EFFECTS OF NUTRITION EDUCATION AND FRUIT AND VEGETABLE CONSUMPTION ON KNOWLEDGE OF ANTIOXIDANTS AND BIOMARKERS OF INFLAMMATION AND CHRONIC DISEASE

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ABSTRACT

Obesity rates have reached epidemic proportions contributing to the majority of Americans experiencing a state of chronic inflammation. Associations between inflammation, oxidative stress, and increased disease risk contribute to detrimental consequences of obesity. Regulation of inflammation and oxidative stress is possible via antioxidants consumed through a diet adequate in fruits and vegetables but consumption among adults is poor. Previous studies have assessed the impact of fruit, vegetable, and antioxidant consumption on oxidative stress and inflammation among healthy individuals. However, no studies have examined effects of education and fruit and vegetable consumption on markers of oxidative stress, inflammation, and other chronic disease biomarkers in a single study of overweight and obese adults. The purposes of this study were to examine effects of nutrition education and fruit and vegetable consumption on: interest and knowledge related to antioxidants; consumption patterns; weight, body mass index (BMI), body composition, blood lipids, and blood glucose; and biomarkers of oxidative stress and inflammation. Fifty-four adults (19 men/35 women; age 44.7±12.1 y; BMI 33.2±7.7 kg/m^2) were randomly assigned to one of three intervention groups. The control group received no intervention, the education group attended weekly nutrition lessons, and the fruit and vegetable group attended weekly nutrition lessons and received one serving of fruits and two servings of vegetables per day for 10 weeks. Fruit and vegetable-related knowledge, attitudes, and behaviors were assessed using questionnaires. Fruit, vegetable, and antioxidant consumption was assessed using semi-quantitative food frequency questionnaires and three-day food records and anthropometric measurements and fasting blood draws were conducted. Results indicated improvements in fruit and vegetable-related knowledge, attitudes, and behaviors and increased consumption of antioxidant-rich fruits and vegetables following nutrition education. Associations

existed between increased fruit and vegetable consumption and improvements in LDL cholesterol. However, minimal associations between changes in consumption of fruits, vegetables, and antioxidants and biomarkers of inflammation and oxidative stress were indicated. In order to be effective, nutrition intervention programs need to thoroughly address participants' fruit and vegetable-related knowledge and attitudes, provide exposure to fruits and vegetables, and promote adequate consumption of antioxidant-rich fruits and vegetables while concurrently emphasizing management of overall energy intake.

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DEDICATION

I dedicate my dissertation work to my parents. It is because of the unrelenting work ethic, intense dedication, and attention to detail that I inherited from my father, the late Don R. Stromsborg, DDS, that I was able to successfully complete my doctoral program in three years. His words, “If you’re going to do it, do it right” have, and will continue to guide me. In addition, it is because of the continuous encouragement, supportive words, and example of teaching excellence provided by my mother, Janet Stromsborg, that I was able to navigate academia and pursue my dream.

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INTRODUCTION

Obesity is a multifactorial condition that affects both males and females of all ages and races. Rates of obesity have reached epidemic proportions in the United States (Centers for Disease Control and Prevention [CDC], 2009, December 7; CDC, 2010, September 1), contributing to the majority of Americans experiencing a state of chronic inflammation (Camhi, Stefanick, Ridker, & Young, 2010; Nguyen, Lane, Smith, & Nguyen, 2009; Stienstra, Duval, Muller, & Kersten, 2007; Vieira et al., 2009). Associations between inflammation, oxidative stress, and increased risk of developing numerous diseases hasten Americans' efforts to continue on the path towards wellness. Inflammation and oxidative stress have been shown to be both promoted and inhibited by common treatments for obesity (Ji, Gomez-Cabrera, & Vina, 2009; Lavoie et al., 2010; Nguyen et al., 2009; Sureda et al., 2008; Tauler et al., 2006).

Evidence indicates that antioxidant systems in the body are in part responsible for regulating oxidative stress and subsequent inflammation. However, in order to function properly, adequate concentrations of antioxidants must be present (Carlsen et al., 2010; Cilla et al., 2009; Dilis & Trichopoulou, 2010; Jones & DeLong, 2000). Evidence suggests that a balanced diet, including antioxidant-rich fruits and vegetables, is beneficial in helping individuals maintain adequate antioxidant concentrations in order to aid in the prevention and regulation of oxidative stress (Chun et al., 2010; Gropper, Smith, & Groff, 2005; Quadir & Akhtar-Danesh, 2010). Unfortunately, few Americans currently consume the recommended servings of fruits and vegetables (CDC, 2010, September 10; U.S. Department of Health and Human Services, 2010). This has spurred an increase in research to identify determinants of fruit and vegetable consumption, including knowledge, perceptions, convenience, and exposure (Chapman, 2010; Guillaumie, Godin, and Vezina-Im, 2010; Haleem, Barton, Borges, Crozier, & Anderson, 2008;

Kidd & Peters, 2010; Powell, Kazlauskaite, Shima, & Appelhans, 2010; Wang & Coups, 2010; Wenrich, Brown, Miller-Day, Kelley, & Lengerich, 2010), and associations between fruit and vegetable consumption and inflammation (Hermsdorff, Zulet, Puchau, & Martinez, 2010; Polidori et al., 2009; Talegawkar et al., 2009).

Problem Statement

Previous studies have assessed fruit and vegetable consumption, the influence of educational interventions on fruit and vegetable consumption, antioxidant consumption, role of antioxidants in oxidative stress, and the correlation between fruit and vegetable consumption and inflammation in healthy individuals. However, no studies to date have examined the effects of education and fruit and vegetable consumption on markers of oxidative stress, inflammation, and other chronic disease biomarkers in a single study of overweight and obese adults.

Purpose Statement

The purposes of this study were to examine the effects of nutrition education and fruit and vegetable consumption on: (1) interest and knowledge related to antioxidants; (2) consumption patterns; (3) weight, body mass index (BMI), body composition, blood lipids, and blood glucose; and (4) biomarkers of oxidative stress and inflammation.

Definition of Terms

- Obesity: “abnormal or excessive fat accumulation that may impair health” (World Health Organization, 2011); “ranges of weight that are greater than what is generally considered healthy for a given height” (CDC, 2010, June 21); a body mass index of 30 or higher.
- Inflammation: “a localized response of increased blood flow, increased capillary permeability, influx of neutrophils and macrophages, and secretion of cytokines” (Dishman, Washburn, & Heath, 2004, p. 284).

- Cytokines: non-antibody proteins secreted by inflammatory white blood cells and adipocytes (Dishman et al., 2004; Federico et al., 2010); common inflammatory cytokines include interleukin-6 and tumor necrosis factor-alpha (Dishman et al., 2004).
- Oxidative stress: state experienced by the body when oxidants predominate over antioxidants (Jones & DeLong, 2000; Murray, 2003); causes include diet, metabolism, and environmental factors; is associated with declines in optimum bodily function (Buico, Cassino, Ravera, Betta, & Osella, 2009; Polidori et al., 2009).
- Antioxidant: molecules capable of reducing oxidants, thus maintaining the proper oxidation-reduction state of the cell (Jones & DeLong, 2000); include enzymatic and non-enzymatic forms.
- Body mass index (BMI): calculated using the metric system by dividing an individual's weight by his or her height squared; correlated with body fatness (CDC, 2009, October 20).
- C-Reactive Protein (CRP): produced in the liver; marker of low-grade inflammation; influences several inflammatory responses (Dishman et al., 2004).
- Tumor Necrosis Factor-alpha (TNF-α): inflammatory cytokine (Dishman et al., 2004).
- Thiobarbituric Acid Reactive Substances (TBARS): plasma concentrations are an index of lipid peroxidation and oxidative stress.
- Enzyme-linked Immunosorbent Assay (ELISA): biochemical technique used to detect the presence of an antibody or antigen.

Research Questions

Interest

1. Are participants interested in receiving information about antioxidants?

Knowledge

2. Are participants knowledgeable about antioxidants?

Consumption

3. How does information about antioxidant properties and content of fruits and vegetables with or without provision of fruits and vegetables influence participants' consumption of fruits and vegetables?
4. How does information about antioxidant properties and content of fruits and vegetables with and without provision of fruits and vegetables influence BMI and body composition in participants?
5. Do changes in fruit and vegetable consumption significantly change antioxidant consumption?
6. Do changes in fruit and vegetable consumption significantly change markers of inflammation (CRP, TNF-α)?
7. Do changes in fruit and vegetable consumption significantly change BMI and body composition in participants?
8. Do changes in fruit and vegetable consumption significantly change blood lipid (total cholesterol, high density lipoprotein, low density lipoprotein, triglycerides) and glucose concentrations?

Hypotheses

Interest

1. Over 50% of participants in the education and fruit and vegetable groups will indicate interest in antioxidant information.

Knowledge

2. Among the education and fruit and vegetable groups, there will be a significant increase in the number of participants who correctly answer knowledge-based questions about antioxidants from pre- to post-intervention periods.

Consumption

3. There will be no significant changes in fruit, vegetable, or antioxidant consumption in control group and education group participants from pre- to post-intervention periods.
4. There will be a significant increase in fruit, vegetable, and antioxidant consumption in fruit and vegetable group participants from pre- to post-intervention periods.
5. There will be no significant changes in BMI and body composition in control, education, or fruit and vegetable group participants from pre- to post-intervention periods.
6. There will be significant changes in total cholesterol in fruit and vegetable group participants from pre- to post-intervention periods.
7. There will be no significant decreases in markers of inflammation in control and education group participants from pre- to post-intervention periods.
8. There will be significant decreases in markers of inflammation in fruit and vegetable group participants from pre- to post-intervention periods.

LITERATURE REVIEW

Obesity

According to the World Health Organization (2011) obesity is defined as "abnormal or excessive fat accumulation that may impair health". The Centers for Disease Control and Prevention (CDC) (2010, June 21) define obesity as "ranges of weight that are greater than what is generally considered healthy for a given height" and those weight ranges that have been identified as increasing the likelihood of an individual developing certain diseases and health problems. These general definitions identify obesity as impairing the health and wellness of an individual.

In addition to general definitions of obesity, there are categorical definitions, which specify how individuals are categorized in terms of weight. The categorical definition of obesity varies between children and adults because of differences in physiological development that occurs during childhood and adolescence. However, all definitions are based on body mass index (BMI), which is calculated using the metric system by dividing an individual's weight by his or her height squared. BMI is used because it is an easy measure to obtain and is known to correlate with body fatness (CDC, 2009, October 20). The BMI categories for children are based on BMI-for-age and include less than 5^{th} percentile, 5^{th} to less than 85^{th} percentile, 85^{th} to less than 95^{th} percentile, and greater than 95^{th} percentile. In adults, the categories include a BMI less than 18.5, 18.5 to 24.9, 25 to 29.9 and greater than or equal to 30 kg/m^2. Each category is assigned a title that reflects the weight status. These include underweight, normal weight, overweight, and obese. In children and teenagers ages 2 to 19 years, obesity is defined as "a BMI at or above the 95^{th} percentile for children of the same age and sex". Alternatively, obesity for individuals over the age of 19 years is defined as “a BMI of 30 or higher” (CDC, 2010, June 21). It is these definitions that are used to classify individuals in the United States as obese.

As of 2010, a total of 36 states in the U.S. had prevalence of obesity greater than or equal to 25% (CDC, 2011, July 21). In fact, only Colorado and the District of Columbia had prevalence below 20% (CDC, 2010, September 1). People of all ages, races, and sexes experience obesity (CDC, 2009, December 7). Results of the 2007-2008 National Health and Nutrition Examination Survey (NHANES) indicated that approximately 16.9% of children and adolescents are obese (Ogden & Carroll, 2010) while the CDC (2010, August 3) reported that 26.7% of U.S. adults are currently obese.

While obesity does not discriminate, certain factors can increase an individual’s risk of becoming obese. These factors include genetics, socioeconomic status, sex, age, and ethnic background. Overweight is more common in working-class groups compared to the wealthy. Likewise, there are more obese women than men but in both sexes, weight increases with age. In the U.S., obesity is more common among black Americans than white Americans (CDC, 2009, December 7).

While a single cause of obesity has not yet been identified, many factors have been associated with increased risk of developing obesity. These factors span the multiple dimensions of wellness and are typically grouped into three categories: behavioral, environmental, and genetic (CDC, 2009, December 7; Wang & Coups, 2010). Behavioral factors include dietary intake and physical activity, while environmental factors include proximity of grocery stores, technology, and access to parks. In fact, the term ‘obesogenic environment’ has been developed to recognize that the environment significantly influences an individual’s chance of developing obesity (Teague, Mackenzie, & Rosenthal, 2009).

Genetic factors related to obesity are still relatively controversial but scientific evidence has demonstrated some instances where genes have played a direct role in the development of obesity. Syndromes like Prader-Willi and Bardet-Beidl both have been recognized as having a direct genetic component (CDC, 2009, December 7). Other genetic factors believed to contribute to obesity include the hormones leptin and ghrelin. Leptin is a hormone produced by adipocytes (fat cells) and plays a role in appetite suppression. It has been shown that an increase in leptin is associated with an increase in adipocytes, leading to a reduction in appetite and an increase in energy expenditure (Teague et al., 2009; Whitney, Cataldo, & Rolfes, 2002). Preliminary research on leptin has indicated that obese individuals may have an insensitivity or resistance to leptin (Whitney et al., 2002) although this mechanism is still being explored. The antagonist hormone to leptin is ghrelin, which is produced in the stomach and serves to increase appetite. In addition, more than a dozen other hormones have been identified as taking part in appetite and energy expenditure with complex interactions that are not yet fully understood (Teague et al., 2009).

In addition to factors that are believed to contribute to obesity, researchers have focused on the health consequences of the condition. Obesity is associated with numerous health conditions and diseases, including coronary heart disease, type 2 diabetes mellitus, various cancers, hypertension, dyslipidemia, stroke, sleep apnea, osteoarthritis, and reproductive problems (CDC, 2009, August 19; National Heart, Lung, and Blood Institute, 2011). In fact, more than 85% of people diagnosed with type 2 diabetes mellitus are overweight at time of diagnosis. Similarly, obese individuals are more likely to develop hypertension and hyperlipidemia, which increase the risk of myocardial infarction and stroke (National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 2007).

Inflammation

An underlying mechanism believed to contribute to the detrimental health outcomes of obesity is the inflammatory process (Dowd, Zajacova, & Aiello, 2010). Excess body fat, particularly abdominal fat, has been associated with increased inflammation in the blood vessels and other tissues of the body leading to disease (NIDDK, 2007). Hyperlipidemia, hypertension, diabetes mellitus, and heart disease all have inflammatory features. According to Dishman, Washburn, and Heath (2004), inflammation is defined as “a localized response of increased blood flow, increased capillary permeability, influx of neutrophils and macrophages, and secretion of cytokines” (p. 284). Neutrophils and macrophages are phagocytic cells that function as part of innate immunity, providing defense against infectious agents and development of cancer. Cytokines are non-antibody proteins secreted by inflammatory white blood cells (Dishman et al., 2004) and adipocytes (Federico et al., 2010).

Cytokines act as intercellular mediators during the inflammatory process (Dishman et al., 2004; Federico et al., 2010). Some cytokines promote the gene expression of adhesion molecules while others can bind with membrane receptors and activate specific enzymes that generate reactive species (Ji, Gomez-Cabrera, & Vina, 2009). Specific cytokines commonly referred to as the inflammatory cytokines include interleukin-1 (IL-1), interleukin-6 (IL-6), interleukin-8 (IL-8), interleukin-10 (IL-10), and tumor necrosis factor-alpha (TNF-α) (Dishman et al., 2004).

