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THE EFFECTS OF NUTRITION EDUCATION ON THIRD AND FIFTH GRADE STUDENTS' FRUIT AND VEGETABLE KNOWLEDGE, PREFERENCE, AND CONSUMPTION

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THE EFFECTS OF NUTRITION EDUCATION ON THIRD AND FIFTH GRADE STUDENTS' FRUIT AND VEGETABLE KNOWLEDGE, PREFERENCE, AND CONSUMPTION

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by

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ABSTRACT

THE EFFECTS OF NUTRITION EDUCATION ON THIRD AND FIFTH GRADE STUDENTS' FRUIT AND VEGETABLE KNOWLEDGE, PREFERENCE, AND CONSUMPTION

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Regular consumption of fruit and vegetables (F/V) may reduce the risk of obesity and obesity-related diseases, yet most American school children fail to meet recommended intakes. One proposed method for reducing childhood obesity is implementing school-based nutrition education programs aimed at increasing F/V intake. This repeated measures study examined the effectiveness of an eight-week F/V-targeted nutrition education intervention on elementary-school students' nutrition knowledge, F/V preference, and salad bar consumption. A convenience sample of third- and fifth-grade students (n = 149) participated in the study. Surveys were administered pre- and post-intervention to assess F/V knowledge and preference. Pre- and post-plate waste analyses determined F/V consumption as well as total plate consumption. Results showed very few significant differences in pre- and post-nutrition knowledge and F/V preference. There were slight differences in overall nutrition knowledge and F/V preference between grades, with fifth-graders generally possessing a better understanding around the benefits of consuming F/V and a greater preference for F/V. There was no significant difference in F/V consumption; however, both grades consumed significantly more of their total

plate after the intervention. The data suggests that a more multicomponent approach with a longer duration is needed to effectively increase elementary-aged students F/V consumption.

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CHAPTER I

INTRODUCTION

The prevalence of overweight and obese children in the United States is at epidemic proportions. Research shows that overweight and obese children are more likely to become overweight and obese adults, with an increased risk of developing obesity-related chronic diseases such as hypertension, Type 2 Diabetes, atherosclerosis, metabolic syndrome, and select cancers (Freedman, 2001; Simmonds, Llewellyn, Owen, & Woolacott, 2016). As a result, it is a public health priority to identify strategies that are effective in lowering the risk of obesity and its subsequent co-morbid conditions in youth. One high-impact, low-cost solution may be nutrition education aimed at increasing fruit and vegetable (F/V) intake among elementary-aged students. Regular consumption of F/V has been shown to reduce the risk of obesity and obesity-related chronic diseases, yet the vast majority of American youth are not meeting the United States Department of Agriculture's (USDA) recommended guidelines for daily F/V intake (Adams, Bruening, & Ohri-Vachaspati, 2015; Bazzano et al., 2002; He et al., 2004; Vernarelli, Mitchell, Hartman, & Rolls, 2011; Wootan, 2012).

Nutrition interventions beginning at the elementary school level provide an ideal environment for setting standards, establishing nutrition curricula, and forming healthy behaviors that may last a lifetime. Previous studies show that interventions that incorporate a combination of methods such as nutrition education, parental involvement, and physical activity, seem to be the most effective in changing children's eating habits (Aloia, Shockey, Nahar, & Knight, 2016). However, comprehensive obesity prevention programs can be expensive and difficult to implement (Graziose, Koch, Claire Wang, Lee

Gray, & Contento, 2016). As a result, there is a need to find cost-effective, easily adaptable solutions. Increasing research shows that children are receptive to nutrition education and it can lead to improvements in their F/V consumption and nutrition knowledge (Anderson et al., 2005; Powers, Struempler, & Parmer, 2005; Upton, Upton, & Taylor, 2013). When the nutrition education is reinforced with other healthy lifestyle factors such as a exposure to a lunch-time salad bar (SB), the effectiveness of the intervention can be amplified (Flock, Nutrition, & Olympia, 2003).

CHAPTER II

LITERATURE REVIEW

Background

Between 1974 and 2012 the rates of childhood obesity tripled in the United States for boys and girls 2-19 years; as a result, reversing childhood obesity rates has become a major public health priority (Fryar, Carroll, & Ogden, 2014). Results from the 2013-2014 National Health and Nutrition Examination Survey (NHANES) report that approximately 33.4% of children are classified as overweight and 17.4% are classified as obese (Skinner, Perrin, & Skelton, 2016). The Centers for Disease Control and Prevention's (CDC) growth charts define overweight for children as $\geq 85^{th} < 95^{th}$ percentile and obesity as $\geq 95^{th}$ percentile for age- and sex-specific body mass index (BMI) (Kuczmarski et al., 2002). More recent studies, in New York City and Philadelphia, suggest that obesity among select childhood populations may be either decreasing or leveling off (Day, Konty, Leventer-Roberts, Nonas, & Harris, 2014; Ogden, Carroll, Kit, & Flegal, 2012; Robbins, Mallya, Polansky, & Schwarz, 2012). This is supported by NHANES data from 2011-2012 that shows the national rate of obesity in children 2-5 years declined significantly from a high of 13.9% in 2003-2004 to 8.4% in 2011-2012 (Fryar et al., 2014). However, the prevalence of severe obesity, defined as $\geq 99^{th}$ percentile for age- and sex-specific BMI, increased significantly from 0.9% to 2.4% between 1999-2000 and 2013-2014, respectively, among children of all ages, genders, and ethnicities ($p < 0.001$) (Skinner et al., 2016). This illustrates a continued need for effective interventions aimed at the prevention and reduction of the prevalence of overweight and obesity in children.

Health Implications of Obesity in Children

The immediate and long-term health implications of obesity among children vary from physiological disease states to psychological disorders to cognitive impairments (Erermis et al., 2004; Lo et al., 2014; Yau, Castro, Tagani, Tsui, & Convit, 2012). Childhood is a critical period for forming dietary and lifestyle habits that persist into adulthood (Ebbeling, Pawlak, & Ludwig, 2002); especially because research shows that obese children are five times more likely to remain obese as adults than non-obese children (Freedman, 2001; Simmonds et al., 2016). They are also at a greater risk for developing obesity-related chronic diseases which were once thought to be limited to adulthood, such as hypertension, atherosclerosis, Type 2 diabetes mellitus, metabolic syndrome (MetS), and select cancers (Berenson et al., 1998; Freedman, 2001; Hannon, 2005; Lo et al., 2014; Tamborlane et al., 2004). These risk factors have now been identified in children as young as five years old (Young-Hyman, 2001). Additionally, because these children are developing obesity-related diseases at younger ages, they are entering middle adulthood with more severe forms of disease which greatly reduces their quality of life as well as their lifespan (Baker, 2011; Franks, 2011; Hannon, 2005; Simmonds et al., 2016). In addition to the physical diseases that can develop as a result of obesity, overweight and obese children experience more psychological disorders, greater incidences of bullying and social shaming, more missed school-days, and lowered academic achievement (Janssen, Craig, Boyce, & Pickett, 2004; Pan, Sherry, Park, & Blanck, 2013; Yau et al., 2012).

Side-effects of childhood obesity include psychological disorders such as depression and aggressiveness, which can be exacerbated by ridicule or bullying from

peers (Sjoberg, 2005). A Turkish cohort examined the type and frequency of psychopathology among three groups of obese and normal weight male and female subjects between 12-16 years of age (Erermis et al., 2004). Participant groups (N = 90) included: 30 obese adolescents recruited from a pediatric endocrinology outpatient clinic (mean BMI: 29.2 ± 2.7 kg/m^2); a nonclinical group of 30 obese adolescents (mean BMI: 26.6 ± 1.2 kg/m^2); and a control group of 30 normal weight adolescents (mean BMI: 18.9 ± 2.4 kg/m^2). Among the participants, the clinically obese group demonstrated significantly higher test scores in aggressiveness ($P = 0.028$), anxiety-depression ($P = 0.002$), social problems ($P = 0.0001$), social withdrawal ($P = 0.0001$), internalizing and externalizing behaviors ($P = 0.0001$ and $P = 0.016$), and total problems, which represented all test scores combined ($P = 0.0001$) than non-clinically obese and normal weight adolescents. In addition, researchers found that the obese group had significantly lower self-esteem than the non-obese group ($P = 0.0073$). In both the clinically obese group and the non-clinically obese group, the frequency of diagnosis of mental disorders was significantly higher ($P = 0.002$ and $P = 0.0442$, respectively) than the normal weight group. The obese participants also demonstrated a greater prevalence for depressive disorders and the parents of the obese individuals identified more emotional and behavioral problems in their children as well (Erermis et al., 2004). This study indicates that as children's BMI rises, classifying them as obese, the more they experience psychological disorders such as depression, aggressiveness, and social withdrawal, which is often tied to peer shaming.

