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To the Graduate Council:

I am submitting herewith a thesis written by Elizabeth Diane Miller entitled "Eat the Rainbow! An Evaluation of a Short-term Fruit and Vegetable Nutrition Education Intervention for Elementary School Children." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Marsha Spence, Major Professor

We have read this thesis and recommend its acceptance:

Hollie Raynor, Denise Bates

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Eat the Rainbow! An Evaluation of a Short-term Fruit and Vegetable Nutrition Education Intervention for Elementary School Children

A Thesis Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Elizabeth Diane Miller
December 2011

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ABSTRACT

Objective: To test differences on mean fruit and vegetable (FV) eaten, liking, preference, and self-efficacy scores among 3 modes of nutrition education intervention after a 3-week intervention.

Design: Convenience sample, pre- and post-test, quasi-experimental design.

Setting: Three elementary schools in a rural Eastern Tennessee County.

Participants: Participants were 160 3rd-5th graders.

Interventions: Three study schools: experiential (nutrition education, taste tests, and learning activity), conventional (nutrition education and learning activity), and control (learning activity).

Main Outcome Measures: Changes in pre- to post-intervention mean FV eaten, liking, preference, and self-efficacy scores.

Analysis: Mixed model ANOVA to compare the mean pre- and post-scores. Significance was set at the 0.05 level.

Results: Significant increases for preference by intervention group (p=0.015). Although there were no differences by intervention group, significant increases and decreases from pre- to post-intervention were noted for overall FV eaten (p=0.016), liking (p=0.001), and preference (p=.003).

Conclusions and Implications: A 3-week school-based nutrition intervention influenced some factors associated with FV consumption. More research is needed to evaluate sustainability and appropriate, practical intervention duration.

Key Words: Fruits and vegetables, short-term nutrition education intervention, Fresh Fruit and Vegetable Program

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CHAPTER I: LITERATURE REVIEW

Childhood Obesity and Health Implications

It is well documented that childhood obesity rates in the United States (US) have reached epidemic proportions.[1-2] The rate of childhood obesity has tripled over the past 30 years to nearly 20%.[3-4] Childhood obesity is associated with many health risks and problems such as bone and joint problems, sleep apnea, type 2 diabetes, dyslipidemia, hypertension, metabolic syndrome, as well as social and psychological problems such as stigmatization and poor self-esteem.[4-5] Medical and psychosocial treatment of childhood obesity costs the US an estimated 14 billon dollars annually.[2] Moreover, childhood obesity is associated with a higher probability of premature death and disability in adulthood, owing to chronic diseases such as diabetes, cardiovascular diseases and cancer.[6] Research suggests that approximately 40% of obese children and about 80% of obese adolescents become obese adults.[7-8]

With such high medical costs associated with these conditions, a logical and more economical alternative to treatment is prevention. In partnership with the US Department of Health and Human Services, *Healthy People* (*HP*) *2020* establishes goals and objectives for the US to promote health and prevent disease and disability.[9] *HP 2020* is comprised of 4 overarching goals, 4 foundation health measures and 42 topic areas with corresponding objectives, interventions and resources.[9] The topic area "Nutrition and Weight Status," focuses on access to healthier foods, providing weight status information in healthcare and worksite settings, healthy weight status for individuals of all ages, food insecurity, diet, and iron deficiency. Specific objectives related to weight status and nutrition for children are to: 1) *reduce the proportion of children and adolescents who are considered obese* (NWS-10), 2) *prevent inappropriate weight gain in youth and adults in the US* (NWS-11), 3) *increase the contribution of fruits to the diets of the population 2 years and older* (NWS-14), and 4) *increase the variety and contribution of*

vegetables to the diets of the population aged 2 years and older (NWS-15).[9] Concisely, *HP 2020* associates weight status with dietary quality. An approach to preventing childhood overweight and obesity is to improve dietary quality by increasing the consumption of fruits and vegetables (FVs) and decreasing the amount of fats and sugars consumed.[1,8,10-11]

Meeting the Dietary Guidelines

Several government agencies have published recommendations for an adequate diet, which focuses on obtaining ample calories, vitamins and minerals to support growth and a healthy life through everyday consumption of healthy foods. Similar to *HP 2020*, the Dietary Guidelines for Americans (DGAs) focus on health promotion and disease risk reduction.[12] The evidence-based DGAs integrate the Dietary Reference Intakes, the Dietary Approaches to Stop Hypertension Eating Plan, and MyPyramid (now ChooseMyPlate) from the US Department of Agriculture (USDA) to ensure Americans achieve the most recent recommendations for nutrient intakes and that those nutrients are obtained primarily from food and not supplements.[12-15]

The DGAs encourage the consumption of FVs, whole grains, and fat-free or low-fat milk and milk products.[12] However, youth today have dietary patterns low in FVs, whole grains and low-fat dairy foods, but high in fat and added sugars.[16] Meeting the daily FV recommendations may be beneficial in preventing chronic diseases such as cardiovascular diseases, obesity and certain types of cancers because they are nutrient-dense, high in fiber, and low in energy density.[10,17-19] Other health benefits associated with FV consumption include lower blood pressure, reduced risk of stroke, lower risk of eye and digestive problems, and leveling effect on blood sugar that can help control hunger and appetite.[20] It is especially important for school-aged children to consume recommended amounts of FVs because this age group grows at a steady and sometimes rapid rate resulting in the need for adequate vitamins and minerals to support growth.

The DGAs recommendations for fruits (not including fruit juice) and vegetables for Americans ages 2 years and older are at least 2 cups of fruit and 2 ½ cups of vegetables per day for a 2,000 calorie diet; daily calorie recommendations for children ages 4-13 years old are 1,200-1,800 calories per day.[12,21] Consuming the suggested amounts of FVs will provide an assortment of micronutrients and fiber, which promote good health and assist in preventing chronic diseases.[12] Americans of all ages are not meeting these recommendations. Data from the Behavioral Risk Factor Surveillance System confirm that in 2009, only 23.5% of US adults consumed FVs 5 or more times per day.[22] Similar numbers have been observed in US youth. In 2009, only 22.3% of students met the daily recommendations for FV intake.[23] Evidential data place the US in a predicament given that the major causes of morbidity and mortality are related to poor diet.[12] Furthermore, research shows that overweight and obese children and adolescents are more likely to consume a poorer quality diet (containing fewer FVs) than that of their normal weight peers.[11] This relationship, along with evidence suggesting that adult food preferences are set during childhood, has led many health organizations to recommend increasing FVs as a potential strategy to decrease childhood obesity through application of public health policies and school-based interventions.[24-26]

Schools as a Venue for Nutrition Intervention

The majority of US children attend school, and more often than not, schools are surrounded by neighborhoods that connect schools with families and the community, which gives school settings the ability to influence a large number of individuals.[27] Schools are a major setting for student life and environmental influences. Research suggests that children's eating behaviors are strongly influenced by the foods available in their immediate environments, which is important because children consume between $^{1}/_{3}$ and $^{2}/_{3}$ of their daily nutrient needs during

school.[8,16,28] With such a responsibility of providing proper nutrition to children, it has been noted that schools should be actively involved in obesity prevention programs.[8,28] Additionally, schools have been considered a prime location for nutrition interventions due to easy access to assessment data, monitoring of behavior(s), and accessibility to multiple change agents and multidisciplinary teams.[10,27]

Increasing FV intake among elementary-school aged children should be approached through various behavior modifications.[29] The Socioecological Model considers an individual's social system of behaviors and influences that surround health behaviors.[30] According to the model, there are different levels of prevention including intrapersonal, interpersonal, community/organizational, and broader societal factors; complex interactions occur between these levels when change is being introduced or sought.[30-31] For example, a person's intrapersonal eating behaviors are influenced by taste preferences, habits, and nutritional knowledge; interpersonal eating behaviors are influenced by the social environment (culture, traditions, family and friends); and at the community/organizational level, a person's eating behaviors are influenced by policies as well as access to and availability of food.[32]

Many behavioral theories merge with the Socioecological Model for health promotion. Bandura's Social Cognitive Theory (SCT) suggests that individuals live within and are influenced by their social environment.[26] The theory is described by several constructs including knowledge, perceived self-efficacy, outcome expectations and goals, and perceived facilitators and impediments.[33] The concept of self-efficacy affects health behavior directly; the stronger the perceived self-efficacy, the higher the goals people set for themselves and commit to them.[33] Many nutrition interventions have focused on influencing FV consumption through behavior

modifications, increases in knowledge, or both.[29] Accordingly, many nutrition interventions have utilized constructs from the SCT as the theoretical framework for program methodologies.

The Child and Adolescent Trial for Cardiovascular Health (CATCH) was a large school-based health promotion study that followed a cohort of 3rd graders from 4 states in the US beginning in 1991 and ending in 1994 when the students were in 5th grade.[34] CATCH focused on the reduction of risk factors and risk-related behaviors for cardiovascular disease through modifications in behavior and the school food environment.[34] The SCT provided the theoretical framework and directed goals concerning dietary fat and sodium, physical activity, and smoking.[34] Even though the goals were not specific for FVs, the program promoted a healthy diet through messages about increasing FV intake.[34] Over the course of 3 years, the cohort received 47 out of 55, 40-minute nutrition lessons in the classroom setting.[34] Research suggests that 50 hours of health education is needed to create behavior change and that behavioral interventions are more successful when the targeted behavior is highly specific.[26,34] The CATCH study was not successful in increasing FV consumption because the program was not directed towards such an outcome.[34] In comparison, the 5-A-Day Power Plus Program greatly resembled CATCH, apart from its focus on influencing FV consumption. This program was a multi-component intervention based on the SCT, which included 2 curricula: "High 5" for 4th graders and "5 for 5" for 5th graders. During the sessions, students were presented with the opportunity to prepare and taste healthy snacks, in addition to participate in a FV eating competition during lunch.[35] Significant intervention effects for the 5-A-Day Power Plus Program were observed for servings of FVs during lunch (Δ=0.47 servings, P<.00).[35] Because of its specific aim, the program was successful in boosting 5th graders' servings of FVs.[35]

Research suggests that effective intervention programs should be multi-dimensional by challenging the classroom, improving the food service environment, and involving parents.[29] In the school setting, a teacher's time is valuable and limited, which may hinder the addition of supplemental curriculum. Taking this into consideration, Perry and colleagues set out to influence school children's FV consumption during lunch by excluding classroom and parental involvement and intervening with the school food service environment alone.[24] To implement their food service intervention, the research team incorporated the 5-A-Day Cafeteria Power Plus project at a number of Minnesota schools during lunch time.[24] Several constructs taken from the SCT directed this intervention by presenting opportunities to eat a variety of FVs, designating role models, and by instituting social support for children to eat FVs during lunch.[24] The 2-year intervention resulted in the following changes: 0.14 servings higher for FVs (without potatoes) ($P<.03$), 0.15 servings higher for FVs (without potatoes and juice) ($P<.02$), and 0.17 servings higher for fruits (with and without juice) ($P<.01$) among the intervention groups.[24] One element in particular, verbal encouragement from food service staff, was an important factor in bringing about significant increases in consumption from baseline to follow-up.[24] Regardless of the success from this study for increases in FVs (without potatoes and juice) and fruit alone, the program was unable to increase overall servings of vegetables among this age group. Furthermore, the magnitude of observed differences were not as large as those seen in multi-component interventions.[24]

Tuuri and colleagues believe children are not familiar with the FVs provided each day during school meals, have not developed a preference for FVs, or when given a choice will not eat them.[26,36] Using the SCT the "Smart Bodies" program combined education with encouragement, modeling, and exposure.[26] The 12-week "Smart Bodies" program, supported by

the Blue Cross Blue Shield of Louisiana Foundation, anticipated an increase in 4th and 5th graders' knowledge of healthy nutrition practices, FV preferences and psychosocial variables associated with FV consumption.[26] The program consisted of a Body Walk™ adventure through the human body, the OrganWise Guys™ (a cast of characters representing organs of the human body) interactive curriculum, and encouragement through teacher role modeling.[26] Teachers and the characters delivered health messages regarding FV consumption through interactive school assemblies, dolls, classroom videos, books, games and lessons.[26] A pilot test allowed researchers to develop questions corresponding with classroom curriculum, validate knowledge assessment questions, and eliminate difficult or easy questions for the control-intervention trial.[26.] Intervention schools showed significant increases in nutrition knowledge and self-efficacy to consume fruit, drink juice, and consume the recommended number of FVs each day (P=0.00).[26] Apart from the positive results surrounding fruit consumption, there were no significant changes in vegetable preferences.[26] In fact, 4th graders' preferences for vegetables decreased from pre- to post-test.[26] Results may be attributed to the short duration of 12 weeks and the choice to utilize teachers as role models instead of the food service employees.[26,37]

