EFFECT OF NUTRITION EDUCATION WITH FRUIT AND VEGETABLE SUPPLEMENTATION ON FRUIT AND VEGETABLE INTAKE AND ANTHROPOMETRIC MEASUREMENTS AMONG ADULTS OF VARYING SOCIOECONOMIC STATUS

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MASTER OF SCIENCE

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ABSTRACT

Intake of fruit and vegetable (F/V) is inadequate and obesity is more prevalent among adults of lower socioeconomic status (SES) in the U.S. This study determined the effect of nutrition education (NutrED) and F/V supplementation (F/VSupp) on F/V intake and anthropometrics of individuals of varying SES. Thirty-eight overweight or obese adults were randomly assigned into a control, education, or F/V group. Participants in the education and F/V groups attended weekly NutrED classes for 10 weeks. The F/V group also received one serving of fruit and two servings of vegetable daily.

Results showed that NutrED with F/VSupp improved fruit intake significantly. Improvements between the education and F/V groups were not significantly different. Individuals with a graduate degree had significant improvements in fruit intake. Few of the improvements in anthropometrics seen were significant.

Future research should focus on specific barriers to F/V intake and include information on total energy intake and expenditure.

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CHAPTER 1. INTRODUCTION

Inadequate fruit and vegetable (F/V) consumption in adults has become a rising concern in the United States. Increased consumption of plant foods has been shown to have a positive effect on obesity and chronic disease prevention (Crujeiras, Goyenechea, & Martinez, 2009). According to the Centers for Disease Control and Prevention's (CDC) 2007 Behavior Risk Factor Surveillance System, the percentage range of adults in the United States who consumed fruit two or more times per day and vegetable three or more times per day was 8.8-20.1% (CDC, 2009). Currently, less than 25% of the United States adult population consumes five or more servings of F/V daily (Thomson & Ravia, 2011). This shows that currently and throughout the past five years, less than a fourth of Americans are consuming recommended servings of F/V daily. The exact factors that influence consumption of plant foods are not known; however, factors that influence food purchases include nutrition attitude, taste, food safety, convenience, and price (Bowman, 2005). Research has also shown that consumption of F/V, as well as other healthy foods, tends to follow a gradient based on socioeconomic status (SES) with individuals of higher SES consuming greater amounts of nutrient-rich foods (Lallukka et al., 2010). Socioeconomic status is a classification of social class or standing of a family or individual. Determinants of SES often include education level, income, and occupation.

Along with poor diet quality, obesity and chronic disease development have become major health concerns in the United States. Despite medical advancements, the prevalence of obesity and chronic disease continues to rise in America. Obesity rates for adults doubled and those for children tripled during 1980-2008 (CDC, 2011). Obesity is a risk factor for developing many chronic diseases. Approximately 70% of all deaths each year in the United States, which are often preventable, are caused by chronic diseases such as

heart disease, cancer, diabetes, lung disease, and stroke (Kapustin, 2010). Nearly half of all Americans suffer from at least one chronic disease and the prevalence is expected to continue to rise (Kapustin, 2010).

Lifestyle factors have been shown to have the most influence on health (Kapustin, 2010). In order to help prevent chronic diseases, lifestyle factors such as diet must play a role. Although people may want to make lifestyle changes, there are often other factors to consider. Factors such as income and convenience may affect certain lifestyle changes. People may also lack the knowledge and resources necessary for change. It has been shown that adults who place importance on nutrition are more likely to practice a healthy lifestyle, demonstrating that interventions should include a nutrition education component (Bowman, 2005).

Studies have shown that food group consumption varies according to SES with increased intakes of F/V among individuals with higher education levels (Deshmukh-Taskar, Nicklas, Yang, & Berenson, 2007). Obesity seems to be more prevalent in lower SES populations. According to Baum II and Ruhm (2009), body mass index (BMI) rises with age and there are faster increases for those growing up in lower SES households. The studies suggest that overall, healthy lifestyle behaviors occur less frequently amongst individuals of lower SES. To prevent chronic disease and obesity, lifestyle change must occur. There are numerous lifestyle factors that contribute to chronic disease and obesity including diet. Consuming adequate amounts of F/V is just one area that may help to improve overall health.

The intervention strategies needed to improve F/V intake among low SES populations are not certain. It has been shown that improving access to fruit during the workday can improve F/V consumption, purchasing habits, and self-efficacy of low-income employees (Backman, Gonzaga, Sugarman, Francis, & Cook, 2011). Nutrition education

has also been shown to have a positive effect on dietary intake. The effect of nutrition education on people of different SES is an area that continues to be researched. Some studies have shown that low-income consumers state unavailability and higher prices among the constraints to eating healthier (Jetter & Cassady, 2006). Nutrition education alone may not have an impact if the audience's primary constraints to healthier eating are unavailability and price.

Statement of the Problem

Dietary intake, particularly F/V consumption, among adults is inadequate in the United States, with worse intakes among individuals of lower SES. Increased nutrition knowledge can help improve F/V consumption. Nutrition attitude plays a significant role in grocery purchasing and improved availability of F/V leads to increased consumption. Thus, nutrition education must work to change participants' attitudes and encourage purchasing of F/V to increase consumption. Anthropometric measurements such as BMI have also been shown to differ among individuals of varying SES, with increased prevalence of higher BMI levels among those of lower SES. The question arises then, how do we effectively educate adults to encourage behavior change in regards to F/V consumption and will this education lead to different results in changes in F/V consumption as well as anthropometric measurements among individuals of varying SES?

Purpose of the Study

The primary outcome to be assessed through this study was whether nutrition education with F/V supplementation leads to greater dietary improvements of F/V intake in overweight or obese individuals (BMI $\geq$ 25.0 kg/m^2) of a certain SES over others. The study also sought to determine if nutrition education alone, without F/V supplementation, improves dietary intake of F/V among overweight and obese individuals of varying SES. The differences in anthropometric measurements between overweight and obese

individuals of varying SES as well as the improvements through education were also assessed.

Research Questions

The following research questions were examined in this study.

1. Are F/V intakes different based on SES, specifically education level, personal income, and household income, in overweight and obese individuals?
2. Do anthropometric measurements also vary based on education level, personal income, and household income among overweight and obese individuals?
3. Through nutrition education classes, is there a difference in improvement of F/V intake amongst varying levels of education, personal income, and household income?
4. Through nutrition education classes, is there also a difference in improvement of anthropometric measurements seen at varying levels of education, personal income, and household income?
5. Does providing F/V supplementation with nutrition education lead to greater improvements in F/V consumption and anthropometric measurements amongst varying levels of education, personal income, and household income than nutrition education alone?

Limitations

The potential limitations to this research included:

1. Dietary intake was assessed through three-day food records. This is a self-reported assessment of dietary intake. Participants may have over reported intake of F/V on the three-day food records. They may have also reported inaccurate serving sizes due to not measuring or weighing foods eaten.

2. Three different instructors led the nutrition education classes. Having different instructors teaching the classes may have led to some inconsistencies in the delivery of the information.
3. The post food records were given while participants were still receiving F/V supplementation. Participants' intake of F/V may have been higher while receiving the supplements and the post food records may have overestimated dietary intake.
4. Participants were self-selected rather than a random sample. In recruitment for the study, it was advertised that they may receive nutrition education. This may have appealed to those who were already more motivated when it comes to health. Once signed up, participants were randomly assigned into intervention groups.
5. The study was conducted in the Midwest where availability of fresh F/V is greater during the summer than the fall and winter months. The study began during the end of summer and ended during the beginning of winter. Prices of fresh F/V are often cheaper during the summer as well which may have led to participants consuming more F/V during the beginning of the study than at the end of the study.
6. Participants were not asked if they received any additional nutrition education outside of the study during the intervention. Information received from other sources may have had an impact on changes in anthropometric measurements and F/V intakes of participants.
7. The majority of participants fell in the highest education categories of a bachelor's degree and a graduate degree. The sample may not have been representative of individuals without post-secondary education.

Definition of Terms

Body mass index (BMI) - an indicator of body fatness calculated from a person's height and weight (Centers for Disease Control and Prevention, 2011).

Diabetes- a condition characterized by high blood glucose levels resulting from the body's inability to utilize blood glucose due to inadequate production of insulin, insulin resistance, or both (American Diabetes Association, n.d.).

Obesity- a condition in which a more than normal amount of fat is present in the body, classified as a BMI $\geq$30.0 kg/m^2 (American Diabetes Association, n.d.).

Overweight- having a weight above normal body weight standards, classified as a BMI of 25.0-29.9 kg/m^2 (American Diabetes Association, n.d.).

Self-efficacy- an individual's perception of whether they will be able to perform a behavior (Contento, 2007).

Socioeconomic status- social standing or class of an individual or group which is often based on education, income, and occupation (American Psychological Association, n.d.).

Stroke- a condition that occurs when a blood vessel that carries oxygen and nutrients to the brain is blocked or bursts, preventing blood flow to the brain (American Stroke Association, n.d.).

CHAPTER 2. REVIEW OF LITERATURE

Does changing the knowledge of adults lead to positive behavior changes in regards to F/V intake and are responses different amongst individuals of varying SES; looking specifically at education level, personal income, and household income? Does increased availability of F/V cause a greater improvement in overall attitude and consumption of these foods? Research has been completed comparing F/V intakes to the availability and also nutrition knowledge of consumers. The question of whether availability and price or nutrition knowledge play a greater role in consumption is still present. Studies have also compared varying SES populations and their intake of F/V along with the effect of nutrition education on consumption. Few studies, however, have compared the effect of nutrition education on dietary intake and anthropometric measurements between SES groups in overweight and obese individuals. Also, there are limited studies that examined the effect of supplementation of specific food groups on dietary intake and anthropometric measurements.

Effect of Nutrition Interventions on Fruit and Vegetable Intake

The Fruits and Veggies - More Matters initiative, led by the CDC and Produce for Better Health Foundation, is aimed to encourage consumers to increase consumption of F/V. The initiative replaced the 5 A Day for Better Health Program. The program was changed due to changing recommendations for F/V intake (Pivonka, Seymour, McKenna, Domel Baxter, & Williams, 2011). The objective of the change was to rebrand the 5 A Day Program's campaign message to be adaptable, sustainable, and compelling (Pivonka et al., 2011). Goals of the program are to increase public awareness of the importance of eating a diet rich in F/V every day for better health, provide consumers with specific information about how to include more servings of F/V into their daily routines, and increase the

availability of F/V at home, school, work, and other places where food is served (CDC, n.d.). The campaign is primarily web-based but also involves print ads, school cafeteria posters, and programs in stores to highlight F/V. The program was launched in March 2007 and awareness of the program has increased since that time (Pivonka et al., 2011). Also, it was shown that mothers who said they were more likely to purchase a product with the Fruits and Veggies – More Matters logo on it increased from 40% in 2009 to 45% in 2010 (Pivonka et al., 2011). However, the change in terms of actual F/V consumption has not shown great improvement. Results from the Behavior Risk Factor Surveillance System showed that from 2005-2009 the percentage of adults nationwide who ate five or more servings of F/V daily only increased slightly from 23.8-24.4% (Pivonka et al., 2011).

Programs like the Fruits and Veggies - More Matters initiative are developed based on research which demonstrates areas that need improvement as well as strategies that have shown to be beneficial in the past. One area of study is food-related behaviors and their impact on intakes of F/V. A cross-sectional study conducted by Crawford, Ball, Mishra, Salmon, and Timperio (2006) examined the associations between food-related behaviors and F/V consumption among women. The participants were 1,580 women of different SES chosen randomly (511 from high-, 588 from mid-, and 481 from low- SES neighborhoods). The study was conducted through surveys and descriptive statistics were used to describe the socioeconomic profile of survey participants, their F/V intakes, and the women's shopping, food preparation, meal, and eating behaviors. The results of this study showed that food-related behaviors do have an impact on intake of F/V. Knowledge of specific shopping, meal preparation, cooking, and meal behaviors, including preplanning of meals and environment during meals, was associated with higher intakes of F/V. Limitations of this study included the cross-sectional design as well as that the behavioral

predictors may be markers of health consciousness generally, or of greater perceived value of healthy eating.

Ha and Caine-Bish (2009) implemented a study designed to determine if nutrition intervention with the use of a general nutrition education course promoted greater F/V intakes among college students. The study consisted of 80 students enrolled in a sophomore level general nutrition course at a Midwestern university. The majority (88%) of participants was female; however, no differences were found in baseline and end of the study measurements of F/V consumption between genders. Dietary intake was assessed using three-day food records. The participants were also interviewed with the food records to ensure accuracy for data entry. The nutrition education classes focused on nutrition knowledge related to prevention of chronic diseases, healthy dietary choices, increasing F/V consumption, dietary feedback, and interactive hands-on activities. Many of the activities and class lectures were tied to the Social Cognitive Theory, allowing students to use their own dietary behaviors and lifestyle choices as a framework to learn course materials. One activity incorporated that gave students dietary feedback was the use of a risk assessment form as well as a food frequency questionnaire developed for calcium intake in which students were able to assess their calcium intake and possible risk for osteoporosis. Students also brought in a food label from a product they used frequently to analyze.