C-reactive protein (CRP) is another identified marker of low-grade inflammation. It is produced in the liver and is commonly used as a marker of inflammation because it is easy to measure, has a long half-life, and influences several inflammatory responses (Dishman et al., 2004). CRP concentrations rise quickly after infection or injury, usually within 24 to 72 hours (Dowd et al., 2010). Like elevated concentrations of inflammatory cytokines, elevated concentrations of CRP have been associated with increased adiposity in both children (Dowd et al., 2010; Parrett et al., 2010) and adults (Lavoie et al., 2010).

Oxidative Stress

During inflammation, cytokines contribute to increased concentrations of reactive species in the body (Basu, Rhone, & Lyons, 2010; Hubbard, O'Mahony, Calver, & Woodhouse, 2008; Soory, 2009). Reactive species, or free radicals, exist in two forms depending on their composition. Those that contain nitrogen are referred to as reactive nitrogen species while those that contain oxygen are called reactive oxygen species, or oxidants (Gropper, Smith, & Groff, 2005). During oxidative reactions, electrons are transferred from one molecule to another. If receiving an even number of electrons, the recipient molecule will remain stable. However, if an uneven number of electrons are transferred, the recipient molecule is left with one or more unpaired electrons (Gropper et al., 2005). This unequal pairing of electrons causes the molecule to be unstable and thus, is termed an oxidant (Jones & DeLong, 2000). Examples of powerful oxidants include superoxide (O^{2}-), hydrogen peroxide (H_2O_2), peroxyl radicals (ROO•), singlet oxygen ($^{1}O_2$), and hydroxyl radicals (OH·) (Buico, Cassino, Ravera, Betta, & Osella, 2009; Jones & DeLong, 2000; Murray, 2003).

Oxidants are produced in blood cells and most other cells of the body throughout metabolism (Gropper et al., 2005; Murray, 2003). They can be formed from any electron transport system that includes oxygen as an electron acceptor (Jones & DeLong, 2000). Although generation of oxidants is a normal component of oxidative metabolism, lapses in the defense systems of the body can result in an improper oxidant: antioxidant balance. When oxidants predominate over antioxidants, the body is said to be experiencing "oxidative stress" (Jones & DeLong, 2000; Murray, 2003). While a minimal amount of oxidative stress is necessary to maintain the integrity of biological systems, massive or prolonged amounts of oxidative stress can be detrimental (Ji et al., 2009; Kusano & Ferrari, 2008). Oxidants and other free radicals are able to react with molecules in the body, including proteins, nucleic acids, and lipids, causing an alteration of their structure with resulting tissue damage (Murray, 2003; Vertuani, Angusti, & Manfredini, 2004).

The diseases and conditions associated with obesity are often associated with an accumulation of oxidative stress (Jones & DeLong, 2000; Murray, 2003). Diet, metabolism, and environmental factors such as pollution and exposure to radiation, can induce formation of free radicals, leading to oxidative stress. Oxidative stress can result in a wide range of detrimental consequences depending on the type of oxidant present and the type of tissue affected. Some potential consequences include mutations of deoxyribonucleic acid (DNA) or loss of enzyme function (Jones & DeLong, 2000). This damage can be the cause or effect of a disease or a number of diseases but either way contributes to a general decline in optimum bodily function (Buico et al., 2009; Polidori et al., 2009).

Human beings are equipped with mechanisms in order to control oxidants in the body (Buico et al., 2009). These mechanisms by which the body defends itself from oxidative damage are referred to as antioxidant systems. These systems serve to reduce free radicals and thus maintain the oxidation-reduction state of the cell (Jones & DeLong, 2000). Defense against oxidants involves both enzymatic and non-enzymatic reactions as well as enzymatic and non-enzymatic antioxidants. Enzymatic antioxidants include superoxide dismutase, glutathione peroxidase, glutathione reductase, and catalase. These enzymes reduce the production of reactive oxygen species and protect against oxidative damage. Non-enzymatic antioxidants include vitamins, minerals, and those derived from plants (Cilla et al., 2009). Proper functioning of antioxidant systems is necessary in order to regulate the amount of damage to the body caused by free radicals.

Obesity and Inflammation

Energy not expended through activity or metabolism is primarily stored in adipose tissue. Increased storage of excess energy in adipocytes during obesity development is believed to result in chronic disruption of metabolic homeostasis (Nguyen, Lane, Smith, & Nguyen, 2009), which results in an accumulation of reactive oxygen species in adipose tissue (Viera et al., 2009). Elevated concentrations of reactive oxygen species in adipose tissue serve to activate nuclear factor-kB (NF-kB1), which controls the transcription of DNA (Ferrante Jr., 2007; Rankin & Turpyn, 2007; Stienstra, Duval, Muller, & Kersten, 2007). In addition, reactive oxygen species in adipose tissue lead to an influx of macrophages in adipose tissue that secrete proinflammatory cytokines, including TNF-α and IL-6 (Cottam et al., 2004; Federico et al., 2010; Marinou, Tousoulis, Antonopoulos, Stefanadi, & Stefanadis, 2009; Stienstra et al., 2007; Vieira et al., 2009). The inflammatory process is perpetuated by IL-6 and TNF-α inducing release of CRP from the liver (Camhi, Stefanick, Ridker, & Young, 2010; Cottam et al., 2004; Nguyen et al., 2009). The increased concentration of inflammatory cytokines and CRP result in a state of chronic, obesity-induced, low-grade inflammation.

Obesity-induced inflammation is associated with detrimental health outcomes, most notably insulin resistance and atherosclerosis (Stienstra et al., 2007). Obesity-induced insulin resistance has been linked to the continuous activation of nuclear transcription factors such as NF-kB1 (Stienstra et al., 2007) by cytokines released from adipose tissue (Ferrante Jr., 2007). Similarly, elevated CRP concentrations seen in obesity are associated with increased inflammation in coronary arteries (Nguyen et al., 2009) and mechanisms regulated by IL-6 and

TNF-α that lead to decreases in serum HDL cholesterol and increases in triglycerides. Both these consequences are known to increase the risk of atherosclerosis and CVD (Cottam et al., 2004), making obesity both a disease in itself and a risk factor for other diseases. Attenuating inflammation in adipose tissue through treatment of obesity may serve to modify metabolic disturbances and reduce risk of diseases associated with obesity (Vieira et al., 2009).

Treatment for Obesity: Physical Activity

While treatment for obesity is multidimensional and may include counseling, pharmacotherapy, and even surgery, two options that encompass both treatment and prevention of obesity include physical activity and diet, which are behavioral factors associated with obesity. The underlying mechanism of both physical activity and diet is energy balance. Either a reduction in the amount of energy consumed through diet or an increase in the amount of energy expended through physical activity can contribute to weight loss.

Methods for increasing energy expenditure include increasing the basal metabolic rate (BMR), the energy spent through muscular work, the thermic effect of food digestion, or the thermic effect of exercise (Dishman et al., 2004). Evidence exists to support the idea that exercise has two major acute effects on energy expenditure. The first effect is that energy expenditure during exercise can be increased anywhere between 2 and 20 times that of BMR with the amount of increased energy expenditure being dependent on the duration and intensity of the exercise performed. The second effect of exercise on energy expenditure is that energy expenditure does not immediately return to preexercise levels when exercise ends. Therefore, an individual can expend an increased amount of energy for a brief period of time even after he or she stops exercising. This increased energy expenditure can contribute to weight loss (Dishman et al., 2004).

Very few prospective cohort studies that have examined associations between physical activity and obesity currently exist. Those that do include the Finnish Cohort, NHANES I Follow-up Study, The CARDIA Study, U.S. Male Health Professionals, and the Aerobics Center Longitudinal Study (ACLS). In the Finnish Cohort study, 12,669 participants were studied for an average of five and a half years. Authors assessed predictors of weight gain and found that the obesity prevalence was inversely associated with participants' level of education and physical activity (Dishman et al., 2004). Similar findings were seen in both the NHANES I Follow-Up Study and The CARDIA Study. Results of NHANES I Follow-Up Study indicated a strong association between low physical activity or decreased physical fitness level and significant weight gain. Finally, in a study of how habitual physical activity, television watching, smoking and diet impact changes in weight, authors of the U.S. Male Health Professionals found that the prevalence of obesity among middle-aged men was lowest among those who maintained a high level of vigorous activity compared to men who were sedentary (Dishman et al., 2004).

In a case-control study of possible associations among purposeful physical activity, android body fat distribution, and steroid hormones, Kumar, Riccardi, Cantor, Dalton, and Allen (2005) followed 218 participants for a period of 36 months. They found that physical activity index was significantly higher in controls compared to cases. In addition, significantly higher weight, BMI, and waist to hip ratios were seen in case compared to control participants. Kumar et al. (2005) concluded that purposeful physical activity limited weight gain and reduced upper body fat distribution.

In another study, Field, Haines, Rosner, and Willett (2010) investigated the association between specific weight-control strategies and subsequent weight change during adolescence and young adulthood. Participants included 4,480 females from the Growing Up Today Study

(GUTS), which included children of women participating in the Nurses' Health Study II (NHS II). Findings revealed that the most popular weight loss strategies included not eating snacks, following low-fat or low-energy diets, and limiting portion sizes. In addition to making dietary changes for weight control, 48% of adolescent females reported exercising at least weekly, and 14% reported exercising five or more days per week. Results indicated that none of the dietary weight-control strategies were significantly associated with weight change. However, the use of exercise to control weight was predictive of less weight gain. More specifically, females who engaged in exercise five or more days per week gained 0.9 kilograms less than the less active participants (Field et al., 2010).

The issue of determining the most effective means of losing weight is pertinent considering the increasing prevalence of obesity in the U.S. While studies that included the American College of Sports Medicine guidelines for physical activity found some success in participants losing weight, the magnitude of weight loss was not substantial. Despite this, the consensus among many researchers is that physical activity is the single best predictor of success in maintenance of weight loss (Dishman et al., 2004).

Role of Physical Activity in the Inflammatory Process

Physical activity has been associated with both weight loss and reduced concentrations of low-grade inflammatory markers. Physical activity has been observed to be inversely associated with serum CRP concentrations in prepubescent children (Parrett et al., 2010) and overweight and obese women (Lavoie et al., 2010), suggesting that regular physical activity may help reduce chronic systemic inflammation in overweight and obese individuals. However, it is unclear if the decreased CRP concentrations are a result of physical activity or weight loss associated with physical activity. Serum CRP concentrations are higher in obese compared to normal weight

(BMI <25.0 kg/m^2) individuals. CRP concentrations in individuals with a BMI greater than or equal 40.0 kg/m^2 have been shown to be 14 times higher than those of normal weight individuals, with subsequent decreases in CRP concentrations associated with lower BMI categories (Nguyen et al., 2009).

Despite the potential positive influences of habitual physical activity on markers of low-grade inflammation, exercise has been shown to contribute to oxidative stress in the body. During exercise, muscle fibers are damaged due to the physical force exerted and the lengthening contraction. This damage results in acute inflammation and the production of reactive oxygen and nitrogen species. The presence of reactive species stimulate gene expression of inflammatory cytokines, including TNF-α, IL-1, and IL-6, from immune cells and damaged muscle tissues (Ji et al., 2009). Research on the effects of acute exercise on the inflammatory cytokines revealed that blood concentrations of IL-1 are unchanged from resting concentrations immediately after exercise but are elevated two to three hours after exercise. Possible mechanisms underlying these changes include the natural circadian variations of IL-1 throughout the day, delayed synthesis of cytokines due to exercise, or alterations in transfer of IL-1 between tissues and blood. In addition, concentrations of IL-1 have been shown to be elevated immediately after and up to five days following heavy resistance exercise (Dishman et al., 2004).

Another inflammatory cytokine known to be affected by acute exercise is interleukin-6 (IL-6). According to Dishman et al. (2004), acute exercise has been shown to increase blood concentrations of IL-6 up to 100 times higher than normal concentrations. However, this is dependent on intensity, duration, type of exercise, and type of muscle contraction performed. These elevations in blood concentrations of IL-6 are believed to promote secretion of additional inflammatory cytokines (Dishman et al., 2004).

Unlike IL-1 and IL-6, research studies examining the effects of exercise on TNF-α have consistently found no substantial changes during and after exercise. Slightly higher increases in TNF-α in the blood have been seen following long duration exercises but these were not sustained. A possible reason for lack of change in TNF-α concentration is believed to be due to its rapid excretion (Dishman et al., 2004).

In addition to elevated concentrations of cytokines, exercise is associated with increased production of free radicals. During acute exercise, red blood cells produce high amounts of reactive oxygen species as a consequence of increased oxygen transport (Tauler et al., 2006). This increased production of reactive oxygen species induces oxidative stress in lymphocytes (Sureda et al., 2008) and other cells. While the effects of acute exercise on concentrations of reactive oxygen species and circulating cytokines in the body are documented, the effects of chronic exercise remain unclear. Recent research findings have suggested that individuals who engage in long-term heavy exercise may become more resistant to oxidative stress (Ji et al., 2009) suggesting that chronic exercise is anti-inflammatory (McAnulty et al., 2010). It has been proposed that reactive oxygen species generated during strenuous exercise promote increased functioning of antioxidant defense systems by promoting release of antioxidant enzymes. The increased expression of antioxidant enzymes is believed to alter the susceptibility of muscle to free radical damage, indicating an adaptive response to consistent exercise. However, this is dependent on adequate dietary intake (Ji et al., 2009). Carlsohn, Rohn, Bittmann, Raila, Mayer, and Schweigert (2008) observed that highly active individuals had significantly elevated antioxidant capacities compared to non-active and moderately active individuals. Their findings suggested a dose-dependent relationship between increased exercise training, including both aerobic and strength training, and elevated antioxidant capacity, which contribute to lower inflammation (Carlsohn et al., 2008). However, results from other studies have indicated little to no improvements in antioxidant defense capacity following exercise training (Ji et al. 2009).

Despite the potential benefits of chronic exercise, extremely intense exercise has been shown to reduce an individual's immune function and increase oxidative stress. In a study of the effects of exercise on the lymphocyte antioxidant system, Sureda et al. (2008) found that participants running a half-marathon, which is considered intense exercise, experienced oxidative stress and cellular damage in lymphocytes as a result of the exercise. This resultant increase in oxidative stress is believed to increase an individual's vulnerability to cell and tissue damage by circulating free radicals in the body (Sureda et al., 2008). Such damage has been linked to cancer, and thus, it is recommended that overtraining be avoided in order to avoid canceling out the benefits of physical activity (Dishman et al., 2004).

While evidence regarding the effects of exercise on inflammation varies depending on the frequency, intensity, and duration of activity, the documented reductions in morbidity and mortality risk associated with activity are believed to outweigh the potential detrimental effects of such activity. In order to achieve substantial health benefits, the 2008 U.S. Physical Activity Guidelines state that adults should perform a minimum of 150 minutes per week of moderate intensity aerobic activity, at least 75 minutes per week of vigorous-intensity aerobic physical activity, or a combination of moderate and vigorous activity that is equivalent. Additional health benefits are believed to be associated with additional physical activity (more than 300 minutes per week) (U.S. Department of Health and Human Services [HHS], 2008) and it has been recognized that this increased frequency of activity may be necessary for weight management (Blair, LaMonte, & Nichaman, 2004).

Treatment of Obesity: Diet

In addition to physical activity, changes in dietary intake can influence the energy balance and contribute to weight loss. By consuming less energy than is expended, weight loss can be achieved. This often requires that higher energy foods be replaced with lower energy foods in order to maintain satiety while decreasing caloric intake. However, this reduction in energy can often be accompanied by a reduction in nutrients. While obese individuals may take in an excessive amount of energy, they may be deficient in micronutrients, including those micronutrients known to have antioxidant properties. Therefore, an important role of diet in the prevention and treatment of obesity is to provide the proper nutrients in adequate amounts to continue on the path towards wellness. Research has shown that increased energy consumption is associated with higher intakes of antioxidants. Carlsohn et al. (2008) found that an increase in total energy intake among participants was accompanied by improved intake of beta carotene, vitamin C, and vitamin E. A reduction in energy intake may therefore contribute to decreased intakes of these nutrients. Thus, the recommended reduction of energy intake from food must be balanced without distorting the intake of essential vitamins and minerals (Trosko, 2008).