Additional studies have stemmed from the Smart Bodies school-based intervention. A study by Lakkakula and colleagues hypothesized that repeated exposure and tastings would increase children's liking of previously disliked foods.[36] Fourth and 5th grade students from 4 low-income elementary schools participated in the "Wellness Partnership for Kids" pilot program, which consisted of cafeteria-based vegetable tastings combined with the Smart Bodies school wellness curriculum.[36] Participants received 10 tastings of 4 vegetables (baby carrot, piece of tomato, diced green bell pepper, and canned green peas) during school lunch. After each tasting, participants completed a survey for each vegetable indicating whether the vegetable was

spit out or swallowed, in addition to, how much the participant liked the vegetable (4-point Likert scale).[36] Students were included in data analysis if they participated in 8 or more tastings. Results from the 1st to the 10th tasting showed a 5.5 times higher liking score for carrots (p=0.04), 5.6 times higher liking score for peas (p=0.05), and 2.8 times higher liking score for tomatoes (p=0.00), but there was no change in liking for bell peppers.[36] Significant changes in liking scores were noted at the 8th tasting for tomatoes and the ninth tasting for carrots and peas.[36] These results can be compared to the suggested exposure of 10 to15 times for acceptance to occur.[38] Although it is thought that increases in preference for a specific food leads to increased consumption, these results did not reflect changes in consumption.[39-41] Program feasibility was not measured, however, the program was reportedly implemented with ease and without additional need for financial or personnel resources.[36]

Another study by Lakkakula and colleagues utilized baseline data from the Smart Bodies school-based intervention to investigate the relationship between children's preferences for FVs and their weight status.[39] Data from 4th and 5th graders included race, height, weight, BMI, and questionnaire responses regarding preferences for 38 different FVs. The questionnaire utilized a 4-point Likert-type scale to represent how much the children liked the fruit or vegetable. All of the children were African-American (n=341), 17% were overweight, and 20% were obese.[39] Results showed that as FV preference increased, BMI decreased (r=-0.26; p=0.01).[39] For example, children with a very low preference for FVs were 5.5 times more likely to be overweight or obese compared to children with a high preference for FVs (p=0.002).[39] However, when FVs were analyzed separately, no associations were observed between preferences and weight status (p=0.13 and p=0.70 for fruits and vegetables respectively).[39] Despite the lack of generalizability due to the use of a homogenous population and use of cross-sectional, self-

reported data, Lakkakula's study was able to identify an association between preference for FVs and weight status.[39]

Many elementary school nutrition interventions have shown increases in fruit consumption.[23,26] However, similar efforts have been ineffective in influencing vegetable intake.[24,26,35] It is thought that children's unwillingness to consume FVs is associated with not liking the taste of such foods, particularly vegetables, and that frequent exposure to certain tastes will lead to an increase in the liking and acceptance of that taste.[38] Additionally, empirical evidence suggests that young children should be exposed to a certain food around 10–15 times for acceptance to occur.[38] The intensity of exposure corresponds with the previously mentioned 50 hours of health education needed to create behavior change.[26]

School intervention studies have shown mixed results with respect to FV consumption and overweight and obesity among children.[2] A unique approach using school gardens has shown favorable results in increasing FV consumption among elementary school-aged children.[42] Parmer and colleagues conducted a 28-week study in 6 southeastern US 2nd grade classes, which were divided into 3 treatment groups: 2 classes received both nutrition education and gardening (NE+G), 2 classes received nutrition education (NE), and 2 classes served as the control group (CG).[42] Treatment groups participating in nutrition education received 1 hour of nutrition education every other week while the CG participated in the pre- and post-test only.[42] Treatment group NE+G, participated in a hands-on gardening experience planting carrots, broccoli, spinach, and cabbage.[42] School garden maintenance resulted in gardening successes with enough produce to harvest and prepare a salad.[42] Participants' FV knowledge, preference, and consumption was assessed using a taste and rate FV survey. Lunchroom observations measured FV knowledge and preferences.

The gardening research team observed an overall change in food group knowledge from pre- to post-test ($F[1,112] = 16.11$, $P<0.001$).[42] However, the increase was not credited to group assignment.[42] Group assignment results indicated that treatment groups receiving nutrition education experienced significantly greater increases in nutrition knowledge (NE+G, $t= 6.6$, $P<0.001$; NE, $t=5.3$, $P<0.001$) for nutrient–food association over time than did the CG ($t=0.3$, $P=0.733$).[42] Additionally, both treatment groups proved to have significantly greater improvements (NE+G, $t = 9.5$, $P < .001$; NE, $t = 2.3$, $P<0.01$) in FV identification than did the CG ($t=0.5$, $P=0.603$).[42] For participants' willingness to try FVs, an overall distinction was found between the 3 groups ($F[1,78]=5.617$, $P=0.005$), with the treatment groups signifying a greater willingness to try FVs than the control group ($F[1,78]=8.851$, $P=0.004$).[42] Lunchroom observations from pre- to post-test showed that treatment group NE+G, was more willing to choose vegetables during school lunch ($t=3.19$, $P<0.01$) than the NE group ($t=1.83$, $P=0.082$) or the CG ($t=0.73$, $P=0.466$).[42]

A multi-year primary prevention study conducted by Hoffman and colleagues was designed to promote FV intake in children who in 2005 were in kindergarten and 1st grade.[1] This study included 4 public elementary schools in Boston taking part in the Athletes in Service FV program from the winter of 2006 through the spring of 2008.[1] Schools were randomly assigned to receive physical activity only (control) or physical activity plus FV promotion components (experimental).[1] At baseline, nearly half of the children in the study were overweight or obese (experimental group=40%, control group=45%).[1] Program components saturated the school environment and were designed to fit within the school structure with minimal interruptions and minimal effort from school staff.[1] Noticeable acceptability of program components were visible

after the 1st year of implementation and lunch aides reported that giving stickers to students with FVs on their tray helped increase FV consumption.[1]

Final results from Hoffman's multi-year primary prevention study were reported in another article several years after initial data collection. Over the course of the study, data were collected on 5 occasions (winter and spring 2006 and spring 2007-2009) including plate waste data, FV preference and knowledge questionnaire, and BMI.[43] In the 1st 2 years of the study, participants in the experimental group consumed more fruit than the control group ($p<0.0001$ and $p<0.0005$ respectively).[43] However, there was no significant difference in fruit consumption in year 3 and 1 year follow-up. In years 1-3 the experimental group consumed more vegetables than the control group ($p<0.005$, $p<0.05$, and $p<0.05$ respectively).[43] There were no significant effects on FV preferences and BMI throughout data collection periods. During each data collection time point, the experimental group showed higher knowledge scores than the control group ($p<0.05$).[43] Hoffman's study suggests that results from school-based programs may not be sustained beyond the duration of the intervention.

Behaviorally focused school-based nutrition interventions that influence multiple health behaviors have been shown effective in eliciting desired changes.[29] As greater consumption of FVs is associated with a better quality diet in children and is one strategy to reducing childhood obesity, understanding factors related to FV consumption is important.[1,10-11,26,36] Several studies have explored factors known to precede behavior change such as such as knowledge of FVs, preference for FVs, and self-efficacy to consume FVs.[16,26,36,43,55] Likewise, programs from the USDA such as the National School Lunch Program (NSLP), Team Nutrition, and the Fresh FV Program (FFVP) have been designed to improve dietary quality by increasing access to healthy

foods, encourage FV consumption, and to influence preference, knowledge and familiarity of FVs.[12,36,43]

USDA Programs

NSLP

The NSLP provides cash reimbursements and USDA commodity foods to local educational agencies for each meal served. Free school meals are available to children from households with incomes at or below 130% of the Federal poverty level, while reduced-price meals are available to children from households that are no greater than 185%of the poverty level.[44] In 2010, the NSLP provided nutritionally balanced, low-cost or free lunches to 32 million children.[44] School lunches must meet the recommendations of the DGAs and should provide one-third of the Recommended Dietary Allowances for protein, vitamin A and C, iron, calcium, and calories.[45] In accordance with the DGAs, school lunches should reduce the sodium content of food, increase the fiber contend and provide no more than 30% of calories from fat and less than 10% of calories from saturated fat.[46]

There has been scrutiny regarding the NSLP and the nutrient quality of foods provided. More notably, the program has been criticized for providing high-fat meals.[28] By federal law the NSLP is required to meet one-third of daily nutrient requirements, and commodity foods (fruits, vegetables, fruit juices, meats, cheeses, beans, and grain products) make up a large portion of those requirements.[47] School meals are only part of a child's eating environment; the home environment plays a major role as well. It has been documented that families of lower socioeconomic status have poorer dietary quality and are at a greater risk of becoming overweight or obese due to factors such as cost of FVs, lack of FV access at home, and familiarity with FVs.[36,48] Considering the school environment, a study by Robinsion-O'Brien

found that ethnically diverse, low-income children participating in the NSLP consumed over half of their daily FV intake during school (54%).[49] Li and colleagues evaluated the relationship between childhood obesity and student participation in the NSLP using data from the National Survey of Children's Health conducted by the Centers for Disease Control and Prevention from 2003 to 2004.[28] They found that a child who was eligible for the NSLP and attended a public school had a BMI that was 0.41 higher than ineligible children ($p<0.001$).[28]

With the growing concern of childhood overweight and obesity in relation to the nutritional quality of children's diets, the NSLP and similar programs have the opportunity to positively influence children's nutrition. The *Child Nutrition Reauthorization Act of 2010* has mandated that schools develop and adopt local school wellness policies that set nutrition guidelines for school meals that are aligned with the most recent DGAs, and that schools set goals for nutrition education.[12,50] Appropriate comprehensive evaluation of these new standards will be necessary to determine possible influences on children's dietary quality and habits.

Team Nutrition

The USDA's Team Nutrition program is available to schools interested in promoting health in the school environment.[51] The program provides an integrated, behavior based comprehensive plan for promoting the nutritional health of children by utilizing principles from the latest DGAs and MyPyramid (now ChooseMyPlate).[51] The behavior-focused strategies of Team Nutrition aim to provide food service professionals training in preparing and serving nutritious meals, to promote nutrition education through multiple communication methods, and to establish school and community partnerships resulting in a school environment infrastructure that encourages healthy eating and physical activity.[51] Schools pledge to make nutritional changes, provide nutrition education, and utilize USDA Food and Nutrition Service materials

when they enroll as Team Nutrition Schools.[51] Local implementation of Team Nutrition occurs through state agency collaboration to develop support systems.[51] Through health promoting school policies, Team Nutrition has the opportunity to transform the school environment and empower students to take charge of their health. This program has been implemented in over 96,000 schools nationwide.[51]

Fresh Fruit and Vegetable Program

The FFVP is funded by the Department of Education through the USDA as part of the NSLP. The program began as part of *The Farm Security and Rural Investment Act of 2002* and was piloted in 4 states and 1 Indian Tribal Organization.[52] *The Child Nutrition and WIC Reauthorization Act of 2004* added 4 more states, 10 schools in South Dakota's Pine Ridge Reservation, and 8 schools in Arizona's Tribal Council.[52] The FFVP was expanded to include schools in 6 more states with money appropriated by *The Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act of 2006*, Public Law 109-97.[52] The FFVP has evolved over time to include selected schools nation wide including the District of Columbia, Guam, Puerto Rico and the Virgin Islands.[52]

Schools submit an annual application to be considered for the FFVP based on the percentage of economically disadvantaged students enrolled, as well as other factors such as the school's efficient use of resources and novel promotional efforts.[53] Because low socioeconomic status has been associated with low consumption of FVs, eligibility for the FFVP is based on the percentage of participation in NSLP.[53] The FFVP provides students the opportunity to sample approved fresh FVs free of charge during the school day potentially introducing new foods and flavors. The USDA's Food and Nutrition Service consider the program a strategy in reducing and preventing childhood obesity by promoting change in children's dietary habits.[52]

The intention of the program is to incorporate FV sampling into class curriculum as a means to become part of daily school activities. Additionally, the goal of the FFVP is to increase exposure and consumption of FVs. Therefore, program evaluation is necessary to determine potential changes in these parameters. The Farm Bill has 3 million dollars set aside for the USDA's Food Nutrition Service to conduct an evaluation of the FFVP by September 30, 2011.[54] Program Policy number SP 31-3008 titled *Nationwide Expansion and Program Operations resulting from the Food, Conservation, and Energy Act of 2008*, briefly discloses the evaluation process and requirements for the FFVP.[54] The policy delegates data collection responsibilities to state agencies requiring them to report the information to Food and Nutrition Service for completion of the evaluation.[54] There is a lack of published information instructing state agencies how to collect data. The only information given is, "Additional information on the evaluation will be provided at a later date."[54] In such challenging economic times, financial support for programs such as the FFVP is at risk of being discontinued. Therefore, it is important that an evaluation process be established and implemented to examine any influences the program has on students' exposure to a variety of FVs, preference for FVs, and FV consumption.