Intake variables for assessing F/V intake included total vegetable, fresh vegetable, starchy vegetable, French fries, vegetable juice, total fruit, fresh fruit, canned fruit, and fruit juice. The results showed statistically significant increases in total vegetable, fresh vegetable, total fruit, and fresh fruit consumption at post-test measurements compared to pre-test. At the beginning of the study, 72% of participants consumed one cup or less of total vegetable and 90% consumed one cup or less of fresh vegetable daily. Vegetable intake was improved significantly with 65% of participants consuming more than one cup of

total vegetable and 50% consuming more than one cup of fresh vegetable daily at the end of the study. A significant improvement was also seen for fruit consumption. Pre-test data showed that 92% of participants were consuming two cups or less of total fruit daily and 90% were consuming one cup or less of fresh fruit daily. At the end of the study, 22% of participants were consuming two or more cups of total fruit daily and 39% of participants were consuming greater than one cup of fresh fruit daily.

Another study examined the effect of nutrition education with the use of a summary nutrient profiling system on food purchasing behavior and the dietary quality of foods consumed by adults in the United States. The study, developed by Glanz et al. (2012), was a randomized, controlled trial which consisted of 128 individuals. The participants were assigned to a Nutrient Rich Foods (NRF) education group or a control group receiving general nutrition education. The NRF approach to eating uses the NRF Index which is a nutrient profiling system that encourages consumers to choose foods that contain higher amounts of vitamins, minerals, and other nutrients per kilocalorie (Glanz et al., 2012). The education provided for the members of the NRF group included a one-hour class, 15-minute video, hands-on activities, and program tools which provided help in selecting nutrient-rich foods. Education given to the control group was focused on MyPyramid and reading a Nutrition Facts Panel. They also attended a one-hour class with a 15-minute video. The measures of the study for both the NRF and control groups included surveys of knowledge, attitudes, and behaviors, two 24-hour recalls administered through telephone, and measurement of height and weight. Each of these measures was administered at the beginning as well as at the end of the intervention. The results indicated that the NRF approach is effective for promoting healthful shopping and eating patterns as well as improving diet quality. Diet quality improved more in the NRF group than the control

group; members of the NRF group had decreased intake of total fat and saturated fat as well as increased consumption of healthful foods.

Measurement of Socioeconomic Status

Socioeconomic status of individuals can be assessed in a variety of ways and the measurement used often varies among research studies. The three most common determinants of SES are education level, income, and occupation. These determinants can be used individually or together. In 1975, Hollingshead proposed an index that takes multiple factors together into consideration for determination of SES. The index combines occupation, level of education, sex, and marital status to classify SES of individuals and households. To determine SES of households, education, occupation, and marital status of the head or heads of the household are used as well as their relationship to the labor force in the present, or for retired persons, in the past. Hollingshead Four Factor Index of Social Position divides individuals and households into five different SES categories including upper, upper-middle, middle, lower-middle, and lower. Hollingshead also proposed a Two Factor Index of Social Position which classifies SES by using occupation and education level. This index was devised prior to the four factor index but received criticism leading to Hollingshead proposing the four factor index (Hollingshead, 1975).

Socioeconomic Status and Fruit and Vegetable Intake

Mullie, Clarys, Hulens, and Vansant (2010) examined the relationship between SES and diet quality using three commonly used methods to determine dietary patterns. One objective of the study was to describe the relationship between the Healthy Eating Index, Mediterranean Diet Score, and Healthy Dietary Pattern as dietary quality assessment tools compared to education and income as indicators for SES. Each of these approaches to assessing dietary quality is based on dietary patterns rather than examining a single food or nutrient alone. The Healthy Eating Index addresses the degree to which a dietary

pattern meets the United States Dietary Guidelines for Americans. The Mediterranean Diet Score rates dietary patterns based on the Mediterranean Diet, which has been associated with lower incidence of chronic diseases such as heart disease and cancer. Eleven main components are analyzed including non-refined cereals, fruits, vegetables, potatoes, legumes, olive oil, fish, red meat, poultry, full fat dairy products, and alcohol. Scores are given based on whether each item is presumed to be close to the Mediterranean Diet (Panagiotakos, Pitsavos, & Stefanadis, 2006). The Healthy Dietary Pattern uses principal component analysis, a statistical approach that identifies foods eaten together rather than single nutrients alone.

The study was a cross-sectional design consisting of 1,852 military men. Officers, non-commissioned officers, and soldiers were selected to represent the total army structure and income levels were divided into three categories based on yearly gross income. Participants were given a food frequency questionnaire and a second questionnaire consisting of questions related to health and lifestyle. Yearly gross salaries were obtained from administrative services. Participation was voluntary and without incentives. Results were adjusted for age and BMI in order to show the independent effect of education and income on Healthy Eating Index, Mediterranean Diet Score, and Healthy Dietary Pattern (Mullie et al., 2010). Education level was classified as low for vocational education, moderate for secondary level, and high for bachelor or master level. Income was classified as low for lowest tertile of yearly gross income of the group, moderate for intermediate tertile of income, and high for highest tertile of yearly income.

The results showed that higher education and income levels were associated with the healthiest dietary pattern, regardless of weight or age, and the association was shown for all three dietary patterns. Limitations of this study included a response rate of only 37%, and the responders were older than non-responders. Having a military population for

this study was an advantage because it limited the influence of occupation as a true socioeconomic influence. Another advantage of the study was having exact income figures from administration. Overall, the study showed a positive association between higher SES and diet quality.

Another study looked specifically at associations between F/V consumption and SES. The study, conducted by Estaquio et al. (2008), was developed to investigate the relationships of socioeconomic, demographic, and behavioral factors with both quantity and variety of F/V consumption. Participants were part of a larger prospective study which was designed as a randomized, double blind, and placebo controlled trial. For this study, subjects included were those aged 45-62 years old who completed at least six 24-hour dietary records during the first two years of follow-up and with available data for all socioeconomic and behavioral characteristics. The total number of subjects included was 4,282. Upon enrollment, participants were asked to complete a questionnaire to provide information on SES, looking specifically at education level and occupation. Dietary intake was measured by 24-hour food records. Participants filled out records for two weekends and four weekdays per year during the study. Dietary intake was shown to be stable over the years of this study, so dietary intake measured over the first two years was considered to be representative of usual intake. While assessing F/V intake, fruit, vegetable, 100% fruit or vegetable juices, and mixed foods whose ingredients contain fruit or vegetable were included. Dried fruit, potatoes, and legumes were not included in the F/V group. Variety of F/V intake was measured by the number of different types of F/V consumed. The results showed that among both genders, the percentage of participants who consumed five or more servings of F/V daily increased with age and education level. An increase in variety was seen with higher education levels as well. For men, the increase in variety was seen with both F/V intake and for women it occurred only with variety in vegetable intake. After

adjustment for education, socioeconomics, and behavior characteristics, there were no associations found among occupation categories and F/V intake.

A cross-sectional study led by Fahlman, McCaughtry, Martin, and Shen (2010) looked at the diet quality of middle school students compared to SES. The study took place in Detroit, Michigan where students were chosen from 40 schools. Students were divided into two groups; low-income, urban, mostly black (n=1,208) and high-income, suburban, mostly white (n=978). Low SES was classified by those receiving free lunches. Of the students who agreed to participate, 83% completed the study. The students were given a survey that assessed dietary behaviors, knowledge, and self-efficacy. Self-efficacy was used in this study to examine students' confidence on their ability to change their dietary behaviors. To measure dietary behaviors, students were presented with a single serving size picture of different food items based on the food groups. Students were asked to pick how many times they had eaten that food item the previous day; answers ranged from zero to three or more times. The dietary knowledge questions were coded for correct or incorrect answers and the self-efficacy questions were formatted using a Likert scale. The results showed a significant group difference for all three aspects studied: dietary behavior, knowledge, and self-efficacy. Overall, students of lower SES were found to eat less F/V than students of higher SES. They were also shown to be less knowledgeable of nutrition and were less confident.

A study in Brazil analyzed data from the 1998/1999 Household Budget Survey to examine the influence of income and food price on total household intake of F/V (Claro, Esvael do Carmo, Sarti Machado, & Monteiro, 2007). The findings were similar as in American studies. The Household Budget Survey included information on all food and drink purchases made by households during a 30-day period including name, brand, type of product, amount purchased, purchase unit, cost, and place of purchase. The sample size

was 2,351 households. The information was then calculated to show price contribution of individual food group calories to total caloric purchases. The price paid for foods in each food group was calculated by taking total cost per calories provided. Income values were determined by using monthly household expenditures. This was chosen because the researchers believed that the family's total expenditures in a month are more accurately represented by permanent income and purchase power. The results showed that monthly expenditures with F/V corresponded to on average 2.4% of monthly income and 10.2% of total food expenditures. The percentage of calories purchased from F/V per total caloric content of household food purchases tended to increase with income. The main limitation of this study was that it measured F/V purchasing, which is not a definite determinant of intake.

Another study looked at individuals of low SES and examined the factors influencing their dietary behaviors related to F/V consumption. The study, conducted by Williams, Ball, and Crawford (2010), included a sample of 355 low SES women who were initially part of a larger study. Socioeconomic status was determined by the level of education with low SES classified as no formal education or up to year 10. To measure F/V consumption, participants were asked two questions: how many servings of fruit and how many servings of vegetable they usually consume each day. Participants who responded two or more servings of fruit consumption daily were classified as high fruit consumers and those who responded three or more servings of vegetable consumption daily were classified as high vegetable consumers. Intrapersonal, social, and environmental measures were determined by 30 different variables which were measured both objectively and subjectively. Objective measurements included availability and accessibility of major chain supermarkets and F/V stores from participants' residence. Subjective measurements included perceived cost of fruit, perceived cost of vegetable, perceived access to healthy food options, and perceived

availability of healthy food options. Other variables examined included aspects such as living situation, support, taste preferences, and self-efficacy. The results showed that among low SES women, with education as a measure, those who were older, had higher self-efficacy for healthy eating, a higher taste preference for F/V, more positive eating behaviors, greater perceived knowledge of cooking, more perceived support from family to eat healthy, a greater perceived availability of healthy food, and whom were less likely to report time as a barrier to healthy eating were more likely to be high F/V consumers (Williams, Ball, & Crawford, 2010).

In comparison to the previous studies, a study conducted by Middaugh, Fisk, Brunt, and Rhee (2012) found that income did not have a significant association with F/V intake. The study examined data from the National Health and Nutrition Examination Survey (NHANES) that is an ongoing cross-sectional survey which began in 1999 and collects health and nutrition data from the non-institutionalized United States population aged 2 months and older. The present study included data from 16,232 adults aged 18 years and older that completed continuous 2-year cycle NHANES studies between 1999 and 2006. Daily F/V intake was measured by a 24-hour dietary recall. Fruit and vegetable intake was measured in grams and included any raw, frozen, or canned source that was not a mixed dish. Income levels were measured using the poverty income ratio (PIR) value which is the ratio of income to the family's appropriate poverty threshold (PT). Poverty threshold is a measure that is updated by the US Census Bureau each year which considers family size as well as age in determining the threshold for poverty classification (Institute for Research on Poverty, n.d.). Poverty income ratio levels were classified as follows: below PT, 100%-199% PT, 200%-299% PT, 300-399% PT, and ≥ 400% PT. The results showed that income did not have a significant effect on intake of F/V until income reaches levels of ≥ 400% PT. Individuals in the highest PIR level (≥ 400% PT) consumed significantly more F/V than

individuals in any other PIR groups. Although individuals with a higher income were found to consume a greater amount of F/V, the difference was small. Fruit and vegetable consumption was measured in grams and the amount consumed by those in the highest PIR level compared to those in the lowest was greater by less than a third of a cup. The study also found that the consumption means of all the groups were ≤ 50% of the recommended servings for F/V.

Socioeconomic Status and Body Weight

Socioeconomic status has been shown to be inversely associated with BMI. Rundle et al. (2008) designed a study with the purpose of assessing both personal and neighborhood levels of SES in comparison to BMI using personal income, personal education level, and zip-code poverty level as measurements of SES. Participants included 13,102 adult residents aged 30 years or older of all regions of New York City (Bronx, Brooklyn, Manhattan, Queens, and Staten Island). Participants completed surveys at different locations including community-based health centers, community hospitals, medical centers, and through the New York Blood Center. The survey collected information on personal demographics, income, and education and height and weight measurements were taken using clinical scales and rigid stadiometers at the specific locations in which participants were enrolled. Neighborhood SES was determined using information from the 2000 Census looking at zip-code poverty levels, specifically the proportion of households below the poverty line, and racial and ethnic composition which measured the proportion of residents who were Black or Hispanic. Researchers also assessed neighborhood walk-ability looking specifically at population density and land use mix which is a measure of the proportion of built environment space dedicated to commercial and residential uses. Increased neighborhood walk-ability has been associated with increased physical activity and decreased BMI levels in previous studies (Frank, Andressen, & Schmid, 2004; Frank,

Schmid, Sallis, Chapman, & Saelens, 2005; Lopez, 2004; Rundle et al., 2007). Results showed that the mean BMI did not vary across personal or neighborhood SES for men; however, it did vary for women. After adjusting for age, race/ethnicity, zip-code level racial and ethnic composition, and neighborhood walk-ability, increasing personal income was significantly associated with a lower BMI among women. This association was found to be stronger for wealthy compared to poor zip-codes. Education level was inversely associated with BMI among both males and females. Associations between education level and BMI were also stronger among individuals living in wealthy zip-codes compared to poor zip-codes. The results suggest that neighborhood SES influences how individual SES characteristics interact in determining BMI.

