4675	9116.74780	83
	Total	Baseline 1	19852.3717	9108.52700	145
		Phase 2	23855.0724	8849.13741	145
Incentives	4	Baseline 1	23976.0551	7308.81924	89
		Phase 2	22723.7472	7207.06689	89
	5	Baseline 1	21102.3813	6844.83196	64
		Phase 2	19718.4641	7848.82661	64
	Total	Baseline 1	22773.9954	7236.58086	153
		Phase 2	21466.6353	7603.74584	153
Total	4	Baseline 1	22377.4638	8265.06585	210
		Phase 2	22936.2062	7742.86939	210
	5	Baseline 1	22023.6796	8394.26292	230
		Phase 2	22563.1187	9165.94901	230
	Total	Baseline 1	22192.5311	8325.24769	440
		Phase 2	22741.1832	8508.95301	440

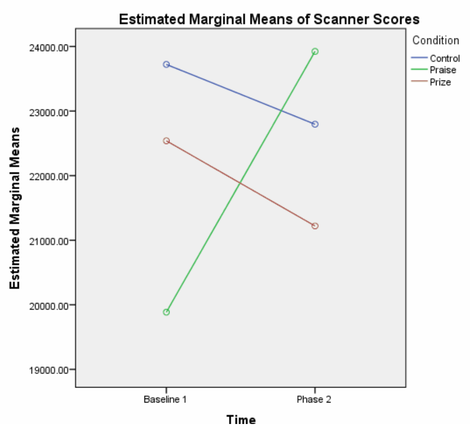

Figure 7 Time by Condition Interaction Plot B1 to P2

Table 9 Pairwise comparison of observed mean scanner scores for Baseline 1 to Phase 3

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	22644.1183	8257.88042	60
		Phase 3	21457.2633	7197.15979	60
	5	Baseline 1	24812.1689	8229.98330	61
		Phase 3	24563.3180	8115.89082	61
	Total	Baseline 1	23737.1025	8281.25340	121
		Phase 3	23023.1256	7799.58743	121
Praise	4	Baseline 1	22809.3174	11513.17842	23
		Phase 3	21425.5087	8535.02454	23
	5	Baseline 1	17476.1732	7565.33070	41
		Phase 3	20316.0854	6846.02257	41
	Total	Baseline 1	19392.7719	9448.79486	64
		Phase 3	20714.7844	7448.74820	64
Incentives	4	Baseline 1	23538.6278	7472.93985	72
		Phase 3	23811.3875	8050.43580	72
	5	Baseline 1	22330.4750	6278.12775	24
		Phase 3	25362.3958	7559.01510	24
	Total	Baseline 1	23236.5896	7180.23512	96
		Phase 3	24199.1396	7919.97293	96
Total	4	Baseline 1	23084.1458	8425.66592	155
		Phase 3	22546.0800	7844.07024	155
	5	Baseline 1	21952.3556	8286.70042	126
		Phase 3	23333.4873	7851.27883	126
	Total	Baseline 1	22576.6527	8367.76298	281
		Phase 3	22899.1523	7843.09243	281

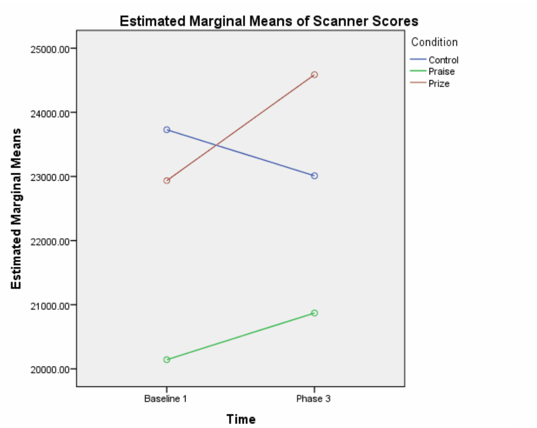

Figure 8 Time by Condition Interaction Plot B1 to P3

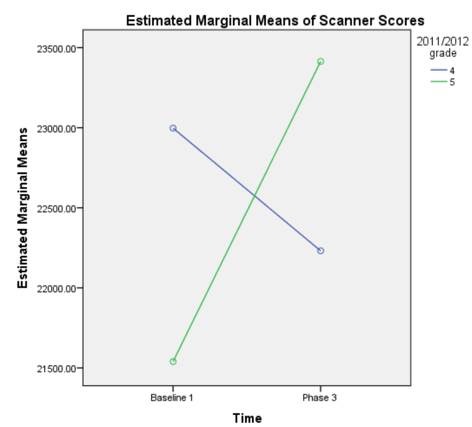

Figure 9 Time by Grade Interaction Plot B1 to P3

Table 10 Pairwise comparison of observed mean scanner scores for Baseline 1 to Phase 4