A group of researchers conducted an evaluation of the FFVP during the pilot phase of the program and after the 1st year of implementation in Mississippi. Neither of these studies had a comparison group. Pilot evaluation data were collected during the 2004-2005 school year from participants in grades 5, 8, and 10.[55] Self-reported student questionnaire pre- and post-test data measured attitudes toward eating FVs, perceived self-efficacy to eat more FV, willingness to try new FVs, familiarity and preference for FV, and intentions to eat more FV.[56] Students in grades 8 and 10 participated in a 24-hour dietary recall.

At post-test 8th grade participants reported more positive attitudes toward eating FVs ($p<0.01$), perceived self-efficacy to eat more FVs ($p<0.01$), and willingness to try new FVs ($p<0.01$).[55] These results were not observed for 5th or 10th grade participants. In fact, 5th grade participants' scores decreased significantly for willingness to try new fruits and new vegetables ($p=0.01$ and $p=0.03$ respectively), and perceived self-efficacy to eat more FVs ($p=0.04$).[55] However, participants' familiarity with FVs and the variety of FVs ever eaten increased significantly among all grade levels.[55] Positive changes in participants' preference for fruits were observed for grades 8 and 10 ($p=0.01$ and $p<0.01$ respectively), but negative changes were observed for 5th grade participants ($p=0.03$).[55] Preference for vegetables decreased among 5th and 8th grade participants' ($p<0.01$ and $p=0.01$ respectively). There were no significant changes in intentions to eat more vegetables for any grade level.[55] However, a significant increase in intention to eat more fruits was observed in 10th grade participants ($p=0.01$).[55] Eighth and 10th graders' 24-hour dietary recall data showed a significant increase in consumption of fruit at school by 0.34 ($p<0.01$) and a significant decrease in vegetables consumed at school ($p=0.05$).[55] The authors concluded that Mississippi pilot FFVP was more successful with the older participants because younger children prefer sweet, energy-dense foods and that this fondness changes as puberty approaches.[55] This study prompted a process evaluation 1 year following full implementation of the Mississippi FFVP.

The process evaluation study of the Mississippi FFVP aimed to address where, when, and how produce was distributed; what was distributed; challenges and successes; and recommended modifications.[56] Quantitative and qualitative data were collected from FFVP coordinators and food service administrators, principals, teachers and other school staff, evaluation site coordinators, parents, and students.[56] Acquiring and preparing the produce became the

responsibility of the food service administrators who reported allotting extra time to prepare the FV snacks.[56] Produce was distributed through classrooms or in a central courtyard.[56] Produce served included 22 types of fresh fruit, 4 types of dried fruit, and 7 types of vegetables; apples, carrots, and celery were served with dips.[56] The frequency of vegetables distributed decreased as the year progressed due to the amount of vegetables not being consumed by students and the preference for fruit.[56] Schools reported time needed to prepare FV snacks and timely produce shipments as the most common challenges.[56] Educational strategies and a parental components were suggested as potential modifications to the program.[56] Results from this process evaluation may be beneficial to other school systems participating in the USDA's FFVP. Additionally, researchers and evaluators may find the research parameters from the pilot study and process evaluation beneficial when implementing an evaluation component to the FFVP.

Challenges in School-Based Research

A meta-analysis conducted by Knai and colleagues concluded that successful FV interventions targeted towards school-aged children include the following characteristics: 1) duration of at least 12 months, 2) specific focus on FVs, 3) school-wide campaign to increase FV exposure, 4) integration of FV lessons into current curriculum, 5) active student involvement and peer encouragement, 6) leadership encouragement from teachers and food service employees, and 7) parental involvement at school and home.[57-58] However, specific challenges in the school setting such as lack of resources, expertise, and competing (instructional) priorities, prevent the inclusion of these characteristics in most comprehensive nutrition interventions.[27]

Competing instructional priorities emerge from the *No Child Left Behind* (NCLB) *Act of 2001*, which was put in place to close the achievement gap between disadvantaged and minority students and their peers. To close the gap, schools are held accountable for higher academic

performance.[45] If a school has poor academic performance, parents can transfer their child to a higher achieving school.[45] Academic performance is measured by annual tests in math, reading, and science; leaving little room for instruction in physical education and other health and social science-based subjects.[59] Consequently, these performance standards have shifted the focus on improving test scores as opposed to searching for a broader idea of education, health, and learning. This focus has placed schools under considerable pressure, thus limiting opportunities for supplemental educational activities. The reauthorization of the Elementary and Secondary Education Act, which encompasses NCLB, recognizes that students need a well-rounded education including: literacy, mathematics, science, technology, history, civics, foreign languages, the arts, financial literacy, and other subjects.[60] Reform could facilitate the opportunity for health and nutrition education in the schools, especially with Michelle Obama's *Let's Move* campaign focusing on raising healthier children by promoting a healthy diet and physical activity in a variety of settings, including schools.[61]

Time and money are considered restrictive resources when implementing school-based nutrition programs. The resource time presents several challenges: 1) time expressed as duration and 2) time expressed as timing, or scheduling. Stakeholders in the USDA's Team Nutrition Pilot Study indicated that the time commitment of managing a multi-level school-based nutrition intervention was similar to a full-time job.[62] Supplemental educational interventions, such as nutrition interventions, compete with academic priorities. The Team Nutrition pilot study recommended integrating nutrition education into existing school curriculum to reduce the conflict of time.[62] As for timing, it is recommended to allow ample time for program planning to ensure implementation and evaluation will coordinate with the school's schedule.[62] As a result of NCLB, time is everything. Annual preparation for standardized examinations constricts both

time and timing of school-based interventions. Dedicated financial resources are necessary for the sustainability of comprehensive school-based nutrition intervention programs. The Team Nutrition Pilot Study identified sustainable financial resources as another challenge in school-based nutrition interventions, and as a result, recommended forming community partnerships and seeking additional grant opportunities.[62]

Future Research

Increasing FV consumption in children has been the target of many obesity prevention programs in the school setting. However, more research is needed determine appropriate durations and methodologies that ensure sustainability for school-based nutrition interventions.[1,29,43] Although increased exposure to FVs has been shown to influence preference and consumption in school-aged children, more research is needed to identify the best methods of increasing exposure and therefore consumption .[36,58,63] To reiterate, time is a limited resource in the school setting. Short-term nutrition interventions and studies are limited, but are needed to meet the needs and requests of schools.

There are many government funded programs available that focus on nutrition and health promotion in the schools. Programs such as Team Nutrition and the FFVP have minimal evidence to support the effectiveness of employing these programs in schools. Grants awarded to schools facilitate the ongoing participation in these programs, which presumably obligates the reporting and evaluation of specific outcome measures. Future research is needed to support the allocation of dedicated funding for such programs, especially during a time of intense budget cuts.

The purpose of this study was to evaluate the effectiveness of, *Eat the Rainbow!*, a nutrition education intervention associated with a school system's FFVP and to test the

effectiveness of supplemental nutrition education components implemented to improve the program. It was hypothesized that FV eaten, liking, preference and self-efficacy survey scores would be significantly higher among children who received a multi-component, short-term intervention that included nutrition education, structured taste tests, and a rainbow plate activity compared to children who received nutrition education and participated in the rainbow plate activity or children in the control group who participated in the rainbow plate activity only, which was the standard activity that had been implemented previously as the nutrition education activity for the FFVP.

CHAPTER II: MANUSCRIPT

INTRODUCTION

It is well documented that childhood obesity in the United States has reached epidemic proportions and is an ongoing public health concern due to the negative social- and health-related outcomes.[1-3] Improving dietary quality by increasing the consumption of fruits and vegetables (FVs) and decreasing the amount of fats and sugars consumed is an approach to reducing and preventing childhood obesity.[1,4-6] Moreover, research suggests that children's eating behaviors are strongly influenced by the foods available in their immediate environments, and with schools providing children between one to two-thirds of their daily nutrient needs, schools should be actively involved in improving dietary quality.[6]

Many school-based nutrition programs have been designed and implemented with the intent of increasing fruit and vegetable (FV) consumption and associated factors including knowledge, preference, and self-efficacy.[6-13] Results from these studies are somewhat polarized showing increases in fruit consumption and associated factors, while vegetable consumption and associated factors remain the same or actually decrease.[7-8,12-13,15] It is thought that children's unwillingness to consume FVs, particularly vegetables, is associated with not liking the taste of such foods, being unfamiliar with the FVs provided each day during school meals, or a lack of preference for and self-efficacy to consume FVs.[8,11,16] Programs from the United States Department of Agriculture (USDA) such as the National School Lunch Program (NSLP), Team Nutrition, and the Fresh FV Program (FFVP) are designed to improve dietary quality by increasing access to healthy foods; encouraging consumption of FVs; and by influencing preference, knowledge and familiarity of FVs.[9,17-18] The FFVP, funded by the Department of Education through the USDA as part of the NSLP, is a nation-wide program awarded to schools

with a high percentage of economically disadvantaged students.[9-10] The goal of the FFVP is to increase exposure and consumption of FVs, thus promoting change in children's dietary habits as a strategy in reducing and preventing childhood obesity.[9-10] To date, few studies have evaluated the FFVP.[13,19]

A process evaluation study of the FFVP by Potter and colleagues aimed to address where, when, and how produce was distributed; what was distributed; challenges and successes; and recommended modifications.[19] Quantitative data showed that the frequency of vegetables distributed decreased as the year progressed due to the amount of vegetables not being consumed by students and the preference for fruit.[19] The most common challenges reported were time needed to prepare FV snacks and timely produce shipments.[19] Suggested modifications to the FFVP were to implement educational strategies and a parental component.[19]

Due to limited studies regarding the FFVP, more studies need to be completed to sustain allocation of funding and effectiveness of employing this program in schools. Furthermore, time has been considered a restrictive resource when implementing school-based nutrition programs, like the FFVP, in terms of duration and scheduling because schools are faced with competing instructional priorities. More research is needed determine appropriate durations and methodologies for nutrition interventions in schools.[14] Previous research in this area has focused on nutrition education interventions that are between 10 weeks to 3 years in duration; however little is known about the impact of short-term interventions, which are often implemented in schools due to time constraints.[1,7-8,11-12,15,24] Many schools desire a brief 1-time nutrition education activity that is practical for the school's daily schedule, thus satisfying USDA school wellness policy mandates for nutrition education.[25] In partnership with the local education agency in this study, the research team negotiated an expansion of the 1-time nutrition activity to

a 3-week nutrition education intervention. The purpose of this study was to evaluate the effectiveness of, *Eat the Rainbow!*, a nutrition education intervention associated with a school system's FFVP and to test the effectiveness of supplemental nutrition education components implemented to improve the program. It was hypothesized that FV eaten, liking, preference and self-efficacy survey scores would be significantly higher among children who received a multi-component, short-term intervention that included nutrition education, structured taste tests, and a rainbow plate activity compared to children who received nutrition education and participated in the rainbow plate activity or children in the control group who participated in the rainbow plate activity only, which was the standard activity that had been implemented previously as the nutrition education activity for the FFVP.

DESCRIPTION OF INTERVENTION AND EVALUATION

Study Design

Eat the Rainbow! used a convenience sample, pre- and post-test, quasi-experimental design to assign 3 rural East Tennessee elementary schools into 1 of 3 intervention groups: experiential, conventional and control. The experiential group was awarded the USDA's FFVP for the 2010-2011 school year based on the percent of students (90%) eligible for the NSLP during 2010; conventional and experiential groups' percent of students eligible for the NSLP was 56% and 51% respectively.[20] Conventional and control groups were assigned accordingly based on the number of students in the 3rd-5th grade with the control group having the largest sample population. For 3 weeks the experiential and conventional groups received 3, 30-minute nutrition education lessons. In addition, experiential group participants received a structured taste test after each nutrition lesson. All intervention groups participated in a rainbow plate activity. The independent variables in this study were the intervention groups, and the dependent variables

were changes in pre- to post-intervention mean FV eaten, liking, preference, and self-efficacy scores. This study was approved by the Institutional Review Board at The University of Tennessee, Knoxville.

Recruitment

At the beginning of the 2010-2011 school year, parental consent forms were sent home with all 3rd-5th grade students from the 3 elementary schools in the district. Consent forms were labeled with student identification numbers to allow data tracking from pre- to post-intervention. Eligibility was based on the following criteria: 1) enrolled in the 3rd-5th grade in an elementary school in the local education agency during the 2010-2011 school year and 2) parental consent and participant assent allowing for pre- and post-intervention data collection. Students were excluded from data collection if their consent forms were returned on the day of baseline data collection or any day thereafter.

Procedures

Teachers distributed and collected parental consent forms during the first week of the 2010-2011 school year; all other procedures were administered by researchers from The University of Tennessee, Knoxville. During the intervention, students assembled in auxiliary rooms accompanied by their teachers. Once a week for 3 weeks, experiential and conventional groups received a 30-minute nutrition education lesson that was adapted from The University of Tennessee Extension Family and Consumer Science's, *Power U Healthy* curriculum.[21] Four lessons titled 1) Variety, Balance, and Moderation, 2) FVs I, 3) FVs II, and 4) Moving on with Fiber were taught during this study; lessons 1 and 2 were combined during the first week. After each nutrition lesson, the experiential group participated in a 5-minute structured FV taste test.