These findings are supported by Sjöberg et al. (2005) who found that obese Swedish adolescents experienced more instances of shaming and had more depressive

symptoms than their normal-weight peers. In Sjöberg's study, adolescent participants completed a population-based survey that assessed their psychosocial health. Survey questions covered BMI, parental employment, parental separation, depressive symptoms, and feelings of shame. The subjects included normal weight (N = 4,159; BMI: 18.5 – 24.9 kg/m^2), overweight (N = 645; BMI: 25 – 29.9 kg/m^2), and obese (N = 131; BMI ≥ 30 kg/m^2) male and female adolescents ages 15 and 17 years. The age- and gender-specific BMI cutoff points were developed by the Childhood Obesity Working Group of International Obesity Task Force, derived from cross-sectional growth-study surveys and the standard adult cutoff points. When stratified by BMI, researchers found that obese subjects provoked significantly more social degradation/bullying and ridicule from their peers ($P < 0.001$). Obese individuals were also at a significantly higher risk for experiencing depressive symptoms compared to the normal weight and overweight subjects ($P = 0.12$). These findings support previous research that adverse psychological feelings of bullying and depression are more prevalent among obese youth than their normal or even overweight peers (Erermis et al., 2004; Pearce, Boergers, & Prinstein, 2002).

Since bullying often leads to depression and anxiety, victims become less productive and successful in school as a result (Strøm, Thoresen, Wentzel-Larsen, & Dyb, 2013). A Norwegian cohort examined the effects of sexual abuse, bullying, and teacher support on academic achievement in school through cross-sectional health surveys that were distributed to over 7,000 15- to 16-year-old boys and girls. Researchers found that bullying was significantly associated with poorer academic achievement ($P < 0.01$) (Strøm et al., 2013). Conversely, teacher support and positive peer relationships

were linked to better grades. In addition to the negative emotional side effects that often arise as a consequence of overweight and obesity in youth, serious cognitive and physical complications are frequently identified as well.

Another recent study conducted at New York University (NYU) by Yau et al., explored whether MetS or obesity were associated with neurocognitive impairment in non-diabetic male and female adolescents (N = 111; mean age: 14-20 years) (Yau et al., 2012). MetS as defined by the National Cholesterol Education Program Third Adult Treatment Panel (NCEP ATP III) is the presence of three or more of the following five risk factors: high levels of circulating triglycerides (> 110 mg/dL); low high-density lipoprotein levels (< 50 mg/dL females, < 40 mg/dL males); elevated blood pressure ($\geq 90^{th}$ percentile for age); elevated fasting blood glucose (quantitative insulin sensitivity check index value of ≤0.350); and the presence of abdominal obesity ($\geq 90^{th}$ percentile for age and gender) (Yates, Sweat, Yau, Turchiano, & Convit, 2012). In the NYU study, 49 subjects (44.1%) were previously diagnosed with MetS and 62 without (55.9%). Post-prandial cognitive testing was completed approximately one hour after the last meal in all study participants over two 1.5 hour periods. The tests assessed intelligence, academic achievement, memory and learning, executive function, and attention. Researchers found that participants diagnosed with MetS demonstrated significantly lower academic achievements in spelling ($P = 0.02$), arithmetic ($P < 0.001$), measures of attention ($P < 0.01$), and mental flexibility ($P < 0.04$) compared to participants free of MetS. These findings indicate that obese adolescents with MetS are more likely to experience diminished academic success. A 2010 study in middle-aged adults showed that the presence of MetS was associated with diminished memory recall, lower overall

intellectual functioning, and reductions in learning ability and executive function (Hassenstab, Sweat, Bruehl, & Convit, 2010). This implies that MetS in addition to negatively affecting childhood academic performance could also inhibit adult work performance and job placement potential.

Other short- and long-term consequences of school bullying include increased truancy, suicidal thoughts, and lower wages in the job market in adulthood (Holt, Chee, Ng, & Bossler, 2013; Takizawa, Maughan, & Arseneault, 2014). These findings suggest that the negative side effects of childhood overweight and obesity are not limited to physical disease states; rather the implications are multifactorial, including neurocognitive impairments, anxiety, depression, and social ridicule. Effective strategies aimed at reducing childhood overweight and obesity not only benefit the individual but may also benefit society as a whole through lowered health care costs and improved worker productivity.

Economic Costs of Childhood Obesity

The treatment of obesity and obesity-related illnesses, both in childhood and adulthood, is an expensive undertaking in terms of health care costs (Cawley & Meyerhoefer, 2012; Trasande & Chatterjee, 2009). In a 2008 study, Finkelstein et al. found that the annual cost of obesity to the U.S. health care system was approximately $147 billion with over 40% of this being funded by taxpayers in the form of Medicaid and Medicare (Eric A. Finkelstein, Trogdon, Cohen, & Dietz, 2009). In a follow up study in 2012, researchers estimated that up to 64% of the current medical costs associated with obesity are funded by Medicare and Medicaid indicating increased costs by taxpayers (Trogdon, Finkelstein, Feagan, & Cohen, 2012). It should be noted that these figures do

not account for other indirect costs, such as productivity losses related to increased absenteeism and presenteeism (reduced on-on-the job productivity) in the workplace as a result of obese employees (John, Wolfenstetter & Wenig, 2012).

In a 2010 study, Finkelstein et al. showed that annual missed workdays spanned from 0.5 more days (95% CI: 0.4-0.6) for overweight men (25.0-29.9 BMI) to 5.9 more days (95% CI: 5.3-6.6) for grade III obese men (40+ BMI), compared to normal weight men (18.5-24.9 BMI) (Finkelstein, DiBonaventura, Burgess, & Hale, 2010). The value of work lost due to presenteeism was also significantly greater for obese men. Estimates ranged from 2.3 days (95% CI: 1.8-2.7) for grade I obese men (30-34.9 BMI) to 21.9 days (95% CI: 20.5-23.3) for grade III obese men. The total annual cost of absenteeism, presenteeism, and medical expenses in men, attributable to obesity, increased with each level of obesity, ranging from $322 in overweight men (95% CI: -$2517 to $1934) to $6087 in grade III obese men (95% CI: $4915-$7292). In women, days and dollars lost to presenteeism approximately doubled with each obesity grade from 6.3 (95% CI: 5.9-6.8) to 11 (95% CI: 10.7-12.1) to 22.7 days (95% CI: 21.8-23.7), respectively). The total annual cost of absenteeism, presenteeism, and medical expenses in women, attributable to overweight and obesity, also increased with each weight category, ranging from $797 in overweight women (95% CI: $347-$1260) to $6694 in grade III obese women (95% CI: $5746-$7669). Aggregated, this shows that the total cost of obesity in full-time U.S. workers is estimated at $73.1 billion. This estimate is expected to rise as overweight and obesity continues to increase among children and adolescents.

In terms of the cost of treating childhood obesity, a recent meta-analysis found that the medical costs accrued over the lifetime of an obese individual, starting at age ten,

are approximately $12,660 to $19,630 greater than those of a normal weight person (Finkelstein, Graham, & Malhotra, 2014). If these numbers are multiplied by the current number of obese ten-year-olds in the U.S., the estimated medical cost attributable to obesity, of this age group alone, ranges from $9.4 to $14 billion (Finkelstein et al., 2014). If the current trajectory remains the same it has been estimated that 40 - 51% of the U.S. population will be obese by the year 2030 (Finkelstein et al., 2012); signifying that the economic cost of obesity will continue to rise. This further illustrates the need for effective interventions that address the root-causes in the prevention and treatment of obesity to reverse this trajectory.