Fruits and vegetables are often recommended for weight loss because of their excellent nutrient profile, high dietary fiber content, and generally low caloric content. Research has demonstrated that consumption of fruits and vegetables in place of foods with higher energy density can greatly impact energy balance (Schroder, 2010). In fact, higher intakes of fruits and vegetables have been associated with weight loss. One example of this was seen in a longitudinal study, which used data from a randomized controlled weight intervention trial involving computer-assisted self-monitoring of food intake. The goals of the initial randomized controlled weight intervention trial were to assess if self-monitoring was effective for decreasing energy intake, increasing fruit and vegetable consumption, and maintaining a balanced diet among participants. Results of the longitudinal study indicated that intake of fruits, but not vegetables, was significantly related to body weight. Both body weight and BMI were significantly lower in participants with higher fruit intake, even after controlling for age, gender, physical activity, and macronutrient consumption (Schroder, 2010).

Fruit and vegetable consumption was also associated with lower body weight among participants in a study by Hermsdorff, Zulet, Pachau, and Martinez (2010). When they examined the effects of fruit and vegetable consumption on proinflammatory gene expression, they found that participants in the highest tertile for fruit and vegetable consumption showed significantly lower values of BMI and waist circumference. Plasma concentrations of CRP and gene expression of IL-6, TNF-α, and NF-kB1 were also lower in those with the highest fruit and vegetable consumption. Based on existing research, it has been concluded that consumption of fruits and vegetables, which are generally low in energy and high in antioxidants, can assist overweight and obese individuals in losing weight while maintaining their nutritional status (Hermsdorff et al., 2010).

Role of Diet in the Inflammatory Process

The effects of diet on inflammation have been widely studied. Fat and carbohydrate content of diets have been manipulated in order to assess changes in markers of oxidative stress and inflammation. Diets high in fat have been shown to be associated with higher concentrations of inflammatory markers (Rankin & Turpyn, 2007) although changes in markers vary depending on the type of fat in the diet. In a study of 65 healthy men, researchers found that after six weeks, neither a moderately low-fat (25% energy from fat) nor a high monounsaturated fat (40% energy from fat; 22% energy from monounsaturated fat) diet affected plasma CRP concentrations

(Desroches et al., 2006). Similarly, no significant decreases were observed in CRP or TNF-α concentrations in participants following the American Heart Association Step I diet (no more than 30% energy from fat, no more than 10% of energy from saturated fat) for a period of 14 weeks (Koh et al., 2003). Significant reductions in CRP have been observed in overweight participants following a low-fat (15% calories from fat) diet, however the reduction in CRP was attributed to loss of body weight and was not independently related to consumption of the low-fat diet (Koren et al., 2006). Alternatively, consumption of a diet high in saturated fat resulted in a proinflammatory gene expression profile while a diet high in monounsaturated fat resulted in a more anti-inflammatory profile, which is consistent with current recommendations to replace saturated fat sources with monounsaturated fat sources (van Dijk et al., 2008). Other studies have observed lower concentrations of CRP in participants who consumed a diet high in polyunsaturated fatty acids (Zhao et al., 2004). Evidence exists that replacing sources of saturated fat with unsaturated fat in the diet may reduce adipose tissue inflammation and thereby reduce the risk of inflammation-related diseases associated with obesity (van Dijk et al., 2008).

The Mediterranean diet, which emphasizes consumption of unsaturated fats and fruits and vegetables, has been popularized for its role in reducing markers of oxidative stress and inflammation. In a prospective study of the effects of adherence to the Mediterranean diet on markers of oxidative stress and inflammation, Chrysohoou, Panagiotakos, Pitsavos, Das, and Stefanadis (2004) followed over 3,000 men and women for a period of one year. A diet score was assigned to reflect adherence to the diet with higher scores indicating closer adherence. Participants in the highest diet score tertile experienced significantly lower CRP and IL-6 concentrations, and moderately significant lower TNF-α concentrations compared to those in the lowest tertile. These observations remained even after adjustments for contributing factors

(Chrysohoou et al., 2004). Similar results were observed by Dai et al. (2008). Adherence to the Mediterranean diet was associated with reduced concentrations of IL-6 but not CRP after adjustment for total energy intake, other nutritional factors, known CVD risk factors, and use of supplements and medications (Dai et al., 2008). While these findings demonstrate the potential influence of the Mediterranean diet on reduced markers of inflammation, the exact components of the diet responsible for the changes remain unclear. Additional research has focused on the fruit and vegetable portion of the diet as possibly being responsible for the beneficial influence on inflammation.

Other research has focused on carbohydrate content of diet and subsequent effects on markers of inflammation. In a study of 29 overweight women, researchers randomly assigned participants to either a low carbohydrate, high fat diet or a high carbohydrate, low fat diet for four weeks. Although participants in the low carbohydrate, high fat diet group lost more weight, CRP concentrations increased by 25% while CRP concentrations were reduced by 43% in participants following the high carbohydrate, low fat diet (Rankin & Turpyn, 2007). Evidence has consistently suggested that diets high in fruits, vegetables, and grains are associated with lower concentrations of CRP while diets higher in fat are associated with high CRP concentrations. Low carbohydrate diets, while popular for weight loss, tend to be low in dietary antioxidants making people who follow them more susceptible to oxidative stress and inflammation (Rankin & Turpyn, 2007). Therefore, low carbohydrate diets are not recommended. Instead, emphasis is placed on choosing fruits, vegetables, and whole grains as the primary sources of carbohydrate because of their fiber and antioxidant content.

Role of Antioxidants in the Inflammatory Process

While generation of reactive oxygen species is a normal component of metabolism, increased concentrations of these reactive oxygen species in the body have been associated with inflammation (Basu et al., 2010; Hubbard et al., 2008; Soory, 2009). Fortunately, the body is able to utilize antioxidants, which are a type of phytochemical or bioactive food constituent derived from plants, to prevent accumulation of free radicals. Antioxidants function by donating electrons to free radicals in order to stabilize them and prevent oxidative damage (Jones & DeLong, 2000). Thus, antioxidants are able to effectively eliminate free radicals and other reactive species from the body (Carlsen et al., 2010; Dilis & Trichopoulou, 2010). Antioxidants are classified as enzymatic and non-enzymatic. Enzymatic antioxidants are present in the body while non-enzymatic antioxidants are consumed through dietary intake (Cilla et al., 2009; Mayes & Botham, 2003). Examples of antioxidants taken in by the diet include plant derived antioxidants, vitamins, and minerals (Vertuani et al., 2004).

Plant derived antioxidants include phenols, polyphenols, flavonoids, and carotenoids. Phenols include tocopherols and tocotrienols, which are essential components of biological membranes. Alpha-tocopherol, or vitamin E, has the highest antioxidant activity among the tocopherols. It functions mainly in response to free radicals generated in cell membranes and lipoproteins during lipid peroxidation (Bender & Mayes, 2003; Jones & DeLong, 2000; Vertuani et al., 2004). While vitamin E is particularly effective at stabilizing free radicals, it also functions as a pro-oxidant, especially at high concentrations. Thus, it is not recommended that individuals consume high doses of vitamin E (Bender & Mayes, 2003; Jones & DeLong, 2000). Alternatively, polyphenols function as scavengers of free radicals and thus are deemed more effective as antioxidants than tocopherols and antioxidant vitamins (Vertuani et al., 2004).

However, research assessing polyphenols in the body have observed low concentrations, suggesting that the bioavailability of polyphenols is poor. Examples of polyphenols include resveratrol, found in grapes and wine, and curcumin, which contributes to the bright yellow color of turmeric (Bisht, Wagner, & Bulmer, 2010).

Flavonoids are a family of compounds found in fruits and vegetables. The flavonoid family includes flavones, isoflavonoids, flavanones, and flavanol. These compounds possess potent antioxidant properties, protecting cells and DNA from stress-mediated injury by inducing antioxidant enzyme production and reducing the destruction of DNA. However, flavonoids also have pro-oxidant properties when present in high concentrations, including production of reactive oxygen species and induction of apoptosis (Bisht et al., 2010). Similarly, carotenoids, which include beta carotene, have been shown to have both antioxidant and pro-oxidant properties. Carotenoids interact with other antioxidants, which can influence whether they have a protective or destructive effect on cells. Like flavonoids, carotenoids are primarily found in fruits and vegetables (Vertuani et al., 2004).

Certain vitamins and minerals are also known to possess antioxidant properties. Antioxidant vitamins function by scavenging for free radicals and/or by participating in the regulation and expression of enzymes (Vertuani et al., 2004) while antioxidant minerals function as coenzymes for enzyme reactions. Examples of antioxidant vitamins and minerals include ascorbate (vitamin C), retinol (vitamin A), and selenium.

Vitamin C is effective as an antioxidant because it acts as a reducing agent, which means it donates electrons and hydrogen ions to free radicals in order to neutralize them. Examples of free radicals that are efficiently reduced by ascorbate include hydroxyl, hydroperoxyl, superoxide, alkoxyl, and peroxyl radicals (Gropper et al., 2005). Like vitamin E, vitamin C protects against lipid peroxidation. It is especially effective for neutralizing oxygen-centered radicals and works to recycle vitamin E. After reacting with a radical, vitamin E is converted to a radical form. However, vitamin C is able to react with the radical form of vitamin E to recycle it back to non-reactive vitamin E (Bender & Mayes, 2003; Jones & DeLong, 2000). However, in high concentrations, vitamin C also functions as a pro-oxidant.

Vitamin A has been touted as an antioxidant vitamin but is actually a term used to describe a group of compounds. Retinol, retinal, retinoic acid, and retinyl ester make up the retinoids and vary in chemical structure and function (Gropper et al., 2005). Vitamin A as retinol is able to scavenge for reactive oxygen species. As retinoic acid, it is able to inhibit nitric oxide production through inhibition of gene transcription in certain tissues (Vertuani et al., 2004). Vitamin A can also be formed from its precursor, beta carotene, which is particularly effective at neutralizing singlet oxygen ($^1O_2$) (Gropper et al., 2005). However, consumption of excessive amounts of vitamin A via dietary supplements has been shown to result in increased oxidative stress due to its ability to function as a pro-oxidant (Kusano & Ferrari, 2008).

Selenium is an essential trace element found in many foods and is required for its role in selenoproteins, many of which are antioxidant enzymes (Semba et al., 2010). Selenium is particularly important in the reactions to neutralize hydrogen peroxide (H_2O_2). It is required for the major forms of glutathione peroxidase, which detoxifies hydrogen peroxide in the cytosol, mitochondria, and blood to oxidized glutathione and water (Bender & Mayes, 2003; Jones & DeLong, 2000). Selenium is also believed to support vitamin E activity by reducing the oxidation rate of lipids and preventing damage seen when vitamin E concentrations are insufficient (Higdon, 2003).

While phenols, carotenoids, vitamin C, and selenium are common antioxidants obtained from the diet, several other antioxidants exist. This network of antioxidants in the body is complex and the protective mechanisms associated with the network are dependent on the presence of all necessary antioxidants (Jones & DeLong, 2000). The type and concentration of antioxidants in the body influence the inflammatory process (McAnulty et al., 2010). Evidence suggests that a combination of antioxidants most likely offers more benefit against oxidative damage than that of an individual antioxidant (Vertuani et al., 2004). In a study of male athletes, Sureda et al. (2008) found that participants that consumed the recommended daily intake of vitamins C and E via diet supplementation with fortified food successfully avoided oxidative damage induced by intense exercise (Sureda et al., 2008). Even with positive preliminary findings, an ongoing challenge in research and practice is determining the optimal concentration of antioxidants in the body (Jones & DeLong, 2000). However, it is believed that identification of such dietary substances as antioxidants that can provide protection against inflammation will continue to reduce the burden of disease (Bisht et al., 2010).

Antioxidant Sources

While the antioxidant content of food is widely variable, plant foods have a substantially higher antioxidant content compared to meat, fish, and other animal-based foods (Carlsen et al., 2010). This is one of the reasons why consumption of plant-based foods, like fruits and vegetables, is so widely encouraged. While whole grains also contain antioxidants, a great deal of emphasis has been placed on fruits and vegetables as key sources of antioxidants in the diet (Gropper et al., 2005). In a study of estimated antioxidant intake in U.S. adults, researchers found that the major dietary sources of vitamin C included citrus fruit juices, potatoes, and tomatoes while major sources of carotene included deep-yellow and dark-green vegetables

(Chun et al., 2010). Consumption of these antioxidant-rich fruits and vegetables has been associated with improved health and well-being. Utilizing logistic regression, researchers have found associations between increased fruit and vegetable intake and prevention or postponement of chronic diseases. In a study of approximately 35,000 people from 12 different ethnic groups, researchers found that after adjusting for age and sex, adequate consumption of fruits and vegetables, excluding juice, was associated with reduced risk of heart disease, other long-term conditions, and overall chronic disease (Quadir & Akhtar-Danesh, 2010).

In addition to being good sources of antioxidants, fruits and vegetables are good sources of dietary fiber, which has also been shown to have anti-inflammatory properties. In a study of fruit and vegetable consumption and proinflammatory gene expression in young adults, Hermsdorff et al. (2010) found an inverse association between fruit and vegetable consumption and IL-1, IL-6, TNF-α, and NF-kB1 expression. However, they also found reduced expression of TNF-α and NF-kB1 in participants with the highest dietary fiber intake. These findings suggest that fruits and vegetables are sources of multiple compounds, including antioxidants and dietary fiber, which have additive and synergistic effects to combat inflammation (Hermsdorff et al., 2010).

Similar results were seen in a study by Polidori et al. (2009) of the association between fruit and vegetable intake and cognitive performance in healthy adults. They found that consumption of a diet rich in fruits and vegetables resulted in higher blood concentrations of antioxidants, lower concentrations of oxidative stress biomarkers, and better scores on tests for neuropsychological function. These results were independent of gender, age, education, BMI, lipid profile, and albumin concentration (Polidori et al., 2009). Likewise, in a study of African Americans, Talegawkar et al. (2009) found that fruit and vegetable intake was associated with increased antioxidant capacities, even after adjusting for dietary intakes of beta carotene and vitamin C from sources other than fruits and vegetables. Overall, consumption of fruits and vegetables has been shown repeatedly to have positive outcomes in regard to oxidative stress and thus, overall improved well-being.

Fruit and Vegetable Consumption

Due to the numerous benefits associated with fruits and vegetables, consumption is highly encouraged in the U.S. and around the world. Research has shown that a regular diet that includes a variety of foods in moderation is sufficient to meet individuals' antioxidant needs. In a study of the antioxidant status of adolescents, Carlsohn, Rohn, Mayer, and Schweigert (2010) found that the majority of adolescents were able to meet the recommended daily amounts of vitamin C (65 mg/day for females; 75 mg/day for males), vitamin E (15 mg/day for both females and males), and reference limits of alpha-tocopherol, beta carotene, and total carotenoids based on age through habitual diet. Habitual diet includes an adequate amount of fruits and vegetables as recommended through the U.S. Dietary Guidelines (HHS, 2010). Current U.S. dietary recommendations for fruit and vegetable consumption for a 2,000 calorie diet include 2.0 servings of fruit and fruit juices per day and 2.5 servings of vegetables and vegetable juices per day (HHS, 2010).