To decrease the effect of exposure time, the conventional group received 5 extra minutes of discussion.

All 3rd-5th graders from the 3 schools participated in the rainbow plate activity on the last day of the intervention. Students walked through a fresh FV buffet receiving 1 each of the following: grape tomatoes, red delicious apples, carrots, cantaloupe, bananas, corn, kiwi, broccoli, purple grapes, and cauliflower. Students arranged the FVs on their plate into a rainbow and were encouraged to taste their rainbow.

Data Collection

This study used a 4-part FV survey modified from 2 previously validated surveys to evaluate mean scores for FVs ever eaten, liking of FVs ever eaten, FV preference, and self-efficacy to consume FVs (Table 1, Appendix B).[22-23] The first 3 sections of the survey were adapted from a validated FV preference survey created by Domel et al in 1993.[22] The 4th section of the survey was adapted from a FV self-efficacy survey created by Domel et al in 1996.[23] Components from both the preference and self-efficacy FV surveys were combined and modified to fit the needs of this study. For both pre- and post-intervention surveys, researchers explained each section and remained in the room. Pre-intervention surveys were administered 1 week following recruitment, while post-intervention surveys were administered during the last week, after the rainbow plate activity.

Survey results were considered incomplete data and were excluded during data analysis if the student was absent during pre- and/or post-intervention data collection, if the student had to be excused during administration, or if the student failed to complete the majority of the survey at either pre- or post-intervention. Results were tracked pre- to post-intervention by student identification number. There were 327 3rd-5th graders eligible for this study of those, 230 (70%)

returned parental consent forms enabling them to participate in data collection (Figure 1, Appendix B). After removing incomplete surveys, 160 (49%) were used for data analysis.

Statistical Analysis

Data analyses were conducted using SPSS version 18.0 (SPSS, Inc., Chicago, IL, 2009). Demographics were analyzed using chi-squared for gender, grade and race/ethnicity. Age and baseline mean FV survey score differences among groups were analyzed using a one-way ANOVA. Mixed model ANOVA identified interval changes in the dependent variables. Post hoc pairwise comparisons were performed using the Bonferroni correction. Significance was set at an alpha of 0.05 level.

RESULTS

This 3-week study analyzed pre- and post-intervention FV survey data from 160 students (Figure 1, Appendix B). Students in the experiential and conventional groups were exposed to 3 nutrition education sessions. The majority of students were white (83%, n=144) and female (60%, n=105). Each grade level represented approximately a third of the sample population, and the majority of students were between 8-10 years of age (96%, n=154). No differences existed between intervention groups and gender, race/ethnicity, or grade level (Table 2, Appendix B). Significant age differences existed between experiential and control groups (p=0.014); the control group was significantly older, making age a covariate during analysis. Additionally, there were no significant differences among the independent variables at baseline. Plots of estimated marginal means for FV survey components are in Appendix C.

Mean FV eaten scores did not vary significantly by treatment group (Table 3, Appendix B). Students' mean FV eaten scores increased significantly from pre- to post-intervention for all

3 intervention groups (F[1,156]=5.9, p=0.016). There were no significant differences in mean eaten scores between treatment groups for fruits or vegetables. Students' mean fruit eaten scores increased significantly from pre- to post-intervention for all treatment groups (F[1,156]=6.3, p=0.013). Mean vegetable eaten scores increased significantly from pre- to post-intervention for all treatment groups (F[1,156]=4.1, p=0.044).

Table 4 in Appendix B describes changes in liking scores from pre- to post-intervention by treatment group. There were no significant effects by treatment group for mean FV liking scores. Mean FV liking scores differed significantly from pre- to post-intervention (F[1,156]=10.9, p=0.001). There were no significant effects by treatment group for liking of fruits or vegetables. Mean liking scores for fruits ever eaten increased significantly from pre- to post-intervention (F[1,156]=9.5, p=0.002) for all intervention groups. Vegetable liking scores differed significantly from pre- to post-intervention (F[1,156]=7.1, p=0.009).

Significant treatment effects were seen between conventional and control treatment groups (F[2,156]=4.4, p=0.015) with the conventional group having a greater mean preference score at pre- and post-intervention (Table 5, Appendix B). Changes in students' preference for FV snacks increased significantly for all intervention groups from pre- to post-intervention (F[1,156]=9.3, p=0.003). Students' mean self-efficacy scores are depicted in Table 5 in Appendix B. There were no significant treatment effects noted for self-efficacy to consume FVs, nor were there significant differences from pre- to post-intervention.

DISCUSSION

The USDA's FFVP aims to increase student exposure to a variety of FVs, thus increasing consumption. This intervention did not assess consumption, rather factors associated with

consumption such as number of FVs ever eaten, liking of FVs ever eaten, preference for FVs, and self-efficacy to consume FVs.[13-14,23-24] This study evaluated differences among 3 modes of intervention on the dependent variables using a novel, short-term approach. Improvements to the experiential school's previous implementation of the FFVP were assessed by incorporating supplemental activities including nutrition education, structured weekly taste tests, and a rainbow plate activity. It was hypothesized that survey scores would differ by intervention group. However, this was only true for FV preference, in which there was a significant difference in preference between conventional and control groups suggesting that nutrition education in the short-term may have contributed to these differences. It was anticipated that the addition of nutrition education and taste tests would positively influence pre- and post-intervention FV survey scores for the dependent variables. This study produced significant differences in mean pre- to post-intervention scores for all dependent variables except for self-efficacy; however, the majority of these results cannot be attributed to intervention group.

Few studies have examined increases in the variety of FVs students have ever eaten. Coyle and colleagues evaluated effects of the FFPV on several schools in Mississippi and found that after 1 year students significantly increased the variety of FVs they had ever eaten.[13] Similarly, we found that all 3 groups' mean eaten scores significantly increased from pre- to post-intervention for FVs combined and separate. It is possible that these increases in FV eaten scores from pre- to post-intervention are partial effects of exposure outside of the intervention (i.e. school breakfast and lunch), which was not accounted for in this study. This study suggests that a 1-time activity, such as the rainbow plate activity, may increase the variety of FVs students have ever eaten in the short-term.

Lakkakula and colleagues demonstrated that previously disliking of foods can be transformed into liking through repeated exposure.[11] The literature suggests 10-15 exposures of a new or disliked food are needed in order for acceptance to occur.[11,16] Lakkakula noticed significant increases in liking by the 8th exposure.[11] Students from this study were not given the opportunity for repeated tastes or exposures. However, modest increases in liking scores for experiential and conventional may be explained by the fact that increased exposure to specific foods can increase liking, even over a short period of time.[11] Furthermore, nutrition education may have contributed the differences in FV liking scores from pre- to post-intervention. More research may be necessary to determine at what point taste tests benefit children's liking of FVs. Vegetables were the least liked of the FVs that participants had ever eaten, and the control school's liking for vegetables actually decreased from pre- to post-intervention. This is similar to other studies, which show that school-aged children like fruits more than vegetables.[7-8,11-13] Research suggests that younger children prefer sweeter, more energy-dense foods compared to the bitter taste of vegetables, especially cruciferous vegetables, and that children are less willing to taste unfamiliar foods.[8,13,24] Also, liking of vegetables may be related to preparation methods (raw versus cooked or with a dip).[13,19,22]

As with liking of FVs, school-age children usually prefer fruits over vegetables.[12-13,19] Increasing FV preference is a strategy to increasing consumption.[11] Previous interventions ranging from 12 weeks to 3 years in duration have reported mixed results in influencing preference for FVs.[8,13-13,24] This study found significant increases in mean preference scores from pre- to post-intervention for all treatment groups; indicating a higher preference for FV snacks after 3 weeks. The significant difference between conventional and control groups for preference

suggest that nutrition education may have had more of an effect on the dependent variables than the rainbow activity, but the taste tests seemed to have no added benefit in the short-term.

Many school-based interventions have been supported by a theoretical framework such as the social cognitive theory, which suggests that individuals are influenced by their social environments.[7-8,12-13,23] Within this theory is the construct of self-efficacy. Previous studies show mixed results regarding self-efficacy to consume FVs.[8,13] A multi-component school-based intervention by Turri and colleagues increased students' self-efficacy to consume FVs in 12-weeks.[8] Coyle and colleagues looked at self-efficacy to consume FVs in a 1 year evaluation of the Mississippi FFVP and found that 5th graders self-efficacy to consume FVs decreased from pre- to post-test.[13] These studies demonstrate that a short-term intervention that addresses multiple influences on health behavior can increase self-efficacy to consume FVs. By adding to the literature, we demonstrated that this 3-week intervention was too short a duration to influence self-efficacy to consume FVs.

Limitations

The sample of participants in this study was fairly homogenous (83% white), hence, the results of this study have limited generalizability. Random assignment was not feasible in this study, instead a convenience sample was used and groups were allocated based on the number of eligible students enrolled, except for the experiential school which was assigned accordingly because of its participation in the FFVP. Another potential limitation to this study was the use of self-reported data, which especially among this age group, can be subject to social desirability and recall bias.[11] In attempt to decrease this bias, researchers remained in the room during survey administration and provided assistance only when a student did not understand a question or did not recognize a particular fruit or vegetable by word or picture. Another limitation to this study is

the assumption that students reported if they had ever eaten the fruits or vegetables from the survey regardless of preparation method. This assumption was unaccounted for, but should be considered in future studies because it has been proposed that preparation methods may influence liking, preference and consumption of FVs.[22]

Research suggests that 50 hours of health education is needed to create behavior change.[8] Although this study evaluated factors associated with increases in FV consumption, actual changes in FV consumption were not evaluated, as the experiential and control groups only received 1.5 hours of nutrition education. Furthermore, evaluating changes in FV consumption would have required a longer evaluation tool that would have increased the respondent burden and therefore variability in results. Because this intervention took place at the beginning of the school year, students may not have accurately recalled the FVs they had ever eaten during the previous school year. Post-intervention data was collected nearly 1 month after the first of the school year; no follow-up data were collected or analyzed and the sustainability of results unable to be obtained.

Parental involvement and home reinforcement were not strong features of this study. Newsletters and worksheets sent home throughout the intervention were not discussed beyond the point of distribution. A process evaluation of the FFVP reported that some of the parents were unaware of the program at their child's school.[19] Parental involvement is viable because parents can increase home FV availability and serve as role models, thus increasing self-efficacy to consume FVs.[13] Research suggests targeting parental FV intake and feeding practices is vital to the success of nutrition interventions designed to increase children's FV consumption.[26] Furthermore, research recommends looking at a variety of environmental factors in the home that may influence FV consumption with the strongest factors being home food availability and

accessibility and parental FV intake.[26] Future research is needed to identify intervention components that will increase parental awareness and involvement, thus increasing FV availability in the home.

Although data regarding the percent of students eligible to participate in the NSLP were available, socioeconomic status was not assessed in this study. Socioeconomic status can affect home food availability and it has been documented that families of lower socioeconomic status have poorer dietary quality, and are at a greater risk of becoming overweight or obese due to factors such as cost of FVs, lack of FV access at home, and familiarity with FVs.[11,18] Considering the school environment, a study by Robinsion-O'Brien found that ethnically diverse, low-income children participating in the NSLP consumed over half of their daily FV intake during school (54%).[27] Future research should assess and account for socioeconomic status and home food availability as these factors clearly affect children's FV consumption and associated factors.

IMPLICATIONS FOR FUTURE RESEARCH

Supplemental components, including evaluation, used in this study can serve as examples for schools participating in the USDA's FFVP. Future studies evaluating the program should measure changes in FV consumption and associated factors at several time intervals throughout the school year to demonstrate changes throughout the year and potential seasonal affects. Follow-up data should be reported to demonstrate sustainability of the FFVP especially during the summer months when children do not attend school.

Schools need practical nutrition interventions that consider their daily and annual time constraints. For schools that are not part of a larger system or not part of a long-term nutrition

research study, the supplemental components used in this study can serve as examples for schools in need of a short-term nutrition intervention. To help answer the question what is feasible in the school setting, future research should explore the least amount of time needed to positively increase and sustain factors associated with FV consumption. To the best of our knowledge, this study represents the shortest in duration for elementary school-based nutrition research. Future research should look at changes in factors associated with FV consumption over nutrition intervention time periods of 4 weeks, 5 weeks, and so on until an appropriate duration, which positively impacts consumption and associated factors can be determined. Another consideration for future research is the idea of intermittent nutrition interventions, which should be looked at as a few weeks at a time several times throughout the year, or several 1 to 2 hour assembly-type interventions throughout the year.