A study conducted by Brown and Siahpush (2006) used data from the 2001 National Health Survey to determine sociodemographic predictors of overweight and obesity among Australian adults. The 2001 National Health Survey used a stratified multistage area sample of private dwellings and face-to-face interviews were conducted with one resident from each dwelling. Sociodemographic and health characteristics examined included age, county of birth, marital status, region of residence, exercise level, smoking status, education level, household income level, occupation, and index of relative socioeconomic disadvantage which classifies individuals using income, education, occupation, housing, household composition, and English fluency. Data were analyzed from a total of 8,643 females and 7,600 males aged 18 and older who responded to the 2001 National Health Survey. Data were analyzed using multinomial logistic regression to examine correlations between different sociodemographic variables and overweight and obesity. Results showed that education levels less than tertiary or post-secondary were associated with increased overweight and obesity with stronger associations among males than females. Occupation was found to be associated with overweight and obesity among males and not females.

Males working in white-collar or professional positions were found to be at increased risk of overweight and obesity compared to those in blue-collar jobs or unemployed. When examining associations of household income on weight status, it was found that both males and females with higher household incomes were at greater risk for being overweight and those with lower household incomes were at greater risk of being obese, thus demonstrating a protective effect of income on obesity but not overweight.

Summary

Current literature has shown that nutrition intervention can lead to improvements in F/V intake. Research has also shown that individuals of lower SES tend to eat less healthful diets and have a higher prevalence of overweight and obesity than those of higher SES. The current literature is not consistent on measuring SES; however, education level and income are often used. Personal and household income levels have both been used when looking at SES; however, many studies look at one or the other but not both. The studies have suggested that those of lower SES may benefit from increased availability of F/V as well as increased knowledge on shopping, preparation, and cooking. Limited research is available on the effects of nutrition intervention on anthropometric measurements among individuals of varying SES. While looking specifically at education level as well as both personal and household annual incomes, this study will examine the effects of nutrition education as well as increased availability of F/V through F/V supplementation on intakes of F/V and anthropometric measurements among overweight and obese adults of varying SES.

CHAPTER 3. METHODS

This study was designed as a 14-week program with three different phases to determine the effect of nutrition education, as well as F/V supplementation, on F/V intake and anthropometric measurements of individuals of varying SES. The phases consisted of pre-testing, intervention, and post-testing. Pre-testing and post-testing were each two weeks and the intervention phase was 10 weeks. This study was approved by the Institutional Review Board (IRB) of North Dakota State University (Appendix A). All members of the research team including instructors for the intervention phase completed IRB training online through the National Institutes of Health prior to the start of the study.

Participant Recruitment

To recruit participants for the study, flyers were posted around businesses in the Fargo, ND/Moorhead, MN area (Appendix B). Advertisements were also sent out with permissions via email listservs. The advertisements included the general purpose of the study, inclusion criteria, and contact information for the research team. Exclusion criteria included anyone under the age of 18, with a BMI <25.0 kg/m^2, with a history of bariatric surgery, currently smoke, or were pregnant or lactating. Persons who were interested were invited to attend an informational session. At the informational session, the purpose of the study as well as what would be expected of them was explained to prospective participants. If they were still interested, they were asked to sign an informed consent form and sign-up to attend a pre-testing session.

Pre-testing

During pre-testing, anthropometric measurements were taken, and participants were asked to fill out questionnaires. Anthropometric measurements included height,

weight, waist circumference, and body fat percentage. Body mass index was calculated for all participants using height and weight measurements. Participants were asked to remove their shoes, socks, and any outer, heavy clothing articles for anthropometric measurements. Height measurements were taken using a stadiometer (HR-200, Tanita Corporation of America, Inc., Arlington Heights, IL). Body weight and body fat percentage were measured with a Tanita Body Composition Analyzer® (TBF-300A, Tanita Corporation of America, Inc., Arlington Heights, IL). Three pounds (1.36 kg) were subtracted from each participant's weight to compensate for clothing. Participants also completed questionnaires on demographic information, general health history, and habitual F/V consumption information (Appendices C & D). Self-reported demographic information included age, gender, race/ethnicity, education level, annual personal income, annual household income, and marital status. Education level and annual personal and household incomes were used as variables for SES. Participants were also asked to report personal history or current diagnosis of food allergies, asthma, anemia, sickle cell anemia, blood clotting disease, diabetes, cancer, heart disease, high cholesterol, and hypertension. In addition, they were asked to report use of any prescription or over the counter medications as well as vitamin, mineral, or herbal supplements. Questions on lifestyle factors including current physical activity levels, diets followed, weight history, and frequency of alcohol and tobacco use were also asked.

The participants were then asked to complete a three-day food record to assess dietary intake (Appendix E). Instructions for completing the three-day food record were reviewed with the participants including that they should be as specific as possible with amounts eaten, brands, and preparation methods, include all foods and beverages eaten, and record dietary intake for two weekdays and one weekend day. The three-day food

records were analyzed using The Food Processor® (ESHA Research, Salam, OR) to assess dietary intake.

Intervention

After completion of pre-testing, participants were randomly assigned into one of three different groups. The groups included control, education, and F/V. Participants assigned to the control group were asked to continue their current routine and come back at post-testing. Participants of the education group attended a weekly nutrition education class for 10 weeks. The F/V group participants also attended the weekly nutrition education classes and received F/V supplements in addition. They were provided with the equivalent of two servings of vegetable and one serving of fruit daily for the 10 weeks of the intervention phase. These amounts were provided because research has shown that adults are usually short of meeting recommendations for F/V intake daily by two servings of vegetable and one serving of fruit. Participants of the F/V group were asked to record their weekly intake of all F/V for the duration of the intervention.

The nutrition education classes were taught by three licensed, registered dietitians. Morning, afternoon, and evening classes 30-45 minutes in length were offered seven different times during the week allowing participants to select the time that worked best for them. The curriculum for the sessions was adapted from the Department of Food and Nutrition at The University of Georgia. The materials are readily available to the public online. The curriculum covers information about the antioxidant content of F/V, the role of antioxidants on the inflammatory process, and current recommendations for F/V consumption. Participants were also provided with a variety of ideas on ways to prepare F/V. The lessons encouraged audience interaction and also included some activities rather than simply lecture.

Week one of intervention covered general information on F/V such as serving sizes, recommended servings, months when certain F/V are in season, and the phytochemicals in F/V as well as their role in health. After week one, each weekly lesson covered a different type of fruit or vegetable including berries, citrus fruits, tomatoes, leafy greens, canned and frozen F/V, cruciferous vegetables, squashes and pumpkins, beans, and garlic and onions. Each lesson began by reviewing information from the prior session. Once review was completed, nutrition benefits of the fruit or vegetable for the week were discussed, selection and storage tips were given, and ideas for preparation of the items were presented. Participants were also given the opportunity to taste a recipe made from the specific fruit or vegetable discussed that week four times during the intervention. Also, participants of the F/V group were given recipes each week which contained the F/V supplements they were receiving as ingredients.

Post-testing

After the 10 weeks of intervention, participants completed post-testing. Post-testing was similar to pre-testing. Anthropometrics were measured again using the same format and Tanita scale. Questionnaires completed were very similar to pre-testing as well (Appendices F & G). In regards to SES, participants were asked whether their personal and household incomes increased, decreased, or stayed the same. They were then asked to report both their personal and household income levels again. A significant change in education level does not usually occur over a four-month period, thus education level was not reassessed during post-testing and education levels from pre-testing were used when assessing SES. During the last week of intervention, participants were given another three-day food record to fill out and bring back during post-testing. At post-testing, participants in the control group were given the option to receive information from the nutrition education classes.

Statistical Analysis

The data collected at pre-testing and at post-testing were analyzed using SAS (version 9.2; SAS Institute Inc., Cary, NC). Descriptive statistics were calculated for age and BMI. Frequencies were calculated for gender, education categories, personal annual income categories, and household annual income categories. The education levels and incomes were divided into categories when analyzing the results. Education level was divided into three separate categories including: less than a bachelor's degree, bachelor's degree, and graduate degree. Personal annual income was classified as follows: <$30,000, $30,000-69,999, and ≥$70,000. Household annual income was also divided into three categories including: <$50,000, $50,000-89,999, and ≥$90,000.

A one-way analysis of variance (ANOVA) was conducted to determine a differential effect of education level, pre-personal annual income, and pre-household annual income on F/V intake and anthropometric measurements prior to the intervention. Each independent variable, education level, pre-personal annual income, and pre-household annual income, were analyzed separately against each dependent variable, daily fruit intake, daily vegetable intake, weight, BMI, body fat percentage, and waist circumference. Gender was also analyzed against each dependent variable to determine if there was a differential effect on F/V intake and anthropometric measurements prior to the intervention.

Paired sample t-tests were used to determine changes in F/V intake as well as anthropometric measurements from pre-testing to post-testing looking at each intervention group, education category, post-personal annual income category, and post-household annual income category individually which were the independent variables.

The effects of nutrition education alone, as well as nutrition education with F/V supplementation, on F/V intake and anthropometric measurements among individuals of varying SES were analyzed using analysis of covariance (ANCOVA). ANCOVA was used to

determine the difference in improvements among different education levels, post-personal annual income, and post-household annual income among the different intervention groups while adjusting for the impact pre-measurements had on post-measurements. Intake of F/V as well as anthropometric measurements were the dependent variables while the different SES categories and intervention groups were the independent variables and the covariates were the pre-measurement, either intake of F/V or anthropometric measurement. Other independent variables included were gender, total number of persons in the household, number of adults in the household, number of children in the household, who does the grocery shopping, and who does the cooking. Categories for total number of persons in the household and number of adults in the household included: one, two, and three or more. For number of children in the household, categories included: zero, one, and two or more. For who does the grocery shopping and cooking, two categories were used which were the person themselves or anyone else. The significance level used for each statistical analysis was $p<0.05$.

CHAPTER 4. RESULTS

Pre-testing and post-testing were used to determine changes in anthropometric measurements and F/V intake of the participants through nutrition education as well as F/V supplementation. The areas of focus included weight, BMI, body fat percentage, waist circumference, and daily servings of fruit and daily servings of vegetable intakes.

Out of 67 original participants, 38 completed the study (57%). Participants who completed the study included 11 males (29%) and 27 females (71%) aged 47.97 ± 10.42 years with a mean BMI of 33.89 ± 6.58 kg/m^2. Twenty-nine percent of participants had less than a bachelor's degree, 26% had a bachelor's degree, and 45% had a graduate degree. The spread for pre-personal annual income was as follows: 29% <$30,000, 58% $30,000-69,999, and 13% ≥$70,000. Results for pre-household annual income showed that 32% of participants reported <$50,000, 42% $50,000-89,999, and 26% ≥$90,000. For post-personal annual income levels, 26% of participants reported <$30,000, 61% $30,000-69,999, and 13% ≥$70,000. For post-household annual income levels, 29% of participants reported <$50,000, 45% $50,000-89,999, and 26% ≥$90,000 (Table 1). There were no significant changes in income levels seen from pre-testing to post-testing.

Socioeconomic Status and Pre-measurements

Analysis of pre-data did not show any significant differences in F/V intake prior to the intervention among individuals of varying SES, looking at education level, pre-personal annual income, and pre-household annual income (Table 2). While looking at pre-anthropometric measurements and SES, BMI and body fat percentage were significantly different among varying education levels and those of varying personal annual incomes. Body fat percentage was also found to be significantly different among differing household annual income levels (Table 3).

Table 1

Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
	n=11 (29%)	n=10 (26%)	n=17 (45%)
Pre-Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
	n=11 (29%)	n=22 (58%)	n=5 (13%)
Pre-Household Annual Income	**<$30K**	**$30K-<70K**	**≥$70K**
	n=12 (32%)	n=16 (42%)	n=10 (26%)
Post-Personal Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
	n=10 (26%)	n=23 (61%)	n=5 (13%)
Post-Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
	n=11 (29%)	n=17 (45%)	n=10 (26%)

[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000

Body mass index and body fat percentage appeared to be significantly different among individuals with less than a bachelor's degree and those with a graduate degree with individuals with a graduate degree having a lower BMI and body fat percentage (Table 3). The mean BMI for individuals with less than a bachelor's degree at pre-testing was 37.06 ± 6.65 kg/m^2 and for those with a graduate degree the mean BMI was 30.96 ± 4.64 kg/m^2. For individuals with less than a bachelor's degree, the mean body fat percentage at pre-testing was 43.16 ± 6.87% and for those with a graduate degree it was 37.20 ± 7.73%.