Research has demonstrated that Americans' consumption of fruits and vegetables, which are good sources of antioxidants, is poor compared to recommended amounts. According to the report of the 2010 Dietary Guidelines, Americans usual intake consists of only 42% and 59% of the recommended intake for fruits and vegetables (HHS, 2010). Inadequate consumption of fruits and vegetables has been seen in all age groups and across all stages of development. In a study of the fruit and vegetable intake of children in elementary school, Ransley et al. (2010) found that the combined daily intake of fruits and vegetables was less than the current recommendations of five servings of fruits and vegetables. Similarly, Robinson-O'Brien, Burgess-Champoux, Haines, Hannan, and Neumark-Sztainer (2010) found that 80% of the 103 fourth to sixth grade boys and girls they studied consumed fewer than five daily servings of fruits and vegetables.

Studies have also consistently shown deficient intakes of fruits and vegetables among college students (Butler, Black, Blue, & Gretebeck, 2004). The decline in fruit and vegetable intake among college students has been found to begin upon entering college and progressively decrease on average by one quarter of a serving each semester. The most significant declines in intake of fruits and vegetables have been observed in students that consume the majority of their meals at fast food restaurants (Yeh et al., 2010), which likely influences availability of fruits and vegetables. Along with inadequate intakes of fruits and vegetables, research has demonstrated increasing numbers of obese college students (Kasparek, Corwin, Valois, Sargent, & Morris, 2008).

The trend of inadequate consumption of fruits and vegetables in childhood and adolescence continues into adulthood. According to the CDC (2010, September 10), only 14% of U.S. adults consume the recommended goal of two or more servings of fruits and three or more servings of vegetables each day. Lower than recommended consumption of fruits and vegetables has been seen repeatedly in different adult cohorts (Schroder, 2010) with overall consumption in some actually decreasing over time. For example, rates of meeting fruit and vegetable recommendations per day among overweight and obese adults in the U.S. significantly decreased from 22.6% to 21.5% between 1996 and 2003. It has been postulated that this may be due to overweight and obese individuals opting to use fad diets rather than balanced, low-energy diets that emphasize intake of fruits and vegetables (Andreyeva, Long, Henderson, & Grode, 2010).

Determinants of Fruit and Vegetable Consumption

In regards to fruit and vegetable intake, previous research has examined several variables believed to impact an individuals' likelihood of consumption. These variables include psychosocial and sociodemographic determinants, including knowledge, informational resources, beliefs, socioeconomic status, convenience, exposure, taste, and sex.

Knowledge as a determinant of fruit and vegetable intake has been widely studied though results of its effectiveness have been mixed. Haleem, Barton, Borges, Crozier, and Anderson (2008) argued that knowledge of the antioxidant content of fruits and vegetables might serve to encourage a higher consumption, particularly of those known to have the highest antioxidant capacity. This hypothesis was evaluated by Guillaumie, Godin, and Vezina-Im (2010). They found that knowledge was one of the most consistent variables associated with combined fruit and vegetable intake as well as fruit intake and vegetable intake examined separately. Thus, it was concluded that knowledge was an important determinant in interventions (Guillaumie et al., 2010). However, in a study of the influence of nutrition education on children's fruit and vegetable consumption, Ransley et al. (2010) found that the number of nutrition lessons promoting fruits and vegetables was not associated with fruit and vegetable consumption. Authors noted that the nutrition lessons alone lacked sufficient behavior change techniques required for increased consumption. Similarly, in his review of evidence for long-term successful dietary changes in the general population, Chapman (2010) noted that knowledge alone had limited effectiveness. Findings indicated that despite knowledge of guidelines, support for change, and the possibility for improved health status, participants did not seem to make dietary changes, including increases in fruit and vegetable intake. This highlights the idea that in addition to knowledge, other components of interventions may be necessary in order to motivate individuals to increase their fruit and vegetable consumption and maintain these changes over time.

Another determinant identified as playing a role in fruit and vegetable consumption is the source of information on the benefits of consumption. In a study of health information sources related to preventative health behaviors, Redmond, Baer, Clark, Lipsitz, and Hicks (2010) found that recent visits to healthcare providers were not associated with greater likelihood of meeting fruit and vegetable intake recommendations. However, it was concluded that increasing the number of health communication modalities may increase the odds of people meeting the recommendations (Redmond et al., 2010). In another study focusing on weight loss and fruit and vegetable consumption, Andreyeva et al. (2010) found that receiving professional advice was significantly, but weakly, related to increased consumption of fruits and vegetables among adults. Additionally, the clarity of information provided has been shown to impact behavior. Findings from a study by Kidd and Peters (2010) indicated that participants who believed that nutrition information was confusing were less likely to consume fruits compared to those who did not find nutrition information confusing. These findings have led researchers to recognize the importance of using simple, direct methods that promote the health and weight benefits when promoting fruit and vegetable consumption (Kidd & Peters, 2010).

Beliefs regarding capabilities and causal factors have also been found to be associated with consumption of fruits and vegetables. In a systematic review of psychosocial determinants of fruit and vegetable intake, Guillaumie et al. (2010) found that beliefs about capability, which is a component of social cognitive theory, was a consistent predictor of fruit and vegetable consumption. Similarly, causal beliefs about obesity and its association to fruit and vegetable intake have also been studied. Wang and Coups (2010) found that participants who believed that obesity is inherited had lower consumption of fruits and vegetables. Components of the Health Belief Model, which includes perceived susceptibility to disease, perceived severity of disease, perceived barriers, and self-efficacy, have also been associated with fruit and vegetable consumption. In a study of changes in intention, planning, and self-efficacy as it relates to changes in fruit and vegetable consumption, it was found that self-efficacy was a key factor in changing fruit and vegetable behavior in adults (Reuter et al., 2010). The authors highlighted the importance of targeting self-efficacy beliefs and planning skills in interventions in order to change behavior related to fruit and vegetable consumption.

Economic determinants have also been the focus of studies examining fruit and vegetable consumption. However, Powell, Kazlauskaite, Shima, and Appelhans (2010) noted that factors other than cost of fruits and vegetables may be more relevant to understanding consumption. They pointed out that price of fruits and vegetables can only affect an individuals' choice regarding consumption if the choice is available; in other words, if fruits and vegetables are available for purchase. Thus, availability may be more of a determinant than price of fruits and vegetables. In their examination of cost compared to nutrient density, Powell and colleagues (2010) argued that purchasing fresh fruits and vegetables can actually help those in socioeconomically disadvantaged situations achieve satiety for less money. While they only examined purchase and intake of fresh produce, alternative forms such as canned and frozen also exist and have comparable nutritional benefits. This is important because research findings have indicated that the perishable nature of fresh fruits and vegetables can contribute to decreased likelihood of individuals purchasing these items (Kidd & Peters, 2010). Therefore interventions should include an emphasis on the nutritional quality and cost associated with different forms of fruits and vegetables.

Fruit and vegetable consumption has also been correlated with convenience and exposure. In a study of family members' influence on family meal vegetable choices, researchers found that the variety of vegetables served at dinner was limited by family members' preferences. If vegetables were not liked by the food preparer or any other family member, the vegetable was generally not served, thereby limiting exposure of these foods to others (Wenrich, Brown, Miller-Day, Kelley, & Lengerich, 2010). Preparation time also has been shown to impact exposure to fruits and vegetables and subsequent consumption. Kidd and Peters (2010) found that with the exception of dried fruits, the lower the required preparation time, the greater the consumption of fruits and vegetables in both amount and frequency. These findings suggest that strategies related to increasing exposure and reducing the required amount of time for preparation of fruits and vegetables be incorporated into interventions.

Besides knowledge of recommendations, cost, and required preparation time, taste preference, particularly pertaining to vegetables, has also been associated with consumption. Di Noia and Contento (2010) found that when offered nine daily servings of fruits and vegetables, adolescents consumed more servings on average but still failed to consume all that were offered. The authors noted that the decreased consumption could have been explained by diminished taste preference for fruits and vegetables. Similarly, both Guillaumie et al. (2010) and Wenrich et al. (2010) found that aversion to vegetable intake among study participants was primarily related to taste. In fact, those vegetables deemed to have the most pleasant taste, including corn, peas, and carrots, were touted as the most rewarding vegetables. Participants' suggestions for improving flavor of vegetables included adding butter, cheese, ketchup, spices, or other foods in order to disguise the flavor so that consumption would be more likely (Wenrich et al., 2010). However, in their study of vegetable consumption of adults, Rolls, Roe, and Meengs (2010) found that participants failed to rate two versions of the same vegetable, one with substantially higher butter content, significantly different in pleasantness of taste. Despite this, the authors suggested that taste preference be accounted for when developing interventions aimed to increase vegetable intake (Rolls et al., 2010). Still limited research on the significance of taste as a determinant of vegetable intake exists with taste being included as a possible determinant in only four studies to date (Guillaumie et al., 2010).

Differences between males and females have also been seen in regard to fruit and vegetable consumption thus highlighting sex as a possible determinant to be considered in interventions. In a study of fruit and vegetable intake, Robinson-O'Brien et al. (2010) found that children's daily fruit and vegetable intake was lower among males compared to females. Hansen et al. (2010) and Wang and Coups (2010) found the same results regarding fruit and vegetable consumption in studies of male and female adults. Similarly, in a study of trends in diet methods from 1996 to 2003, Andreyeva et al. (2010) found that the rate of meeting the recommended intake of fruits and vegetables was higher for women than men, particularly if weight loss was desired. Despite these differences, some research findings discourage tailoring interventions separately to males or females. Guillaumie et al. (2010) concluded that research involving samples of both men and women had more success in explaining variability in fruit and vegetable intake than studies that included only men or women in the sample.

METHODS

Participants

A convenience sample of 67 male and female adults with a body mass index (BMI) of 25 kg/m^2 or greater was recruited from the Fargo and Moorhead communities. Information about the study, inclusion criteria, and contact information were posted on flyers that were distributed to businesses throughout the communities and sent out electronically via email. Additional information about the study was provided upon request. Exclusion criteria included anyone under18 years of age, having a BMI lower than 25 kg/m^2, who currently smoke, or with a history of bariatric surgery. All participants were provided with information on the purpose, procedures, and potential benefits of the study, and written informed consent was obtained from each person. Study protocol was approved by the North Dakota State University Institutional Review Board prior to implementation.

Procedures

Study Overview

The intervention was based on the Health Belief Model, which includes perceived susceptibility to disease, perceived severity of disease, perceived barriers, and self-efficacy (Reuter et al., 2010). These components were addressed throughout the nutrition lessons. Education regarding how consumption of fruits and vegetables can help lower the risk for chronic diseases was aimed at addressing perceived susceptibility to disease. Information about how to purchase, store, clean, prepare, and incorporate fruits and vegetables into meals and snacks was provided in order to address perceived barriers and self-efficacy. In addition, samples of fruits and vegetables were provided to participants in the fruit and vegetable group in order to overcome the barriers of cost and exposure. Finally, information regarding positive outcomes associated with increased intake of fruits and vegetables was provided in order to encourage behavior change (Garcia, 2005).

The study consisted of three phases over a 14-week period: pre-testing (2 weeks), intervention (10 weeks), and post-testing (2 weeks). During the pre-test, demographic information, anthropometric measurements, health history, interest and knowledge regarding antioxidants, food intake, information about habitual fruit and vegetable intake, and a fasting blood sample were collected. Three self-report questionnaires were used during pre-testing to collect demographic and health history information, information about habitual fruit and vegetable consumption, and information about participants' interest and knowledge regarding antioxidants, fruits, and vegetables. It took participants approximately 30 minutes to complete all three questionnaires. In addition, actual food intake was assessed using a three-day food record that included all foods and beverages consumed over two weekdays and one-weekend day.

Following pre-testing, participants were randomly assigned to one of three intervention groups: control, education, or fruit and vegetable group. Random assignment was accomplished using a table of random numbers. Each participant was given a numeric identification number ranging from 00 to 67. The first numeric identification number between 00 and 67 encountered on a table of random numbers was assigned to the control group, the second to the education group, and the third to the fruit and vegetable group until each group had the predetermined number of participants (11 in control, 29 in education, and 27 in fruit and vegetable) (Thomas, Nelson, & Silverman, 2005).

Study interventions took place from the end of September to the beginning of December, lasting a total of 10 weeks. Participants assigned to the control group received no intervention. However, they were given the option of receiving the information about fruits and vegetables provided to other participants after the 10-week intervention was over. Participants in the education group attended weekly nutrition lessons where they received information from licensed, registered dietitians about the antioxidant content of fruits and vegetables, the role of antioxidants in the inflammatory process, and the current recommendations for fruit and vegetable consumption. Participants assigned to the fruit and vegetable group received the same information (antioxidant content of fruits and vegetables, the role of antioxidants in the inflammatory process, the current recommendations for fruit and vegetable consumption) in the nutrition lessons as participants in the education group. In addition, they also received recommendations for incorporating fruits and vegetables into their current meal plan and samples of fresh, frozen, or canned fruits and vegetables every week. The samples of fruits and vegetables included fresh, frozen, or canned fruits and vegetables and were provided to participants at the weekly nutrition education sessions. Fruits and vegetables samples were chosen based on nutrient content, cost, and availability. All canned and frozen varieties of fruits and vegetables provided were free of added sugar or salt. The quantity provided to each fruit and vegetable group participant was the equivalent of one serving of fruits and two servings of vegetables per day for a week because on average, Americans fail to meet the recommended servings of fruits and vegetables by these amounts (CDC, 2007, March 16). Servings provided were consistent with the serving sizes listed in the 2010 U.S. Dietary Guidelines for Americans (HHS, 2010). Participants in the fruit and vegetable group were encouraged to consume these fruits and vegetables as a supplement to their usual fruit and vegetable intake.

All weekly nutrition lessons were approximately 30 minutes in duration and were held in the Department of Health, Nutrition, and Exercise Sciences at North Dakota State University. Curriculum materials, developed by nutrition experts in the Department of Food and Nutrition at

The University of Georgia (Garcia, 2005; Johnson et al., 2003), were used for the nutrition lessons. This curriculum was chosen because it was consistent with the purpose of the study, had been used for previous research (Garcia, 2005; Hendrix et al., 2008; Wade, 2003), and was readily available to the public via the Internet (Johnson et al., 2003). Curriculum materials included handouts describing how to purchase and store fruits and vegetables, nutrient content of various fruits and vegetables, and suggestions for incorporating fruits and vegetables into meals and snacks (Appendices R-UU). Existing curriculum was used since appropriate materials are readily available to the public.

After conclusion of the 10-week intervention, post-testing began. Data, including demographic and health history information, interest and knowledge regarding antioxidants, food intake, and a fasting blood sample, were collected using the same instruments, equipment, and procedures utilized for pre-testing. In addition, information about habitual fruit and vegetable intake was assessed using a questionnaire. At the conclusion of the intervention, all participants received the results of their blood lipids and glucose and had the opportunity to meet individually with a licensed, registered dietitian.

Self-Report Assessments

Demographic and health history information was self-reported on a questionnaire. Participants were asked to indicate their age, gender, race/ethnicity, education level, annual income, and marital status. In addition, participants were asked to report personal history or current diagnosis of allergies, asthma, anemia, sickle cell anemia, blood clotting disease, diabetes, cancer, heart disease/heart attack, high cholesterol, or hypertension. They were also asked to indicate use of prescription and over the counter medications and use of any vitamin, mineral, or herbal supplements, including details about brand, dosage, and frequency. In addition, participants were asked to report current physical activity in minutes per week, weight history, including any diets followed and the duration, general eating habits, and frequency of smoking and alcohol consumption.

Information about participants' interest and knowledge regarding antioxidants, fruits, and vegetables was also collected during post-testing via a questionnaire. Participants reported receipt of and interest in information about healthy eating, weight management, cooking, antioxidants, and physical activity. The questionnaire featured eight questions/statements aimed at assessing perceptions of general health and food consumption, and eleven questions assessing knowledge of general nutrition, antioxidants, and physical activity.