Contributing Causes of Childhood Obesity

Numerous lifestyle factors have been identified as contributing factors in the obesity epidemic. These include but are not limited to: decreases in physical activity; lack of access to health care; obesogenic community and environmental factors; overconsumption of energy-dense, highly-processed convenience foods; and a general shift away from home-cooked meals and family dinners (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Fiscella & Williams, 2004; Hernández et al., 1999; Trost, Kerr, Ward, & Pate, 2001; Veugelers & Fitzgerald, 2010). The typical American diet, characterized as being high in saturated fats and added sugars and low in whole grains and fruit and vegetables (F/V) is often implicated as a primary culprit.(Frazao & Allshouse, 2003)

Research consistently shows that regular consumption of F/V reduces the risk of obesity and obesity-related diseases (Adams et al., 2015; Bazzano et al., 2002; He et al., 2004; Vernarelli et al., 2011; Wootan, 2012). Although these benefits are highly

publicized, the message is not reaching American youth. A 2007 - 2010 report by the National Cancer Institute (NCI) showed that 60% and 93% of children between the ages of 1 - 18 years old did not meet the U.S. Department of Agriculture's fruit and vegetable consumption recommendations, respectively; which is defined as 1- 2 cups for fruit/day and 1- 2 ½ cups for vegetables/day depending on caloric needs (Kim et al., 2014; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2010). While obesity is clearly a complex disease, one high impact, cost-effective method of addressing it may be to encourage greater consumption of F/V among children through nutrition education programs aimed at improving knowledge and leading to behavioral change. Nutrition interventions at the elementary school level provide an ideal environment for setting standards and establishing nutrition curricula for children that may impact dietary behaviors that last a lifetime.

Background and History NSLP

The National School Lunch Program (NSLP) was established in 1946, by President Harry Truman and the 79th congress to "safeguard the health and well-being of the Nation's children and to encourage the domestic consumption of nutritious agricultural commodities and other food"(Gunderson, 1962). Funds were appropriated through the United States Department of Agriculture (USDA) to every state for food and equipment purchases and administrative expenses (Gunderson, 1962). Participating schools were required to, among other things, serve lunches that met national nutrition requirements, offer free and reduced meals to children who were unable to pay the full cost of lunch, and operate the program on a non-profit basis (Gunderson, 1962). Throughout the second half of the 21st century the NSLP evolved to meet changing

nutrient requirements and fill gaps in low-income children's daily food intake (Ralston, Newman, Clauson, Guthrie, & Buzby, 2008). One example of this was the addition of the School Breakfast Program (SBP) in 1975 (Ralston et al., 2008). Additionally, in 2010, the Healthy Hunger-Free Kids Act (HHFKA) was signed into law (Wootan, 2012). It introduced some of the most dramatic changes to the NSLP in over 30 years by calling for improved nutrition in all foods sold at schools, stronger nutrition and physical activity wellness policies, greater accountability in meeting national nutrition standards, and better financing aimed at supporting healthier meals (Wootan, 2012). The HHFKA proposed that the amount of fruits and vegetables offered be doubled and the variety increased, the amount of whole grains be increased, sodium gradually reduced, saturated fats limited, milk restricted to low-fat and nonfat options, and calorie minimums and maximums be established based on age (specific guidelines outlined in **Appendix A**) (Wootan, 2012).

In 2016 the NSLP served over 30 million children school lunches, of those approximately 73.3% were either free or reduced meals (USDA, 2016). Another 14.5 million children participated in the SBP, 85% of which were either free or reduced.(USDA, 2016) These numbers indicate that schools are one of the most important sources of daily nutrients for children and fill a void for families in need (Gundersen & Ziliak, 2014). In addition, because schools have continuous and intensive contact with children, they are one of the best places to implement wellness policy programs including those aimed at fighting and preventing obesity (Story, 1999).

Obesity Prevention Strategies in Schools

While obesity prevention policies in schools are a widely-researched area, no single solution has been identified (Khambalia, Dickinson, Hardy, Gill, & Baur, 2012). Numerous studies have found significant associations between school-based obesity interventions and a reduction in childhood obesity while others have reported no significant relationships (Gonzalez-Suarez, Worley, Grimmer-Somers, & Dones, 2009; Kamath et al., 2008; Katz, O'Connell, Njike, Yeh, & Nawaz, 2008; Sobol-Goldberg, Rabinowitz, & Gross, 2013). In a meta-analysis by Katz et al. (2008), it was identified that a combination of interventions that incorporated two or more of the following: parent involvement, a physical activity (PA) component, and/or nutrition education, were most effective in significantly reducing the body weight of children ($P < 0.05$). It that study, the researchers also found that nutrition education alone and/or reducing TV time significantly reduced the body weight of children ($P < 0.05$). At the time the review was conducted, there was limited data on the effectiveness of single strategy interventions, so the authors warned that this data should be interpreted cautiously. In a 2009 review paper, Gonzalez et al. found that interventions which were longer in duration (> one year) had a significant weighted mean difference in students' BMI of -0.42 (95% CI: -0.69, -0.14), compared to those that only last six months or less. That study also found that combining physical activity interventions with classroom education programs was significantly protective against overweight and obesity among students, when compared to groups that did not receive an intervention (OR = 0.74, 95% CI = 0.60, 0.92).

In contrast to the reported results discussed above, Kamath et al.'s (2008) clinical review found that targeted obesity prevention programs in schools caused small changes in eating behaviors but had no significant effect on BMI either positively or negatively.

That study examined the effects of interventions aimed at increasing physical activity, decreasing sedentary activity, increasing healthy dietary behavior, and reducing unhealthy dietary behavior. Interventions aimed at increasing physical activity showed a small but significant increase in physical activity among participants (average increase = 0.12; CI = 0.04-0.20); while interventions aimed at decreasing sedentary behavior showed a small but statistically significant reduction of sedentary activity (average decrease = -0.29; CI = -0.35 to -0.22). However, interventions aimed at increasing healthy dietary behavior showed a minor, insignificant increase in healthy dietary behavior (average increase = 0.06; CI = -0.09- 0.21); while interventions aimed at reducing unhealthy dietary behavior showed a small but significant reduction in unhealthy dietary behavior (average decrease = -0.15; CI = -0.22 to -0.08). In terms of BMI, all the interventions (dietary only, PA only, or combined) yielded inconsequential to small effects on BMI compared to controls. The limitations of these meta-review studies include the possibility that not all eligible studies were included, and many of the studies that were analyzed contained design-related shortcomings such as lack of follow-up and/or blinding. Additionally, there was also unexplained inconsistencies among study results, especially in terms of BMI outcomes. The varied results among these papers can be explained in part to the heterogeneity among study participants, interventions, outcomes, and study designs in obesity prevention programs. However, regardless of the irregularities, several intervention components have been identified as successful in effecting behavior change.

The most effective intervention strategies included parent or family participation, longer intervention durations, and multiple strategies focused on both PA and healthy

diet. A consistent element in the most effective interventions was nutrition education, the majority of which promoted well-balanced diets and increased F/V intake.(Aloia et al., 2016) However, providing nutrition education alone has demonstrated mixed results in terms of increasing F/V consumption among adolescents.(Contento, 2008)

Nutrition Education Interventions

A 2005 clinical trial by Powers et al. implemented a six-week nutrition intervention program that addressed dairy consumption, F/V consumption, Food Guide Pyramid knowledge, and general nutrition knowledge. Participants included 1,100 2nd and third grade students selected through convenience-type sampling from Alabama public schools (treatment group: N = 702, mean age: 7.58 ± 0.71 years; control group: N = 398, mean age: 7.58 ± 0.72 years). In that study nutrition educators focused on teaching skills that enabled the treatment group to select healthy foods both at school and at home. Concepts were reinforced through hands-on activities, role-modeling, and posters advertising nutrition education concepts in the cafeteria. Researchers assessed pre- and post-dietary behavior and nutrition knowledge of both groups through an interactive evaluation tool called “Pizza Please”. Pizza Please is a dynamic assessment tool that includes two components: an interactive game and a questionnaire that addresses dietary behavior and nutrition knowledge. Results illustrated that the treatment group significantly improved their overall dietary behavior ($P < 0.001$) compared to the control group that did not receive any aspects of the intervention. Additionally, children in the treatment group demonstrated significantly greater improvements ($P < 0.001$) in overall nutrition knowledge than those in the control group. While this study demonstrated promising results from a nutrition education intervention numerous limitations were

observed. First, the assessment method was based on memory recall that may have led to bias; second, the children's meals were not examined in the cafeteria to confirm that the treatment group chose and consumed more F/V than the control group; and third, the short duration of the study may have contributed to the children's observed dietary behavior changes. The importance of analyzing actual consumption as well as the long-term effects of a nutrition education intervention is highlighted in other studies.