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APPENDICIES

APPENDIX A: EXPANDED RESEARCH METHODS AND PROCEDURES

Research Design

This study used a convenience sample, pre- and post-test, quasi-experimental design to determine, through the use of a validated FV survey, possible changes in mean scores for FVs eaten, FVs liking, FVs preference, and self-efficacy to consume FVs. Three elementary schools within the same district were allocated into 1 of 3 intervention groups: experiential, conventional and control. The experiential group was awarded the USDA's FFVP for the 2010-2011 school year based on the percent of economically disadvantage students (89.8%) who were eligible for the National School Lunch Program during 2010.[20] The experiential group received weekly nutrition education and taste tests during the intervention. The conventional group received weekly nutrition education lessons. All intervention groups participated in the rainbow plate activity during the last day of the intervention. This study design, as well as all materials used, was approved by the Institutional Review Board at The University of Tennessee, Knoxville and by the director of schools at the local educational agency in this study.

Recruitment

Participants were recruited from 3 elementary schools within 1 school district in a rural county in East Tennessee. Third through 5th grade students enrolled during the 2010-2011 school year were invited to participate. During the first week of the school year, a parental consent form was sent home with students. The form explained the purpose of the study, information on the intervention, potential harms and/or benefits, and a brief demographic questionnaire. Consent forms were labeled with student identification numbers to allow for tracking of data from pre- to post-intervention. Students had 1 week to return a signed form to their homeroom teacher.

Parental consent permitted students to participate in pre- and post-intervention data collection, but was not necessary for participation in the rainbow plate activity, nutrition

education, or taste tests. Eligibility was based on the following criteria: 1) enrolled in the 3rd-5th grade at the local education agency under study for the 2010-2011 school year and 2) parental consent allowing for pre- and post-intervention data collection. Students were excluded from data collection if the consent form was returned on the day of baseline data collection or any day thereafter.

Based on eligibility criteria, a total of 363 students were qualified to participate in this study, 230 (63.8%) returned consent forms, and complete data were available from 160 students (Figure 1, Appendix A). Survey results were regarded as incomplete data and were excluded during data analysis if the student was absent during pre- and/or post-test data collection, if the student had to be excused from taking the FV survey, or if the student failed to complete the majority of the FV survey. Results were tracked from pre- to post-intervention by student identification number. Insufficient data for any student for the pre-intervention survey were considered insufficient data for that student's post-intervention survey and vice versa.

Curriculum and Instruments

Nutrition education. This study adapted nutrition education curriculum from The University of Tennessee Extension Family and Consumer Science's, *Power U Healthy* program (Power U), which was designed for classrooms, community youth groups, and other educational settings for children in 4th grade.[21] The Power U curriculum promotes healthy eating and physical activity and was funded by the BlueCross BlueShield of Tennessee Health Foundation, the Memorial Foundation, and Tennessee Farm Bureau Groups.[21] Power U is comprised of 10, 30-minute lessons. Four lessons titled 1) variety, balance, and moderation, 2) FVs I, 3) FVs II, and 4) moving on with fiber were taught during this study. Lessons 1 and 2 were combined during the first week of the intervention. Curriculum components utilized during this study included a

teacher's guide, food cards, and reproducible master copies of family newsletters and student activity sheets.

Fruit and vegetable survey. The FV survey used in this study was validated to measure preference for FVs and self-efficacy to consume FVs.[22-23] Utilization of these surveys was ideal for this study because they were designed, piloted, and field tested on 4th and 5th graders where the majority of students were eligible for free and reduced priced lunches.[22-23] Our 4-part survey evaluated students' self-reported number of FVs ever eaten (eaten), how much they liked what they had eaten (liking), if they preferred to consume a FV snack or a non-FV snack (preference), and if they had the self-efficacy to consume FVs under certain circumstances (self-efficacy). Each component of the FV survey represented the dependent variables, while each intervention group served as an independent variable. In addition to evaluating effects of this intervention, the FV survey was utilized as a means to evaluate the effectiveness of the USDA's FFVP in the experiential group.

The first 2 sections of the survey provided a list with pictures of 33 FVs (16 fruits and 17 vegetables), and asked participants whether or not they had ever eaten a specific fruit or vegetable (yes or no). If so, they were asked how much they liked the fruit or vegetable. Liking was rated on a Likert-type scale with numbers and cartoon faces to indicate ranking from "really did not like" to "liked it a lot." The 3rd section presented 8 questions where students indicated whether they preferred to eat a FV snack or a non-FV snack when arriving home from school. Non-fruit or vegetable food choices were typical snacks such as a candy bar, a soda, cookies, chips, or peanut butter on bread. Available vegetable choices specified that the vegetable be raw accompanied with a dip; there were no specifications for preparation of fruit choices. The 4th section consisted of 5 questions asking students how sure they were that they could choose to eat

a fruit or vegetable under certain circumstances. For example, "How sure are you that you could eat fruit for dessert, even if there are cookies around?" Table 1, Appendix A explains score appropriation for each component of the survey.

Procedures

Teachers distributed and collected parental consent forms during the 1st week of school. All other procedures were administered by researchers from The University of Tennessee, Knoxville. Dates, times, and locations were negotiated and agreed upon during the summer months prior to the 1st week of the 2010-2011 school year. The intervention was approved and finalized for 3, 30-minute sessions once a week for 3 weeks beginning in the fall of 2010. In addition to, 1, 20-minute session for pre-intervention data collection and 1, 40-minute session for the rainbow plate activity and post-intervention data collection. During the intervention, students assembled in auxiliary rooms accompanied by their teachers. In the experiential group, all 3rd-5th grade students assembled at a single point in time, while students in the conventional and control groups gathered by grade level.

Nutrition education lessons. Experiential and conventional groups received 3, 30-minute nutrition lessons over the course of 3 weeks and were sent home with 2 parent newsletters and 2 worksheets. The words variety, moderation and balance helped explain the different parts of MyPyramid (now ChooseMyPlate), while the FVs I lesson discussed health benefits associated with eating more FVs and ways to eat more everyday. This lesson referred to FVs as the original fast foods, which initiated discussion regarding the difference between healthy and unhealthy foods, why FVs are different colors, and how FVs correspond with the colors of the rainbow. Week 1 concluded with a take home activity that allowed students to research, draw and color a fruit or vegetable chosen by the researchers. Fruits and vegetables were chosen from a FV

identification list in the Power U curriculum. Students were sent home with the Power U Home: FV family newsletter and Give It a Try worksheet. Worksheets and parent newsletters were not discussed beyond the point of distribution.

During the 2nd week, students participated in the FVs II lesson by reviewing key points from week 1 and reporting on the FV they were assigned the previous week. Willing students had 30 seconds to a minute to report their findings. After the presentations, students mounted their plates by the colors of the rainbow on a wall in their homeroom. Students learned about fiber during week 3 by discussing the health benefits of fiber in regards to satiety and digestion. Several activities and demonstrations facilitated a better understanding of what foods contain fiber and why fiber is imperative for nutritional and digestive health. One activity used a 25 foot long rope to represent the length of the human intestines, demonstrating how fiber facilitates the migration of food through the digestive system. Fiber food cards were used to compare and contrast similar foods to determine the food with the highest gram amount of fiber (e.g. apple verses apple juice; bran cereal verses corn cereal). Students were sent home with the Power U Home: Moving on with Fiber newsletter and Fiber Facts worksheet.

Taste tests. Students from the experiential group sampled 1 fruit and 1 vegetable each week after each nutrition education lesson. Fresh FVs were selected from a FV Identification List provided in the Power U curriculum.[21] Taste tests were designed to take approximately 5 minutes. Following the Power U protocol, all fresh FVs were washed, cut up into bite-sized pieces, and served raw. Each participant received a paper plate and a napkin. Those preparing and distributing the FVs (researchers and school teachers) wore disposable food handler's gloves during preparation and service of the foods. Parental consent forms enabled participants'

parent(s) or guardian(s) to inform the researchers of any food allergies. To decrease the effect of exposure time, the conventional group was allotted 5 extra minutes of discussion.

Rainbow activity. All 3rd-5th graders from the 3 schools participated in the rainbow plate activity on the last day of this short-term intervention. Researchers arranged a fresh FV buffet of grape tomatoes, red delicious apples, carrots, cantaloupe, bananas, corn, kiwi, broccoli, purple grapes, and cauliflower. Students walked through the buffet in a single file line while researchers placed 1 of each FV on students' plates to ensure safe food handling and equal distribution. Once through the buffet, students arranged the FVs on their plate into a rainbow and were encouraged to taste their rainbow. The rainbow activity was the only form of intervention the control group received over the duration of this study.

Data collection. FV surveys were labeled with students' identification numbers prior to distribution and administration. Individual assent was acquired upon initiation of the survey. If at anytime during the pre- or post-intervention data collection, a student felt uncomfortable, he/she was able to stop taking the survey, submit it uncompleted and leave the room. For both pre- and post-surveys, researchers explained each section of the survey and remained in the room. Both pre- and post-intervention surveys took approximately 20 minutes to administer. The pre-intervention survey was administered the week following recruitment, while post-intervention data collection occurred during the last week directly after the rainbow activity. Researchers provided assistance during data collection only when a student did not understand a question or if the student did not recognize a particular fruit or vegetable by word or picture.

Statistical Analysis

All data analyses were conducted using SPSS version 18.0 (SPSS, Inc., Chicago, IL, 2009). A Chi-Square analysis examined associations between intervention group and

demographic categorical variables (gender, grade, race/ethnicity). One-way ANOVA tested for differences between intervention group and age, as well as baseline differences among the independent variables. Double-data entry for pre- and post-intervention surveys verified the accuracy of data entry and identified discrepancies. When discrepancies were identified, researchers revisited the student's survey and corrected the data value. Mixed model ANOVA tested for changes in the dependent variables over time. Post hoc pairwise comparisons were performed using the Bonferroni correction to identify where differences occurred. Variables were considered to be significant at the 0.05 level.

APPENDIX B: TABLES AND FIGURES

Table 1: Description of FV Survey Components and Scoring

	Sections 1 and 2		Section 3	Section 4
	Eaten Score	**Like-it Score**	**Snack Preference Score**	**Self-Efficacy Score**
Score Assignment[1]	"Have you ever eaten this food?" Yes = 2 No = 1 Maximum score: 66[b]	"If you have eaten the food, what do you think about this food?" Really do not like it = 1 Do not like it = 2 It is ok = 3 Like it a little = 4 Really like it a lot = 5 Maximum score: 165[c]	"When I get home from school, I prefer to have…" Non-FV snack = 0 FV snack = 1 Maximum score: 8	"How sure are you that you could…" Not at all sure = 1 Somewhat sure = 2 Sure = 3 Very sure = 4 Maximum score: 20

[1]Sums were totaled to determine the mean score
[b]Sum of fruit (32) and vegetable (34) scores
[c]Sum of fruit (80) and vegetable (85) scores

Table 2: Frequencies of Reported Demographics from Parental Consent Forms

		School Count (%)			
		Experiential	**Conventional**	**Control**	**Total**
		28 (16.1)	60 (34.5)	86 (49.4)	174 (100)
Gender[1]	Male	9 (32.1)	25 (41.7)	35 (40.7)	69 (39.7)
Count (%)	Female	19 (67.9)	35 (58.3)	51 (59.3)	105 (60.3)
Grade[2]	3rd	11 (39.3)	26 (27.9)	24 (27.9)	61 (35.1)
Count (%)	4th	12 (42.9)	17 (28.3)	25 (29.1)	54 (31)
	5th	5 (17.9)	17 (28.3)	37 (43)	59 (33.9)
Race/Ethnicity[3]	White	20 (71.4)	56 (93.3)	68 (79.1)	144 (82.8)
Count (%)	Black	1 (3.6)	0 (0)	5 (5.8)	6 (3.4)
	Hispanic	0 (0)	0 (0)	2 (2.3)	2 (1.2)
	Asian/PI	1 (3.6)	0 (0)	1 (1.2)	2 (1.2)
	Other	6 (21.4)	4 (6.7)	10 (11.6)	20 (11.5)
Age[4]	7	0 (0)	0 (0)	1 (1.3)	1 (0.6)
Count (%)	8	11 (47.8)	23 (39)	22 (28.2)	56 (35)
	9	11 (47.8)	19 (32.2)	24 (30.8)	54 (33.8)
	10	1 (4.4)	17 (28.8)	26 (33.3)	44 (27.5)
	11	0 (0)	0 (0)	5 (6.4)	5 (3.1)

[1]No relationship between treatment group and gender (p=0.67)
[2]No relationship between treatment group and grade (p=0.065)
[3]No relationship between treatment group and race/ethnicity (p=0.073)
[4]Significant difference between age and experiential and control treatment groups (p =0 .013)

Figure 1: Flow Diagram of Student Sample and Attrition through the Phases of the Study