Table 2

Pre-Testing Fruit and Vegetable Intake (daily servings) and Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**	**P-Value**
Fruit[1]	1.62 ± 0.81	1.30 ± 1.25	1.20 ± 0.88	0.54
Vegetable[1]	1.64 ± 0.66	1.86 ± 0.69	1.38 ± 0.85	0.28
Pre-Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**	
Fruit[1]	1.36 ± 0.90	1.44 ± 1.04	0.93 ± 0.78	0.58
Vegetable[1]	1.86 ± 0.79	1.41 ± 0.72	1.71 ± 0.85	0.27
Pre-Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**	
Fruit[1]	1.58 ± 1.27	1.33 ± 0.69	1.10 ± 0.94	0.52
Vegetable[1]	1.58 ± 0.79	1.52 ± 0.75	1.67 ± 0.83	0.90

[1] Data were presented as mean ± standard deviation
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000

Body mass index and body fat percentage appeared to be significantly different among individuals with a personal annual income of <$30,000 and those with a personal annual income of ≥$70,000 with those in the highest income category having a lower BMI and body fat percentage (Table 3). The mean BMI at pre-testing for individuals with a personal annual income of <$30,000 was 38.40 ± 7.13 kg/m^2 and for those with a personal annual income of ≥$70,000 the mean BMI was 29.88 ± 4.00 kg/m^2. Individuals with a personal annual income of <$30,000 had a mean body fat percentage of 43.12 ± 7.09% at pre-testing and those with ≥$70,000 had a mean body fat percentage of 32.38 ± 3.89%.

Body fat percentage also appeared to be significantly lower among those in the highest household annual income category than those in the lowest household annual income category (Table 3). The mean body fat percentage for those with a household annual income of <$50,000 was 44.36 ± 5.15% at pre-testing and for those with a household annual income of ≥$90,000 the mean body fat percentage was 36.23 ± 7.82%.

Table 3

Pre-Testing Anthropometric Measurements and Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**	**P-Value**
Weight (kg)[1]	106.00 ± 17.45	98.86 ± 23.59	96.36 ± 21.00	0.49
BMI (kg/m^2)[1*]	37.06 ± 6.65^	35.39 ± 7.71	30.96 ± 4.64^	0.04
Body Fat (%)[1]	43.16 ± 6.87^	43.04 ± 5.94	37.20 ± 7.73^	0.049
Waist Circum. (cm)[1^^]	122.61 ± 11.63	117.91 ± 20.27	113.61 ± 13.67	0.32
Pre-Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**	
Weight (kg)[1]	110.14 ± 17.73	95.75 ± 20.92	95.05 ± 20.86	0.14
BMI (kg/m^2)[1*]	38.40 ± 7.13^	32.55 ± 5.71	29.88 ± 4.00^	0.01
Body Fat (%)[1]	43.12 ± 7.09^	40.97 ± 7.23	32.38 ± 3.89^	0.02
Waist Circum. (cm)[1^^]	123.85 ± 14.96	115.44 ± 15.24	111.38 ± 13.72	0.21
Pre-Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**	
Weight (kg)[1]	96.05 ± 17.59	101.45 ± 22.82	101.77 ± 21.73	0.75
BMI (kg/m^2)[1*]	34.54 ± 6.16	34.41 ± 7.17	32.30 ± 6.46	0.68
Body Fat (%)[1]	44.36 ± 5.15^	40.19 ± 7.61	36.23 ± 7.82^	0.03
Waist Circum. (cm)[1^^]	117.91 ± 12.95	118.36 ± 16.81	114.38 ± 16.41	0.86

[1] Data were presented as mean ± standard deviation
[*] Body mass index
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000
^ Indicates a significant difference between groups
^^ Waist circumference

Significant differences among varying SES were not seen for weight and waist circumference at pre-testing. Weight was lower among individuals with a higher education; however, it was not a significant difference. The mean weight at pre-testing by education was 106.00 ± 17.45 kg for individuals with less than a bachelor's degree, 98.86 ± 23.59 kg for those with a bachelor's degree, and 96.36 ± 21.00 kg for those with a graduate degree. Waist circumference was also smaller among those with a higher education level at pre-testing. The mean waist circumference for individuals with less than a bachelor's degree was 122.61 ± 11.63 cm, among those with a bachelor's degree it was 117.91 ± 20.27 cm, and

for those with a graduate degree the mean waist circumference at pre-testing was 113.61 ± 13.67 cm. While weight was found to be highest among those of lower education levels, in regards to income, weight was found to be the highest among those in the lowest personal annual income category but highest among those in the highest household annual income category. Body mass index was not consistent with weight among household income categories and individuals in the highest household annual income category had a lower BMI than those in the lowest income category (Table 3).

Overall, F/V intake did not vary significantly prior to the intervention among those of varying SES; however, significant differences were seen for BMI and body fat percentage. Trends were also seen for weight and waist circumference among individuals of varying SES; however, these differences were not found to be significant. Individuals with a higher education had a lower weight, BMI, body fat percentage, and waist circumference than those with a lower education with the differences of BMI and body fat percentage being significant among individuals with a graduate degree and those with less than a bachelor's degree. Individuals with the highest pre-personal annual income, ≥$70,000, were also found to have a significantly lower BMI and body fat percentage than those of the lowest pre-personal annual income, <$30,000. The results also showed that individuals in the highest household annual income category had a significantly lower body fat percentage than those in the lowest household income category.

Gender and Pre-measurements

Daily intake of F/V was not found to be significantly different between males and females at pre-testing. In regards to anthropometric measurements, males had a significantly higher weight but females had a significantly higher body fat percentage at pre-testing (Table 4). Body mass index and waist circumference were not significantly different between males and females at pre-testing.

Table 4

Pre-Testing Anthropometric Measurements and Gender

Gender	Male	Female	P-Value
Weight (kg)[1]	115.86 ± 20.64^	93.30 ± 16.97^	0.001
BMI (kg/m^2)[1*]	34.58 ± 5.64	33.61 ± 7.00	0.69
Body Fat (%)[1]	33.80 ± 7.62^	43.18 ± 5.56^	0.0002
Waist Circum. (cm)[1^^]	121.16 ± 15.19	115.77 ± 15.27	0.33

[1] Data were presented as mean ± standard deviation
[*] Body mass index
^ Indicates a significant difference between groups
^^ Waist circumference

Changes in Anthropometric Measurements

After the 10 weeks of intervention, only a few significant improvements were seen in anthropometric measurements. Overall, weight, BMI, and body fat percentage were all increased; however, the increases were not significant (Table 5). At pre-testing, the overall mean weight was 99.83 ± 20.61 kg and at post-testing the overall mean weight increased to 99.91 ± 20.01 kg. Prior to the intervention, the mean BMI was 33.89 ± 6.58 kg/m^2. The mean BMI measurements increased from pre-testing to 33.91 ± 6.34 kg/m^2 at post-testing. Overall, body fat percentage also increased with a pre-testing mean of 40.46 ± 7.48% and a mean of 41.08 ±7.31% at post-testing. While weight, BMI, and body fat percentage all increased, overall waist circumference measurements did show an improvement from pre-testing to post-testing, improving from a mean of 117.35 ± 15.24 cm to 116.26 ± 14.45 cm However, the improvement in waist circumference was not significant.

Looking at different intervention groups, most of the changes in anthropometric measurements were not significantly different among the control, education, or F/V groups; however, the F/V group did have a significant improvement in waist circumference from pre-testing to post-testing and body fat percentage increased significantly among the

control group from pre-testing to post-testing (Table 5). The F/V and control groups had increases in weight, BMI, and body fat percentage but reduced waist circumference (Table 5). The mean waist circumference for participants in the F/V group improved significantly from 119.40 ± 15.57 cm to 117.09 ± 15.11 cm. In the control group, the mean waist circumference improved but not significantly from 112.88 ± 15.34 cm at pre-testing to 111.53 ± 12.55 cm at post-testing. The mean body fat percentage for participants in the control group was 35.25 ± 13.08% at pre-testing and increased significantly to 36.35± 12.76% at post-testing. Among participants in the education group, weight and BMI decreased non-significantly while body fat percentage and waist circumference measurements increased non-significantly.

Looking at SES and changes in anthropometric measurements, there were some improvements seen but few that were significant (Tables 6, 7, 8, & 9). Among varying education levels, personal annual incomes, and household annual incomes, there was a significant improvement in BMI among those of the lowest education level; all other improvements were not significantly different from pre-testing to post-testing among individuals of varying SES (Table 6). At pre-testing, the mean BMI of those of the lowest education level, less than a bachelor's degree, was 37.06 ± 6.65 kg/m^2. Post-testing measurements showed BMI improved significantly among those in the lowest education category to a mean of 36.38 ± 6.59 kg/m^2. Although the changes were not significantly different from pre-testing measurements, individuals of the lowest education level also had improvements in weight, body fat percentage, and waist circumference (Tables 7,8, & 9). The mean weight of participants in the lowest education category improved from 106.02 ± 17.45 kg at pre-testing to 104.02 ± 16.77 kg at post-testing. Body fat percentage of those with the lowest education decreased from a mean of 43.16 ± 6.87% at pre-testing to 42.76 ± 6.57% at post-testing. Waist circumference measurements also improved from a mean of

122.60 ± 11.63 cm at pre-testing to 121.69 ± 8.97 cm at post-testing. While body fat percentage decreased among individuals with less than a bachelor's degree, there was an increase in body fat percentage among those with a bachelor's degree and a graduate degree with the increase among those with a bachelor's degree being significant.

Table 5

Change in Anthropometric Measurements

Intervention Group	Overall	Control	Education	F/V**
Weight (kg)	99.83 ± 20.61	95.32 ± 19.11	102.79 ± 24.30	98.65 ± 18.81
Pre-Testing[1]	99.91 ± 20.01	96.14 ± 18.34	102.21 ± 23.72	99.05 ± 18.28
Post-Testing[1]	+0.08 ± 2.85	+0.82 ± 1.27	-0.58 ± 3.40	+0.40 ± 2.66
Change[1,2]	0.86	0.29	0.54	0.51
P-Value				
BMI (kg/m²)*				
Pre-Testing[1]	33.89 ± 6.58	34.78 ± 12.06	33.33 ± 5.29	34.12 ± 6.45
Post-Testing[1]	33.91 ± 6.34	35.00 ± 11.66	33.13 ± 4.93	34.25 ± 6.27
Change[1,2]	+0.02 ± 0.94	+0.22 ± 0.42	-0.20 ± 1.08	+0.13 ± 0.93
P-Value	0.90	0.36	0.50	0.54
Body Fat (%)				
Pre-Testing[1]	40.46 ± 7.48	35.25 ± 13.08	39.04 ± 6.52	42.51 ± 6.43
Post-Testing[1]	41.08 ± 7.31	36.35 ± 12.76	39.81 ± 6.21	42.92 ± 6.53
Change[1,2]	+0.62 ± 2.09	+1.10 ± 0.67^	+0.77 ± 2.72	+0.41 ± 1.81
P-Value	0.08	0.0469	0.31	0.32
Waist Circum. (cm)^^				
Pre-Testing[1]	117.35 ± 15.24	112.88 ± 15.34	115.67 ± 15.37	119.40 ± 15.57
Post-Testing[1]	116.26 ± 14.45	111.53 ± 12.55	116.43 ± 14.68	117.09 ± 15.11
Change[1,2]	-1.09 ± 5.97	-1.35 ± 3.05	+0.76 ± 7.67	-2.31 ± 4.85^
P-Value	0.27	0.44	0.71	0.0458

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
* Body mass index
** Fruit and vegetable
^ Indicates a significant change within group
^^ Waist circumference

Table 6

Change in Body Mass Index (kg/m²) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	37.06 ± 6.65	35.39 ± 7.71	30.96 ± 4.64
Post-Testing[1]	36.38 ± 6.59	35.59 ± 7.49	31.33 ± 4.60
Change[1,2]	-0.68 ± 0.92^	+0.20 ± 0.45	+0.37 ± 0.96
P-Value	0.03	0.20	0.14
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	39.12 ± 7.08	32.50 ± 5.59	29.88 ± 4.00
Post-Testing[1]	38.65 ± 6.80	32.72 ± 5.54	29.92 ± 3.85
Change[1,2]	-0.47 ± 0.95	+0.22 ± 0.96	+0.04 ± 0.49
P-Value	0.15	0.27	0.86
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	34.85 ± 6.37	34.22 ± 6.99	32.30 ± 6.46
Post-Testing[1]	34.64 ± 6.11	34.34 ± 6.59	32.40 ± 6.56
Change[1,2]	-0.21 ± 0.79	+0.12 ± 1.19	+0.10 ± 0.62
P-Value	0.40	0.69	0.62

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000
^ Indicates a significant change within group

Looking at income and changes in anthropometric measurements, individuals in the lowest personal annual income category, <$30,000, along with those in the lowest household annual income category, <$50,000, had non-significant improvements in weight and BMI (Tables 6 & 7). The mean weight for individuals of the lowest personal annual income improved from 112.39 ± 16.95 kg at pre-testing to 110.91 ± 15.00 kg at post-testing. Weight of individuals with the lowest annual household income improved from 96.79 ± 18.24 kg at pre-testing to 96.17 ± 17.56 kg at post-testing. The mean body fat percentage decreased non-significantly among individuals in the lowest personal annual income category and increased for each of the other personal and household annual income

categories (Table 8). The increase in body fat percentage for the highest household annual income was significant increasing from 36.23 ± 7.82% at pre-testing to 37.66 ± 7.72% at post-testing. The mean waist circumference decreased among both the highest and lowest annual household and personal income levels and increased among the middle income categories. None of the changes seen in waist circumference were significantly different among varying income levels (Table 9).