A study by Upton et al. (2013) showed promising results in their between-group analysis which included a treatment group who received a targeted F/V nutrition education intervention and a control group who received no nutrition education (treatment group N = 1282, control group N = 1151; ages: 4-11 years). The intervention involved a program referred to as "Food Dudes" (Lowe, Fergus; Horne, 2009) administered over a 16-day period. Children in the treatment group watched a series of televised episodes of the cartoon adventurers the "Food Dudes," who gain strength from eating F/V. In addition to watching the videos, children received rewards, such as juggling balls and pedometers, for tasting targeted F/V (Lowe, Fergus; Horne, 2009). Researchers found three months after the intervention, that the treatment group who consumed school lunch increased their consumption of F/V significantly ($p < 0.05$) compared to the control group. However, there was no difference pre- and post-intervention in F/V consumption in children who brought lunch from home. Twelve-months post-intervention there was no longer a significant increase in F/V intake among children who consumed school lunch, suggesting that nutrition education needs to be a continuous fixture in school curricula to remain effective.

Salad Bars in Schools

Another method that may potentially improve F/V intake among children is the implementation of salad bars (SBs) in schools (Harris et al., 2012). In 2002, the Olympia School District in Washington State piloted an Organic Choices SB at Lincoln Elementary (Flock et al., 2003). The initial goals of the program included offering students and staff fresh organic produce, providing protein alternatives, and reducing sugar intake. Lincoln Elementary already had in place an organic garden, greenhouse, and worm-bin composting system. School administrators found that the SB was financially feasible, and while the program did come with extra costs, they were manageable. A food service participation report showed that with the addition of the SB, lunch participation increased 16% when compared to the same period the previous year (no SB). During the 2002 – 2003 school year, approximately 104 students and staff ate lunch at Lincoln daily, of those 33% chose the SB as a lunch option. The number of F/V servings selected also increased by 29% from the previous year. Although the organic SB initiative showed promising early results, the long-term effects on F/V uptake have not been examined. Notably, the report also lacked data on actual F/V consumption measured through a plate waste or dietary recall analysis. Lincoln Elementary also had several other programs in place that promoted nutrition education, gardening, and sustainability, something most schools do not have available for their students in terms of education, hands-on activities, and school-wide promotion, which may have further influenced the observed increases in F/V consumption. Research examining the effects of a salad bar intervention alone on F/V consumption have shown varying results.

There are only a few studies to date that have looked at how a SB affects F/V intake (Adams et al., 2015). Adams et al. examined whether students at schools with self-

service SBs consumed more F/V than students in schools with pre-portioned servings (Adams, Marc A.; Pelletier, Robin L.; Zive, Michelle M.; Sallis, 2005). Researchers measured plate waste in four San Diego-area elementary schools, two with SBs and two that used pre-portioned servings of F/V, among 294 - 1st through fifth grade students. Results showed that simply having a SB present in the cafeteria did not lead to greater consumption of F/V. However, the school that offered more variety in the SB (seven items versus four) saw significantly greater consumption of F/V than the SB school that offered less variety ($P < 0.05$). This suggests that having a greater variety of F/V offerings rather than the presence of a SB alone is an important factor in increasing elementary student consumption. More promising research examining increased F/V consumption among school-aged children involved a multicomponent approach including both the effect of the presence of SBs as well as nutrition education.

Slusser and colleagues reported on F/V consumption both pre and post a SB intervention in the Los Angeles Unified School District (LAUSD) between 1998 and 2000 (Slusser, Cumberland, Browdy, Lange, & Neumann, 2007). The introduction of the SB in the schools included all-school assemblies teaching SB etiquette, education on eating a well-balanced lunch, field trips to local farmer's markets and farms, and student artwork in the cafeteria promoting the program. Subjects included second - fifth grade students attending 14 schools (pre-intervention group: N = 96; and two-year post-intervention group: N = 241). Using 24-hour recalls they determined that F/V consumption increased significantly from 2.97±2.0 items in 1998 to 4.09±2.7 items in 2000 after the SB was introduced ($P < 0.001$). It was determined that this increase in F/V consumption was almost entirely attributable to lunchtime intake (84%). In that study it

should be noted that the SBs were part of a larger nutrition education intervention that included hands-on activities and school-wide advertising, and thus, it is difficult to separate the effectiveness of the SB alone from the other initiatives that promoted F/V consumption, suggesting a combined approach may be the most successful.

Conclusions and Study Objectives

Research shows that the most effective obesity prevention programs contain multiple components including nutrition education, promotion of physical activity, and community and/or parental involvement (Shirley et al., 2015). Unfortunately few schools have the resources to implement such a comprehensive approach, if any (Shirley et al., 2015). As a result, the goals of current obesity prevention research focuses on highly adaptable, cost- and time-effective interventions (Graziose et al., 2016). The aim of the current study is to evaluate the effectiveness of eight weekly 20-minute nutrition education classes, combined with a SB lunch option, on a convenience sample of third and fifth grade children's lunch intake. We hypothesize that following a nutrition education intervention; students will have a higher intake of F/V from the school SB, as demonstrated through a plate waste analyses. Additionally, students will demonstrate greater knowledge about the importance of regular F/V consumption and greater preference for F/V, shown through pre- and post-intervention surveys.

CHAPTER III

JOURNAL ARTICLE

THE EFFECTS OF NUTRITION EDUCATION ON THIRD AND FIFTH GRADE STUDENTS' FRUIT AND VEGETABLE KNOWLEDGE, PREFERENCE, AND CONSUMPTION

The Effects of Nutrition Education on Third and Fifth Grade Students' Fruit and Vegetable Preference, Knowledge and Consumption
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ABSTRACT

Purpose/Objectives:

Most American school children fail to meet recommended intakes of fruits and vegetables (F/V). Possible solutions to increase intake include nutrition education interventions paired with access to a cafeteria salad bar (SB). The aim of this research was to determine if a F/V-targeted nutrition education intervention would increase F/V knowledge, preference, and consumption among elementary-school students.

Methods:

This repeated measures experimental design examined the effects of a nutrition education intervention among third- and fifth-grade students (n = 149). Pre- and post-intervention surveys, as well as SB specific plate waste analysis, were used to measure change in F/V knowledge, preference, and consumption. Participants received eight weekly 20-minute nutrition education lessons focusing on the benefits of consuming F/V. A series of two-way ANOVA models with interactions were used to examine changes in F/V knowledge, preference, and consumption in each grade.

Results:

A few significant improvements in nutrition knowledge and F/V preference were observed. There were slight differences in overall nutrition knowledge and F/V preference between grades but not a change post-intervention. Fifth-grade students generally possessed a better understanding about the benefits of consuming F/V and a greater preference for F/V. Non-significant increases in F/V consumption was noted post-intervention.

Application to Child Nutrition Professionals:

The results of this study suggest that targeted nutrition interventions may be effective in increasing F/V intake among elementary-age students. Although, positive outcomes seem to depend on several factors, including the existence and duration of other F/V promotional programs like SBs, as well as peer- and adult-modeling of F/V consumption. This study as well as previous research implicates exposure and modeling as a powerful tool in future research in increasing adolescent F/V consumption.

Keywords: elementary schools, nutrition education, plate waste, fruit and vegetables, childhood obesity

INTRODUCTION

The epidemic of overweight and obese children in the United States remains a public health priority. Results from the 2013-2014 National Health and Nutrition Examination Survey (NHANES) report that approximately 33.4% of children are classified as overweight and 17.4% of those are obese (Skinner et al., 2016). While some research suggests a decline in obesity among 2-5 year old children, the prevalence of severe obesity (≥ 99th percentile for age- and sex-specific body mass index [BMI]) among children of all ages, genders and ethnicities continues to increase (Skinner et al., 2016). Overweight and obese children are more likely to become overweight and obese adults and develop obesity-related chronic diseases such as hypertension, Type 2 diabetes, atherosclerosis, metabolic syndrome, and select cancers (Freedman, 2001; Simmonds et al., 2016); all diseases which were once thought to only affect adults (Freedman, 2001; Hannon, 2005; Lo, Chandra, Sinaiko, Daniels, Prineas, Maring, Parker, Sherwood, Daley, Kharbanda, Adams, Magid, Connor & Greenspan, 2014; Tamborlane, Taksali, Yeckel, Allen, Lopes, Savoye, Morrison, Sherwin, & Caprio, 2004). In addition to chronic obesity-related diseases, cognitive impairments and psychological disorders have also been identified in obese children and adults which may adversely affect academic performance, long-term job potential, and overall quality of life (E. a Finkelstein et al., 2010; Sjoberg, 2005; Yates et al., 2012; Yau et al., 2012).