Condition	2011/2012 grade	Phase	Mean	Std. Deviation	N
Control	4	Baseline 1	22243.3581	7053.89677	43
		Phase 4	19341.1628	6042.09762	43
	5	Baseline 1	25669.0262	7760.88965	65
		Phase 4	25490.0154	8249.81732	65
	Total	Baseline 1	24305.1028	7641.69948	108
		Phase 4	23041.8611	8011.42047	108
Praise	4	Baseline 1	20834.3491	9225.86060	57
		Phase 4	22767.3860	8872.96695	57
	5	Baseline 1	18153.0444	7739.25147	36
		Phase 4	21443.5000	8116.44367	36
	Total	Baseline 1	19796.4247	8736.17865	93
		Phase 4	22254.9140	8567.63964	93
Incentives	4	Baseline 1	22198.9500	6606.85146	40
		Phase 4	23490.6750	6963.10046	40
	5	Baseline 1	22377.1000	6920.33096	15
		Phase 4	23620.4000	9656.57024	15
	Total	Baseline 1	22247.5364	6629.32447	55
		Phase 4	23526.0545	7693.88938	55
Total	4	Baseline 1	21657.0021	7876.66345	140
		Phase 4	21921.7000	7708.08657	140
	5	Baseline 1	22910.8000	8306.79615	116
		Phase 4	23992.4397	8520.42569	116
	Total	Baseline 1	22225.1293	8082.62902	256
		Phase 4	22860.0039	8135.94712	256

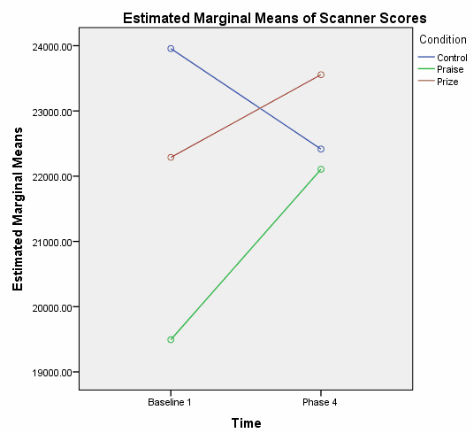

Figure 10 Time by Condition Interaction Plot for B1 to P4

significant difference for total fruit between the prize group and the control group at P4 (P<0.05).

The large standard deviations compared to the means seen in the demographic table demonstrate the inherent issue of variability with the FVSQ self-reported data. Also, the data was positively skewed, but it was determined that one-way ANOVA was still an appropriate measure due to the robustness of the test and the large sample size available.

Correlation Between Self-Reported and PWPA Lunchtime FV Intake

Associations between self-reported lunch time FV intake from the FVSQ and lunch time FV intake from the PWPA were examined using Spearman's rank order correlation. The test was run at B1 and P1-P4. Lunch time fruit intake had a significant medium positive correlation at all times measured (range of r across assessment periods = .313 to .411, P<0.01, see Table 12). Lunch time vegetable intake had a significant small to medium positive correlation across all times measured (range of r across assessment periods = .286 to .380, P<0.01, see Table 12).

Correlation Between Scanner Score and Self-Reported Total FV Intake

Spearman's rank order correlations were also done to compare scanner score and self-reported total FV intake for time B1 and P1-P4. A significant, small to medium positive correlation was found at all times measured (range of r across assessment periods = .154 to .330 P<0.01, see Table 13).

Correlation Between Scanner Score and Lunchtime FV Intake

Spearman's rank order correlations were also done to compare scanner score and lunch time FV intake from PWPA for time B1 and P1-P4. A significant, small to medium

Table 11 Observed Means from One-Way ANOVA of FVSQ Data P3 and P4 (Comparison of 2012-2013 6th Graders Only)