Dietary Intake Assessments

Food and nutrient intakes at pre- and post-testing were assessed using a three-day food record. Validity of food records in assessment of energy and nutrient intake has been demonstrated in previous studies of adults (Comrie, Masson, & McNeill, 2009; Drapeau et al., 2007; Shuaibi, Gustaaf, Sevenhuysen, & House, 2008). Three-day food records were collected as they have been observed to provide comparable accuracy as seven-day food records, require less participant burden, and have been shown to result in improved compliance (Larkin, Metzner, & Guire, 1991). Participants were provided with instructions and asked to record by hand everything they ate or drank over the course of two weekdays and a weekend day. To ensure accuracy, participants were encouraged to record foods and beverages as they consumed them over the three-day period.

Information about habitual fruit and vegetable intake was assessed using two questionnaires, a pre-test and post-test. These semi-quantitative food frequency questionnaires were developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005) and are based on the Block Food Frequency Questionnaire, which has been demonstrated to have validity and reliability (Garcia, 2005). Modifications to the original questionnaires have been recommended previously (Garcia, 2005; Wade, 2003) and included the addition of foods to the food frequency questionnaire as well as questions assessing knowledge, attitudes, and behaviors regarding fruit and vegetable consumption. In addition, a tenth frequency category (0/week) was added. Modifications to the food frequency questionnaire included the addition of oranges/grapefruit/tangerines and fresh tomatoes (Wade, 2003), and addition of ‘prepared with tomato or vegetable sauce’ to spaghetti or lasagna. On the pre-test, modifications included the addition of the following questions: (a) Do you eat more fresh fruits and vegetables when they are in season? If yes, which fruits and vegetables?; (b) Do you feel that fruits and vegetables are expensive?; (c) How are the fruits and vegetables that you eat usually prepared? (Wade, 2003); (d) Do you feel canned and frozen fruits and vegetables are just as good for you as fresh fruits and vegetables?; and (e) Are you concerned about chronic diseases, such as cancer or heart disease? (Garcia, 2005). Modifications to the post-test questionnaire included the addition of the following: (a) Because of the information you learned in the lessons, do you think you are more willing to try different fruits and vegetables?; and (b) Because of the information you learned in the lessons, did you replace foods previously consumed with fruits and vegetables? (Garcia, 2005).

The modified pre-test and post-test food frequency questionnaires included 18 items, with six fruit items (100% orange juice, 100% cranberry/apple/purple grape juice, berries such as strawberries/blueberries/blackberries, nectarines/peaches/apricots, oranges/grapefruits/tangerines, and cantaloupe/honeydew melon), and 12 vegetable items (broccoli/cabbage/cauliflower, leafy greens such as mustard greens/turnip greens/collard greens, corn, cooked or stewed tomatoes, spaghetti/lasagna with tomato or vegetable sauce, onions, squash/zucchini, spinach, sweet potatoes/yams, carrots, and baked beans/pintos/black-eyed peas/other beans). These particular fruits and vegetables were included on the questionnaires because they are known to contain a high concentration of antioxidants and consumption of them has been associated with reduced risk of chronic disease (Garcia, 2005). Consumption frequency was measured using 10 frequency categories (0/week, less than 1/week, 1/week, 2/week, 3/week, 4/week, 5/week, 6/week, 1/day, or 2/day) for each food item. Additional information about knowledge, attitudes, and access to fruits and vegetables was assessed by binary response (yes, no) to 21 questions/statements on the pre-test questionnaire. Six of these questions/statements were also included on the post-test questionnaire while the remaining 15 were specific to the pre-test questionnaire.

Anthropometric, Clinical, and Biochemical Assessments

Anthropometric data collected included height, weight, waist circumference, and body composition. All measurements were conducted by the same researcher, trained in the proper techniques. Height was measured with participants' shoes off using a stadiometer (HR-200, Tanita Corporation of America, Inc., Arlington Heights, IL). Participants were instructed to stand with their feet together, looking straight ahead. Weight and body composition measures, including fat mass, fat free mass, and percent body fat, were measured with participants' shoes and socks off and any outerwear removed using a Tanita Body Composition Analyzer® (TBF-300A, Tanita Corporation of America, Inc., Arlington Heights, IL). Participants' waist circumference was measured at the top portion of the iliac crest, with a horizontal tape at the end of gentle exhalation. Body mass index was then calculated by the quotient between weight (kg) and the squared height (m^2). Values for body mass index were then applied to categorize obesity class I (30.0-34.9 kg/m^2), obesity class II (35.0-39.9 kg/m^2), and obesity class III ($\geq$ 40.0 kg/m^2), according to criteria established by the World Health Organization (World Health Organization, 2006).

During pre- and post-testing, a total of 30 mL of venous whole blood sample was drawn after a 12-hour overnight fast. All blood draws were scheduled and performed by a phlebotomist at Sanford Health in Fargo, North Dakota. Within 30 minutes of blood being drawn, EDTA-plasma samples were separated from whole blood by laboratory staff at Sanford Health and frozen immediately at -80 degrees Celsius (C). Samples were transferred from Sanford Health to the Nutrition Laboratory at North Dakota State University in ice and stored in a freezer at -80 degrees C. Each aliquot was slowly brought to room temperature before any tests were performed.

Data assessed from fasting blood samples included total cholesterol, high density lipoprotein, low density lipoprotein, triglycerides, glucose, C-reactive protein, tumor necrosis factor-alpha, and thiobarbituric acid reactive substances. Total cholesterol, high density lipoprotein, low density lipoprotein, triglycerides, and glucose were measured at Sanford Health in Fargo, North Dakota. Plasma concentrations of CRP, TNF-α, and thiobarbituric acid reactive substances (TBARS) were measured in the Nutrition Laboratory at North Dakota State University using Enzyme Linked- Immuno-Sorbent Assay (ELISA) kits. All standards and samples were run in duplicate for the CRP and TNF-α assays and in triplicate for the TBARS assay.

CRP concentration was measured using a human C-reactive protein ELISA kit (Cayman Chemical Company, catalog number 10011236, Ann Arbor, MI). Measurement of CRP concentration involved adding 100 μL of standard or sample to wells of a microtiter plate, incubating for 60 minutes at room temperature on an orbital shaker (MTS 2/4 D S1, IKA® Works, Inc., Wilmington, NC), and then washing four times and removing any moisture from the plate. Anti-CRP conjugate (100 µL) was then added to each well, incubated for 30 minutes at room temperature on an orbital shaker, and then washed four times. Following washing and removal of moisture, 100 µL of CRP tetramethylbenzidine (TMB) substrate solution was added to each well and incubated on an orbital shaker for 15 minutes at room temperature in the dark. Following incubation, 100 µL of CRP horseradish peroxidase (HRP) stop solution was added to each well to stop the reaction. Plates were then read by a microtiter plate reader (ELx 808 IU, Bio-Tek Instruments, Inc., Winooski, VT) at 550 nm. Results were expressed as pg CRP/mL and then converted to mg CRP/L.

Tumor Necrosis Factor-Alpha was measured with a human TNF-α UltraSensitive (US) ELISA Kit (Invitrogen Corporation, Catalog number KHC3013, Camarillo, CA). For this assay, 50 µL of buffered protein base containing 8 mM sodium azide, 100 µL of each standard or sample, and 50 µL of human TNF-α US biotin conjugate were pipetted into each well, incubated for two hours at 37 degrees C, and then aspirated and washed four times. Following washes, 100 µL of streptavidin-HRP working solution was added to each well, incubated for 30 minutes at room temperature, and washed four times. Following washes, 100 µL of stabilized chromogen TMB was added to each well and incubated for 30 minutes at room temperature in the dark. Finally, 100 µL of stop solution was added to stop the reaction. Plates were read at 550 nm and results expressed as pg TNF/mL.

Concentration of lipid peroxides in plasma, which is an indicator of oxidative stress, was determined using a TBARS kit. For this assay, 100 µL of each standard or sample and 100 µL of sodium dodecyl sulfate were mixed in 5 mL vials. Color reagent (4 mL), containing thiobarbituric acid, acetic acid, and sodium hydroxide, was added to each vial and vortexed. Vials were then incubated in 95 degree Celsius water bath for 65 minutes and then immediately transferred to an ice bath to stop the reaction. Following incubation in the ice bath for 10 minutes, vials were centrifuged for 15 minutes at 3,000 RPMs at 4 degrees C. Finally, 150 µL of each standard or sample were pipetted onto a microtiter plate and read at 550 nm. Results reflected the concentration of malondialdehyde (MDA), which is a byproduct of lipid peroxidation (Yagi, 1998). Results were expressed as MDA equivalent content (nmol MDA/mL plasma), with higher values indicating a higher degree of oxidative stress.

Statistical Analysis

Personal identifiers were collected throughout this study. However, all participants were assigned an identification number upon initiation of the study and any documents containing personal identifiers matched to identification numbers were stored separate from other data, in a locked file cabinet on the campus of North Dakota State University. All statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL). Chi square analyses were used to assess differences among intervention groups in regard to demographics. The mean fruit and vegetable consumption frequency was calculated based on the conversion factor shown in . Descriptive statistics, including frequencies, means, standard error of the mean, and standard deviations were then generated for all participants completing both pre-test and post-test. Chi square tests for independence and follow-up pairwise comparisons were used to determine differences in frequencies of responses to knowledge, attitude, and behavior questions from pre-test to post-test and between the three groups: control, education, and fruit and vegetable. Paired sample t-tests were utilized to evaluate mean differences in fruit and vegetable consumption; BMI, anthropometric, and body composition measures; and concentrations of blood glucose, blood lipids, CRP, TNF-α, and TBARS from pre-test to post-test for all participants. One-sample t-tests were conducted to evaluate how participants' actual consumption of fruits and vegetables, according to three-day food records, compared to recommended servings of fruits and vegetables according to the U.S. Dietary Guidelines (HHS, 2010). Pearson correlation analysis was used to evaluate relationships between changes in fruit and vegetable consumption and changes in blood glucose, blood lipids, BMI, waist circumference, body composition, and biomarkers of inflammation and oxidative stress from pre-test to post-test. Finally, one-way ANOVAs were used to test the hypothesis that nutrition education and/or nutrition education with the provision of fruits and vegetables had a differential effect on fruit and vegetable consumption, blood glucose, blood lipids, body composition, anthropometrics, BMI, CRP, TNF-α, and TBARS concentrations from pre-test to post-test compared to no intervention (control group). An alpha level of < .05 was selected to indicate statistical significance.

Table 1

Calculations for the Mean Fruit and Vegetable Consumption Frequency

Frequency Indicated on FFQ	Conversion to Weekly Frequency for Statistical Analysis (x7)
Never	0
Less than 1 per week	.07
1 per week	.14
2 per week	.29
3 per week	.43
4 per week	.57
5 per week	.71
6 per week	.86
1 per day	1.0
2 per day	2.0

Note. FFQ = food frequency questionnaire.

COMMUNITY-BASED NUTRITION EDUCATION IMPROVES KNOWLEDGE, ATTITUDES, AND BEHAVIORS RELATED TO FRUIT AND VEGETABLE CONSUMPTION

Abstract

Knowledge, beliefs, and availability have been shown to be determinants of successful behavior change related to fruit and vegetable consumption. However, no studies to date have examined the effects of nutrition education and provision of fruits and vegetables on changes in fruit and vegetable-related knowledge, attitudes, and behaviors. The objectives of this study were to identify perceived and actual barriers to intake of fruits and vegetables and determine the effectiveness of a 10-week community-based nutrition education program on improving knowledge, attitudes, and behaviors related to fruit and vegetable consumption among overweight and obese adults. Fifty-four adults (19 men/35 women; age 44.7 ± 12.1 y; body mass index 33.2 ± 7.7 kg/m^2) were randomly assigned to one of three intervention groups. The control group received no intervention, the education group attended weekly nutrition lessons, and the fruit and vegetable group attended weekly nutrition lessons and received one serving of fruits and two servings of vegetables per day for 10 weeks. Fruit and vegetable-related knowledge, attitudes, and behaviors were assessed at pre-test and post-test using questionnaires. The main determinants observed to impact fruit and vegetable-related behavior among participants included attitudes, knowledge, and exposure, more so than availability. Participants who received nutrition education, especially those in the fruit and vegetable group, reported more improvements in knowledge, attitudes, and behaviors related to fruit and vegetable consumption compared to those in the control group. Nutrition intervention programs designed to improve fruit and vegetable consumption-related behaviors among overweight and obese adults need to

thoroughly address participants' attitudes, knowledge, and provide exposure to fruits and vegetables.

Introduction

The number of adults in the U.S. struggling with overweight or obesity continues to rise each decade (Centers for Disease Control and Prevention [CDC], 2011, November 17) putting an increasingly higher number of Americans at risk for chronic diseases. Such diseases include heart disease, hypertension, hyperlipidemia, type 2 diabetes mellitus, and certain types of cancer, including breast, colon, and prostate cancer (CDC, 2009, August 19; National Heart, Lung, and Blood Institute, 2011). It has been estimated that obese individuals are two times more likely to develop hypertension, three times more likely to be diagnosed with type 2 diabetes mellitus, and have life expectancy reduced by one year (Thompson, Edelsberg, Colditz, Bird, & Oster, 1999).

According to the World Health Organization, a key contributor to the increase in overweight and obesity is increased consumption of energy-dense foods (Puska, Nishida, & Porter, 2003). Thus, changes in dietary intake are necessary in order to promote weight loss among overweight and obese adults. One such change is an increased consumption of fruits and vegetables. When consumed in place of energy-dense foods, fruits and vegetables have been shown to aid in weight loss. In addition, with their excellent nutrient profile, high dietary fiber content, and generally low energy density, increased consumption of fruits and vegetables has been associated with prevention or postponement of chronic diseases (Quadir & Akhtar-Danesh, 2010).

Despite their numerous health benefits, consumption of fruits and vegetables is poor in comparison to recommendations stated in the Dietary Guidelines for Americans, 2010 (U.S. Department of Health and Human Services [HHS], 2010). More than 85% of adults in the U.S.

fail to consume the recommended five or more servings of fruits and vegetables per day (CDC, 2010, September 10). Among overweight and obese adults, rates of meeting fruit and vegetable consumption recommendations have actually decreased in recent years (Andreyeva, Long, Henderson, & Grode, 2010).

Previous research on the influence of educational interventions on fruit and vegetable consumption (Chapman, 2010; Guillaumie, Godin, & Vezina-Im, 2010; Ransley et al., 2010) suggested that several factors, including knowledge, informational resources, beliefs, cost, convenience, exposure, and taste, are determinants of successful behavior change related to fruit and vegetable consumption. However, no studies to date have examined the effects of nutrition education and provision of fruits and vegetables on changes in knowledge, attitudes, and behaviors related to fruit and vegetable consumption. This study was designed to determine the effectiveness of a community-based fruit and vegetable education program on improving knowledge, attitudes, and behaviors among overweight and obese adults. Goals were to identify perceived and actual barriers to fruit and vegetable consumption, and improve knowledge, attitudes, and behaviors related to fruit and vegetable intake.

Methods

Participants

A convenience sample of male and female adults with a body mass index (BMI) of 25 kg/m^2 or greater was recruited from the two neighboring communities with a combined population of approximately 135,000 residents. Information about the study, inclusion criteria, and contact information were posted on flyers that were distributed to businesses throughout the communities and sent out electronically via email. Exclusion criteria included being under18 years of age, a current smoker, having a BMI lower than 25 kg/m^2, or having a history of bariatric surgery. All participants were provided with information on the purpose, procedures, and potential benefits of the study, and written informed consent were obtained from each person. Study protocol was approved by the university's institutional review board prior to implementation.

Sixty-seven participants enrolled in the study and were randomly assigned to intervention groups. Fifty-four participants completed the study, which represented an attrition of 13 participants (19.4%). Of the 13 participants who dropped out of the study, 10 dropped out immediately upon learning about which intervention group they were randomly assigned while the other three individuals dropped out because of an inability to attend the weekly education sessions due to conflicting schedules. No significant differences in gender, ethnicity, marital status, education completed, annual household income, or age existed between those who participated and those who dropped out. The final sample included 9 participants in the control group (18.2% attrition), 19 in the education group (34.5% attrition), and 26 in the fruit and vegetable group (3.7% attrition).