Obesity is a multifactorial disease with a mix of contributing factors including genetics, environment, and lifestyle. Factors identified as contributing to the obesity epidemic include but are not limited to: overconsumption of energy-dense foods, decreased physical activity, obesogenic community and environmental factors, and a

general shift away from home-cooked meals and family dinners (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Fiscella & Williams, 2004; Hernández, Gortmaker, Colditz, Peterson, Laird, & Parra-Cabrera, 1999; Paul J. Veugelers, 2010; Trost, Kerr, Ward, & Pate, 2001). The American diet, characterized as high in saturated fats and added sugars and low in fruit and vegetables (F/V), is often targeted as a primary culprit (Frazao & Allshouse, 2003). Although research shows that regular consumption of F/V reduces the risk of obesity and obesity-related chronic diseases, the vast majority of American youth are not meeting the United States Department of Agriculture's (USDA) recommended guidelines for daily F/V intake (Adams, Bruening, & Ohri-Vachaspati, 2015; Bazzano, He, Ogden, Loria, Vupputuri, Myers, & Whelton, 2002; He, Hu, Colditz, Manson, Willett, & Liu, 2004; Vernarelli, Mitchell, Hartman, & Rolls, 2011; Wootan, 2012). A 2007-2010 report by the National Cancer Institute (NCI) showed that 60% of children between the ages of 1-18 years old did not meet the USDA's fruit intake recommendations and 93% did not meet vegetable intake recommendations (Kim, Moore, Galuska, Wright, Harris, Grummer-Strawn, Merlo, Nihiser, & Rhodes, 2014), defined as 1 - 2 cups and 1- 2 ½ cups for F/V, respectively, depending on caloric needs (Department of Agriculture, 2013). One high impact, cost-effective method of addressing obesity may be to encourage greater consumption of F/V through increased nutrition education interventions in schools aimed at increasing nutrition knowledge and awareness. Nutrition interventions beginning at the elementary school level provide an ideal environment for setting standards, establishing nutrition curricula, and forming healthy behaviors that may last a lifetime.

Elementary schools offer an ideal learning platform as well as a large pre-adolescent audience (Story, 1999). These elements paired with the National School Lunch Program (NSLP) make for an ideal setting for nutrition interventions. The NSLP was established in 1946 to fill nutritional gaps in the American child's diet and it has continually evolved to meet changing dietary requirements (Gunderson, 1962; Ralston et al., 2008). It is an important source of daily nutrients for American school children (Gundersen & Ziliak, 2014), with over 30 million children served in 2016 (USDA, 2016). In conjunction with changing nutrition requirements, many schools are implementing their own healthy lifestyle initiatives in an attempt to reverse the childhood obesity epidemic (Khambalia et al., 2012).

Obesity prevention in the school setting calls for multipronged intervention research as no single, effective solution to combat obesity has been identified (Adams, 2015; Aloia, Shockey, Nahar, & Knight, 2016; Shirley, Rutfield, Hall, Fedor, McCaughey, & Zajac, 2015). Previous studies show that interventions that incorporate a combination of methods such as nutrition education, parental involvement, and physical activity, seem to be the most effective in improving children's eating habits (Aloia et al., 2016). However, comprehensive obesity prevention programs can be expensive and difficult to implement (Graziose et al., 2016). As a result, a large body of research is dedicated to finding cost-effective, easily adaptable solutions. One aspect of obesity prevention programs that is relatively easy and inexpensive to implement is nutrition education curriculum (Gonzalez-Suarez et al., 2009), that is aimed at improving children's F/V consumption and nutrition knowledge (Anderson, Porteous, Foster, Higgins, Stead, Hetherington, Ha, & Adamson, 2005; Powers, Struempler, & Parmer,

2005; Upton, Upton, & Taylor, 2013). Additionally, intervention effectiveness is amplified when it is reinforced with other healthy lifestyle exposures, such as a lunch-time salad bar (SB) (Flock et al., 2003).

There are few studies to date, that explore the knowledge, preference, and consumption outcomes of combining nutrition education interventions with SB access. The aim of this research was to examine the effectiveness of eight weekly 20-minute nutrition education classes on third- and fifth-graders F/V knowledge, preference and SB consumption. It was hypothesized that following a nutrition education intervention, students would demonstrate greater knowledge about the importance of regular F/V intake, have a higher preference for F/V, and increase their consumption of F/V.

METHODOLOGY

Study Design

This repeated-measures study assessed how a nutrition education intervention, combined with access to a lunch-time SB, affected third- and fifth-grade students' F/V knowledge, preference, and consumption. Central Washington University's (CWU) Human Subjects Review Committee approved this study prior to initiation and it was registered at ClinicalTrials.gov as NCT03179852. This study, including data collection and the education intervention, was conducted over a ten-week period in the winter of 2017. Data from validated surveys to assess F/V knowledge and preference (REF), as well as plate waste data to assess F/V consumption, were collected during weeks one and ten. The education intervention was conducted for eight weeks (weeks two – nine).

Study Sample

The 149 third- and fifth-grade study participants represented a convenience sample, recruited from a rural public elementary school located in central Washington. The elementary school has a 20-minute lunch period during which time students have access to the self-serve SB. All third- and fifth-grade students, whose parents did not opt out, were included in the nutrition education intervention and plate waste study. The participant baseline demographics are presented in Table 1.

Table 1. Baseline demographic characteristics of third- and fifth-grade students who participated in a nutrition education intervention (n, %).

Characteristics	Third-grade	Fifth-grade
Gender		
Male	36 (47.4)	42 (59.2)
Female	40 (52.6)	29 (40.8)
Ethnicity		
Hispanic or Latino	16 (21.1)	9 (12.7)
Non-Hispanic White	60 (78.9)	62 (87.3)
NSLP & NSBP		
Free	37 (48.6)	28 (39.4)
Reduced	10 (13.2)	5 (7.0)
Paid	29 (38.2)	38 (53.5)

Nutrition Intervention

A primary investigator and seven undergraduate co-investigators from CWU's Department of Health Sciences conducted the nutrition education intervention. Eight classroom-based nutrition education lessons based on California's Power Play! Campaign (CDPH, 2009) were administered over eight weeks to six classrooms (three each in third- and fifth-grade). Each lesson lasted approximately 20 minutes and was led by the primary investigator, with two co-investigators assigned to assist with each lesson. The intervention focused on plant-based components, macro- and micronutrients, My Plate guidelines, serving sizes, diet-related disease prevention, preparing healthy snacks, and how to ask parents for more F/V (Morris & Zidenberg-Cherr, 2009). Each lesson included a snack component that featured targeted F/V including homemade hummus with celery and carrots, beet smoothies, green smoothies, and zucchini pumpkin muffins, among others.

Data Collection

Identical baseline and post-intervention measurements were collected from students. A previously validated self-report survey developed by California's Power Play! Campaign (Hall, Chai, Koszewski, & Albrecht, 2015) was used to assess pre- and post-nutrition knowledge and F/V preference and contained 34 T/F and multiple-choice questions and two fill-in the blank questions.

Two to three co-investigators worked with the primary investigator during the plate waste data collection. Plate waste was assessed using the validated quarter-waste method, a visual estimation method that reports consumption in quarter percentage increments: 0%, 25%, 50%, 75% or 100% of the food was consumed using the tray as a

reference (Bontrager Yoder, Foecke, & Schoeller, 2015; Hanks, Wansink, & Just, 2014; Kenney, Davison, Bryn, Giles, Cradock, Lee, & Gortmaker, 2014; Swanson, 2008). The "before" and "after" photos were captured with a Sony MHS-TS10 Bloggie digital camera fixed on tripods approximately 18" above trays.

Data Analyses

Two co-investigators independently compared each "before" and "after" photo to visually estimate the amount of F/V consumed by each student. Differences in observations among the investigators that were greater than 50% were re-examined by the primary investigator. The two closest of the three independent estimates were averaged for the tray in question. Photographs were excluded if a tray lacked either a "before" or "after" meal image, if the photograph quality was too poor to determine an amount consumed, or if items had been added or removed from the tray between the two photographs. For example, while the students had been told not to share or trade, empty cookie wrappers would appear on the "after" tray when no cookies had been on the "before" tray. Similarly, items like oranges or bananas that had been in the "before" picture sometimes disappeared from the "after" along with evidence of their peel.

Statistical Analysis

Two-way ANOVAs with grade (third or fifth) and time (before and after) as main factors were used to test differences in F/V knowledge and preference in the survey data and the F/V consumption data. Because plate-waste was associated with the same students before and after the intervention, the two-way ANOVA used to analyze these data included subject as a random effect (**Table 2**). All statistical analyses were

performed using the statistical software package R version 3.3.3(R Core Team, 2017) with $\alpha = 0.05$.