		P3			P4		
		N	Mean	Std Deviation	N	Mean	Std Deviation
Sugar Sweetened Beverage	Control	94	.5632	.79112	83	.6870	.77572
	Praise	73	.5735	.75033	74	.8573	.99971
	Prize	42	.3840	.70139	27	.4990	.69494
	Middle School Control	137	.6297	.85052	97	.6679	.85957
Salty Snacks	Control	93	.5729	.70213	81	.5288	.64487
	Praise	73	.5792	.59852	72	.5956	.68915
	Prize	42	.4920	.46331	27	.5117	.59706
	Middle School Control	135	.6419	.55184	95	.6321	.57269
Sweets	Control	93	.7524	.86882	80	.6378	.66922
	Praise	70	.6894	.85235	73	.7608	.86801
	Prize	43	.4931	.52285	27	.6948	.83193
	Middle School Control	135	.5868	.58288	94	.7003	.70759
Fruit	Control	91	.4174	.55557	80	.4043[e]	.57319
	Praise	71	.2617[a]	.40313	73	.3299	.50168
	Prize	42	.5185	.59552	27	.7573[e]	.78390
	Middle School Control	134	.4797[a]	.53175	91	.4867	.56124
Vegetable	Control	93	.7470[b]	.89845	82	.6890	.71910
	Praise	74	.7413[c]	.79330	73	.7473	.96038
	Prize	43	1.0099	1.23273	26	1.1112	1.14759
	Middle School Control	135	1.1487[b,c]	1.03083	96	1.0012	.91747
Total FV	Control	90	1.2008	1.30646	80	1.1153	1.11935
	Praise	71	1.0190[d]	1.03559	72	1.0871	1.29500
	Prize	42	1.5748	1.71899	26	1.8538	1.67744
	Middle School Control	134	1.6270[d]	1.30970	89	1.4794	1.29115
Lunch Fruit	Control	91	.4181	.41742	80	.3675	.35950
	Praise	71	.3097	.42212	73	.3776	.37962
	Prize	42	.3856	.41394	27	.5074	.39569
	Middle School Control	134	.3845	.36928	91	.5003	.38150
Lunch Vegetable	Control	91	.2511	.32544	82	.2332	.30833
	Praise	74	.2186	.31262	73	.2574	.35871
	Prize	43	.2784	.33420	26	.2865	.32308
	Middle School Control	134	.2814	.33395	96	.3505	.37113

a. Significant difference between means for middle school control and praise ($p<0.05$)
b. Significant difference between means for middle school control and control ($p<0.05$)
c. Significant difference between means for middle school control and praise ($p<0.05$)
d. Significant difference between means for middle school control and praise ($p<0.05$)
e. Significant difference between means for prize and control ($p<0.05$)

Table 12 Correlations Between FVSQ and PWPA Lunchtime FV Intake.

	Spearman's Rho	P	n
Fruit B1	.377	<0.000	460
Vegetable B1	.371	<0.000	467
Fruit P1	.374	<0.000	500
Vegetable P1	.383	<0.000	504
Fruit P2	.393	<0.000	501
Vegetable P2	.364	<0.000	498
Fruit P3	.303	<0.000	370
Vegetable P3	.290	<0.000	377
Fruit P4	.434	<0.000	198
Vegetable P4	.319	<0.000	211

Table 13 Correlation Between Scanner Score and Total Self-Reported FV Intake

Phase	Scanner Score[1] Mean ± SD	Total FV (FVSQ)[2] Mean ± SD	Spearman's Rho	P	n
Baseline 1	22022 ± 8503	1.46 ± 1.65	.154*	0.003	382
Phase 1	24093 ± 8445	1.26 ± 1.48	.227*	<0.000	361
Phase 2	22833 ± 8684	1.18 ± 1.55	.185*	0.001	294
Phase 3	22860 ± 8087	1.33 ± 1.57	.330*	<0.000	385
Phase 4	22381 ± 7775	1.24 ± 1.37	.234*	<0.000	266

* significant at p<0.05
1. Scanner scores are measured in Raman counts
2. Total FV consumption is measured in cups

Table 14 Correlation Between Scanner Score and Total Lunchtime FV Intake (PWPA)

Phase	Scanner Score[1] Mean ± SD	Total Lunch FV (PWPA)[2] Mean ± SD	Spearman's Rho	P	n
Baseline 1	22022 ± 8503	.4259 ± .40112	.151*	0.001	517
Phase 1	24093 ± 8445	.6435 ± .41525	.191*	<0.000	492
Phase 2	22833 ± 8684	.3306 ± .36920	.137*	0.004	439
Phase 3	22860 ± 8087	.2810 ± .32571	.219*	<0.000	338
Phase 4	22381 ± 7775	.4256 ± .37521	.313*	0.001	109

* significant at p<0.05
1. Scanner scores are measured in Raman counts
2. Total FV consumption is measured in cups

positive correlation was found at all times measured (range of r across assessment periods = .137 to .313 P<0.01, see Table 13).