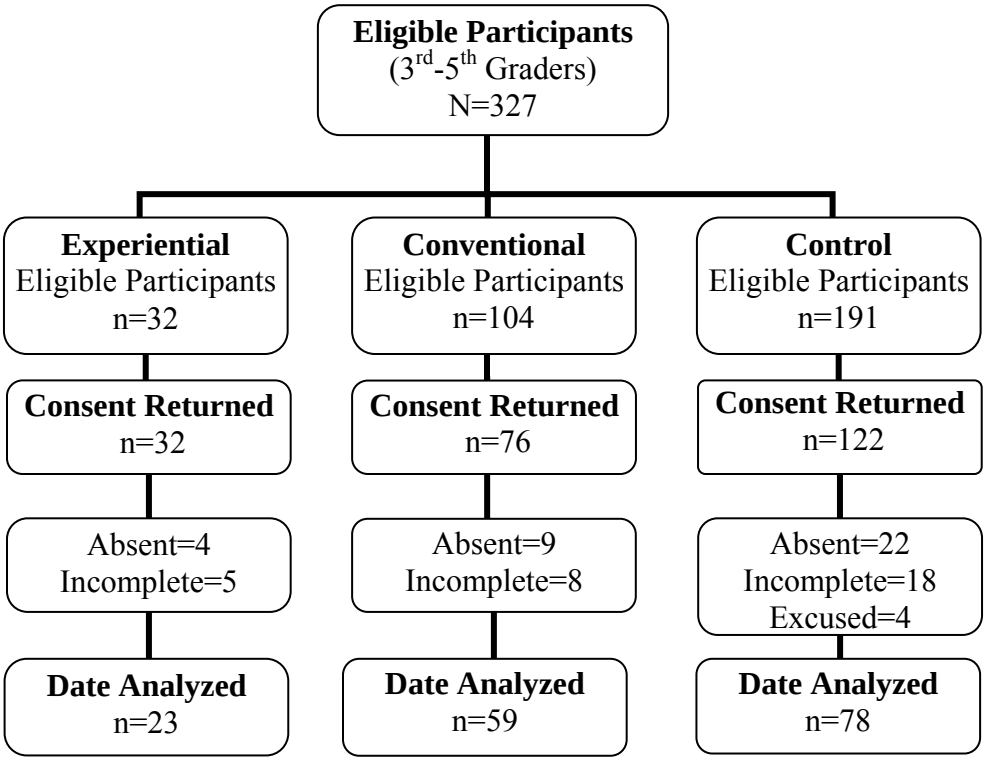

Table 3: Changes in Mean Eaten Scores from Pre- to Post-intervention by Treatment Group (Mean±SD)

	Treatment Group		
	Experiential n=23	Conventional n=59	Control n=78
FV[1]			
Pre-intervention	54.6±8.5	53.2±7.3	53.3±8.7
Post-intervention	56.6±7.9	54.8±7.6	54.0±7.5
Fruit[2]			
Pre-intervention	27.9±3.8	27.9±3.4	27.6±3.7
Post-intervention	28.8±3.4	28.5±3.4	27.9±3.3
Vegetable[3]			
Pre-intervention	26.7±5.0	25.3±4.7	25.7±5.5
Post-intervention	27.7±4.7	26.3±4.9	26.1±4.9

[1]Significant difference in mean FV eaten scores from pre- to post- ($F[1,156]=5.9$, $p=0.016$)
[2]Significant difference in mean fruit eaten score from pre- to post- ($F[1,156]=6.3$, $p=0.013$)
[3]Significant difference in mean vegetable eaten score from pre- to post- ($F[1,156]=4.1$, $p=0.044$)

Table 4: Changes in Mean Liking Scores from Pre- to Post-intervention by Treatment Group (Mean±SD)

	Treatment Group		
	Experiential Means n=23	Conventional Means n=59	Control Means n=78
FV[1]			
Pre-intervention	78.8±29.6	81.7±30.7	79.3±28.4
Post-intervention	87.1±31.5	88.2±31.0	78.4±27.7
Fruit[2]			
Pre-intervention	50.2±16.7	51.3±16.9	49.5±15.0
Post-intervention	53.8±17.1	54.5±15.8	49.6±14.7
Vegetable[3]			
Pre-intervention	28.7±15.2	30.4±17.0	29.8±15.6
Post-intervention	33.3±15.9	33.6±18.8	28.8±16.3

[1]Significant difference in mean FV liking scores from pre- to post- ($F[1,156]=10.9$, $p=0.001$)
[2]Significant difference in mean fruit liking score from pre- to post- ($F[1,156]=9.5$, $p=0.002$)
[3]Significant difference in mean vegetable liking score from pre- to post- ($F[1,156]=7.1$, $p=0.009$)

Table 5: Changes in Mean Preference and Self-efficacy Scores from Pre- to Post-intervention by Treatment Group (Mean±SD)

	Treatment Group		
	Experiential n=23	Conventional n=59	Control n=78
Time			
Preference[1]			
Pre-intervention	4.9±2.1	5.2±2.3	4.4±2.5
Post-intervention	5.7±2.1	5.9±2.4[a]	4.6±2.3[a]
Self-efficacy			
Pre-intervention	16.0±3.6	14.1±3.6	13.8±4.2
Post-intervention	15.5±4.6	14.4±4.1	13.3±4.3

[1]Significant difference in preference scores from pre- to post-intervention ($F[1,156]=9.3$, $p=0.003$)
[a]Significant difference between conventional and control groups ($F[2,156]=4.4$, $p=0.015$)

APPENDIX C: ESTIMATED MARGINAL MEAN PLOTS

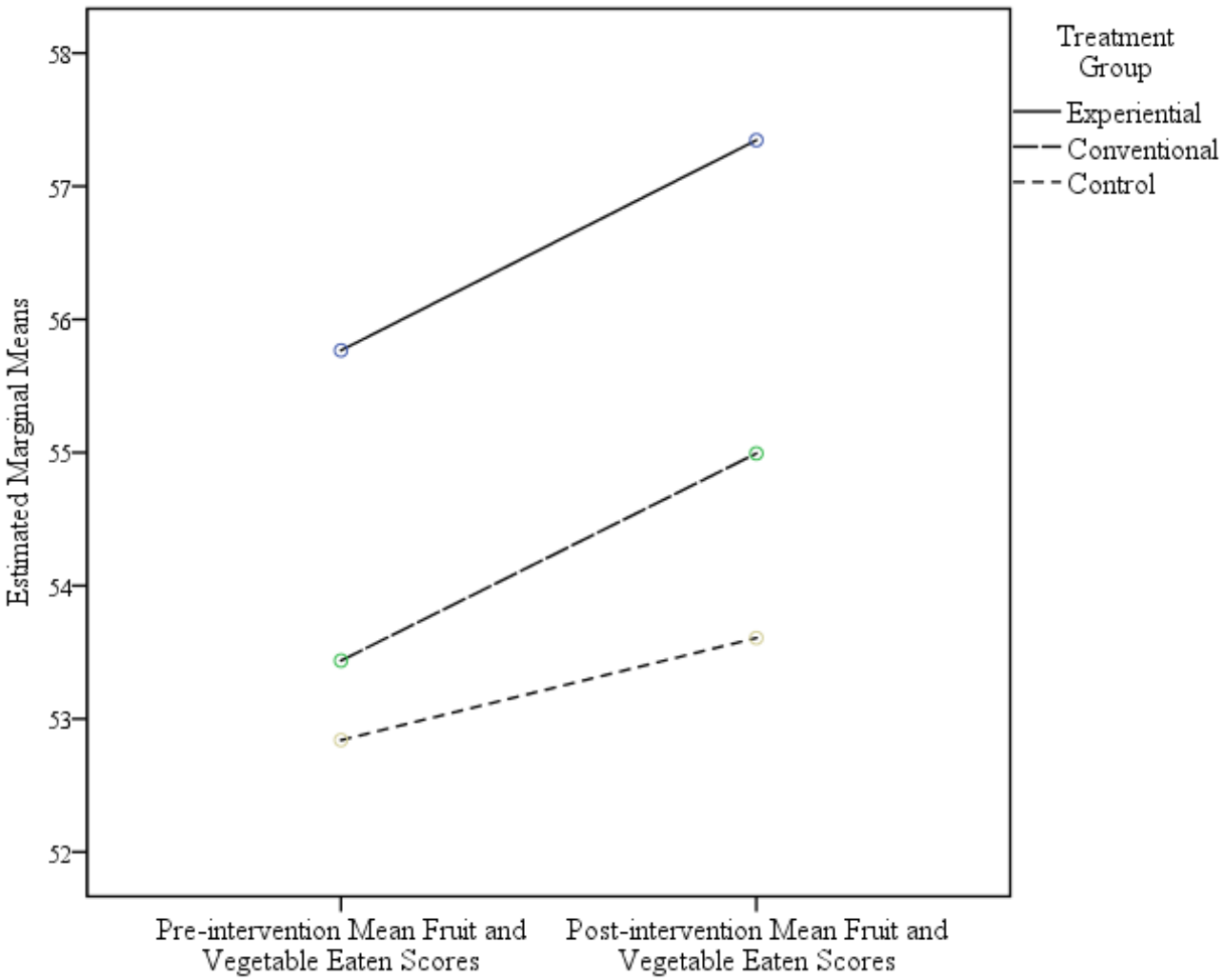

Figure 2: Estimated Marginal Means for Pre- and Post-intervention Fruit and Vegetable Eaten Scores by Treatment Group

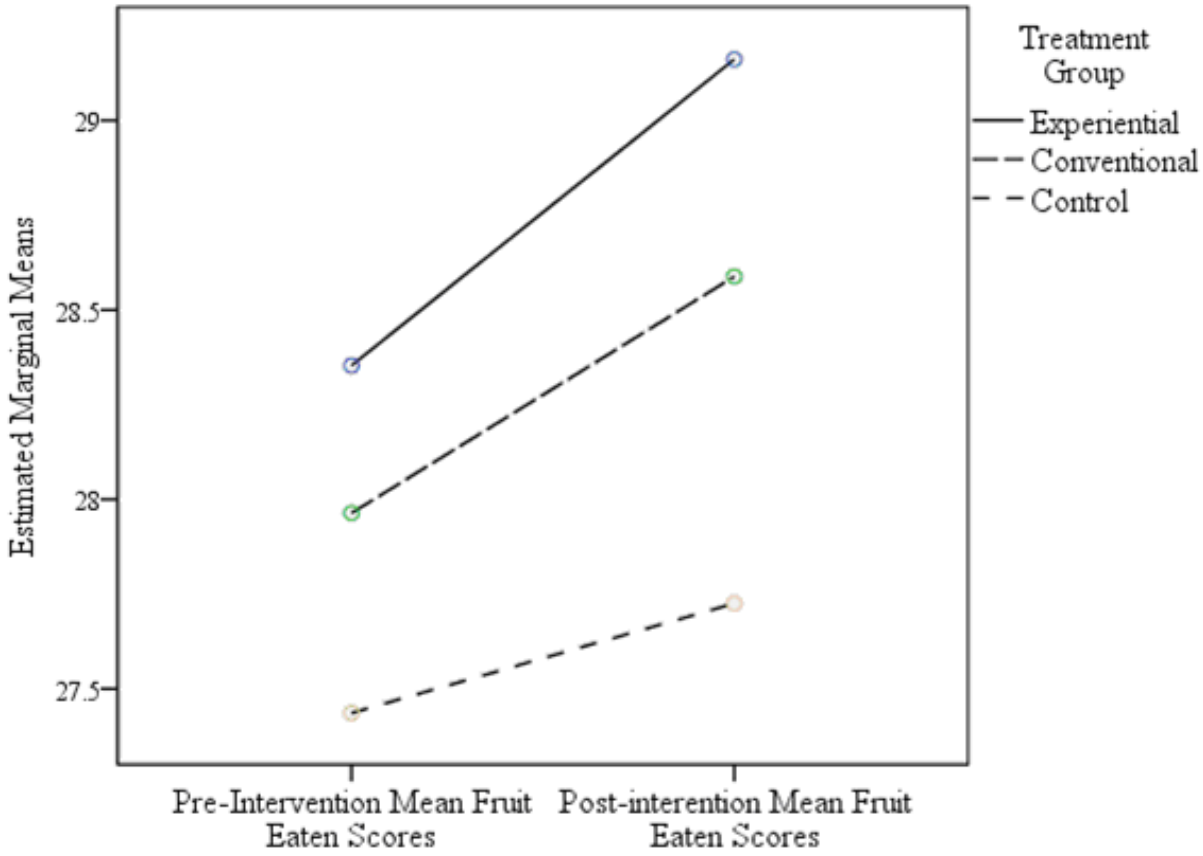

Figure 3: Estimated Marginal Means for Pre- and Post-intervention Fruit Eaten Scores by Treatment Group