Table 2. Changes in fruit and vegetable knowledge pre- and post-nutrition education intervention (n).

	3rd		5th		P		
Fruits and vegetables	Pre	Post	Pre	Post	Grade	Time	Interaction
Eating F/V protects you from diseases. (True)	60	52	46	53	**	•	*
Most of the vitamin C we get comes from F/V. (True)	55	58	56	60	NS	NS	NS
How many servings of F/V do you think elementary school students should eat each day to be healthy?					NS	NS	NS
1 serving	7	10	7	3			
2 servings	19	13	21	13			
3 servings	14	15	15	19			
4 servings	7	6	5	10			
5 servings or more	3	8	10	20			
Don't know	11	12	5	1			
How many servings of vegetables do kids your age need every day?					NS	*	NS
1 serving	6	9	5	2			
2 servings	20	28	21	29			
3 servings	11	14	20	19			
4 servings	8	3	12	6			
5 servings or more	15	10	7	8			
If I eat fruits and vegetables every day…							
I will become stronger					NS	NS	NS
I disagree very much	1	6	1	4			
I disagree a little	0	2	4	2			
I am not sure	3	3	2	0			
I agree a little	6	10	15	10			
I agree very much	51	43	44	49			
my friends will start eating them too					NS	NS	NS
I disagree very much	13	15	13	10			
I disagree a little	6	7	10	16			
I am not sure	15	18	22	23			
I agree a little	7	7	16	10			
I agree very much	21	12	4	6			

Table 2. Changes in fruit and vegetable knowledge pre- and post-nutrition education intervention (n).

	3rd		5th		P		
Fruits and vegetables	Pre	Post	Pre	Post	Grade	Time	Interaction
I will have stronger eyes					NS	NS	NS
I disagree very much	8	4	8	3			
I disagree a little	7	4	1	1			
I am not sure	3	12	10	5			
I agree a little	7	6	13	13			
I agree very much	37	35	32	44			
I will have a nicer smile					NS	NS	NS
I disagree very much	19	18	20	14			
I disagree a little	10	13	8	6			
I am not sure	13	13	15	16			
I agree a little	3	7	8	10			
I agree very much	17	12	13	20			
I will be healthier					•	NS	NS
I disagree very much	4	2	1	3			
I disagree a little	0	2	0	0			
I am not sure	1	1	0	0			
I agree a little	5	3	1	2			
I agree very much	51	54	62	60			
I will think better in class					NS	NS	NS
I disagree very much	9	5	9	8			
I disagree a little	6	10	10	0			
I am not sure	10	13	9	11			
I agree a little	9	9	18	23			
I agree very much	26	25	16	23			
it will keep me from getting fat					NS	NS	NS
I disagree very much	6	6	11	7			
I disagree a little	7	4	4	4			
I am not sure	4	12	8	5			
I agree a little	5	9	11	12			
I agree very much	39	32	30	39			
I will have more energy					*	NS	NS
I disagree very much	6	6	2	3			
I disagree a little	4	0	0	2			
I am not sure	5	5	2	1			
I agree a little	5	4	9	10			
I agree very much	43	46	53	50			

Table 2. Changes in fruit and vegetable knowledge pre- and post-nutrition education intervention (n).

	3rd		5th		P		
Fruits and vegetables	Pre	Post	Pre	Post	Grade	Time	Interaction
my family will be proud of me					*	•	NS
I disagree very much	5	5	7	6			
I disagree a little	2	6	4	5			
I am not sure	3	9	11	10			
I agree a little	8	12	11	10			
I agree very much	45	33	33	36			
I think I can write my favorite fruit or vegetable on the family's shopping list					*****	**NS**	**NS**
I disagree very much	8	10	5	6			
I disagree a little	9	8	4	3			
I am not sure	12	13	7	11			
I agree a little	14	13	13	14			
I agree very much	21	22	36	33			
I think I can ask someone in my family to buy my favorite or vegetable					*****	**NS**	**NS**
I disagree very much	5	5	5	5			
I disagree a little	6	6	2	0			
I am not sure	5	8	4	4			
I agree a little	7	12	11	10			
I agree very much	41	34	44	48			
I think I can go shopping with my family for my favorite fruit or vegetable					**NS**	**NS**	**NS**
I disagree very much	8	6	6	5			
I disagree a little	2	2	1	2			
I am not sure	6	10	7	6			
I agree a little	13	9	13	11			
I agree very much	35	39	39	42			
I think I can pick out my favorite fruit or vegetable at the store and put it in the shopping basket					*	NS	NS
I disagree very much	13	13	6	11			
I disagree a little	4	6	5	5			
I am not sure	12	13	7	8			
I agree a little	9	5	9	10			
I agree very much	26	28	39	32			

Note. Significant differences are noted as follows: NS $P > 0.10$; • $P < 0.10$; * $P < 0.05$; ** $P < 0.01$; $P < 0.00$

RESULTS AND DISCUSSION

This study found that an eight-week nutrition intervention improved some aspects of third- and fifth-grade students' F/V knowledge and preference, but not actual F/V consumption from the SB. The intervention increased preference for targeted F/V but not non-targeted F/V, as would be expected. There was an observed but insignificant increase in F/V consumption post-intervention.

Nutrition Knowledge

To determine change in nutrition knowledge after the intervention, 17 survey questions were analyzed individually. The first question—"eating F/V protects you from disease"—had a significant interaction whereby fifth-grade students were more likely to answer "True" in the post-survey compared to third-grade students ($P < 0.05$). In the second question about F/V having vitamin C, neither time nor grade was significant. . Question four asked students "how many servings of vegetables do kids your age need every day?" Prior to the intervention third-grade students were more likely to answer "3 servings," but after the intervention they were significantly more likely to answer "2 servings" ($P < 0.05$) while fifth-grade students did not significantly change their answers. Significant outcomes included the following: 1) "if I eat F/V every day I will have more energy" (fifth-grade students were significantly more likely to answer "I agree a little," whereas third-grade students were more likely to answer "I agree very much" [$P < 0.05$]); 2) "if I eat F/V every day my family will be proud of me" (third-grade students were more likely to answer "I agree very much" compared to fifth-grade students [$P < 0.05$]); 3) "I think I can write my favorite F/V on the family shopping list" (fifth-grade students were significantly more likely to answer "I agree very much" compared to third-

grade students [$P < 0.05$]); 4) "I think I can ask someone in my family to buy my favorite F/V" (fifth-grade students were significantly more likely to answer "I agree very much" compared to third-grade students [$P < 0.05$]); and 5) "I think I can pick out my favorite F/V at the store and put it in the shopping basket" (fifth-grade students were significantly more likely to answer "I agree very much" compared to third-grade students [$P < 0.05$]).

The lack of a significant relationship observed between the nutrition education and improved F/V knowledge is inconsistent with other studies (Anderson et al., 2005; Powers et al., 2005; Tuuri, Zanovec, Silverman, Geaghan, Solmon, Holston, Guarino, Roy, & Murphy, 2009). Powers et al. (2005) saw a significant improvement in F/V knowledge in their elementary-aged treatment group following a six-week nutrition education program. Tuuri et al. (2009) also saw an improvement in F/V knowledge after a 12-week nutrition education intervention. It should be noted that those studies adopted a wider-scale nutrition education approach which included school assemblies to generate enthusiasm, parental involvement, hands-on activities for kids, classroom videos, school gardens, farm visits, F/V tastings, and assigned readings. This suggests that effective nutrition education programs aimed at increasing F/V knowledge, preference and consumption need to contain multiple components in order to be successful.

The current study did find a significant difference in knowledge between grades. In general, fifth-grade students possessed greater knowledge than third-grade students about the health benefits of F/V pre- and post-intervention. They were also more likely to answer, "I agree a little" or "I agree very much" regarding questions that addressed one's ability to succeed. For example, they were more likely to answer, "I agree very much" when asked whether they felt they could add their favorite F/V to the family-shopping list

or put it in the shopping basket. Fifth-grade students also had a higher preference for a greater variety of F/V, both pre- and post-intervention. These findings suggest that as students age, their understanding around the health benefits of F/V consumption improves even without targeted nutrition education programs.

Fruit and Vegetable Preference

Of the 17 questions, 11 demonstrated significant outcomes ($P < 0.05$) either between the pre- and post-intervention time frames or between grades (**Table 3**).

Table 3. Changes in fruit and vegetable preferences pre- and post-nutrition education intervention (n).