FVSQ Correlations

Associations between sugar-sweetened beverage, salty snack, sweet snack, and total FV intake were assessed using Spearman's rank order correlation. At B1, P1, and P2 there was a small, but significant positive correlation between sugar-sweetened beverage intake and total FV intake (range of r across assessment periods = .145 to .181, P<0.01). At P3 and P4 no correlation was found between sugar-sweetened beverage intake and total FV intake. At all of the time points measured there was a weak, but significant positive correlation between salty snack intake and total FV intake (range of r across assessment periods = .125 - .324, P<0.01). At all of the time points measured there was also a significant small to medium positive correlation between sweet snack intake and total FV intake (range of r across assessment = .198 to .355, P<0.01). These correlations seem to suggest that an increase in FV intake may be associated with an increase in overall food intake.

There was a significant small to medium positive correlation between sugar-sweetened beverage intake and salty snack intake (range of r across assessment periods = .274 to .329, P<0.01). There was a significant small to medium positive correlation between sugar-sweetened beverage intake and sweet snack intake (range of r across assessment periods = .267 to .366, P<0.01). There was a significant medium positive correlation between salty snack intake and sweet snack intake (range of r across assessment periods = .328 to .424, P<0.01). These correlations suggest that for participants that consume any less healthy snack food there is a positive association with increased intake of other less healthy snack foods.

DISCUSSION

Consistent with other FD studies, total FV intake was found to increase immediate post intervention (19-21, 29) for participants in the prize intervention. The results of this study also suggest that participation in the prize version of the FD program may provide a positive impact on lunch time FV intake over the long term. Although there was an overall drop in lunch time FV intake from baseline at P2 and P3, the drop was less steep than for the praise or control groups. At P4 the overall mean lunch time FV intake was higher than baseline for prize participants, while it remained at or below baseline for praise and control participants.

It is interesting to note that a drop in total FV intake was seen for 5th graders at the beginning of the transition into 6th grade, but the overall mean total FV intake had increased above baseline again by the end of 6th grade. One possible explanation for this is that with the increased level of autonomy of food choice available in middle school the 6th graders developed the health promoting behavior of eating more fruits and vegetables. Although some researchers have associated increasing autonomy during adolescence with unhealthy eating behaviors (30, 31), other researchers have suggested that increased autonomy may lead to the development of greater self-control leading to health promoting behaviors (32, 33). Results for the 4th graders were also of interest as there was a drop from baseline at P2 and P4, but the drop was less profound for participants in the prize intervention of the FD program.

The results of the mixed-design ANOVA for the scanner scores gave a less clear picture. The mean baseline scanner scores were not the same between groups which makes interpretation of this test more difficult. The changes scanner scores do not follow the same pattern as the changes in lunch time FV intake. One possibility for this difference is that children who were consuming more FV at school may not have been consuming more FV at home. Lunch time FV intake was found to have only a small to medium positive correlation with scanner scores. Because the self-reported total FV intake also showed only a small to medium positive correlation with scanner scores, we cannot rely on that data to help give a clearer picture of total FV intake compared to lunch time FV intake.

The results of the total diet portion of the study are also not clear. The results of the Spearman correlation analyses run to compare the intake of energy dense snacks and beverages to the intake of FV showed a weak positive correlation between sugar-sweetened beverage, salty snack, and sweet snack intake and total FV intake. This seems to suggest that if children are eating more of one type of food they are likely increasing their overall intake of other foods as well. There have been few studies looking at the impact of increasing FV intake in children on the intake of less healthy, energy dense foods. A study by Looney and Raynor found no relationship between increasing FV intake and intake of unhealthy snack foods and drinks (15).

Comparison of self-reported lunch time FV intake with lunch time FV intake data from PWPA showed only a mild correlation, suggesting that the self-reported data is likely not an accurate way to assess actual FV intake. This was further confirmed by comparing self-reported total FV intake with skin carotenoid scan data, which also showed only a weak correlation between the two. There was no objective measure of energy dense food intake to be able to compare to, but given the poor quality of the self-reported data for FV intake, it is likely that the FVSQ is also an unreliable measure of actual energy dense food and beverage intake.

One way ANOVA done at P3 and P4 showed very little difference between 6th graders intake of sugar-sweetened beverages, salty snacks, sweets snacks, fruits, and vegetables, regardless of what intervention group they were part of. This may be because there was no actual difference, but also may have been due to the unreliable nature of self-reported diet data from children (34). The FVSQ does not seem to be an effective tool for comparing total diet between study participants.

It is of interest to note that mean intake levels reported during baseline 1 were higher for almost all categories than during subsequent measurements. This was found to be true even after excluding the schools that completed a different FVSQ at baseline. This is consistent with a review by McPherson et al. which found that when children complete FFQs for the first intake is generally reported as higher than on subsequent administrations of the same FFQ.