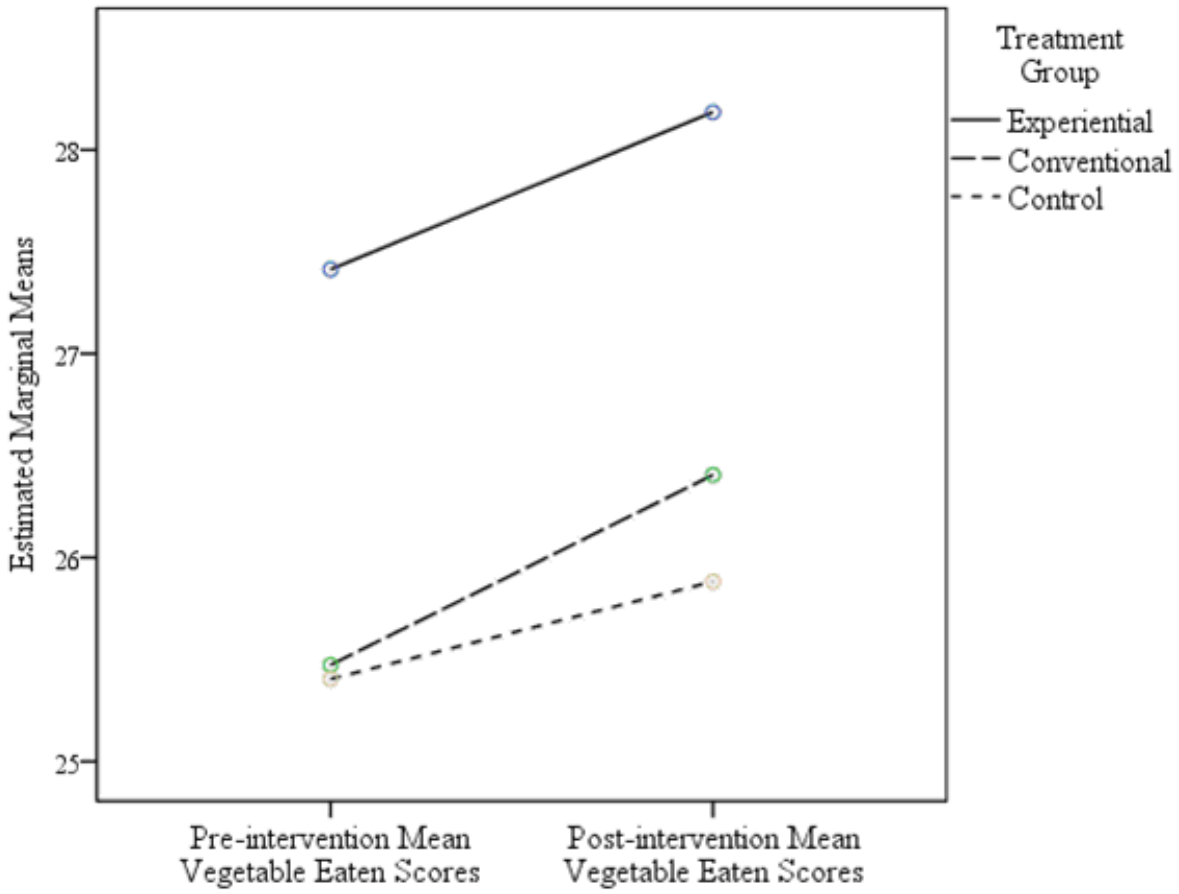

Figure 4: Estimated Marginal Means for Pre- and Post-intervention Vegetable Eaten Scores by Treatment Group

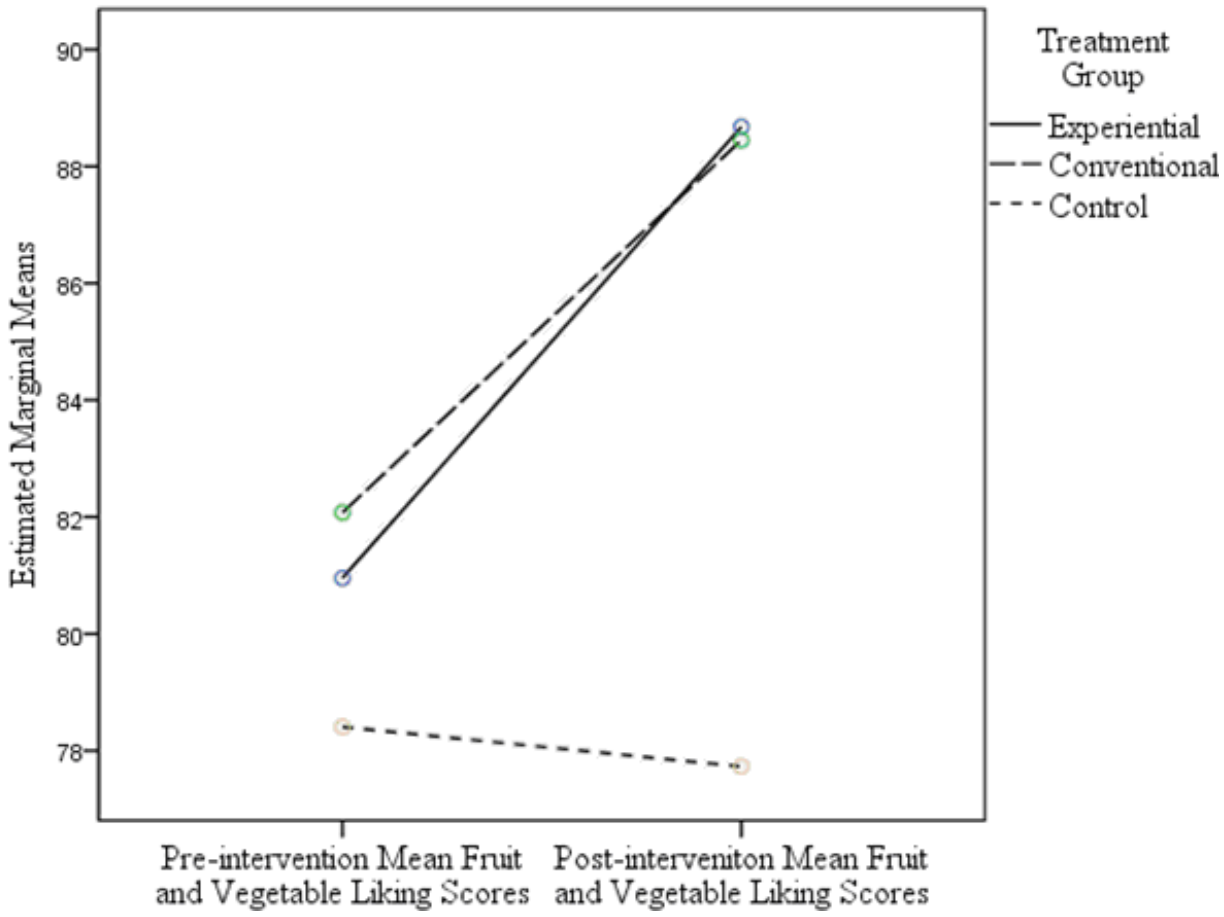

Figure 5: Estimated Marginal Means for Pre- and Post-intervention Fruit and Vegetable Liking Scores by Treatment Group

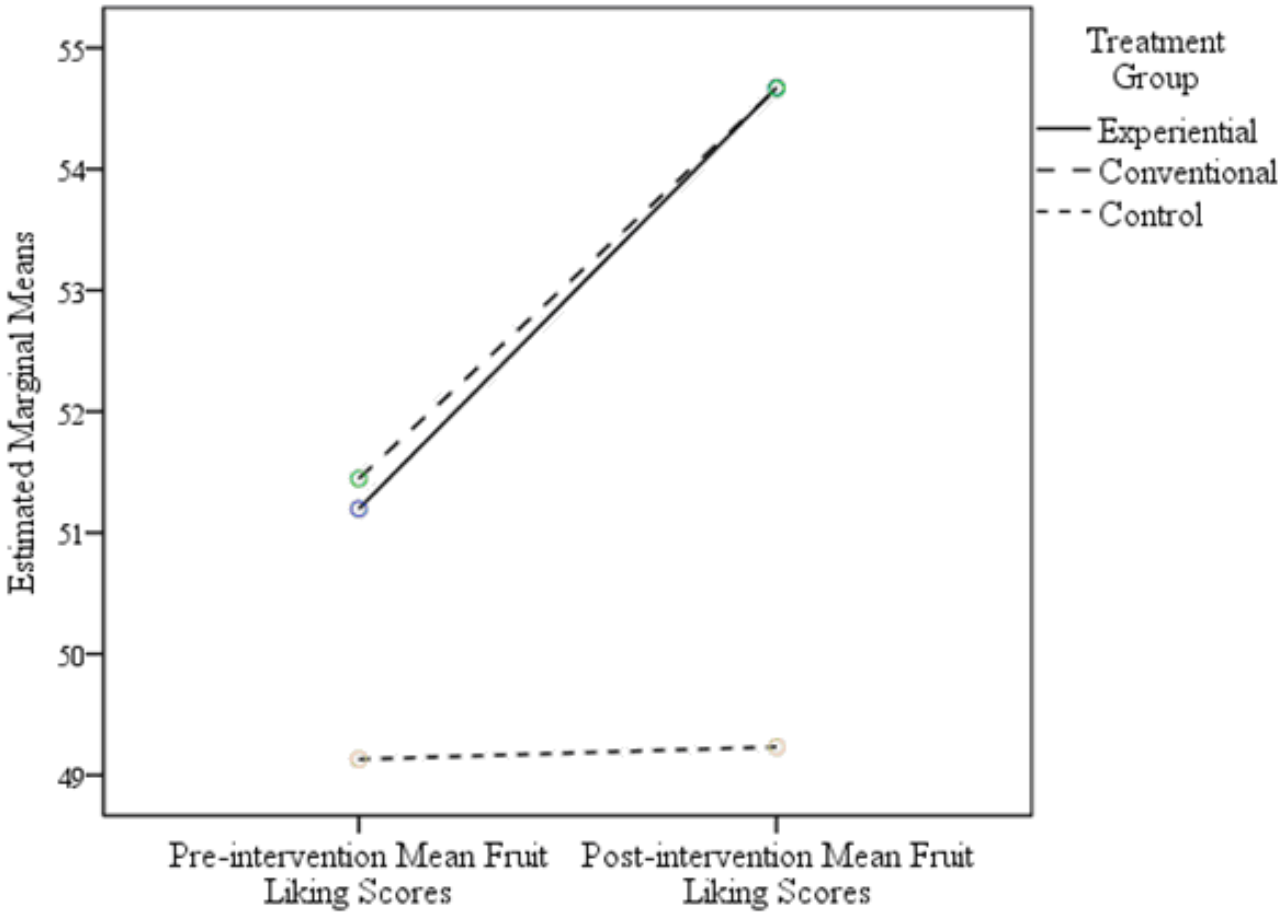

Figure 6: Estimated Marginal Means for Pre- and Post-intervention Fruit Liking Scores by Treatment Group

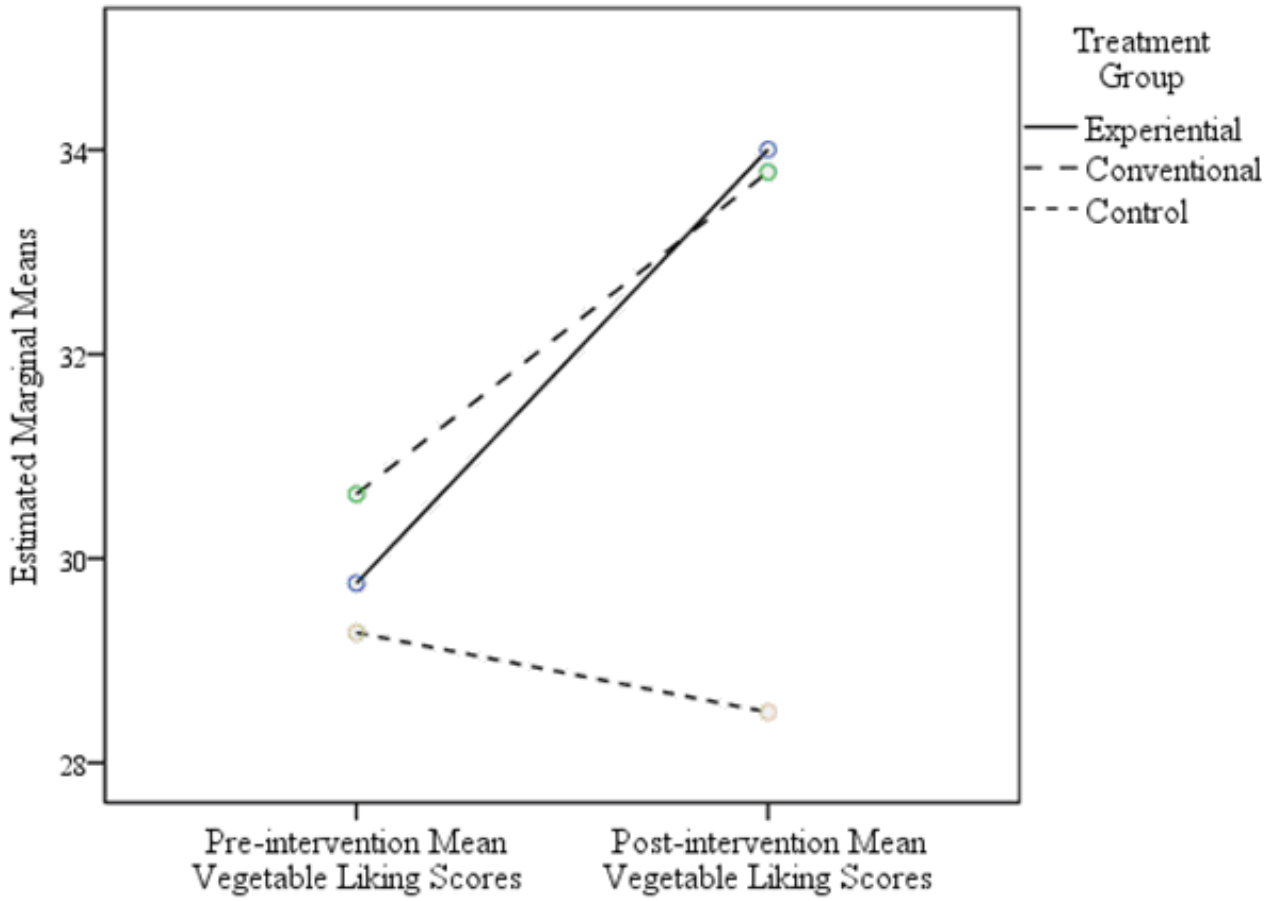

Figure 7: Estimated Marginal Means for Pre- and Post-intervention Vegetable Liking Scores by Treatment Group