Table 7

Change in Weight (kg) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	106.02 ± 17.45	98.87 ± 23.57	96.39 ± 20.98
Post-Testing[1]	104.02 ± 16.77	99.47 ± 23.33	97.51 ± 20.65
Change[1,2]	-2.00 ± 3.00	+0.60 ± 1.26	+1.12 ± 2.81
P-Value	0.05	0.17	0.12
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	112.39 ± 16.95	95.41 ± 20.50	95.05 ± 20.88
Post-Testing[1]	110.91 ± 15.00	96.14 ± 20.70	95.25 ± 20.75
Change[1,2]	-1.48 ± 3.11	+0.73 ± 2.75	+0.20 ± 1.69
P-Value	0.17	0.21	0.80
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	96.79 ± 18.24	100.64 ± 22.36	101.79 ± 21.72
Post-Testing[1]	96.17 ± 17.56	100.97 ± 21.01	102.21 ± 22.23
Change[1,2]	-0.62 ± 2.16	+0.33 ± 3.62	+0.42 ± 1.97
P-Value	0.36	0.71	0.52

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000

Overall, waist circumference measurements improved significantly among individuals receiving F/V supplementation. Individuals with the lowest education level had improvements in weight, BMI, body fat percentage, and waist circumference at post-testing.

Also, when looking at income levels, individuals with the lowest personal and household annual incomes had improvements in weight and BMI. Changes in anthropometric measurements were not significantly different between males and females. There were also no significant differences in changes in anthropometric measurements when looking at total number of persons in the household, number of children in the household, number of adults in the household, who does the grocery shopping, or who does the cooking.

Table 8

Change in Body Fat (%) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	43.16 ± 6.87	43.04 ± 5.94	37.20 ± 7.73
Post-Testing[1]	42.76 ± 6.57	44.20 ± 5.70	38.15 ± 7.82
Change[1,2]	-0.40 ± 2.27	+1.16 ± 1.45^	+0.95 ± 2.16
P-Value	0.57	0.03	0.09
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	43.54 ± 7.32	40.88 ± 7.08	32.38 ± 3.89
Post-Testing[1]	43.30 ± 7.13	41.66 ± 7.21	33.98 ± 4.18
Change[1,2]	-0.24 ± 2.14	+0.77 ± 2.09	+1.60 ± 1.71
P-Value	0.73	0.09	0.10
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	44.85 ± 5.09	40.11 ± 7.37	36.23 ± 7.82
Post-Testing[1]	45.11 ± 5.05	40.48 ± 7.44	37.66 ± 7.72
Change[1,2]	+0.26 ± 1.77	+0.37 ± 2.38	+1.43 ± 1.85^
P-Value	0.64	0.53	0.04

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000
^ Indicates a significant change within group

Table 9

Change in Waist Circumference (cm) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	122.60 ± 11.63	117.90 ± 20.27	113.61 ± 13.67
Post-Testing[1]	121.69 ± 8.97	117.32 ± 19.61	112.14 ± 13.28
Change[1,2]	-0.91 ± 8.56	-0.58 ± 5.26	-1.47 ± 4.57
P-Value	0.73	0.74	0.20
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	124.89 ± 15.34	115.37 ± 14.88	111.38 ± 13.72
Post-Testing[1]	122.94 ± 12.52	115.11 ± 14.35	108.28 ± 15.67
Change[1,2]	-1.95 ± 5.64	+0.26 ± 6.40	-3.10 ± 4.72
P-Value	0.30	0.85	0.22
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	118.29 ± 13.51	118.08 ± 16.31	115.06 ± 16.41
Post-Testing[1]	117.45 ± 13.39	117.73 ± 13.77	112.47 ± 17.32
Change[1,2]	-0.84 ± 4.17	+0.35 ± 7.54	-2.59 ± 4.75
P-Value	0.52	0.86	0.12

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000

Changes in Fruit Intake

Overall, intake of fruit improved with a significant improvement from pre-testing to post-testing seen among the F/V group (Table 10). The overall mean intake of fruit at pre-testing was 1.35 ± 0.96 daily servings and increased to 1.75 ± 1.03 daily servings at post-testing.

Among intervention groups, daily intake of fruit was significantly different among participants in the F/V group than the control at post-testing (Table 10). The mean fruit intake for the control group at post-testing was 1.27 ± 0.59 servings and for the F/V group it was 2.10 ± 0.95 servings. Pre-testing intake of fruit for the F/V group was 1.42 ± 0.90 daily servings which significantly increased to 2.10 ± 0.95 daily servings at post-testing.

Participants in the control group had a decline in intake from 2.07 ± 1.08 daily servings to 1.27 ± 0.59 daily servings. The education group had a non-significant improvement in fruit intake from 1.03 ± 0.94 daily servings to 1.40 ± 1.11 daily servings.

Table 10

Change in Intake of Fruit and Vegetable (daily servings)

Intervention Group	Overall	Control	Education	F/V**
Fruit Intake				
Pre-Testing[1]	1.34 ± 0.16	2.07 ± 1.08	1.03 ± 0.94	1.42 ± 0.90
Post-Testing[1]	1.75 ± 1.03	1.27 ± 0.59	1.40 ± 1.11	2.10 ± 0.95
Change[1,2]	+0.41 ± 1.04^	-0.80 ± 0.61	+0.37 ± 0.80	+0.68 ± 1.11^
P-Value	0.02	0.08	0.10	0.01
Vegetable Intake				
Pre-Testing[1]	1.58 ± 0.76	1.72 ± 0.65	1.61 ± 0.91	1.53 ± 0.70
Post-Testing[1]	1.69 ± 0.79	1.80 ± 0.61	1.39 ± 0.78	1.89 ± 0.80
Change[1,2]	+0.11 ± 0.98	+0.08 ± 1.19	-0.22 ± 0.89	+0.36 ± 0.98
P-Value	0.47	0.89	0.36	0.11

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
** Fruit and vegetable
^ Indicates a significant change within group

For each of the education categories, there was an increase in fruit intake from pre-testing to post-testing. A significant improvement was seen among those with a graduate degree with a pre-testing mean intake of 1.20 ± 0.88 servings per day and 1.65 ± 1.04 servings per day at post-testing (Table 11). Improvements were also seen from pre-testing to post-testing in each of the personal and household annual income categories with significant improvements seen in the lowest and highest personal annual income categories as well as the middle household annual income category (Table 11). The mean intake for the lowest personal income category, <$30,000, improved from 1.30 ± 0.92 daily servings at pre-testing to 2.17 ± 1.00 daily servings at post-testing. The highest personal annual

income, ≥$70,000, had an improvement in fruit intake from a mean of 0.93 ± 0.78 daily servings at pre-testing to 1.38 ± 0.86 daily servings at post-testing. The middle household annual income category, $50,000-89,999, had an improvement in fruit intake from a mean of 1.37 ± 0.69 daily servings at pre-testing to 1.94 ± 0.99 daily servings at post-testing.

Table 11

Change in Fruit Intake (daily servings) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	1.61 ± 0.81	1.30 ± 1.25	1.20 ± 0.88
Post-Testing[1]	1.76 ± 0.98	1.94 ± 1.14	1.65 ± 1.04
Change[1,2]	+0.15 ± 1.23	+0.64 ± 1.20	+0.45 ± 0.81^
P-Value	0.71	0.13	0.04
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	1.30 ± 0.92	1.46 ± 1.02	0.93 ± 0.78
Post-Testing[1]	2.17 ± 1.00	1.65 ± 1.06	1.38 ± 0.86
Change[1,2]	+0.87 ± 0.82^	+0.19 ± 1.17	+0.45 ± 0.25^
P-Value	0.01	0.43	0.02
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	1.54 ± 1.32	1.37 ± 0.69	1.10 ± 0.94
Post-Testing[1]	1.58 ± 1.23	1.94 ± 0.99	1.63 ± 0.91
Change[1,2]	+0.04 ± 1.21	+0.57 ± 0.24^	+0.53 ± 0.93
P-Value	0.91	0.03	0.10

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000
^ Indicates a significant change within group

The improvement in fruit intake was also found to be significantly different between males and females (Table 12). Males had a significant improvement compared to females with an increase from a mean of 1.14 ± 0.85 daily servings at pre-testing to 1.91 ± 1.03 daily servings at post-testing. Females improved their intake of fruit from a mean of 1.43 ± 1.00 daily servings at pre-testing to 1.69 ± 1.04 daily servings at post-testing. While looking at total number of persons in the household, number of children in the household, number of

adults in the household, who does the grocery shopping, and who does the cooking, no significant differences were seen in change in fruit intake. Overall, intake of fruit improved throughout the study with those receiving supplements of F/V having greater improvements. Improvements in fruit intake were also significantly better among males than females. Also, individuals with the highest education had significant improvements in fruit intake.

Table 12

Change in Fruit and Vegetable Intake (daily servings) by Gender

Gender	Male	Female	P-Value
Fruit Intake			
Pre-Testing[1]	1.14 ± 0.85	1.43 ± 1.00	
Post-Testing[1]	1.91 ± 1.03	1.69 ± 1.04	
Change[1,2]	+0.77 ± 0.96^	+0.26 ± 1.05^	0.04
Vegetable Intake			
Pre-Testing[1]	1.63 ± 0.76	1.56 ± 0.78	
Post-Testing[1]	1.64 ± 0.65	1.72 ± 0.85	
Change[1,2]	+0.01 ± 0.69	+0.16 ± 1.08	0.25

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
^ Indicates a significant difference between groups

Changes in Vegetable Intake

Overall, there was an improvement in vegetable intake seen from pre-testing to post-testing. Pre-testing data showed that overall, participants had a mean consumption of 1.58 ± 0.76 servings of vegetable per day prior to the intervention and at post-testing the mean consumption was 1.69 ± 0.79 servings per day.

The change in vegetable intake was not significantly different among individuals in different intervention groups or of varying SES (Tables 10 & 13). Participants in the control and F/V groups increased their vegetable consumption from pre-testing to post-

testing; whereas, participants in the education group decreased their vegetable intake from 1.61 ± 0.91 servings per day at pre-testing to 1.39 ± 0.78 servings per day at post-testing. The mean intake for the control group prior to the intervention was 1.72 ± 0.65 daily servings and increased to 1.80 ± 0.61 daily servings at post-testing. Participants in the F/V group increased their intake from 1.53 ± 0.70 daily servings to 1.89 ± 0.80 daily servings.

Table 13

Change in Vegetable Intake (daily servings) by Socioeconomic Status

Education Level	**<Bachelor's Degree**	**Bachelor's Degree**	**Graduate Degree**
Pre-Testing[1]	1.64 ± 0.66	1.86 ± 0.68	1.38 ± 0.85
Post-Testing[1]	1.89 ± 0.95	1.67 ± 0.65	1.59 ± 0.78
Change[1,2]	+0.25 ± 1.21	-0.19 ± 0.98	+0.21 ± 0.83
P-Value	0.51	0.55	0.31
Personal Annual Income	**<$30K[+]**	**$30K-<70K**	**≥$70K**
Pre-Testing[1]	1.77 ± 0.77	1.47 ± 0.76	1.71 ± 0.85
Post-Testing[1]	1.98 ± 0.89	1.67 ± 0.76	1.25 ± 0.64
Change[1,2]	+0.21 ± 1.08	+0.20 ± 0.96	-0.46 ± 0.85
P-Value	0.55	0.33	0.29
Household Annual Income	**<$50K**	**$50K-<90K**	**≥$90K**
Pre-Testing[1]	1.47 ± 0.73	1.60 ± 0.79	1.67 ± 0.82
Post-Testing[1]	1.36 ± 0.68	1.95 ± 0.76	1.63 ± 0.89
Change[1,2]	-0.11 ± 0.49	+0.35 ± 1.20	-0.04 ± 0.96
P-Value	0.46	0.24	0.91

[1] Data were presented as mean ± standard deviation
[2] Difference in the mean between post-testing and pre-testing
[+] $30K = $30,000, $50K = $50,000, $70K = $70,000, $90K = $90,000

In relation to education level, those with less than a bachelor's degree and those with a graduate degree increased their vegetable consumption non-significantly and those with a bachelor's degree decreased their consumption non-significantly from pre-testing to post-testing (Table 13). Individuals in the highest personal annual income category had a non-significant decline in daily servings of vegetable intake and individuals in the two

lowest categories had a non-significant improvement from pre-testing to post-testing (Table 13). While looking at change in vegetable intake compared to household annual incomes, the lowest and highest categories had non-significant declines in intake and the middle category had a non-significant improvement from a mean of 1.60 ± 0.79 daily servings a pre-testing to 1.95 ± 0.76 daily servings at post-testing. Overall, vegetable intake increased; however, no significant improvements were seen in vegetable intake from pre-testing to post-testing and there were no significant differences in improvement seen among individuals of varying SES. Improvement in vegetable intake was also not significantly different between males and females (Table 12). Also, while looking at total number of persons in the household, number of children in the household, number of adults in the household, who does the grocery shopping, and who does the cooking, no significant differences were seen in improvement in vegetable intake.

CHAPTER 5. DISCUSSION

This study aimed to test the effectiveness of nutrition education with F/V supplementation on intake of F/V as well as anthropometric measurements in overweight and obese adults of varying SES. According to Thomson and Ravia (2011), less than 25% of adults in the United States consume the recommended servings, five or more, of F/V daily. The concern of inadequate intake of F/V seems to be more prevalent in individuals of lower SES (Lallukka et al., 2010). Nutrition education has been one strategy implemented to improve the intake of F/V among adults. Strategies that are most effective for individuals of varying SES are uncertain; Backman et al. (2011) suggested that increased access to F/V may lead to increased consumption among individuals of low SES. The current study assessed the effectiveness of nutrition education as well as increased availability of F/V by providing supplementation of F/V to one of the intervention groups throughout the duration of the study on intakes of F/V as well as anthropometric measurements of individuals of varying SES.