Aside from the limitations of the FVSQ that have already been addressed, this study had other limitations. One issue is the reliability of the scanner scores. Although a previous USU study has confirmed the validity of skin carotenoid scans in children (26), a difference in calibration between the Pharmanex biophotonic scanners used to obtain skin carotenoid levels was found. Subsequent studies that have used the scanners have been careful to scan the same child on the same scanner for each measurement so the scores can be adjusted for differences between the scanners, but the issue was discovered too far into this study to be able to implement that procedure. Another issue with the scanner scores is that there confounding factors that can influence the reliability of scanner scores including illness, radiation from the sun, and smoking or second hand smoke exposure (35).

Another concern was the decrease in participation as the study went on. Participation in the lunch time PWPA portion of the study was especially poor during P4 for 5th graders who had moved into 6th grade. For the P4 analysis there was only PWPA data for seven participants who were original 5th graders and part of the prize intervention group, compared to data for 160 from the same category for P1 analysis. Photo data for three of the elementary schools was also missing for phase 4 (one praise school, one prize school, and one control school) further decreasing the power of the phase 4 analysis.

IMPLICATIONS FOR FUTURE RESEARCH

Low FV consumption in children and adolescents remains a serious health concern (1, 2). The results of this study appear to suggest that the FD program may help to improve or at least stabilize intake of FV at school over the long term, but further research needs to be done to confirm these results. Future research also needs to be done to find a better method for accurately measuring changes in total FV consumption, since FVSQ data was found to be a poor indicator of actual total FV intake.

REFERENCES

1. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371-9.

2. Lorson BA, Melgar-Quinonez HR, Taylor CA. Correlates of fruit and vegetable intakes in US children. J Am Diet Assoc 2009;109:474-8.

3. Currie C, Robert, C., Morgan, A., Smith, R., Setterbulte, W., Samdal, O., Rasmussen, V. B. Young people's health in context. Health behaviour in school-aged children. Copenhagen: WHO, 2004.

4. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. Am J Health Promot 2000;14:222-8.

5. Perez A, Hoelscher DM, Brown HS, 3rd, Kelder SH. Differences in food consumption and meal patterns in Texas school children by grade. Prev Chronic Dis 2007;4:A23.

6. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJ. Health consequences of obesity. Arch Dis Child 2003;88:748-52.

7. Boeing H, Bechthold A, Bub A, Ellinger S, Haller D, Kroke A, Leschik-Bonnet E, Muller MJ, Oberritter H, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. Eur J Nutr 2012;51:637-63.

8. Matthews VL, Wien M, Sabate J. The risk of child and adolescent overweight is related to types of food consumed. Nutr J 2011;10.

9. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. Nutr Rev 2004;62:365-74.

10. Evidence Analysis: Fruit and Vegetable Intake and Childhood Overweight. 2014 http://andevidencelibrary.com/evidence.cfm?evidence_summary_id=25 (accessed 21 March 2014)

11. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. J Am Med Assoc 2010;303:242-9.

12. Freedman DS, Mei ZG, Srinivasan SR, Berenson GS, Dietz WH. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bogalusa Heart Study. J Pediatr 2007;150:12-7.

13. 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.

14. Epstein LH, Paluch RA, Beecher MD, Roemmich JN. Increasing healthy eating vs. reducing high energy-dense foods to treat pediatric obesity. Obesity (Silver Spring) 2008;16:318-26.

15. Looney SM, Raynor HA. Are changes in consumption of "healthy" foods related to changes in consumption of "unhealthy" foods during pediatric obesity treatment? Int J Environ Res Public Health 2012;9:1368-78.

16. Rasmussen M, Krolner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. Int J Behav Nutr Phys Act 2006;3:22.

17. National school lunch program: Participation and lunches served. Available from: http://www.fns.usda.gov/pd/slsummar.htm (accessed 2013)

18. Evans CE, Christian MS, Cleghorn CL, Greenwood DC, Cade JE. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. Am J Clin Nutr 2012;96:889-901.

19. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. Eur J Clin Nutr 2004;58:1649-60.

20. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. Eur J Clin Nutr 2004;58:510-22.

21. Wengreen HJ, Madden GJ, Aguilar SS, Smits RR, Jones BA. Incentivizing children's fruit and vegetable consumption: results of a United States pilot study of the Food Dudes Program. J Nutr Educ Behav 2013;45:54-9.

22. Lowe CFaH, P. J. 'Food Dudes': Increasing children's fruit and vegetable consumption. Cases in Public Health Communication & Marketing 2009;3:161-85.