Procedures

The study was conducted in fall 2011 and consisted of three phases over a 14-week period: pre-testing (2 weeks), intervention (10 weeks), and post-testing (2 weeks). During pre-testing and post-testing, demographics, receipt of and interest in health topics, and nutrition-related knowledge and attitude data were collected. Demographic information was self-reported on a questionnaire, and included age, gender, race/ethnicity, education level, annual income, and marital status. A second questionnaire was used to assess participants' receipt of and interest in information about healthy eating, cooking, and antioxidants, as well as perceptions of general health and knowledge of general nutrition and antioxidants. In order to assess participants' knowledge of the specific benefits of fruits and vegetables and barriers to consumption, participants responded to 21 yes or no questions on a modified version semi-quantitative food frequency questionnaire, originally developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005). Six of these questions were also included on the modified post-test questionnaire while the remaining 15 were specific to the pre-test questionnaire.

Following pre-testing, participants were randomly assigned to one of three intervention groups: control, education, or fruit and vegetable. Random assignment was achieved using a table of random numbers (Thomas, Nelson, & Silverman, 2005). The final sample included 11 participants in control, 29 in education, and 27 in the fruit and vegetable group. The study intervention was 10 weeks in duration. Participants assigned to the control group received no intervention. However, they were given the option of receiving the information about fruits and vegetables provided to other participants after the intervention was over. Participants in the education group received weekly information about the antioxidant content of fruits and vegetables, the role of antioxidants in the inflammatory process, and the current recommendations for fruit and vegetable consumption. Participants assigned to the fruit and vegetable group received the same information as participants in the education group. In addition, they received recommendations for incorporating fruits and vegetables into their current meal plan and samples of fruits and vegetables. The samples of fruits and vegetables included fresh, frozen, or canned fruits and vegetables and were provided to participants at the weekly nutrition education sessions. The quantity provided to each fruit and vegetable group participant was the equivalent of one serving of fruits and two servings of vegetables per day for a week because on average, Americans fail to meet the recommended servings of fruits and vegetables by these amounts (CDC, 2007, March 16). Servings provided were consistent with the serving sizes listed in the 2010 U.S. Dietary Guidelines for Americans (HHS, 2010). Participants in the fruit and vegetable group were encouraged to consume these fruits and vegetables as a supplement to their usual fruit and vegetable intake.

All weekly nutrition lessons were approximately 30 minutes in duration and were taught by licensed, registered dietitians. All education sessions were held at a local university. Curriculum materials, developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005; Johnson et al., 2003), were used for the nutrition lessons. This curriculum was chosen because it was consistent with the purpose of the study, had been used for previous research (Garcia, 2005; Hendrix et al., 2008; Wade, 2003), and was readily available to the public via the Internet (Johnson et al., 2003). Curriculum materials included handouts describing how to purchase and store fruits and vegetables, nutrient content of various fruits and vegetables, and suggestions for incorporating fruits and vegetables into meals and snacks.

The intervention was based on the Health Belief Model, which includes perceived susceptibility to disease, perceived severity of disease, perceived barriers, and self-efficacy (Reuter et al., 2010). These components were addressed throughout the nutrition lessons. Education regarding how consumption of fruits and vegetables can help lower the risk for chronic diseases was aimed at addressing perceived susceptibility to disease. Information about how to purchase, store, clean, prepare, and incorporate fruits and vegetables into meals and snacks was provided in order to address perceived barriers and self-efficacy. In addition, samples of fruits and vegetables were provided to participants in the fruit and vegetable group in order to overcome the barriers of cost and exposure. Finally, information regarding positive outcomes associated with increased intake of fruits and vegetables was provided in order to encourage behavior change (Garcia, 2005).

After conclusion of the 10-week intervention, post-testing was initiated in order to evaluate changes in knowledge, attitudes, and behaviors related to fruit and vegetable consumption. Knowledge of the benefits of fruit and vegetable consumption and attitudes regarding barriers to consumption were assessed using a modified post-test questionnaire originally developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005), which was similar to the pre-test questionnaire but with the addition of 12 binary response questions to assess change in behavior.

Statistical Analysis

All statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL). Chi square analyses were used to assess differences among intervention groups in regard to demographics. Descriptive statistics, including frequencies, means, and standard deviations were then generated for all participants completing both pre-test and post-test. Chi square tests for independence and follow-up pairwise comparisons were used to determine differences in frequencies from pre-test to post-test and between the three groups: control, nutrition education, and fruit and vegetable. An alpha level of $< .05$ was selected to indicate statistical significance.

Results

Baseline characteristics for all participants are depicted in Table 2. Participants were predominantly female (64.8%), white (92.5%), married or partnered (75.9%), and reported an annual household income in the range of $50,000-$99,999 (44.4%). Chi square tests for independence did not indicate differences in proportions in regard to gender (male, female),

Table 2

Characteristics of Participants

Characteristic	Total sample (N = 54)	Control group (n = 9)	Education group (n = 19)	Fruit and Vegetable group (n = 26)
	n	n	n	n
Gender				
Male	19	5	8	6
Female	35	4	11	20
Ethnicity				
White	50	7	19	24
Asian	3	2	0	1
Latin American	1	0	0	1
Marital status				
Single	7	1	2	4
Married/Partnered	41	7	14	20
Divorced	5	1	2	2
Widowed	1	0	1	0
Education completed				
High school/GED	3	0	3	0
Some college	6	2	2	2
2-year college degree	6	0	3	3
4-year college degree	18	3	5	10
Master’s degree	14	2	5	7
Professional/Doctoral degree	7	2	1	4
Annual household income				
$10,000-$49,999	18	2	6	10
$50,000-$99,999	24	5	10	9
$100,000-$149,999	10	2	2	6
More than $150,000	2	0	1	1
Age (y, mean ± S.D.)	44.7 ± 12.1	41.4 ± 13.3	45.5 ± 11.9	45.2 ± 12.1

Note. y = years; S.D. = standard deviation.

ethnicity (white, non-white), relationship status (married, other), or reported annual household income (≤$39,999, ≥$40,000) among participants assigned to the three intervention groups.

When asked about receipt of information regarding healthy eating, cooking, and antioxidants, 22 (32.4%) participants indicated they had previously received information on healthy eating from a health care provider. Alternatively, only five (7.4%) participants indicated receiving information on cooking and only three (4.4%) reported receiving information on antioxidants from a health care provider. Of those who reported receiving information on healthy eating (n = 51), 39 (76.4%) received information verbally or as a written handout from a healthcare provider, eight (15.7%) received information verbally from a family member, friend, or neighbor, and four (7.8%) indicated a different source. Of those who reported receiving information on cooking (n = 16), four (25.0%) received information verbally or as a written handout from a healthcare provider, 10 (62.5%) received information verbally from a family member, friend, or neighbor, and two (12.5%) indicated a different source. Of those who reported receiving information on antioxidants (n = 8), three (37.5%) received information verbally or as a written handout from a health care provider, three (37.5%) received information verbally from a family member, friend, or neighbor, and two (25.0%) indicated a different source.

Participant's responses to knowledge and attitude questions at pre-test are depicted in Table 3. The majority of participants (88.9%) indicated they were concerned about chronic diseases such as cancer and heart disease. In addition, 90.7% expressed interest in learning more about healthy eating and 81.5% reported interest in receiving information about cooking. When asked about knowledge of the health benefits of fruits and vegetables, 94.4% indicated they would like to know more about which fruits and vegetables are good for health and 85.2%

Table 3

Responses to Knowledge, Attitude, and Behavior Questions at Pre-test

Variable Name and Description	Control group (n = 9)	Education group (n = 19)	Fruit and Vegetable group (n = 26)	
	n	n	n	p value
Concerned about chronic disease				
Yes	7	16	25	.23
No	2	3	1	
Learn more about healthy eating				
Yes	6	18	25	.02*
No	3	1	1	
Interest in information about cooking				
Yes	7	16	21	.91
No	2	3	5	
Would like to know more about fruits and vegetables for health				
Yes	6	19	26	.00*
No	3	0	0	
Interest in information about antioxidants				
Yes	6	17	23	.23
No	3	2	3	
Would like to know more about cooking vegetables				
Yes	8	18	23	.76
No	1	1	0	
Would like healthy recipes/menus to take home				
Yes	8	18	26	.28
No	1	1	0	

Table 3 (Continued)

Feel grocery store has a wide selection of fruits and vegetables				
Yes	8	16	22	.59
No	0	2	3	
Feel fruits and vegetables are expensive				
Yes	3	12	19	.10
No	6	6	7	
Like the way most vegetables taste				
Yes	7	16	23	.73
No	2	3	3	
Eat more fresh fruits and vegetables when in season				
Yes	8	18	26	.28
No	1	1	0	

*Indicates significant difference in response between intervention groups.

expressed interest in receiving information about antioxidants. In addition, 90.7% expressed interest in learning more about different ways to cook vegetables and 96.3% reported they would like handouts with healthy recipes and menus to take home.

At pre-test, chi square tests for independence indicated a significant relationship between intervention group and interest in receiving information about healthy eating, χ^2 = (2, N = 54) = 7.48, p = .02. The effect was small (Φ = .37, Cramer's V = .37). Follow-up pairwise comparisons indicated significant differences between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 5.74, p = .02). Participants in the fruit and vegetable group were 4.2 times more likely to express interest in receiving information about healthy eating compared to control group participants. A significant relationship also existed between intervention group and desire to learn more about which fruits and vegetables are good for health, χ^2 = (2, N = 54) = 15.88, p = .00. The effect was medium (Φ = .54, Cramer's V = .54). Follow-up pairwise comparisons indicated significant differences between the control and education group (χ^2 = (1, N = 28) = 7.09, p = .01) and between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 9.48, p = .00). Participants in the education and fruit and vegetable groups were 3.2 and 4.3 times more likely to express wanting to learn more about which fruits and vegetables are good for health compared to control group participants. No other significant relationships between knowledge and attitudes and intervention group at pre-test were observed.

In addition to knowledge and attitudes, other determinants of fruit and vegetable consumption, including convenience, exposure, taste, and cost, were assessed at pre-test. When asked about convenience and availability, 86.8% of participants reported that their grocery store has a wide selection of fruits and vegetables. However, 63.0% noted that they think fruits and vegetables are expensive. Eighty-five percent of participants reported they like the way most vegetables taste and 96.3% indicated they consume more fresh fruits and vegetables when they are in season. Chi square tests for independence did not indicate significant relationships between these determinants of fruit and vegetable consumption and intervention group.

Chi square tests for independence indicated significant relationships between participants' rating of importance regarding statements about fruit and vegetable consumption and time (pre-test to post-test) (Table 4). When asked about how important it is to choose a diet with plenty of fruits and vegetables, 74.1% of participants indicated it was very important at post-test compared to 51.9% at pre-test, χ^2 = (3, N = 108) = 6.67, p = .04. The effect was small (Φ = .25, Cramer's V = .25). A similar difference in level of importance was noted in regard to consuming a variety of foods. More participants responded that it is very important at post-test (79.6%) compared to pre-test (48.1%), χ^2 = (3, N = 108) = 12.63, p = .01. The effect was medium (Φ = .34, Cramer's V = .34). In addition, more participants at post-test (55.6%) strongly agreed that eating a variety of food each day probably gives a person all the vitamins and minerals he or she needs, which represents a difference from 31.5% strongly agreeing to this statement at pre-test, χ^2 = (3, N = 108) = 10.38, p = .02. The effect was medium (Φ = .31, Cramer's V = .31).

Significant relationships between perceived knowledge of antioxidants and time point were also indicated following chi square tests for independence. At post-test, 48.1% of participants strongly agreed that they know what antioxidants are and 44.4% strongly agreed they understand the effects of antioxidants in the body. These represent significant differences in agreement from 9.3% strongly agreeing to these statements at pre-test, χ^2 = (3, N = 108) = 26.29, p = .00, Φ = .49, Cramer's V = .49; χ^2 = (3, N = 108) = 27.82, p = .00, Φ = .51, Cramer's V = .51. The effects were medium. Participants at post-test also reported excellent or very good

Table 4

Responses to Knowledge, Attitude, and Behavior Questions at Pre-test and Post-test

Characteristic	Total sample (N = 54)		
	Pre (n)	Post (n)	p value
General health			
Excellent	1	4	.36
Very good	12	15	
Good	30	30	
Fair	9	4	
Poor	2	1	
Importance of variety			
Very important	26	43	.01*
Somewhat important	25	11	
Not too important	2	0	
Not at all important	1	0	
Importance of eating plenty of fruits and vegetables			
Very important	28	40	.04*
Somewhat important	21	13	
Not too important	5	1	
Not at all important	0	0	
What you eat makes a difference in risk of disease			
Strongly agree	39	47	.25
Somewhat agree	12	6	
Somewhat disagree	2	1	
Strongly disagree	1	0	
Variety of foods provides necessary vitamins and minerals			
Strongly agree	17	30	.02*
Somewhat agree	26	22	
Somewhat disagree	9	2	
Strongly disagree	2	0	
Know what antioxidants are			
Strongly agree	5	26	.00*
Somewhat agree	33	26	
Somewhat disagree	11	2	
Strongly disagree	5	0	
Understand effects of antioxidants			
Strongly agree	5	23	.00*
Somewhat agree	24	26	
Somewhat disagree	16	3	
Strongly disagree	9	1	
Which of the following is an antioxidant?			
Correct	13	20	.66
Incorrect	39	34	
How many fruits and vegetables should people eat each day?			
1	1	0	.00*
2	2	1	
3	11	1	
4	7	0	
5 or more	33	52	

*Indicates significant difference in response from pre-test to post-test.

perceived general health (35.2%) and strongly agreed that what a person eats can make a big difference in his or her chance of getting a disease like heart disease or cancer (87.0%) compared to pre-test (24.1%; 72.2%). However, these relationships were not significant.

Chi square tests for independence also indicated significant relationships between participants' actual knowledge of fruit and vegetable recommendations and time point. Specifically, more participants were able to correctly identify the number of servings of fruits and vegetables recommended each day at post-test (94.4%) compared to pre-test (61.1%), χ^2 = (1, N = 107) = 19.55, p = .00. The effect was medium (Φ = .43, Cramer's V = .43). More participants at post-test were also able to correctly identify an example of an antioxidant when provided with a list of vitamins and minerals compared to pre-test, but a significant relationship between identification of an antioxidant and time point was not indicated.