The main variables this study assessed included daily servings of F/V intake, weight, BMI, body fat percentage, and waist circumference. Pre-testing and post-testing data were collected to determine changes in each of these variables and assess the effect of SES, looking at education level, personal annual income, and household annual income, on improvements. The study also looked at pre-testing data to determine if there was a differential effect of SES on each of these areas prior to the intervention.

Anthropometric measurements were assessed due to their relation with risk for chronic disease development. Increased consumption of F/V has been promoted for reducing the risk of chronic disease development and we sought to determine if an intervention focusing specifically on F/V led to an improvement in anthropometric

measurements which may lead to a reduced risk for developing chronic diseases. Overweight and obesity, classified as a BMI >25.0 kg/m^2, are risk factors for developing many chronic diseases including heart disease, diabetes mellitus, and cancer. While BMI does not directly measure fat mass and muscle mass, increased total body fat is also a risk factor for developing chronic diseases. The distribution of body fat has also been linked to chronic disease with those with higher abdominal fat having a greater risk. For women, a waist circumference of greater than 35 in. (88.9 cm) is associated with more obesity-related health problems and for men those having a waist circumference greater than 40 in. (101.6 cm) are at greater risk (National Institute of Diabetes and Digestive, and Kidney Diseases, 2008).

Education levels were divided into categories as follows: less than a bachelor's degree, bachelor's degree, and graduate degree. Personal annual income was divided into categories including: <$30,000, $30,000-69,999, and ≥ $70,000. Household annual income was also divided into three categories as follows: <%50,000, $50,000-89,999, and ≥ $90,000. The income categories were chosen by examining the per capita incomes and median household incomes for the United States as well as North Dakota. The per capita income for the United States in 2011 was $27, 915 and for North Dakota it was $27, 305 (United States Census Bureau, 2012). The median annual household income in the United States from 2007-2011 was $52,762 and for North Dakota it was $49,415 (United States Census Bureau, 2012). The lowest personal annual income category was set around the United States per capita income and the lowest household annual income category was set for less than the median household income for the United States. After choosing the lowest income categories, frequencies were run and the remaining categories were chosen by trying to divide the categories evenly. Individuals were asked their incomes at both pre-testing and post-testing. Incomes reported at pre-testing were used when assessing F/V intake and

anthropometric measurements prior to the intervention among varying levels of SES and incomes reported at post-testing were used when assessing improvements in intake of F/V and anthropometric measurements among varying levels of SES.

Previous studies suggested that both dietary habits and anthropometric measurements vary based on SES. The results of this study showed that intake of F/V, prior to the intervention, did not differ based on SES which is inconsistent with the current literature; however, a few studies have found similar results. Mullie et al.'s study (2010) showed that higher education and personal income levels were associated with healthier dietary patterns, looking at overall eating patterns rather than single nutrients or food groups alone. Education levels and income levels were categorized differently in Mullie et al.'s study (2010) than in the current study and food frequency questionnaires were used to assess dietary habits in Mullie et al.'s study (2010). For the current study, three-day food records were used to assess intake of F/V which may be a more accurate measure because they do not rely on recall as food frequencies do. Also, Mullie et al.'s study (2010) divided income into three categories based on the lowest, intermediate, and highest tertile of yearly gross income of the group. The participants were all in the military and these income levels may not have been representative of the overall population. Mullie et al. (2010) included anyone with a bachelor's degree in the highest education level; whereas for the current study, the highest education category included only those with a graduate degree. Comparison of the two studies is also difficult because Mullie et al.'s study (2010) assessed overall dietary patterns and our study looked specifically at F/V intake. It may be assumed that a healthier dietary pattern includes more F/V; however, intake of individual food groups was not reported.

A study by Estaquio et al. (2008) looked specifically at F/V intake among individuals of varying SES and results showed that the percentage of individuals who consumed the

recommendation of five or more servings of F/V daily increased with education level. A major difference between Estaquio et al.'s (2008) study and the current study is that Estaquio et al. (2008) used six-day food records and the current study used three-day food records. Estaquio et al. (2008) may have had a more accurate measure of dietary intake due to having an average of six days rather than three. Also, on average, participants in our study did not consume the recommended servings of F/V, regardless of SES. Participants in Estaquio et al.'s study (2008) lived in France and our participants lived in the Midwestern United States. Geographical differences in regards to availability of F/V may have an impact on meeting the recommendation of five or more servings of F/V daily.

A study by Fahlman et al. (2010) showed that children of lower SES ate less F/V than those of higher SES which may have been due to lack of availability. Fahlman et al. (2010) focused specifically on children; whereas, the current study focused on adults and the assessment of intake of F/V varied among the two studies. For Fahlman et al.'s (2010) study, middle school students were presented with a single serving size picture of different foods and asked how many times they had eaten that food the previous day. Recall of dietary intake may have been a difficult task for the students and may have led to inaccurate assessment of F/V intake. Also, students received one or two meals daily from school in which F/V are provided to all students so it may be difficult to determine if intakes differ among those of varying SES based on availability or if intakes differ due to other factors such as taste preference.

While much of the research shows an association between SES and intake of F/V, a study by Middaugh et al. (2012) showed that there was not a significant difference in daily intake of F/V in adults of varying incomes looking specifically at poverty income ratio (PIR) which is consistent to our findings in regards to income and F/V intake. Our study had similar results showing that income did not have an association with F/V intake; however,

Middaugh et al. (2012) used PIR to assess income levels which is the ratio of income to a family's appropriate poverty threshold. Poverty threshold is a measure that is updated annually by the US Census Bureau which considers family size and age in determining the threshold for poverty classification (Institute for Research on Poverty, n.d.). We measured income differently for our study by using both personal and household annual incomes to determine income levels. Another difference between our study and the studies discussed is that we focused specifically on overweight and obese adults; whereas, previous studies have included all individuals regardless of weight when looking at SES and F/V intake.

The literature on SES and anthropometric measurements suggests that individuals of higher SES have a lower BMI and body fat percentage. Our study was fairly consistent with the literature in regards to SES and anthropometric measurements. The results showed that participants with a higher education level had a significantly lower BMI and body fat percentage prior to the intervention. Also, pre-personal annual income was significantly associated with BMI and body fat percentage at the beginning of the study with individuals of higher income levels having a lower BMI and body fat percentage. Rundle et al. (2008) found that among women, increasing personal income was significantly associated with lower BMI levels. Education level was also found to be inversely associated with BMI among both males and females in Rundle et al.'s study (2008). Rundle et al.'s study (2008) did not find a difference among the mean BMI of men of different personal incomes as it did for women but the mean BMI of both males and females varied by education level. For our study, 71% of participants were female. The association between higher personal annual income and a lower BMI and body fat percentage may have been a result of the majority of our participants being female. This is consistent with Rundle et al.'s (2008) findings of more significant associations between income and anthropometric measurements among females than males.

Another study, by Brown & Siahpush (2006), found that education levels of less than post-secondary were associated with increased overweight and obesity with stronger associations among males than females. Our results also showed that individuals with less than a bachelor's degree had a higher BMI than those with a bachelor's degree and those with a graduate degree had the lowest mean BMI among each of the education categories. Brown & Siahpush (2006) also found that individuals with a higher household income were at greater risk for being overweight and those with a lower household income were at greater risk of being obese. The current study looked only at individuals who were overweight or obese. Our results showed that individuals in the highest personal annual income category had the lowest weight, BMI, body fat percentage and waist circumference with BMI and body fat percentage being significantly lower compared to those in the lowest personal annual income category. Our results also showed that participants in the highest household income category had the highest weight yet the lowest BMI, body fat percentage, and waist circumference. It appears that heights of those in the lowest household income category may have been shorter than those in the highest category which may explain why the trends between weight and BMI were inconsistent. Overall, the current study's findings were fairly consistent with Brown & Siahpush's (2006).

While significant differences among BMI and SES were found in our study, no significant differences in weight were seen among participants of varying SES. Participants with higher levels of education did have lower weights than those of lower education levels yet the difference was not significant. The differences may not have been significant due to the sample size; if the sample size had been larger significant differences may have been seen. Waist circumference measurements also followed a trend with education level with those of the lowest education having the largest waist circumferences; however, this was also not significant. Limited research is available on waist circumference

measurements and SES. Waist circumference measurements may be inconsistent due to measurement error which may be why many studies do not assess waist circumference while looking at anthropometric measurements. We chose to assess waist circumference because it is a method for evaluating fat distribution and is also an individual risk factor for chronic disease development.

Along with looking at differences between F/V intake and anthropometric measurements among individuals of varying SES prior to the intervention, this study also assessed the effectiveness of nutrition education and F/V supplementation on F/V intake and anthropometric measurements among individuals of varying SES looking specifically at education level, personal annual income, and household annual income. Current literature suggests that increased availability of F/V may lead to greater intakes among those with lower income levels due to accessibility (Backman et al., 2011). The results of our study showed that intake of fruit was significantly different among the control and F/V groups at post-testing. Participants in the F/V group also had a greater increase in intake of vegetable than those in the control and education groups. These findings suggest that increased availability of F/V may improve intake.

While literature has shown individuals with higher education levels to have higher intakes of F/V (Estaquio et al., 2008), it may also be expected that individuals with higher education levels may have greater improvements in intake of F/V through nutrition education classes than those of lower education levels. Intake of fruit was significantly higher at post-testing than pre-testing among individuals with a graduate degree. Intake of vegetable also improved among participants with a graduate degree from pre-testing to post-testing. This suggests that individuals with a higher education level may benefit more from nutrition education classes than those of lower education levels in regards to F/V intake. However, participants with less than a bachelor's degree also had an increase in

F/V intake and those with a bachelor's degree had a slight decrease in vegetable intake but an increase in fruit intake. It appears that those with a higher education may have benefited more from nutrition education in regards to fruit intake; however, it did not appear to make a significant difference in improvements in vegetable intake. Individuals with a higher education may have benefited more from nutrition education due to a greater understanding of the material presented.

While the results showed that increased availability of F/V through supplementation may lead to higher intakes of fruit, the improvements in intake among varying income levels in the F/V group were not significantly different among one over another. Overall, participants with the lowest and highest personal annual incomes did have significant improvements in fruit intake from pre-testing to post-testing along with those in the middle household income category; however, when looking specifically at participants in the F/V group, the improvements were not significantly different among personal or household income levels. The study by Backman et al. (2011) looked only at individuals of low income in which they found that increased availability of fruit led to greater intake of F/V among these individuals. The results of the current study show that in general, increased access to fruit may lead to improvements in intake and the improvements may not be due to the affordability. While this study showed a significant improvement in fruit intake by providing F/V supplementation, significant improvements were not seen for intake of vegetable. This shows us that there may be an outlying factor affecting intake of vegetable such as taste. For our study, we had participants that were unwilling to try some of the F/V they were not familiar with demonstrating that exposure to F/V is also important. Other factors that play a role in consumption of F/V and may have had an effect include convenience and knowledge of selection, storage, and preparation methods. While our nutrition education classes covered selection, storage, and preparation methods, motivation

to make change was not addressed. It may be beneficial to assess participants' motivation to make change prior to an intervention in order to provide effective education to promote behavior change. Without motivation to change, having the knowledge and resources available to do so may not lead to change. Seasonal availability may also affect consumption of F/V and for our study, pre-testing was held during the summer and post-testing was held during the winter in which fresh F/V are less available.

Our study also looked at the effect of nutrition education, without F/V supplementation, on improvements in F/V intake. The education group did have an increase in fruit intake from pre-testing to post-testing; however, it was not significant. The mean vegetable intake decreased among the education group from pre-testing to post-testing. Providing supplementation of F/V along with nutrition education appears to lead to greater improvements in intake than nutrition education alone. However, the differences in improvement of F/V intake among the education and F/V groups were not significant. This shows that providing supplements of F/V may not be beneficial especially when looking at cost-effectiveness.

There is limited research on the change of anthropometric measurements through nutrition education and the differences in change among those of varying SES. Looking at the different intervention groups and changes in anthropometrics, the only significant improvement seen was waist circumference of those in the F/V group. The accuracy of this may be of concern because weight, BMI, and body fat percentage of those in the F/V group all increased. It is unlikely that there was a significant improvement in waist circumference measurements when the other anthropometric measurements actually worsened. Anthropometric measurements may have also varied due to other aspects such as seasonal changes and hydration status. Looking at SES and improvements in

anthropometric measurements, the only significant improvement seen was BMI among those of the lowest education category.

An explanation for the increase in weight, BMI, and body fat percentage among participants in the F/V group may be that they were provided with additional calories. During the nutrition education classes, it was encouraged for participants to use the F/V supplements to replace other food; however, if they just added the supplements to the food they were already eating they would be getting more calories which may lead to weight gain. Nutrition education classes focused on F/V intake may have little effect on anthropometric measurements among overweight or obese adults. Our nutrition education classes focused mainly on F/V intake and did not discuss physical activity or calorie needs in detail. While eating F/V has many health benefits, simply adding F/V to the diet and not making any other changes such as decreasing total energy intake or increasing physical activity will not lead to improvements in anthropometric measurements.