23. Lambert A. A multiday record-assisted fruit, vegetable, and snack questionnaire to assess intake among fourth and fifth grade students. Unpublished master's thesis. Utah State University, Logan, Utah, 2013.

24. Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids. . In: Institute of Medicine NAoS, Food and Nutrition Board, Panel on Dietary

Antioxidants and Related Compounds, editor. Washington D.C.: National Academies Press, 2000.

25. Mayne ST, Cartmel B, Scarmo S, Lin HQ, Leffell DJ, Welch E, Ermakov I, Bhosale P, Bernstein PS, Gellermann W. Noninvasive assessment of dermal carotenoids as a biomarker of fruit and vegetable intake. Am J Clin Nutr 2010;92:794-800.

26. Aguilar SS, Wengreen HJ, Lefevre M, Madden GJ, Gast J. Skin carotenoids: a biomarker of fruit and vegetable intake in children. J Acad Nutr Diet 2014.

27. Richardson JTE. Eta squared and partial eta squared as measures of effect size in educational research. Educ Res Rev 2011;6:135-47.

28. Hemphill JF. Interpreting the magnitudes of correlation coefficients. Am Psychol 2003;58:78-9.

29. Horne PJ, Hardman CA, Lowe CF, Tapper K, Le Noury J, Madden P, Patel P, Doody M. Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention. Eur J Clin Nutr 2009;63:613-8.

30. Stevenson C, Doherty G, Barnett J, Muldoon OT, Trew K. Adolescents' views of food and eating: Identifying barriers to healthy eating. J Adolesc 2007;30:417-34.

31. Bassett R, Chapman GE, Beagan BL. Autonomy and control: The co-construction of adolescent food choice. Appetite 2008;50:325-32.

32. Spear HJ, Kulbok P. Autonomy and adolescence: A concept analysis. Public Health Nurs 2004;21:144-52.

33. Stok FM, De Ridder DTD, Adriaanse MA, De Wit JBF. Looking cool or attaining self-rule. Different motives for autonomy and their effects on unhealthy snack purchase. Appetite 2010;54:607-10.

34. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: Validity and reliability. Prev Med. 2000;31:S11-S33.

35. Lademann J, Meinke MC, Sterry W, Darvin ME. Carotenoids in human skin. Exp Dermatol 2011;20:377-82.

CHAPTER 4

SUMMARY AND CONCLUSION

SUMMARY

Americans are not consuming as many FV as they should be (1). The stats are even more alarming for adolescents. Results from both cross sectional and cohort studies have shown a significant decreases in FV intake occur during the transition from childhood into adolescence (2-5). Cross sectional data from the 1999-2002 NHANES study for children and adolescents age 2-18 showed adolescents ages 12-18 to be the least likely to meet recommendations for FV intake (5). Increased consumption of less healthy, energy dense foods over this same time period contributes to overall poor diet quality (2-5).

Increasing FV intake in adolescents is an important goal as diets rich in FV have been associated with decreased risk for many chronic diseases and obesity (6-9). Studies have also indicated that childhood FV intake carries over into adolescence (10), so targeting children before they transition into secondary school may be an important means of improving future adolescent nutrition. School based nutrition interventions have been targeted as a cost effective way of reaching large numbers of children, but although many of the studies have shown statistical significance, few have demonstrated clinical significance (11). The FD program uses repeated tasting, rewards, and modeling. Studies have shown the FD program to increase children's lunch time school FV intake at a clinically significant level (12-15), especially for those children who consumed little or no FV to begin with. Most of the research that was cited to justify the effectiveness of the program was done in pre-school or early elementary school age children, but a review of the literature on repeated tasting, rewards, and peer modeling supports the use of these elements to increase FV intake in older children as well.

The purpose of this study was to answer the question: Does participation in the Food Dudes program help to offset the decrease in FV intake and the increase in energy dense food commonly seen during the transition from 5th grade (elementary school) into 6th grade (middle school)? To answer this question, data from 4th and 5th grade students who were part of the larger six school FD intervention was analyzed from baseline through the transition into 5th and 6th grade, when an additional control group of 6th graders was recruited. Students' lunch time FV consumption was measured by plate waste photo analysis (PWPA). A fruit, vegetable, and snack questionnaire (FVSQ) was used to estimate total diet intake of fruits, vegetables, and less healthy snack foods. Skin carotenoid levels were also measured as an indicator of long-term FV intake.

The limitations of the study design made it difficult to fully answer the question posed. Results from the PWPA seem to show that the FD program may have long term effects, even over the transition into middle school. Although the 5th grade cohort initially saw a decrease from baseline FV consumption upon entering middle school (6th grade), data from the final follow-up done at the end of the school year suggests that overall FV intake returned to higher than baseline. The prize group appeared to have the greatest increase in FV intake, but the limited number of students from this group who had PWPA done for this phase made it difficult to accurately measure the change.