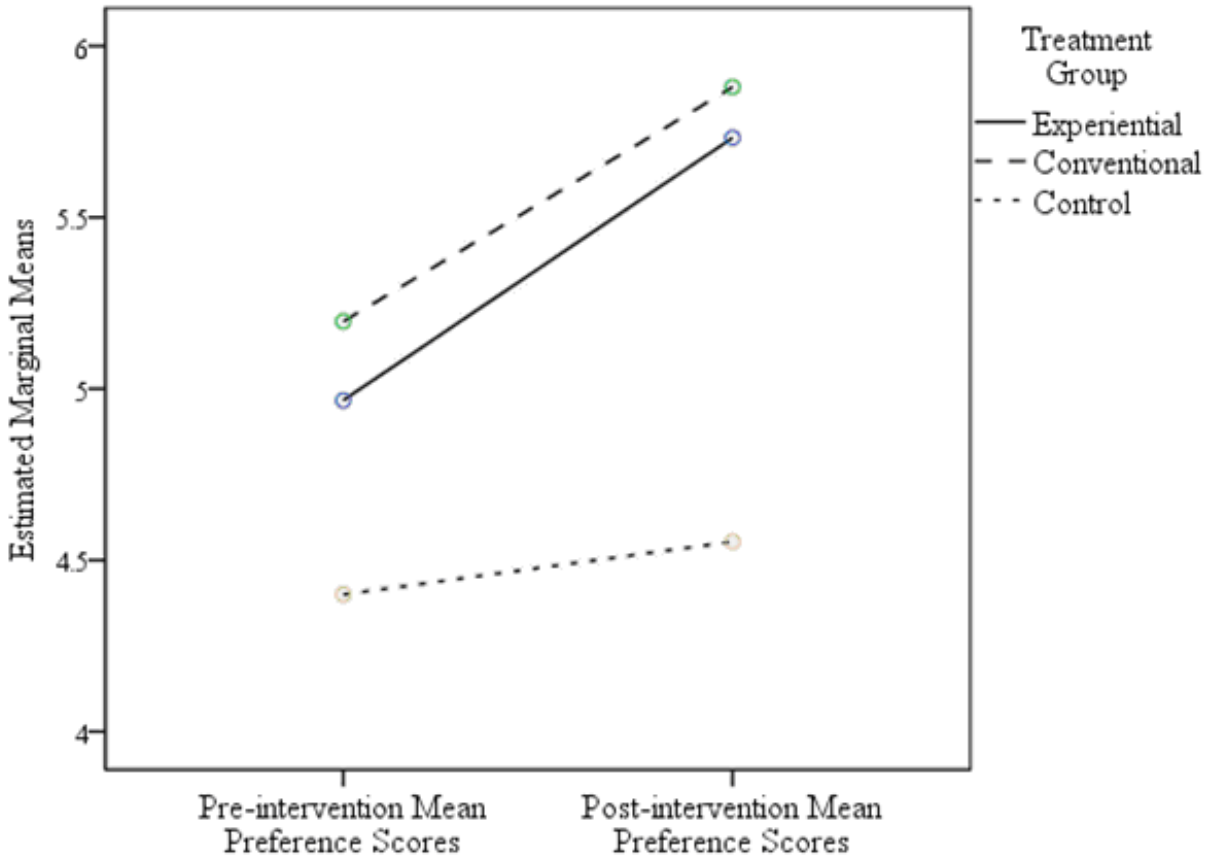

Figure 8: Estimated Marginal Means for Pre- and Post-intervention Preference Scores by Treatment Group

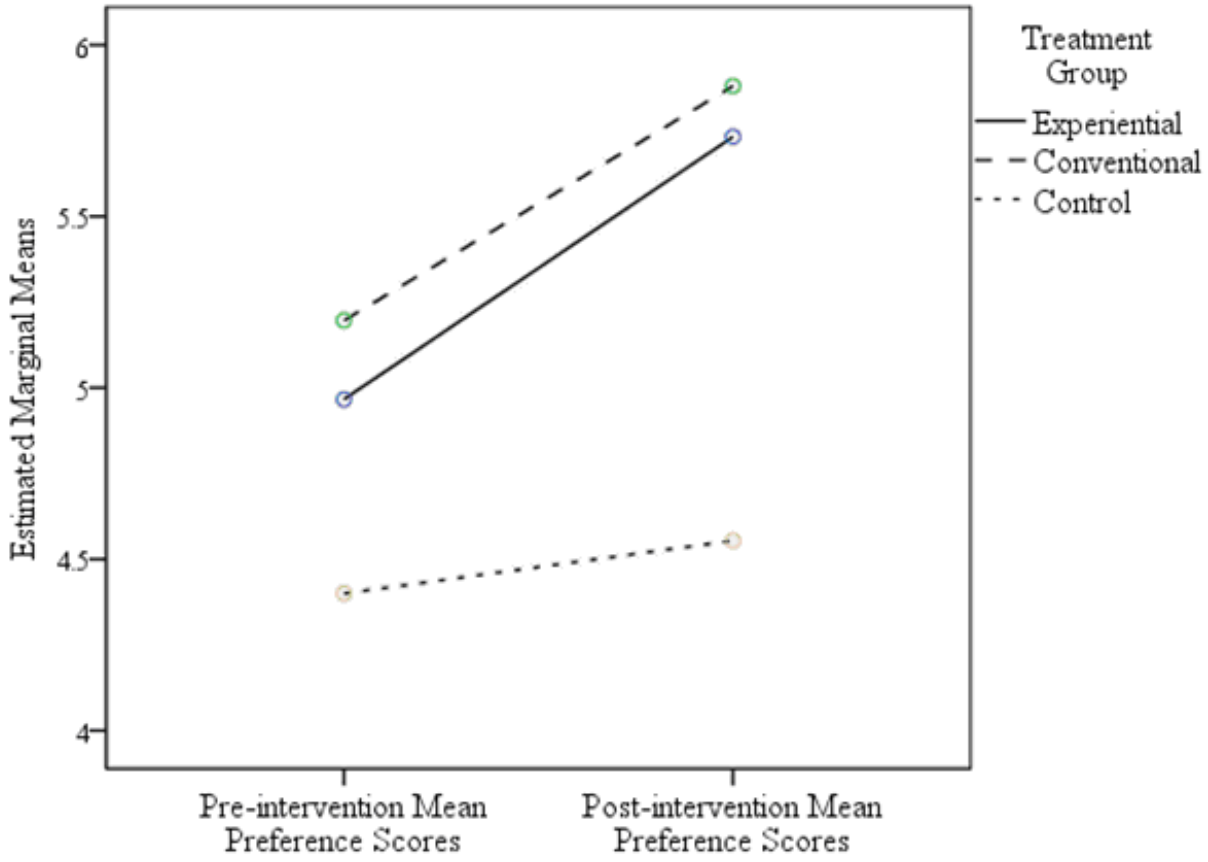

Figure 9: Estimated Marginal Means for Pre- and Post-intervention Preference Scores by Treatment Group

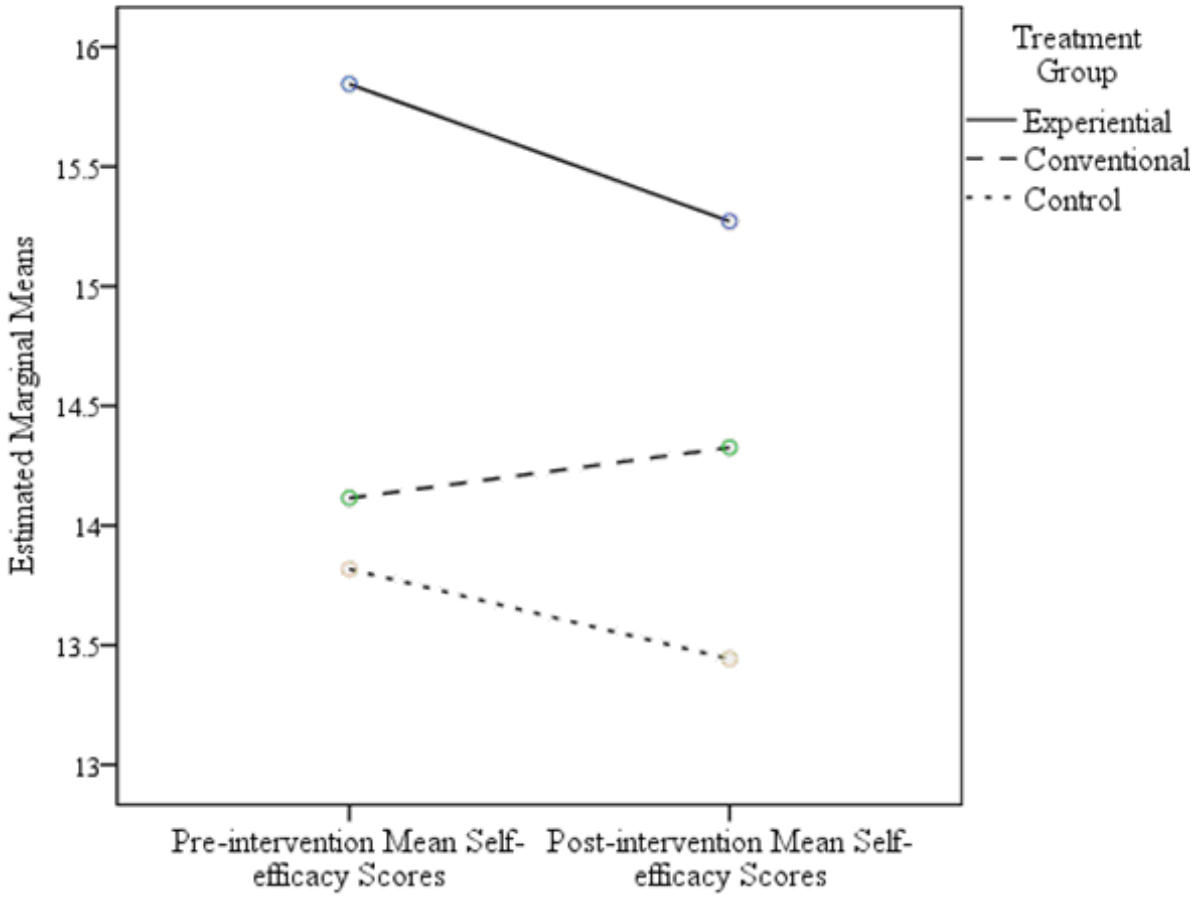

Figure 10: Estimated Marginal Means for Pre- and Post Self-efficacy Scores by Treatment Group

VITA

Elizabeth Diane Miller was born in Atlanta, Georgia on November 16, 1984. Her family quickly moved to Maryville, Tennessee where she grew up. Elizabeth earned her Bachelor of Science in Nutrition at The University of Tennessee, Knoxville in 2008. Her spontaneity and passion for culture has taken her many places, including China where she participated in a student culture exchange through a Christian organization, Volunteers for China. There she taught American cultures to Chinese college students and lead many group activities, including dance and cooking classes. Immediately after graduation, Elizabeth got married and started graduate school pursuing a dual degree in Nutrition with a concentration in Public Health Nutrition and Public Health with a concentration in Community Health Education. Highlights from her time in graduate school were leading discussions as a Graduate Teaching Assistant for Nutrition 100, and developing her leadership skills as a Graduate Assistant for the Maternal and Child Health Nutrition Leadership Education and Training Grant. Additionally, she broadened her academic experience and gained valuable hands-on experience through her thesis work. Elizabeth, who also successfully completed The University of Tennessee Dietetic Internship Program, plans to become a Registered Dietitian and find employment in a public health nutrition position.