While the increased calories may have had an effect on the F/V group, this would not be the case for the control or education groups. The control group also had an increase in weight, BMI, and body fat percentage from pre-testing to post-testing. Although each of these measurements did increase for both the control and F/V group, the changes were minimal with none of them being significant. The education group actually had a decline in weight and BMI from pre-testing to post-testing but the changes were also small and non-significant. Other possible causes for changes in weight, BMI, and body fat percentage may include seasonal effects as well as hydration status. Participants were asked to ensure they were normally hydrated and had an empty bladder prior to testing; however, we did not monitor this. The Tanita Body Composition Analyzer® (TBF-300A, Tanita Corporation of America, Inc., Arlington Heights, IL) is accurate within +/- 5 percent of the institutional standard of body composition analysis which is the Dual Energy X-ray Absorptiometry

(DEXA); however, results may not be accurate if a person is dehydrated or overhydrated. The DEXA has a 2-3% error rate and in general, standard body composition measurements have a 3-4% error rate (Laya, 2011; Kravitz & Heyward, 1992). Pre-testing was held during the summer and post-testing was held during the winter which may have led to some of the gain being seasonal gains. Research has shown that on average, people gain a pound each winter (Vitetta-Miller, 2008). Also, participants may have had heavier clothing on at post-testing since it was during the winter. Participants were asked to remove outer, heavy layers of clothing but participants may have been wearing shorts at pre-testing and pants at post-testing or a t-shirt at pre-testing and a sweater at post-testing. Although these would not make large differences, they may have a small effect and the changes seen were minimal.

Overall, our study showed that nutrition education with supplementation of F/V did lead to significant improvements in fruit intake and individuals with a higher education level had greater improvements. Significant improvements in fruit intake were also seen among participants in the lowest and highest personal annual income categories as well as the middle household annual income category. Providing supplementation along with nutrition education also led to an increase in vegetable intake. Although the intervention did lead to significant improvements in fruit intake and non-significant improvements in vegetable intake, the improvements did not increase F/V intake to the recommended servings of five or more per day. Unlike our hypothesis, improvements in intake among the F/V group did not appear to be significantly different among those of varying income levels.

Our results also showed that improvements of F/V intake were not significantly different among the education and F/V groups. While looking at cost-effectiveness, providing F/V supplementation may not be beneficial. While providing F/V supplements did lead to slightly greater improvements in F/V intake than nutrition education alone,

providing one serving of fruit and two servings of vegetable a day for 10 weeks to each participant can be expensive and the differences of improvement between the two groups were not significant. Also, providing the F/V supplements did not lead to participants meeting the recommendation for five or more servings of F/V daily.

While the results showed few significant improvements in anthropometric measurements among varying SES through the intervention, we did find that individuals of lower SES weighed more and had a higher body fat percentage at pre-testing. It appears that if the focus is on anthropometric measurements, participants may benefit from an intervention focused more on total energy intake and energy expenditure rather than simply focusing on F/V. Individuals of lower SES do seem to be more at risk for being obese and future interventions focused on anthropometric measurements should consider centering interventions on those of lower SES.

Future studies should focus on identifying and targeting barriers to F/V consumption regardless of SES. They should also focus more on vegetable intake. Our study did not lead to great improvements of vegetable intake and there may be an outlying factor causing inadequate intake of vegetable. Future research should also look at ways to make nutrition education effective for those of lower education levels. This study led to greater improvements in fruit intake among those of a higher education level. The content and materials of nutrition education must be appropriate for the audience. Individualizing interventions looking specifically at backgrounds and interests of participants may help to further improve intakes of F/V. Considering the location is also important when focusing on F/V due to differing availabilities in different regions at certain times of the year. If focusing on changes in anthropometric measurements through nutrition education, the intervention should also focus on total energy intake and expenditure rather than solely on intake of single food groups.

In conclusion, nutrition education focusing on F/V intake appears to have beneficial effects on F/V intake among overweight and obese adults. Providing F/V supplements does not appear to be cost-effective for promoting F/V intake through nutrition education. Nutrition education should focus on specific barriers to F/V intake among individuals of all SES including aspects such as taste, availability, and also motivation to make changes. Without addressing motivation, simply providing the education and materials to make a change will not be effective. Future research should assess the effects of nutrition education on F/V intake over a longer period of time to eliminate the influence of seasonal effects. Also, future research should ensure that education materials are at a reading level appropriate for all audiences. A major strength of this study was that participants were provided with supplements of F/V which made it easier to determine if differences among varying income levels were due to affordability. A major weakness of the study was the seasonal differences from pre-testing to post-testing which may have led to variability in F/V intake and anthropometric measurements regardless of the intervention.

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APPENDIX A. IRB APPROVAL

NDSU NORTH DAKOTA STATE UNIVERSITY

Institutional Review Board
Office of the Vice President for Research, Creative Activities and Technology Transfer
NDSU Dept. 4000
1735 NDSU Research Park Drive
Research 1, P.O. Box 6050
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Federalwide Assurance #FWA00002439
~~*Expires April 24, 2011*~~

July 18, 2011

Dr. Yeong Rhee
Dept. of Health, Nutrition and Exercise Sciences
351 E. Morrow Lebedeff Hall

IRB Expedited Review of: "**Effects of Fruit and Vegetable Consumption on Health**", Protocol #**HE11308**
Co-investigator(s) and research team: **Meredith Wagner, Kerrie Hert, Jamie Levine**
Research site(s): **NDSU, Sanford Health** Funding: **n/a**

The protocol referenced above was reviewed under the expedited review process (category # 4,7) on **6/27/11**, and the IRB voted for: ☐ approval ☒ approval, contingent on minor modifications. These modifications have now been accepted. IRB approval is based on the original submission, with revised: protocol, consent form and recruitment messages (received – 7/15/11).

Approval expires: 6/26/2012 **Continuing Review Report Due: 5/1/2012**

Please note your responsibilities in this research:

- All changes to the protocol require approval from the IRB prior to implementation, unless the change is necessary to eliminate apparent immediate hazard to participants. Submit proposed changes using the *Protocol Amendment Request Form*.
- All research-related injuries, adverse events, or other unanticipated problems involving risks to participants or others must be reported in writing to the IRB Office within 72 hours of knowledge of the occurrence. All significant new findings that may affect risks to participation should be reported in writing to subjects and the IRB.
- If the project will continue beyond the approval period, a continuing review report must be submitted by the due date indicated above in order to allow time for IRB review and approval prior to the expiration date. The IRB Office will typically send a reminder letter approximately one month before the report due date; however, timely submission of the report is your responsibility. Should IRB approval for the project lapse, recruitment of subjects and data collection must stop.
- When the project is complete, a final project report is required so that IRB records can be inactivated. Federal regulations require that IRB records on a protocol be retained for three years following project completion. Both the continuing review report and the final report should be submitted according to instructions on the *Continuing Review/Completion Report Form*.
- Research records may be subject to a random or directed audit at any time to verify compliance with IRB regulations.

Thank you for cooperating with NDSU IRB policies, and best wishes for a successful study.

Sincerely,

Teryl Grosz, CIP
HRPP Manager

Last printed 7/18/2011 8:15:00 AM

APPENDIX B. RECRUITMENT FLYER

ARE YOU INTERESTED IN RECEIVING:

- INFORMATION ABOUT THE HEALTH BENEFITS OF FRUITS AND VEGETABLES FROM A REGISTERED DIETITIAN?

- SAMPLES OF FRESH, FROZEN, OR CANNED FRUITS AND VEGETABLES?

- BLOOD LIPID PROFILES (Total Cholesterol, High Density Lipoprotein ("good" cholesterol), Low Density Lipoprotein ("bad" cholesterol), Triglycerides (amount of fat floating around in your blood), and Blood Glucose (blood sugar)?

IF SO, YOU SHOULD CONTACT US TO LEARN MORE ABOUT A 14-WEEK RESEARCH STUDY OFFERED THROUGH NORTH DAKOTA STATE UNIVERSITY.

This research study is designed to show how consumption of fruits and vegetables can influence oxidative stress and inflammation in overweight individuals. Oxidative stress is an imbalance in the production of molecules that damage the body. Inflammation is a reaction of the immune system to cell damage.

Study participants must be 18 years of age or older, may not have a history of bariatric surgery (e.g., stomach stapling, stomach banding), may not be current smokers, and may not be pregnant/lactating. The protocol for this research study has been reviewed and approved by the NDSU Institutional Review Board.

Interested participants should contact Meredith Wagner, MS, RD, LRD at the email or phone numbers listed below.

MEREDITH WAGNER
meredith.stromsborg@my.ndsu.edu
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APPENDIX C. PRE HEALTH HISTORY QUESTIONNAIRE

Name

How would you describe your eating habits? (Check one)
a. ___ Good b. ____ Fair c.____ Poor

How many times a day do you eat? a.____How many foods per meal average? b.____

How often do you eat out? _____ (number of times per week)

When you go out to eat, what are the three most common places you go?
a. _____

b. _____

c. _____

During the past month, other than your regular job, did you participate in any moderate or vigorous physical activities or exercise (e.g. walking fast, doing water aerobics, pushing a lawn mower, running, swimming laps, playing tennis)?
a._____ Yes b. _____No

If yes, how long did you workout? _____minutes per week

Do you use the nutrient analysis information that is available to help you make food selections?
a. _____Yes b. _____No

If so, what do you use most often:
a. _____ Nutrition Fact Panels
b. _____ Internet
c. _____ Restaurant Brochures
d. _____ Other

Are you currently following any kind of diet? a. _____Yes b. _____No
If yes, please specify _____
Please list any diets you have followed in the last 6 months:
Diet _____ Duration _____
Diet _____ Duration _____
Diet _____ Duration _____
Diet _____ Duration_____

Have you experienced any weight changes within the last 6 months? ___Yes ____No
Please specify amount of weight _____ (pounds)
Was weight lost or gained? _____ Lost ____Gained
Was the weight loss: _____ Voluntary _____ Involuntary

On average, how many times per day do you have a bowel movement? _____

Do you have or have you ever had any of the following conditions?

Condition	No	Yes	Specify
Allergies			
Asthma			
Anemia			
Sickle Cell Anemia			
Blood Clotting Disease			
Cancer			
Diabetes			
Heart Disease or Heart Attack			
High Blood Cholesterol			
High Blood Pressure or Hypertension			

Do you have any family history of the following conditions?

Condition	No	Yes	Specify
Heart Disease			
Diabetes			
High Blood Pressure			

Do you currently take any medications, vitamin, mineral, or herbal supplements on a regular basis?
a. _____Yes b. _____No

If yes, please specify all medications and supplements taken on a regular basis:
Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Are you sensitive or allergic to any foods? _____Yes _____No
If yes, please list: _____

Do you smoke? _____Yes _____No
If yes, number of cigarettes per day_____

Do you drink alcoholic beverages (beer, wine, hard liquor)? _____Yes _____No
If yes, frequency of intake _____ per week
Number of servings at a sitting: _____

What is the highest level of education you have completed?

Less than high school	High school/GED
Some college	2-year college degree (Associates)
4-year college degree (Bachelors)	Master's degree
Doctoral degree	Professional degree (MD, JD)

What is your income per year?

Less than $10,000	$10,000-$19,999	$20,000-$29,999	$30,000-$39,999
$40,000-$49,999	$50,000-$59,999	$60,000-$69,999	$70,000-$79,999
$80,000-$89,999	$90,000-$99,999	$100,000-$149,999	More than $150,000

What is your total household income per year?

Less than $10,000	$10,000-$19,999	$20,000-$29,999	$30,000-$39,999
$40,000-$49,999	$50,000-$59,999	$60,000-$69,999	$70,000-$79,999
$80,000-$89,999	$90,000-$99,999	$100,000-$149,999	More than $150,000

What is your current marital status?

Single Married/Partnered Separated Divorced Widowed

What is your gender?

Male Female

What is your race/ethnicity?

White Black Hispanic Other Prefer not to answer

What county do you live in? _____

What is your current age? _____ Date of birth _____

APPENDIX D. PRE FRUIT AND VEGETABLE FOOD FREQUENCY QUESTIONNAIRE

Name (ID):							Date (M/D/Y):			
How often do you eat or drink these fruits and vegetables? ***Think about fresh, frozen, and canned fruits and vegetables***	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. 100% orange juice	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
2. 100% cranberry, apple, or purple grape juice	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
3. Berries such as strawberries, blueberries, or blackberries	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
4. Nectarines, peaches, or apricots	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
5. Broccoli, cabbage, or cauliflower	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
6. Oranges, grapefruit, or tangerines	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
7. Cantaloupe or honeydew melon	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
8. Leafy greens such as mustard, turnip or collard greens	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
9. Corn	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
10. Cooked or stewed tomatoes such as in vegetable soup or rice and tomato gravy	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
11. Spaghetti or lasagna prepared with tomato or vegetable sauce	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

How often do you eat or drink these fruits and vegetables? *Think about fresh, frozen, and canned fruits and vegetables*	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
12. Fresh tomatoes	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
13. Onions	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
14. Squash or zucchini	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
15. Spinach	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
16. Sweet potatoes or yams	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
17. Carrots	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
18. Baked beans, pintos, black-eyed peas, other beans	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
19. How often do you eat fruit as a snack?	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
20. How often do you eat fruit as dessert?	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
21. How often do you eat vegetables as a snack?	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
22. When you are at home, how often do you eat <u>fresh fruit?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
23. When you are at home, how often do you eat <u>frozen fruit?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
24. When you are at home, how often do you eat <u>canned fruit?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
25. When you are at home, how often do you eat <u>fresh vegetables?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

How often do you eat or drink these fruits and vegetables? *Think about fresh, frozen, and canned fruits and vegetables*	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
26. When you are at home, how often do you eat <u>frozen vegetables?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
27. When you are at home, how often do you eat <u>canned vegetables?</u>	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

28. How are the fruits and vegetables you eat usually prepared?

Fried *Steamed* *Boiled* *Raw* *Sautéed* *Grilled*

With fat or meat *In a casserole* *In a soup* *Other:*_____

Please answer "yes" or "no" to these next questions.