The study was also limited because the middle school control group did not participate in PWPA, so comparisons with the other groups was difficult. The FVSQ was not found to be a good indicator of actual lunch time FV intake or long term FV intake.

Comparisons on sugar sweetened beverage, salty snack, sweet snack, and total FV intake seemed to suggest that increased consumption of any one food was positively associated with an increased intake of all of the others. Since there was no way to test the validity of the questions about less healthy snack and beverage intake, it is difficult to make any definitive conclusions about the results found from that data. Future research investigating the influence increased FV intake on total diet in adolescents will need a better method for measuring actual food intake.

Another significant limitation to this study came from the skin carotenoid scanner scores. Skin carotenoids have been validated an indicator of long term FV intake in both adults and children (16), but there are other confounding factors that can influence skin carotenoid levels. Exposure to solar radiation, illness, and smoking (or exposure to second hand smoke) can all impact skin carotenoid levels (17). Furthermore, for this particular study there was an issue in differences in calibration between the scanners used to measure skin carotenoid levels. The issue with the scanners was not apparent until late in the study, so little could be done about it since students were measured with multiple scanner units over time.

CONCLUSION

Creating time and cost effective interventions that target increased FV intake in children and adolescents is an important goal that has the potential to decrease rates of obesity and chronic disease. This study demonstrated that the elements of the FD program, repeated tasting, rewards, and role modeling may be effective tools in reaching that goal among children transitioning from elementary to secondary schools. We found that although decreases in lunch time FV intake were seen following the initial transition into middle school, by the end of the school year FV intake levels exceeded baseline FV intake, with the greatest increase seen in the FD prize group.

Plate waste photo analysis was an effective way of measuring changes in FV at school, but it was a time consuming practice and gave no feedback about changes in total FV intake or overall diet quality. The FVSQ used for this study proved inaccurate at measuring school FV intake and thus likely total FV and other food intake. Future efforts need to target creating a cost effective, but more accurate way to study changes in total FV intake and overall diet quality.

REFERENCES

1. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371-9.
2. Currie C, Robert, C., Morgan, A., Smith, R., Setterbulte, W., Samdal, O., Rasmussen, V. B. Young people's health in context. Health behaviour in school-aged children. Copenhagen: WHO, 2004.
3. Perez A, Hoelscher DM, Brown HS, 3rd, Kelder SH. Differences in food consumption and meal patterns in Texas school children by grade. Prev Chronic Dis 2007;4:A23.
4. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. American Journal of Health Promotion 2000;14:222-8.
5. Lorson BA, Melgar-Quinonez HR, Taylor CA. Correlates of fruit and vegetable intakes in US children. J Am Diet Assoc 2009;109:474-8.

6. Boeing H, Bechthold A, Bub A, Ellinger S, Haller D, Kroke A, Leschik-Bonnet E, Muller MJ, Oberritter H, et al. Critical review: vegetables and fruit in the prevention of chronic diseases. Eur J Nutr 2012;51:637-63.

7. Newby PK. Plant foods and plant-based diets: protective against childhood obesity? Am J Clin Nutr 2009;89:1572S-87S.

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

9. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. Nutr Rev 2004;62:365-74.

10. Rasmussen M, Krolner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. Int J Behav Nutr Phys Act 2006;3:22.

11. Evans CE, Christian MS, Cleghorn CL, Greenwood DC, Cade JE. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. Am J Clin Nutr 2012;96:889-901.

12. Horne PJ, Tapper K, Lowe CF, Hardman CA, Jackson MC, Woolner J. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. Eur J Clin Nutr 2004;58:1649-60.

13. Horne PJ, Hardman CA, Lowe CF, Tapper K, Le Noury J, Madden P, Patel P, Doody M. Increasing parental provision and children's consumption of lunchbox

fruit and vegetables in Ireland: the Food Dudes intervention. Eur J Clin Nutr 2009;63:613-8.

14. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. Eur J Clin Nutr 2004;58:510-22.

15. Wengreen HJ, Madden GJ, Aguilar SS, Smits RR, Jones BA. Incentivizing children's fruit and vegetable consumption: results of a United States pilot study of the Food Dudes Program. J Nutr Educ Behav 2013;45:54-9.

16. Mayne ST, Cartmel B, Scarmo S, Lin HQ, Leffell DJ, Welch E, Ermakov I, Bhosale P, Bernstein PS, Gellermann W. Noninvasive assessment of dermal carotenoids as a biomarker of fruit and vegetable intake. Am J Clin Nutr 2010;92:794-800.