Participants' responses to knowledge, attitude, and behavior questions at post-test are depicted in Table 5. Prior to the intervention, no significant relationships existed between intervention group and knowledge, attitudes, and behaviors related to fruits and vegetables. Following the intervention, significant relationships were observed between knowledge regarding the impact of fruit and vegetable consumption on health and intervention group. A chi square test for independence indicated a significant relationship between being able to correctly identify the recommended daily number of fruit and vegetable servings and intervention group, χ^2 = (2, N = 54) = 10.39, p = .01, Φ = .44, Cramer's V = .31. Follow-up pairwise comparisons revealed significant differences between the control and education group (χ^2 = (1, N = 28) = 4.55, p = .03) and between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 6.13, p = .01). Participants in the education and fruit and vegetable groups were 2.7 and 3.7 times more likely to correctly identify the recommended daily number of fruit and vegetables servings

Table 5

Responses to Knowledge, Attitude, and Behavior Questions at Post-test

Characteristic	Control group (n = 9)	Education group (n = 19)	Fruit and Vegetable group (n = 26)	
	n	n	n	p value
Identify the correct number of servings of fruits and vegetables each day				
Yes	7	19	26	.01*
No	2	0	0	
Identify diseases and conditions that may be improved by eating fruits and vegetables				
Yes	7	19	26	.06
No	1	0	0	
Feel strongly that eating fruits and vegetables will reduce disease risk				
Yes	5	19	26	.00*
No	4	0	0	
Feel canned and frozen fruits and vegetables are just as good as fresh				
Yes	1	15	24	.00*
No	6	3	2	
Importance of eating plenty of fruits and vegetables				
Very important	3	14	23	.01*
Somewhat important	5	5	3	
Not too important	1	0	0	
Not at all important	0	0	0	
Know what antioxidants are				
Strongly agree	2	8	16	.01*
Somewhat agree	5	11	10	
Somewhat disagree	2	0	0	
Strongly disagree	0	0	0	

Table 5 (Continued)

Understand effects of antioxidants				
Strongly agree	2	6	16	.00*
Somewhat agree	4	12	10	
Somewhat disagree	3	0	0	
Strongly disagree	0	1	0	
Tried to follow a healthier diet				
Yes	2	18	26	.00*
No	6	1	0	
Willing to try different fruits and vegetables				
Yes	5	19	25	.00*
No	3	0	0	
Eat more fruits and vegetables because feel they are good for you				
Yes	4	18	26	.00*
No	3	1	0	
Have replaced foods previously consumed with fruits and vegetables				
Yes	3	14	24	.00*
No	5	5	1	
Tried different ways to prepare fruits and vegetables				
Yes	2	13	23	.00*
No	7	6	3	
Eat more dark green vegetables				
Yes	2	11	17	.10
No	6	8	8	

*Indicates significant difference in response between intervention groups.

compared to control group participants. All (100%) participants in both the education and fruit and vegetable groups also reported being able to identify diseases and conditions that may be decreased by a diet high in fruits and vegetables, but this proportion was not different than the proportion of control group participants (77.8%).

Relationships also existed between attitudes and intervention group at post-test. Specifically, intervention group and attitude regarding the ability of fruit and vegetable consumption to reduce risk of disease were found to be significantly related, χ^2 = (2, N = 54) = 21.60, p = .00. The effect size was large (Φ = .63, Cramer's V = .63). Follow-up pairwise comparisons revealed significant differences between the control and education group (χ^2 = (1, N = 28) = 9.85, p = .00) and between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 13.05, p = .00). Participants in the education and fruit and vegetable groups were 3.8 and 5.2 times more likely to indicate that eating fruits and vegetables can help reduce risk of disease compared to control group participants. A significant relationship was also observed between intervention group and attitude regarding the importance of including plenty of fruits and vegetables in the diet, χ^2 = (4, N = 54) = 13.19, p = .01. The effect was medium (Φ = .49, Cramer's V = .35). Follow-up pairwise comparisons indicated a significant difference between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 11.29, p = .00), with fruit and vegetable group participants being 7.7 times more likely than control group participants to report that it is very important to include plenty of fruits and vegetables in the diet.

Seventy-nine percent of education and 88.9% of fruit and vegetable group participants reported believing that canned and frozen vegetables are just as good for people as fresh fruits and vegetables, a perception that was reported by 11.1% of control group participants, χ^2 = (2, N = 51) = 20.24, p = .00. The effect size was large (Φ = .63, Cramer's V = .63). Follow-up pairwise comparisons revealed significant differences between the control and education group (χ^2 = (1, N = 28) = 10.43, p = .00) and between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 18.28, p = .00). Finally, significant relationships between intervention group and agreement to statements regarding antioxidants were observed. When asked if they know what antioxidants are, differences in responses were seen between groups, χ^2 = (4, N = 54) = 13.35, p = .01, Φ = .50, Cramer's V = .50. Specifically, a significant difference was indicated between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 8.24, p = .02). Participants in the fruit and vegetable group were 8.0 times more likely to report that they know what antioxidants are compared to control group participants. Similar results were noted when participants were asked if they understand the effects of antioxidants in the body, χ^2 = (3, N = 54) = 21.68, p = .00; Φ = .64, Cramer's V = .45. Fruit and vegetable group participants were 8.0 times more likely to report understanding compared to participants in the control group (χ^2 = (1, N = 35) = 10.74, p = .01).

At post-test, chi square tests for independence also indicated significant relationships between intervention group and behaviors, including having tried to follow a healthier diet, being more willing to try different fruits and vegetables, eating more fruits and vegetables, and replacing energy-dense, nutrient-poor foods previously consumed with fruits and vegetables. Over 90% of participants in the education group and 100% of participants in the fruit and vegetable group reported having tried to follow a healthier diet compared to only 22.2% of control group participants, χ^2 = (2, N = 53) = 31.65, p = .00. The effect size was large (Φ = .77, Cramer's V = .77). Follow-up pairwise comparisons revealed significant differences between both the control and education groups (χ^2 = (1, N = 28) = 14.26, p = .00) and control and fruit and vegetable groups (χ^2 = (1, N = 28) = 23.68, p = .00). Similarly, participants who received nutrition education were more likely to report eating more fruits and vegetables because they think they are good for them, χ^2 = (2, N = 52) = 14.52, p = .00. This was a large effect (Φ = .53, Cramer's V = .53) with participants in the education and fruit and vegetable groups being 4.5 and 6.5 times more likely to report increased consumption compared to control group participants.

In addition, 100% of education group participants and 96.2% of fruit and vegetable group participants reported being more willing to try different fruits and vegetables compared to 55.6% of control group participants, χ^2 = (2, N = 52) = 17.51, p = .00. The effect size was large (Φ = .58, Cramer's V = .58). Follow-up pairwise comparisons revealed significant differences between the control and education group (χ^2 = (1, N = 28) = 8.02, p = .01) and between the control and fruit and vegetable group (χ^2 = (1, N = 35) = 10.31, p = .00). Participants in the education and fruit and vegetable groups were 3.8 and 5.0 times more likely to try different fruits and vegetables compared to control group participants. In addition, the majority of participants in the education and fruit and vegetable groups reported having tried different ways to prepare vegetables, χ^2 = (2, N = 52) = 14.12, p = .00. These were large effects (Φ = .58, Cramer's V = .58; Φ = .51, Cramer's V = .51). Differences between control and education (χ^2 = (1, N = 28) = 5.24, p = .02) and between control and fruit and vegetable group (χ^2 = (1, N = 35) = 14.37, p = .00) were indicated.

At post-test, 96% of participants in the fruit and vegetable group reported replacing energy-dense, nutrient-poor foods previously consumed with fruits and vegetables. This represented a significantly higher proportion of participants than the control group, from which 37.5% reported substituting fruits and vegetables for energy-dense, nutrient-poor foods, χ^2 = (2, N = 52) = 12.91, p = .00. The effect size was medium (Φ = .50, Cramer's V = .50). The majority of education and fruit and vegetable group participants also reported eating more dark green vegetables (57.9% education, 68.0% fruit and vegetable) but these proportions were not significantly different than those in the control group (25.0%).

Discussion

This study investigated the effects of a 10-week nutrition education intervention on knowledge, attitudes, and behaviors related to fruit and vegetable consumption among overweight and obese adults. Results indicated that at pre-test, few participants had received information on healthy eating, cooking, or antioxidants yet the majority reported concern regarding risk of chronic disease and expressed interest in learning more about how fruit and vegetable consumption could help decrease disease risk. Following the intervention, significant improvements in knowledge, attitudes, and behaviors regarding fruit and vegetable consumption were observed. This suggests that modifiable barriers, including knowledge and attitudes, were improved, thereby potentially increasing the likelihood of behavior change.

Knowledge as a determinant of fruit and vegetable intake has been widely studied though results of its effectiveness have been mixed. Haleem, Barton, Borges, Crozier, and Anderson (2008) argued that knowledge of the antioxidant content of fruits and vegetables might serve to encourage a higher consumption, particularly of those known to have the highest antioxidant capacity. In the present study, improvement in knowledge regarding antioxidants over time was evident. There were also differences between groups, with more of the participants in the education and fruit and vegetable groups demonstrating knowledge and understanding of antioxidants compared to control group participants. Knowledge of the recommended daily number of fruit and vegetable servings also improved from pre-test to post-test among participants who attended weekly nutrition lessons. These findings support previous research indicating the necessity of knowledge in order to produce behavior change (Guillaumie et al., 2010; Haleem et al., 2008).

While knowledge of fruit and vegetable consumption recommendations was improved among those who attended weekly nutrition education sessions compared to the control group, knowledge of health benefits associated with fruits and vegetables was not. At the end of the study, an increased number of participants in all three groups were able to recognize an example of an antioxidant and identify diseases and conditions that may be decreased by a diet high in fruits and vegetables. These findings indicate that while additional knowledge was gained by participating in the intervention, adults in this study were already knowledgeable about benefits associated with fruit and vegetable consumption. Taken together, the improvements in knowledge and lack thereof observed among participants are consistent with discrepancies regarding the effects of knowledge on behavior change. While some have noted knowledge to be an important determinant to increased fruit and vegetable consumption (Guillaumie et al., 2010), others have noted that knowledge alone has limited effectiveness (Chapman, 2010).

A greater degree of consistency among adults in the nutrition education intervention groups was noted in regard to changes in attitude and subsequent behavior change. Following the intervention, participants were more confident about the benefits of, and more willing to try, fruits and vegetables. Reported behavior changes included following a healthier diet and eating more fruits and vegetables. Similar improvements have been noted in previous research. In a study of changes in intention, planning, and self-efficacy as it relates to fruit and vegetable consumption, it was found that self-efficacy was a key factor in changing fruit and vegetable behavior in adults (Reuter et al., 2010). Thus, attitudes regarding potential health benefits of fruit and vegetable intake may be improved, and subsequent increases in consumption observed, by providing nutrition education focused on increasing adults' self-efficacy related to fruit and vegetable consumption.

Additional determinants of fruit and vegetable consumption identified in the literature include convenience, exposure, cost, and taste. Throughout the nutrition lessons, simple recipes specific to the fruit or vegetable emphasized in the lesson were provided to participants in the education and fruit and vegetable groups. In addition, cooking demonstrations and taste-testing were provided. This resulted in increased willingness to consume a variety of fruits and vegetables, utilize healthier ways of preparing fruits and vegetables, and substitute fruits and vegetables for energy-dense, nutrient-poor foods. Similar increases in consumption of fruits and vegetables following increased exposure were observed by Kidd and Peters (2010). These findings suggest that education regarding fruits and vegetables, including how to purchase, store, clean, and prepare them, combined with actual cooking demonstrations, increases adults' exposure to fruits and vegetables and may improve their consumption patterns.

Economic determinants have been the focus of many studies examining fruit and vegetable consumption. The majority of participants in the current study reported that fruits and vegetables are expensive. However, Powell, Kazlauskaite, Shima, and Appelhans (2010) noted that availability of fruits and vegetables may be more relevant to understanding of consumption compared to cost. A related factor is the form of fruits and vegetables being purchased and consumed. While much emphasis has been placed on intake of fresh fruits and vegetables, alternative forms such as canned and frozen also exist and have comparable nutritional benefits. This is important because research findings have indicated that the perishable nature of fresh fruits and vegetables can contribute to decreased likelihood of individuals purchasing these items (Kidd & Peters, 2010). Since the majority of participants in all three groups agreed that their grocery store has a wide selection of fruits and vegetables, and since those receiving nutrition education reported increased acceptance of the nutritional quality and lower price of canned and frozen fruits and vegetables, availability of fruits and vegetables did not appear to be a significant determinant of consumption.

At pre-test, the majority of participants reported liking the way most vegetables taste and this was reflected in reports of increased consumption at post-test, particularly among those who received fruits and vegetables throughout the intervention. However, findings from previous research regarding taste as a determinant of fruit and vegetable consumption are mixed. Both Guillaumie et al. (2010) and Wenrich, Brown, Miller-Day, Kelley, and Lengerich (2010) found that aversion to vegetable intake among study participants was primarily related to taste. In fact, those vegetables deemed to have the most pleasant taste, including corn, peas, and carrots, were touted as the most rewarding vegetables (Wenrich et al., 2010). Alternatively, in their study of vegetable consumption of adults, Rolls, Roe, and Meengs (2010) found that participants rated two versions of the same vegetable, one with substantially higher butter content, equally in regard to pleasantness of taste. Despite some studies indicating taste as a significant determinant of fruit and vegetable intake while others have found taste to play a small role in influencing consumption, it has been suggested that taste preference be accounted for when developing interventions aimed at increasing vegetable intake (Rolls et al., 2010). Additional research examining taste preferences and both reported and actual consumption of vegetables is recommended.

Limitations

Despite recruitment from two communities with a combined population of 135,000 residents, the final sample consisted of adults who were predominantly female, Caucasian, and college-educated. Thus, participants' fruit and vegetable-related knowledge prior to the intervention may have been high compared to the general population. Another limitation was the unequal sample size of the intervention groups, which may have hindered the probability of detecting significant differences between groups. An additional limitation was that follow-up was not conducted. Thus, it is unknown if improvements in knowledge, attitudes, and behaviors related to fruit and vegetable consumption were maintained following the conclusion of the study.

Conclusion

The present study suggests that community-based nutrition education can increase knowledge and improve attitudes regarding fruit and vegetable consumption, thereby leading to behavior change among overweight and obese adults. In addition, provision of fruits and vegetables was found to contribute additional improvements in fruit and vegetable-related attitudes and behaviors. The main determinants observed to impact behavior in this study included attitudes, knowledge, and exposure, more so than availability. Thus, nutrition intervention programs designed for overweight and obese adults need to thoroughly address participants' attitudes, knowledge, and provide exposure to fruits and vegetables. While these findings contribute to the body of evidence regarding the influence of nutrition education and provision of fruits and vegetables on consumption-related behaviors, additional research is warranted. Longitudinal studies of overweight and obese adults are needed to assess if improvements in fruit and vegetable-related knowledge and attitudes lead to sustainable improvements in fruit and vegetable consumption, subsequent weight loss, and decreased disease risk in overweight and obese adults.

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NUTRITION EDUCATION IS EFFECTIVE IN INCREASING FRUIT AND VEGETABLE CONSUMPTION AMONG OVERWEIGHT AND OBESE ADULTS

Abstract

Despite the benefits of fruit and vegetable consumption on weight and decreased risk for chronic disease, Americans' intake of fruits and vegetables is well below the recommended daily servings. While previous studies have assessed fruit and vegetable consumption and the influence of educational interventions on fruit and vegetable intake, no studies to date have examined the effects of nutrition education combined with provision of fruits and vegetables on changes in fruit and vegetable consumption among overweight and obese adults. The objectives of this study were to evaluate fruit and vegetable consumption patterns, including intake of antioxidant-rich fruits and vegetables, provide education about benefits of consuming fruits and vegetables, expose participants to different varieties of fruits and vegetables, and improve fruit and vegetable consumption. Fifty-four adults (19 men/35 women; 44.7 ± 12.1 y) were randomly assigned to one of three intervention groups. The control group received no intervention, the education group attended weekly nutrition lessons focused on benefits of fruit and vegetable consumption, and the fruit and vegetable group attended weekly nutrition lessons and received one serving of fruits and two servings of vegetables per day for 10 weeks. Intake of fruits and vegetables was assessed using semi-quantitative food frequency questionnaires and three-day food records. Findings suggested that while the majority of participants failed to consume the recommended number of servings of fruits and vegetables per day, nutrition education was helpful in improving the consumption of antioxidant-rich fruits and vegetables among overweight and obese adults.

Introduction

As of 2010, a total of 36 states in the U.S. had prevalence of obesity greater than or equal to 25% (Centers for Disease Control and Prevention [CDC], 2011, July 21). The increase in obesity is particularly concerning because of the multitude of health consequences resulting from excess weight. Obesity is associated with coronary heart disease, type 2 diabetes mellitus, various cancers, hypertension, dyslipidemia, stroke, sleep apnea, osteoarthritis, and reproductive problems (CDC, 2009, August 19; National Heart, Lung, and Blood Institute, 2011). In fact, more than 85% of people diagnosed with type 2 diabetes mellitus are overweight at time of diagnosis. Similarly, obese individuals are more likely to develop hypertension and hyperlipidemia, which increase the risk of myocardial infarction and stroke (National Institute of Diabetes and Digestive and Kidney Diseases, 2007).