	3rd		5th		P		
	Pre	Post	Pre	Post	Grade	Time	Interaction
Asparagus					***	NS	NS
I like this a lot	12	15	18	22			
I like this a little	11	13	19	19			
I do not like this	19	24	19	20			
I don't know what this is	18	14	9	4			
Avocados					•	•	NS
I like this a lot	17	25	21	22			
I like this a little	5	8	10	15			
I do not like this	26	22	31	26			
I don't know what this is	14	9	4	1			
Beets					NS	*	NS
I like this a lot	10	6	6	11			
I like this a little	5	5	10	17			
I do not like this	20	35	30	35			
I don't know what this is	25	19	17	3			
Broccoli					*	NS	NS
I like this a lot	35	34	41	39			
I like this a little	11	14	14	17			
I do not like this	11	18	8	9			
I don't know what this is	3	0	0	0			
Cabbage					***	•	NS
I like this a lot	10	16	18	21			
I like this a little	9	10	19	7			
I do not like this	27	25	22	16			

Table 3. Changes in fruit and vegetable preferences pre- and post-nutrition education intervention (n).

	3rd		5th		P		
	Pre	Post	Pre	Post	Grade	Time	Interaction
I don't know what this is	13	13	6	2			
Carrots					NS	•	•
I like this a lot	45	37	46	46			
I like this a little	13	18	13	16			
I do not like this	3	6	6	3			
I don't know what this is	0	1	0	0			
Celery					***	NS	NS
I like this a lot	23	23	33	34			
I like this a little	10	14	21	19			
I do not like this	19	22	12	11			
I don't know what this is	10	5	0	1			
Corn					NS	NS	NS
I like this a lot	50	47	55	59			
I like this a little	8	9	7	5			
I do not like this	5	5	4	3			
I don't know what this is	1	1	0	0			
Grapefruit					NS	NS	NS
I like this a lot	33	38	32	34			
I like this a little	4	8	10	10			
I do not like this	9	7	12	12			
I don't know what this is	14	12	10	10			
Green beans					NS	*	*
I like this a lot	36	27	29	37			
I like this a little	11	12	21	16			
I do not like this	14	21	11	9			
I don't know what this is	2	5	3	3			
Lettuce					***	NS	NS
I like this a lot	28	30	45	42			
I like this a little	12	11	14	15			
I do not like this	12	14	5	6			
I don't know what this is	9	11	1	1			
Mushrooms					NS	NS	NS
I like this a lot	14	13	11	17			
I like this a little	4	8	10	8			

Table 3. Changes in fruit and vegetable preferences pre- and post-nutrition education intervention (n).

	3rd		5th		P		
	Pre	Post	Pre	Post	Grade	Time	Interaction
I do not like this	36	38	42	39			
I don't know what this is	6	4	2	1			
Plums					**	NS	NS
I like this a lot	34	38	14	54			
I like this a little	8	7	10	6			
I do not like this	11	13	5	4			
I don't know what this is	9	6	7	3			
Radishes							
I like this a lot	10	13	11	15	*	**	NS
I like this a little	5	9	12	21			
I do not like this	25	34	29	23			
I don't know what this is	20	9	14	3			
Spinach					***	•	NS
I like this a lot	11	14	16	19			
I like this a little	9	9	11	20			
I do not like this	27	28	31	21			
I don't know what this is	15	15	7	2			
Sweet potatoes					NS	NS	NS
I like this a lot	30	30	34	33			
I like this a little	13	7	10	16			
I do not like this	13	20	7	15			
I don't know what this is	4	7	3	2			
Tomatoes					NS	NS	NS
I like this a lot	23	23	25	25			
I like this a little	8	11	15	14			
I do not like this	27	25	26	27			
I don't know what this is	4	4	0	0			

Note. Significant differences are noted as follows: NS $P > 0.10$; • $P < 0.10$; * $P < 0.05$; ** $P < 0.01$; $P < 0.00$

Several "targeted" F/V listed on the survey were also highlighted during the nutrition education lessons. For example, beets were offered in the form of a smoothie and radishes in a raw cut form. Researchers led students through a "tasting," which

involved describing the snack in terms of its physical and sensory characteristics and eating ("modeling") the snack with the students. After the intervention, fifth-grade students increased their preference for beets and both grades increased their preference for radishes. The researchers observed that during the tasting, "odeling by peers and instructors greatly influenced the students' willingness to try the target F/V. For example, some children expressed dislike of certain items, such as beets or radishes, but were willing to try them during the lesson to actively participate in the discussion. These findings are supported by previous research that suggests modeling and exposure, both positive and negative, can have a powerful effect on children's food intake (Birch & Fisher, 2015; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Hendy, Williams, & Camise, 2005; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). Lowe et al. (2004) found that elementary-aged children improved their liking for F/V following a 16-day intervention which involved watching videos with super hero cartoon characters who gained "special" powers from consuming F/V (Lowe et al., 2004). Similarly, Fisher et al. (2002) found that F/V intake among five-year-old girls' was positively related to their parents' F/V intake. Parents who increased their consumption of F/V saw increased consumption in their daughters' intake. Parents with lower F/V intake reported using greater pressure when feeding their children F/V, which correlated with lower intake in their children. In support of these findings, additional research has shown that repeated and consistent exposure to F/V increases children's preference for and consumption F/V (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Wardle, Herrera, Cooke, & Gibson, 2003). This finding demonstrates the importance of positive role modeling in increasing children's consumption of F/V.

Preference for other items on the survey varied between grades. For asparagus, both pre- and post-intervention, third-grade students were significantly more likely to choose "I like this a little," compared to fifth-grade students who were more likely to choose "I do not like this" ($P < 0.01$). For green beans, third-grade students changed their answer from "I like this a lot" pre-intervention to "I like this a little" post intervention, whereas fifth-grade students changed from "I like this a little" pre-intervention to "I like this a lot" post-intervention ($P < 0.05$). However, compared to third-grade students, fifth-grade students had a higher preference for broccoli ($P < 0.001$), cabbage ($P < 0.01$), celery ($P < 0.001$), lettuce ($P < 0.001$), plums ($P < 0.01$), and spinach ($P < 0.01$) both pre- and post-intervention. Fifth-grade students significantly changed their preference for beets from "I do not like this," pre-intervention to "I like this a little" post-intervention ($P < 0.05$). Finally, both grades liked radishes more post-intervention ($P < 0.01$) with fifth-grade students having a higher preference for them at baseline and post-intervention ($P < 0.05$).

Fruit and Vegetable Consumption

There was a non-significant increase in F/V consumption observed among grades post-intervention. Previous research has shown mixed results on the effectiveness of nutrition education programs in increasing F/V consumption. Powers et al. (2005) found that children who received a nutrition education program improved their overall dietary behavior including greater consumption of F/V compared to children who did not receive the intervention while Upton et al. (2013) also found short-term improvements in F/V consumption among students following a nutrition education intervention, however, increased intake was not maintained 12 months post-intervention (Upton et al., 2013).

Finally, Anderson et al. (2005) found that students who participated in a nutrition education intervention increased their fruit but not vegetable intake. These findings along with the results of the current research indicate that a variety of factors need to be considered in designing the intervention including the home environment, the length of the intervention, the variety and quantity of F/V offerings in the cafeteria, as well as modeling of F/V consumption by peers, educators, and parents (Gonzalez-Suarez et al., 2009; Gosliner, 2014; Struempler, Mastropietro, Parmer, Arsiwalla, & Smith, 2013). Although the percentage of F/V consumed did not change significantly between pre- and post-intervention, the percentage of total plate consumed increased significantly post-intervention (data not shown). The increased total plate consumption post-intervention was most likely due to the varying menus that were served during the plate waste data collection periods and the children's higher preference for the menu post-intervention, factors that were outside of the researchers control.

Strengths and Limitations

This study has several strengths. First, F/V consumption was measured through a plate waste analysis, rather than relying on less reliable dietary recall or observation methods (Hulshof, Ovesen, & Amorim, 2002). Second, the use of digitally-captured images to show F/V consumption allowed for minimal interruption to the students' lunch period permitting students to have the full 20-minute allotted lunch period to consume their meals (Nicklas, O'Neil, Stuff, Goodell, Liu, & Martin, 2012). Lastly, all of the nutrition education lessons were led by the primary investigator; thus, the content, style, and length of the lessons was consistent between classrooms.