17. Lademann J, Meinke MC, Sterry W, Darvin ME. Carotenoids in human skin. Exp Dermatol 2011;20:377-82.

APPENDIX - FVSQ

What did you eat and drink yesterday?

ID#______________________

	Yes	No
Q1. Did you eat SCHOOL breakfast yesterday?	O	O
Q2. Did you eat SCHOOL lunch yesterday?	O	O
Q3. Did you fill out your Food Record yesterday?	O	O

	None	A few bites	1 Handful	2 Handfuls	3 Handfuls	4 or more Handfuls
Q4. How much fruit did you eat for **lunch** yesterday?	O	O	O	O	O	O
Q5. How much vegetable did you eat for **lunch** yesterday?	O	O	O	O	O	O

Fill in the circle of things you drank **yesterday**. This should include breakfast, lunch, dinner and snacks. Mark none if you did not drink the item. Please do not leave any question blank.

	None	A few sips	1/2 cup	1 cup	2 cups	3+ cups
Q6. 100% orange juice, apple juice or other 100% juice	O	O	O	O	O	O
Q7. Vegetable juice like V8, carrot, or tomato	O	O	O	O	O	O
Q8. Fruit flavored drinks and sports drinks like Capri Sun, Kool-Aid, Sunny Delight, Gatorade or PowerAde	O	O	O	O	O	O

	None	A few sips	1/2 cup	1 cups	2 cups	3+ cups
Q9. Regular soda pop (not diet) or energy drinks like Rockstar, Red Bull or Monster	○	○	○	○	○	○
Q10. Plain milk	○	○	○	○	○	○
Q11. Flavored milk (such as chocolate or strawberry)	○	○	○	○	○	○
Q12. Smoothie made with yogurt and fruit	○	○	○	○	○	○

Fill in the circle of the things you ate ***yesterday***. Count one handful as about the amount that would fit in the cup of your hand. Please include breakfast, lunch, dinner, and snacks. Mark none if you did not eat any of the items. Please do not leave any question blank.

	None	A few bites	1 Handful	2 Handfuls	3 Handfuls	4 or more Handfuls
Q13. Potato or tortilla chips either flavored or plain	○	○	○	○	○	○
Q14. French fries or tater tots	○	○	○	○	○	○
Q15. Popcorn	○	○	○	○	○	○
Q16. Pretzels or salty crackers including gold fish crackers, Ritz crackers	○	○	○	○	○	○

	None	A few bites	1 Handful	2 Handfuls	3 Handfuls	4 or more Handfuls
Q17. Graham crackers or animal crackers	○	○	○	○	○	○
Q18. Candy such as jelly beans, licorice, or gummy bears	○	○	○	○	○	○
Q19. Chocolate or chocolate candy bars	○	○	○	○	○	○
Q20. Cookies, brownies, pies, cake, doughnuts, or pop tarts	○	○	○	○	○	○
Q21. Popsicles, Slurpees, or shaved ice	○	○	○	○	○	○
Q22. Ice cream or milkshakes	○	○	○	○	○	○

Please fill in the circle of the fruits and vegetables that you ate *yesterday*. Count one handful as a medium sized piece of fruit or vegetable, or about the amount of canned or cooked vegetable that could fit in the cup of your hand. If you did not eat the item mark none.

Location	None	A few bites	1 Handful	2 Handfuls	3 Handfuls	4 or more Handfuls
Q23. Fresh or frozen fruit	○	○	○	○	○	○
Q24. Canned fruit like peaches, pears, applesauce, or pineapple	○	○	○	○	○	○

	None	A few bites	1 Handful	2 Handfuls	3 Handfuls	4 or more Handfuls
Q25. Dried fruit like raisins or Craisins	O	O	O	O	O	O
Q26. Baked, boiled or mashed potatoes	O	O	O	O	O	O
Q27. Green salad, spinach, kale or other dark green leafy vegetable	O	O	O	O	O	O
Q28. Spaghetti sauce, tomatoes or salsa	O	O	O	O	O	O
Q29. Yams, sweet potatoes or winter squash like butternut	O	O	O	O	O	O
Q30. Vegetable soup, or stew with vegetables	O	O	O	O	O	O
Q31. Carrots	O	O	O	O	O	O
Q32. Beans such as baked beans, garbonzo beans, kidney beans, or black beans	O	O	O	O	O	O
Q33. Any other vegetables, including string beans, peas, corn, broccoli, celery, or cauliflower	O	O	O	O	O	O