29. Are you concerned about chronic diseases, such as cancer or heart disease?	No	Yes	Don't know
30. Do you think that eating more fruits and vegetables will help reduce your risk of <u>cancer</u>?	No	Yes	Don't know
31. Do you think that eating more fruits and vegetables will help reduce your risk of <u>heart disease</u>?	No	Yes	Don't know
32. Do you think if you improved the way you eat, that you would be a much healthier person?	No	Yes	Don't know
33. Do you think that your grocery store has a wide selection of fruits and vegetables?	No	Yes	Don't know

34. How many fruits and vegetables should people eat each day?

Circle one: 1 2 3 4 5 or more

35. Do you eat more fresh fruits and vegetables when they are in season? If yes, which fruits and vegetables?	No	Yes
36. Do you like the way most vegetables taste?	No	Yes
37. Do you have tooth or mouth problems that make you usually eat easy-to-chew fruits and vegetables?	No	Yes
38. Do you feel fruits and vegetables are expensive?	No	Yes
39. Do you feel that canned and frozen fruits and vegetables are just as good for you as fresh fruits and vegetables?	No	Yes
40. Would you like to know more about which fruits and vegetables are good for your health?	No	Yes
41. Would you like to know more about different ways to cook vegetables?	No	Yes
42. Would you like a handout with healthy recipes/menus to take home?	No	Yes
Which of these kitchen tools can you easily use to cook vegetables at home?		
43. Sharp knife?	No	Yes
44. Can opener?	No	Yes
45. Pot of hot water?	No	Yes
46. Do you shop for your own groceries? If you answered no, then who shops for you? *Spouse Other family Friend Other:* _____	No	Yes
47. Do you plan the meals you eat?	No	Yes
48. Do you cook the meals you eat?	No	Yes
49. Do you use a microwave at home?	No	Yes
50. Do you use a stove at home?	No	Yes

APPENDIX E. THREE-DAY FOOD RECORD

Food Diary

1. Keep your food diary current. List foods immediately after they are eaten. **Please print all entries**.
2. Record only one food item per line in this record booklet.
3. Be as specific as possible when describing the food item eaten: the way it was cooked (if it was cooked) and the amount that was eaten.
4. Include brand names whenever possible.
5. Report only the food portion that was actually eaten – for example: **T-bone steak, 4 oz. broiled**. (do not include the bones.)
6. Record amounts in household measures – for example**: ounces, tablespoons, cups, slices** or **units**, as in one cup nonfat milk, two slices of wheat toast, or one raw apple.
7. Include method that was used to prepare food item – for example: **fresh, frozen, stewed, fried, baked, canned, broiled, raw, or braised**.
8. For canned foods, include the liquid in which it was canned – for example: **sliced peaches in heavy syrup, fruit cocktail in light syrup**, or tuna in water.
9. Food items listed without specific amounts eaten will be analyzed using portion sizes.
10. Do not alter your normal diet during the period you keep this diary.
11. Remember to record the amounts of visible fats (oils, butter, salad dressing, margarine, and so on) you eat or use in cooking.
12. Remember to include condiments such as salad dressing and estimated amount, catsup, mustard, mayo, etc. and also garnishes such as tomato and pickle.
13. Remember to include supplements such as protein powder (list brand, and be sure to specify what it is mixed with).
14. List any beverages including water, diet soda, energy drinks, etc. and amount consumed in cups or ounces.

*The following are examples of the way to list food items and amounts.

Time	Food Item and Method of Preparation	Amount Eaten
7 am	Apple, raw, fresh	1 medium
12 pm	Beef Stew	10 oz portion
12 pm	Bread, whole wheat, fresh	2 slices
3 pm	Cereal, Corn flakes	2 cups
	With sugar	2 Tbsp
	With milk, non fat	½ cup
7 pm	Chicken, fried	2 legs
7 pm	Coleslaw, with mayo	1 cup
7 pm	Eggs, chicken (fried in butter)	2 large
7 pm	Fish, salmon, baked	10 oz

Source: LEE RD, Nieman DC. Appendix E Food Record Recording Form. In: Nutritional Assessment. 2nd ed. St. Louis, MO; 1996:506-508.

I.D. _____ Date _____

Time	Food Item and Method of Preparation	Amount Eaten

APPENDIX F. POST HEALTH HISTORY QUESTIONNAIRE

Name _____

How would you describe your eating habits? (Check one)

a. ___ Good b. ____ Fair c.____ Poor

How many times a day do you eat? a.____How many foods per meal average? b.____

How often do you eat out? _____ (number of times per week)

When you go out to eat, what are the three most common places you go?

a. _____

b. _____

c. _____

During the past month, other than your regular job, did you participate in any moderate or vigorous physical activities or exercise (e.g. walking fast, doing water aerobics, pushing a lawn mower, running, swimming laps, playing tennis)?

a._____ Yes b. _____No

If yes, how long did you workout? _____minutes per week

Do you use the nutrient analysis information that is available to help you make food selections?

a. _____Yes b. _____No

If so, what do you use most often:

a. _____ Nutrition Fact Panels
b. _____ Internet
c. _____ Restaurant Brochures
d. _____ Other

Are you currently following any kind of diet? a. _____Yes b. _____No

If yes, please specify _____

Please list any diets you have followed in the last 6 months:

Diet _____ Duration _____

Diet _____ Duration _____

Diet _____ Duration _____

Diet _____ Duration_____

Have you experienced any weight changes within the last 6 months? ___Yes ____No

Please specify amount of weight _____ (pounds)

Was weight lost or gained? _____ Lost ____Gained

Was the weight loss: _____ Voluntary _____ Involuntary

On average, how many times per day do you have a bowel movement? _____

Please list <u>any</u> health conditions you have currently:

_____

_____

_____

_____

_____

_____

Do you have any <u>family history</u> of the following conditions?

Condition	No	Yes	Specify
Heart Disease			
Diabetes			
High Blood Pressure			

Do you currently take any medications, vitamin, mineral, or herbal supplements on a regular basis?

a. _____Yes b. _____No

If yes, please specify all medications and supplements taken on a regular basis:

Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Name _____ Brand _____ Dose_____ How often ____per day/week

Do you smoke? _____Yes _____No

If yes, number of cigarettes per day_____

Do you drink alcoholic beverages (beer, wine, hard liquor)? _____Yes _____No

If yes, frequency of intake _____ per week

Number of servings at a sitting: _____

Who does the majority of the grocery shopping in your household?

____ You ____Roommate _____ Parent

_____Spouse/Partner _____Other:_____

Who does the majority of the cooking in your household?

____ You ____Roommate _____ Parent

_____Spouse/Partner _____Other:_____

Including you, how many adults (18 years of age or older) currently live in your household? _____

How many children currently live in your household? _____

What is your income per year?

Less than $10,000	$10,000-$19,999	$20,000-$29,999	$30,000-$39,999
$40,000-$49,999	$50,000-$59,999	$60,000-$69,999	$70,000-$79,999
$80,000-$89,999	$90,000-$99,999	$100,000-$149,999	More than $150,000

Which of the following best describes your yearly income compared to September 2011?

Decreased Remained the same Increased

What is your total household income per year?

Less than $10,000	$10,000-$19,999	$20,000-$29,999	$30,000-$39,999
$40,000-$49,999	$50,000-$59,999	$60,000-$69,999	$70,000-$79,999
$80,000-$89,999	$90,000-$99,999	$100,000-$149,999	More than $150,000

Which of the following best describes your yearly household income compared to September 2011?

Decreased Remained the same Increased

What is your current marital status?

Single Married/Partnered Separated Divorced Widowed

What is your gender?

Male Female

What is your race/ethnicity?

White Black/African American American Indian/Alaska Native

Asian Native Hawaiian/Pacific Islander Other:_____

What is your current age? _____ **Date of birth** _____

APPENDIX G. POST FRUIT AND VEGETABLE FOOD FREQUENCY QUESTIONNAIRE

Name (ID):								Date (M/D/Y):			
How often do you eat or drink these fruits and vegetables? ***Think about fresh, frozen, and canned fruits and vegetables***	None	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. 100% orange juice	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
2. 100% cranberry, apple, or purple grape juice	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
3. Berries such as strawberries, blueberries, or blackberries	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
4. Nectarines, peaches, or apricots	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
5. Broccoli, cabbage, or cauliflower	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
6. Oranges, grapefruit, or tangerines	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
7. Cantaloupe or honeydew melon	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

How often do you eat or drink these fruits and vegetables? ***Think about fresh, frozen, and canned fruits and vegetables***	None	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
8. Leafy greens such as mustard, turnip or collard greens	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
9. Corn	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
10. Cooked or stewed tomatoes such as in vegetable soup or rice and tomato gravy	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
11. Spaghetti or lasagna prepared with tomato or vegetable sauce	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
12. Fresh tomatoes	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
13. Onions	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
14. Squash or zucchini	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
15. Spinach	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
16. Sweet potatoes or yams	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

How often do you eat or drink these fruits and vegetables? ***Think about fresh, frozen, and canned fruits and vegetables***	None	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
17. Carrots	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
18. Baked beans, pintos, black-eyed peas, other beans	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
19. How often do you eat fruit as a snack?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
20. How often do you eat fruit as dessert?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
21. How often do you eat vegetables as a snack?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
22. When you are at home, how often do you eat <u>fresh fruit?</u>	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
23. When you are at home, how often do you eat <u>frozen fruit?</u>	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
24. When you are at home, how often do you eat <u>canned fruit?</u>	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

How often do you eat or drink these fruits and vegetables? ***Think about fresh, frozen, and canned fruits and vegetables***	None	Less than 1 per wk	1 per wk	2 per wk	3 per wk	4 per wk	5 per wk	6 per wk	1 per day	2 per day	Don't Know
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
25. When you are at home, how often do you eat <u>fresh</u> vegetables?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
26. When you are at home, how often do you eat <u>frozen</u> vegetables?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK
27. When you are at home, how often do you eat <u>canned</u> vegetables?	0	<1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6/wk	1/dy	2/dy	DK

	Please answer "yes" or "no" to these next questions.			
	28. Do you think that eating more fruits and vegetables will help reduce your risk of <u>cancer</u>?	No	Yes	Don't know
	29. Do you think that eating more fruits and vegetables will help reduce your risk of <u>heart disease</u>?	No	Yes	Don't know
	30. Do you think if you improved the way you eat, that you would be a much healthier person?	No	Yes	Don't know
	31. Do you think that your grocery store has a wide selection of fruits and vegetables?	No	Yes	Don't know
	32. How many fruits and vegetables should people eat each day? *Circle one: 1 2 3 4 5 or more*			

	33. Have you increased your overall consumption of fruit (fresh, frozen, and canned)? *Please list fruits: Total servings per week:___*	No	Yes	Don't know
	34. Have you increased your overall consumption of vegetables (fresh, frozen, and canned)? *Please list vegetables: Total servings per week:____*	No	Yes	Don't know
	35. Can you think of some diseases or conditions that might be decreased by a diet high in fruits and vegetables? *Please list:*	No	Yes	Don't know
	(Questions 36-43) Since beginning this program, have you or do you:			
	36. Tried different ways of preparing fruits and vegetables?	No	Yes	Don't know
	37. Tried a fruit or vegetable that you didn't like before, but now like?	No	Yes	Don't know
	38. Eat more fruits and vegetables because you think they are good for you?	No	Yes	Don't know
	39. Feel more strongly than before that eating fruits and vegetables will reduce the risk of disease?	No	Yes	Don't know
	40. Feel that canned and frozen fruits and vegetables are just as good for you as fresh fruits and vegetables?	No	Yes	Don't know
	41. Tried to follow a healthier diet?	No	Yes	Don't know
	42. Eat more dark green vegetables than before?	No	Yes	Don't know
	43. Made a recipe from one of the lessons?	No	Yes	Don't know
	44. As a result of participating in this program, do you think you are more willing to try different fruits and vegetables?	No	Yes	Don't know
	45. As a result of participating in this program, did you replace foods previously consumed with fruits and vegetables?	No	Yes	Don't know
	46. What was your overall level of satisfaction with this fruit and vegetable nutrition education program? *Circle one: Poor Fair Good Very Good Excellent Not applicable*			

	47. How many sessions of the fruit and vegetable nutrition education program did you attend? *Circle one: 1 2 3 4 5 6 7 8 9 10 Not applicable*