Limitations of this study included the convenience sample, which was based on the willingness of certain teachers at the elementary school to participate. Only the third- and fifth-grade teachers volunteered for this study. This resulted in the need to find appropriate teaching materials and surveys that were consistent and understandable to both grades. However, there is a clear difference in the learning ability, cognition, and memory retention between third- and fifth-grade students. For this reason materials appropriate to fourth-grade students were chosen and approved by the teachers in both grades prior to the start of the study. As a result, the researchers found the third-grade students had a difficult time understanding some of the survey instructions and questions, possibly altering the outcomes measured. Second, as previously mentioned, the menu cycle of the elementary school did not match the plate waste data collection periods. During the two five-day periods, the items on the menu differed from each other. This may have led to a higher preference for the items post-intervention and less total plate waste, independent of the nutrition education intervention.

CONCLUSIONS AND APPLICATIONS

As childhood obesity continues to be a public health crisis worldwide, the need for effective disease prevention policies continues to be of high priority. One possible solution is greater implementation of nutrition education programs in school settings, combined with other health-promoting initiatives that encourage F/V consumption, such as school gardens, cooking classes, and SB. While school-based health programs can be effective in increasing children's consumption of F/V, an identified important factor in the prevention of obesity, the ideal approach for this has yet to be identified (Shirley et

al., 2015; Sobol-Goldberg, Rabinowitz, & Gross, 2013; Summerbell, Moore, Vögele, Kreichauf, Wildgruber, Manios, Douthwaite, Nixon, & Gibson, 2012) As the current study observed and similar to previous research, increasing F/V intake among elementary-aged children requires a multifaceted approach (Adams et al., 2015; Aloia et al., 2016; Shirley et al., 2015).

To the knowledge of the researchers, this study is the first to examine plate waste associated with a targeted F/V nutrition education combined with a SB program in elementary-aged children. The findings from the current study indicate that several other considerations besides nutrition education alone need to be taken to improve students' F/V intake. One interesting aspect of this study that warrants further exploration in future research is the role of modeling and exposure in increasing F/V intake. As suggested by previous research, peer, parental, and teacher modeling can all have a significant impact, both positive and negative, on children's F/V consumption and should be a core component of future interventions aimed at increasing F/V intake (Fisher et al., 2002; Reynolds, Franklin, Binkley, Raczynski, Harrington, Kirk, & Person, 2000; Wrotniak, Epstein, Paluch, & Roemmich, 2005). The length of the intervention also appears to be critical, with weekly interventions lasting 50 minutes in length and longer than six months proving more effective (Gonzalez-Suarez et al., 2009; Sobol-Goldberg et al., 2013; Carolyn D Summerbell et al., 2005). Other important aspects to consider include parental involvement, the home environment, and the incorporation of physical activity programs, as multifaceted approaches have proven to be most effective in eliciting long-term behavioral change (Katz et al., 2008; Shirley et al., 2015; Sobol-Goldberg et al., 2013). Yet, as stated previously, the multicomponent approach can be expensive and

time-consuming for schools to implement. The aim of the current study was to find an affordable, highly adaptable program that most schools could adopt without extensive interruption to the normal school curricula and schedule. The results of this study illustrate the need for additional research in order to find an effective, yet cost-efficient, way to increase F/V consumption among elementary-aged children.

One possible solution may be for Registered Dietitians in Child Nutrition positions to have a percent of their FTE that is devoted to nutrition education. In addition, RD's working in child nutrition always have the opportunity to be a positive role model for students and to provide additional exposure to F/V through special events like "Harvest of the Month" or school gardens…

Implications for Future Research

Previous research has shown that nutrition education programs in the school environment aimed at lowering childhood obesity can be successful in increasing F/V intake. The results of the present study offer limited support for the effectiveness of easy-to-implement, low-cost nutrition education programs. In order to be successful, it is evident that nutrition education programs need to include a long-term, multicomponent approach, which may prove costly and difficult to implement. This study highlighted the need for further work in establishing nutrition education curricula that is highly adaptable, affordable, and sustainable.

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APPENDIXES

Appendix A
Healthy Hunger-Free Kids Act Guidelines

Final Rule Nutrition Standards in the National School Lunch and School Breakfast Programs – Jan. 2012

	Breakfast Meal Pattern			Lunch Meal Pattern		
	Grades K-5[a]	*Grades 6-8*[a]	*Grades 9-12*[a]	*Grades K-5*	*Grades 6-8*	*Grades 9-12*
Meal Pattern	**Amount of Food**[b] **Per Week (Minimum Per Day)**					
Fruits (cups)[c,d]	5 (1) [e]	5 (1) [e]	5 (1) [e]	2½ (½)	2½ (½)	5 (1)
Vegetables (cups)[c,d]	0	0	0	3¾ (¾)	3¾ (¾)	5 (1)
Dark green [f]	0	0	0	½	½	½
Red/Orange [f]	0	0	0	¾	¾	1¼
Beans/Peas (Legumes) [f]	0	0	0	½	½	½
Starchy[f]	0	0	0	½	½	½
Other [f,g]	0	0	0	½	½	¾
Additional Veg to Reach Total[h]	0	0	0	1	1	1½
Grains (oz eq) [i]	7-10 (1) [j]	8-10 (1) [j]	9-10 (1) [j]	8-9 (1)	8-10 (1)	10-12 (2)
Meats/Meat Alternates (oz eq)	0 [k]	0 [k]	0 [k]	8-10 (1)	9-10 (1)	10-12 (2)
Fluid milk (cups) [l]	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)
Other Specifications: Daily Amount Based on the Average for a 5-Day Week						
Min-max calories (kcal)[m,n,o]	350-500	400-550	450-600	550-650	600-700	750-850
Saturated fat (% of total calories)[n,o]	< 10	< 10	< 10	< 10	< 10	< 10
Sodium (mg)[n, p]	≤ 430	≤ 470	≤ 500	≤ 640	≤ 710	≤ 740
Trans fat[n,o]	Nutrition label or manufacturer specifications must indicate zero grams of trans fat per serving.					

[a]In the SBP, the above age-grade groups are required beginning July 1, 2013 (SY 2013-14). In SY 2012-2013 only, schools may continue to use the meal pattern for grades K-12 (see § 220.23).
[b] Food items included in each food group and subgroup and amount equivalents. Minimum creditable serving is ⅛ cup.
[c]One quarter-cup of dried fruit counts as ½ cup of fruit; 1 cup of leafy greens counts as ½ cup of vegetables. No more than half of the fruit or vegetable offerings may be in the form of juice. All juice must be 100% full-strength.
[d]For breakfast, vegetables may be substituted for fruits, but the first two cups per week of any such substitution must be from the dark green, red/orange, beans and peas (legumes) or "Other vegetables" subgroups as defined in §210.10(c)(2)(iii).
[e]The fruit quantity requirement for the SBP (5 cups/week and a minimum of 1 cup/day) is effective July 1, 2014 (SY 2014-2015).
[f]Larger amounts of these vegetables may be served.
[g] This category consists of "Other vegetables" as defined in §210.10(c)(2)(iii)(E). For the purposes of the NSLP, "Other vegetables" requirement may be met with any additional amounts from the dark green, red/orange, and beans/peas (legumes) vegetable subgroups as defined in §210.10(c)(2)(iii).
[h]Any vegetable subgroup may be offered to meet the total weekly vegetable requirement.
[i]At least half of the grains offered must be whole grain-rich in the NSLP beginning July 1, 2012 (SY 2012-2013), and in the SBP beginning July 1, 2013 (SY 2013-2014). All grains must be whole grain-rich in both the NSLP and the SBP beginning July 1, 2014 (SY 2014-15).
[j]In the SBP, the grain ranges must be offered beginning July 1, 2013 (SY 2013-2014).
[k]There is no separate meat/meat alternate component in the SBP. Beginning July 1, 2013 (SY 2013-2014), schools may substitute 1 oz. eq. of meat/meat alternate for 1 oz. eq. of grains after the minimum daily grains requirement is met.
[l]Fluid milk must be low-fat (1 percent milk fat or less, unflavored) or fat-free (unflavored or flavored).
[m]The average daily amount of calories for a 5-day school week must be within the range (at least the minimum and no more than the maximum values).
[n]Discretionary sources of calories (solid fats and added sugars) may be added to the meal pattern if within the specifications for calories, saturated fat, trans fat, and sodium. Foods of minimal nutritional value and fluid milk with fat content greater than 1 percent milk fat are not allowed.
[o]In the SBP, calories and trans fat specifications take effect beginning July 1, 2013 (SY 2013-2014).
[p]Final sodium specifications are to be reached by SY 2022-2023 or July 1, 2022. Intermediate sodium specifications are established for SY 2014-2015 and 2017-2018. See required intermediate specifications in § 210.10(f)(3) for lunches and § 220.8(f)(3) for breakfast