Changes in dietary intake are necessary in order to achieve weight loss in overweight and obese individuals. Consumption of fruits and vegetables is often recommended because of their excellent nutrient profile, high dietary fiber content, and generally low caloric content. Research has demonstrated that consumption of fruits and vegetables in place of foods with higher energy density can greatly impact energy balance and aid in weight loss (Schroder, 2010). Despite potential benefits, Americans’ consumption of fruits and vegetables is poor compared to recommended amounts. According to the CDC (2010, September 10), only 14% of U.S. adults consume the recommended goal of two or more servings of fruits and three or more servings of vegetables each day. Lower than recommended consumption of fruits and vegetables has been seen repeatedly in different adult cohorts with overall consumption in some actually decreasing over time (Schroder, 2010). For example, rates of meeting daily fruit and vegetable recommendations among overweight and obese adults in the U.S. significantly decreased from 22.6% to 21.5% between 1996 and 2003 (Andreyeva, Long, Henderson, & Grode, 2010).

Previous studies have assessed fruit and vegetable consumption (Chapman, 2010; Guillaumie, Godin, & Vezina-Im, 2010; Kidd & Peters, 2010; Powell, Kazlauskaite, Shima, & Appelhans, 2010; Wang & Coups, 2010; Wenrich, Brown, Miller-Day, Kelley, & Lengerich, 2010) and the influence of educational interventions on fruit and vegetable consumption (Chapman, 2010; Guillaumie et al., 2010; Ransley et al., 2010). Findings from these studies suggest that several factors, including knowledge, beliefs, cost, convenience, and taste, are determinants of successful behavior change related to fruit and vegetable consumption. However, no studies to date have examined the effects of nutrition education and provision of fruits and vegetables on changes in fruit and vegetable consumption. This study was designed to determine the effectiveness of a community-based fruit and vegetable education program and provision of fruits and vegetables on changes in fruit and vegetable consumption among overweight and obese adults. Goals were to evaluate fruit and vegetable consumption patterns, including intake of antioxidant-rich fruits and vegetables, provide education about benefits of consuming fruits and vegetables, expose participants to different varieties of fruits and vegetables, and ultimately improve fruit and vegetable consumption among participants.

Methods

Participants

A convenience sample of 67 male and female adults with a body mass index (BMI) of 25 kg/m^2 or greater was recruited from two neighboring communities with a combined population of approximately 135,000 residents. Information about the study, inclusion criteria, and contact information were posted on flyers that were distributed to businesses throughout the communities and sent out electronically via email. Exclusion criteria included being under18 years of age, a current smoker, having a BMI lower than 25 kg/m^2, or having a history of bariatric surgery. All participants were provided with information on the purpose, procedures, and potential benefits of the study, and written informed consent was obtained from each person. Study protocol was approved by the university's institutional review board prior to implementation.

Fifty-four participants completed the study, which represented an attrition of 13 participants (19.4%) over a 14-week period. Of the 13 participants who dropped out of the study, 10 dropped out immediately upon learning about which intervention group they were randomly assigned while the other three individuals dropped out because of an inability to attend the weekly education sessions due to conflicting schedules. No significant differences in gender, ethnicity, marital status, education completed, annual household income, or age existed between those who participated and those who dropped out. The final sample included 9 participants in the control group (18.2% attrition), 19 in the education group (34.5% attrition), and 26 in the fruit and vegetable group (3.7% attrition). Sample sizes varied depending on the number of participants who completed each assessment.

Procedures

The study was conducted in fall 2011 and consisted of three phases over a 14-week period: pre-testing (2 weeks), intervention (10 weeks), and post-testing (2 weeks). At pre-testing and post-testing, demographic information was self-reported on a questionnaire, and included age, gender, race/ethnicity, education level, annual income, and marital status.

Food and nutrient intakes at pre- and post-testing were assessed using a three-day food record. Validity of food records in assessment of energy and nutrient intake has been demonstrated in previous studies of adults (Comrie, Masson, & McNeill, 2009; Drapeau et al., 2007; Shuaibi, Sevenhuysen, & House, 2008). Three-day food records have been observed to provide comparable accuracy as seven-day food records, require less participant burden, and result in improved compliance (Larkin, Metzner, & Guire, 1991). Participants were provided with instructions and asked to record by hand everything they ate or drank over the course of two weekdays and a weekend day. To ensure accuracy, participants were encouraged to record foods and beverages as they consumed them over the three-day period. Data collected from the three-day food records were analyzed using The Food Processor® (ESHA Research, Salam, OR). A Registered Dietitian entered the food type and quantity recorded into the program for analysis. To ensure validity, all data were entered by the same individual. Participant's age, gender, height, weight, and physical activity level were also entered into the program to allow for comparison with U.S. Dietary Guideline recommendations (U.S. Department of Health and Human Services [HHS], 2010) for servings from each food group.

Information about habitual fruit and vegetable intake was assessed using two questionnaires, a pre-test and post-test. These semi-quantitative food frequency questionnaires were developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005) and are based on the Block Food Frequency Questionnaire, which has been demonstrated to have validity and reliability (Garcia, 2005). Modifications to the original questionnaires have been recommended previously (Garcia, 2005; Wade, 2003) and included the addition of foods to the food frequency questionnaire as well as questions assessing knowledge, attitudes, and behaviors regarding fruit and vegetable consumption. In addition, a tenth frequency category (0/week) was added. Modifications to the food frequency questionnaire included the addition of oranges, grapefruit, and tangerines and fresh tomatoes (Wade, 2003), and addition of ‘prepared with tomato or vegetable sauce’ to spaghetti or lasagna. On the pre-test, modifications included the addition of the following questions: (a) Do you eat more fresh fruits and vegetables when they are in season? If yes, which fruits and vegetables?; (b) Do you feel that fruits and vegetables are expensive?; (c) How are the fruits and vegetables that you eat usually prepared? (Wade, 2003); (d) Do you feel canned and frozen fruits and vegetables are just as good for you as fresh fruits and vegetables?; and (e) Are you concerned about chronic diseases, such as cancer or heart disease? (Garcia, 2005). Modifications to the post-test included the addition of the following: (a) Because of the information you learned in the lessons, do you think you are more willing to try different fruits and vegetables?; and (b) Because of the information you learned in the lessons, did you replace foods previously consumed with fruits and vegetables? (Garcia, 2005).

The modified pre-test and post-test food frequency questionnaires included 18 items, with six fruit items (100% orange juice, 100% cranberry/apple/purple grape juice, berries such as strawberries/blueberries/blackberries, nectarines/peaches/apricots, oranges/grapefruits/tangerines, and cantaloupe/honeydew melon), and 12 vegetable items (broccoli/cabbage/cauliflower, leafy greens such as mustard greens/turnip greens/collard greens, corn, cooked or stewed tomatoes, spaghetti/lasagna with tomato or vegetable sauce, onions, squash/zucchini, spinach, sweet potatoes/yams, carrots, and baked beans/pintos/black-eyed peas/other beans). These particular fruits and vegetables were included on the questionnaires because they are known to contain a high concentration of antioxidants and consumption of them has been associated with reduced risk of chronic disease (Garcia, 2005). Consumption frequency was measured using 10 frequency categories (0/week, less than 1/week, 1/week, 2/week, 3/week, 4/week, 5/week, 6/week, 1/day, or 2/day) for each food item. Additional information about knowledge, attitudes, and access to fruits and vegetables was assessed by binary response (yes, no) to 21 questions/statements on the pre-test questionnaire. Six of these questions/statements were also included on the post-test questionnaire while the remaining 15 were specific to the pre-test questionnaire.

Following pre-testing, participants were randomly assigned to one of three intervention groups: control, education, or fruit and vegetable. Random assignment was achieved using a table of random numbers (Thomas, Nelson, & Silverman, 2005). The final sample included 11 participants in control, 29 in education, and 27 in the fruit and vegetable group. Participants assigned to the control group received no intervention. However, they were given the option of receiving the information about fruits and vegetables provided to other participants after the intervention was over. Participants in the education group received weekly information about the antioxidant content of fruits and vegetables, the role of antioxidants in the inflammatory process, and the current recommendations for fruit and vegetable consumption. Participants assigned to the fruit and vegetable group received the same information as participants in the education group. In addition, they received recommendations for incorporating fruits and vegetables into their current meal plan and samples of fruits and vegetables. The samples included fresh, frozen, or canned fruits and vegetables and were provided to participants at the weekly nutrition education sessions. The quantity provided to each fruit and vegetable group participant was the equivalent of one serving of fruits and two servings of vegetables per day for a week because on average, Americans fail to meet the recommended servings of fruits and vegetables by these amounts (CDC, 2007, March 16). Servings provided were consistent with the serving sizes listed in the 2010 U.S. Dietary Guidelines for Americans (HHS, 2010). Participants in the fruit and vegetable group were encouraged to consume these fruits and vegetables as a supplement to their usual fruit and vegetable intake.

All weekly nutrition lessons were approximately 30 minutes in duration and were taught by licensed, registered dietitians. All education sessions were held at a local university and attendance was taken to discourage attrition. Curriculum materials, developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005; Johnson et al., 2003), were used for the nutrition lessons. This curriculum was chosen because it was consistent with the purpose of the study, had been used for previous research (Garcia, 2005; Hendrix et al., 2008; Wade, 2003), and was readily available to the public via the Internet (Johnson et al., 2003). Curriculum materials included handouts describing how to purchase and store fruits and vegetables, nutrient content of various fruits and vegetables, and suggestions for incorporating fruits and vegetables into meals and snacks.

The intervention was based on the Health Belief Model, which includes perceived susceptibility to disease, perceived severity of disease, perceived barriers, and self-efficacy (Reuter et al., 2010). These components were addressed throughout the nutrition lessons. Education regarding how consumption of fruits and vegetables can help lower the risk for chronic diseases was aimed at addressing perceived susceptibility to disease. Information about how to purchase, store, clean, prepare, and incorporate fruits and vegetables into meals and snacks was provided in order to address perceived barriers and self-efficacy. In addition, samples of fruits and vegetables were provided to participants in the fruit and vegetable group in order to overcome the barriers of cost and exposure. Finally, information regarding positive outcomes associated with increased intake of fruits and vegetables was provided in order to encourage behavior change (Garcia, 2005).

After conclusion of the intervention, post-testing was initiated in order to evaluate changes in fruit and vegetable consumption. The post-test questionnaire included the same listing of fruits and vegetables and six binary response questions as the pre-test questionnaire. In addition, the post-test questionnaire featured 12 additional binary response questions to assess behavior change.

Statistical Analysis

All statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL). Chi square analyses were used to assess differences among intervention groups in regard to demographics. The mean fruit and vegetable consumption frequency was calculated based on the conversion factor shown in Table 6. Descriptive statistics, including frequencies, means, standard error of the mean, and standard deviations were generated for all participants that completed both pre-test and post-test. Paired sample t-tests were utilized to determine mean differences in fruit and vegetable consumption from pre-test to post-test for all participants and within the three groups: control, nutrition education, and fruit and vegetable. One-sample t-tests were then conducted to evaluate how participants' actual consumption of fruits and vegetables, according to three-day food records, compared to recommended servings of fruits and vegetables according to the U.S. Dietary Guidelines (HHS, 2010). Finally, one-way ANOVAs were used to test the hypothesis that nutrition education and/or nutrition education with the provision of fruits and vegetables had a differential effect on fruit and vegetable consumption from pre-test to post-test compared to no intervention (control group). An alpha level of $< .05$ was selected to indicate statistical significance.

Table 6

Calculations for the Mean Fruit and Vegetable Consumption Frequency

Frequency Indicated on FFQ	Conversion to Weekly Frequency for Statistical Analysis (x7)
Never	0
Less than 1 per week	.07
1 per week	.14
2 per week	.29
3 per week	.43
4 per week	.57
5 per week	.71
6 per week	.86
1 per day	1.0
2 per day	2.0

Note. FFQ = food frequency questionnaire.

Results

Baseline characteristics for all participants are depicted in Table 7. Participants were predominantly female (64.8%), white (92.5%), married or partnered (75.9%), and reported an annual household income in the range of $50,000-$99,999 (44.4%). Chi square tests for independence did not indicate differences in proportions in regard to gender (male, female), ethnicity (white, non-white), relationship status (married, other), or reported annual household income (≤$39,999, ≥$40,000) among participants.

Responses on the food frequency questionnaire are depicted in Tables 8 and 9. The following fruits and vegetables were self-reported as being consumed once a week or less by greater than or equal to 50% of all participants at pre-test: orange juice (75.5%), cranberry/apple/grape juice (88.7%), berries (60.4%), nectarines/peaches/apricots (81.1%), broccoli/cabbage/cauliflower (54.7%), oranges/grapefruits/tangerines (71.7%), cantaloupe/honeydew (83.0%), leafy greens (69.8%), corn (73.6%), cooked tomatoes (62.3%),

Table 7

Characteristics of Participants

Characteristic	Total sample (N = 54)	Control group (n = 9)	Education group (n = 19)	Fruit and Vegetable group (n = 26)
	n	n	n	N
Gender				
Male	19	5	8	6
Female	35	4	11	20
Ethnicity				
White	50	7	19	24
Asian	3	2	0	1
Latin American	1	0	0	1
Marital status				
Single	7	1	2	4
Married/Partnered	41	7	14	20
Divorced	5	1	2	2
Widowed	1	0	1	0
Education completed				
High school/GED	3	0	3	0
Some college	6	2	2	2
2-year college degree	6	0	3	3
4-year college degree	18	3	5	10
Master’s degree	14	2	5	7
Professional/Doctoral degree	7	2	1	4
Annual household income				
\$10,000-\$49,999	18	2	6	10
\$50,000-\$99,999	24	5	10	9
\$100,000-\$149,999	10	2	2	6
More than \$150,000	2	0	1	1
Age (y, mean ± S.D.)	44.7 ± 12.1	41.4 ± 13.3	45.5 ± 11.9	45.2 ± 12.1

Note. y = years; S.D. = standard deviation.

Table 8

Individual Fruit and Vegetable Consumption

Variable Name	Total sample (N = 53)		Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Orange juice								
0-1 times/week	40	34	9	7	14	11	17	16
2-3 times/week	8	10	0	1	3	4	5	5
4-5 times/week	3	6	0	0	1	4	2	2
6+ times/week	2	3	0	1	1	0	1	2
Mean (times) ± S.E./week	1.0 ± .2	1.6 ± .4	.1 ± .1	1.8 ± 1.5	1.1 ± .4	1.5 ± .4	1.3 ± .4	1.6 ± .4
Cranberry/Apple/Grape juice								
0-1 times/week	47	43	8	7	17	13	22	23
2-3 times/week	2	5	0	1	1	3	1	1
4-5 times/week	2	3	0	0	1	3	1	0
6+ times/week	2	2	1	1	0	0	1	1
Mean (times) ± S.E./week	.7 ± .2	.9 ± .2	.9 ± .8	1.1 ± .8	.6 ± .3	1.2 ± .4	.7 ± .3	.6 ± .3
Berries								
0-1 time/week	32	25	6	6	11	10	15	9
2-3 times/week	18	21	2	3	7	5	9	13
4-5 times/week	3	4	1	0	1	3	1	1
6+ times/week	0	3	0	0	0	1	0	2
Mean (times) ± S.E./week	1.4 ± .2	2.0 ± .3	1.2 ± .5	.8 ± .4	1.4 ± .3	2.3 ± .7	1.4 ± .3	2.2 ± .4
Nectarine/Peach/Apricot								
0-1 times/week	43	44	9	9	16	17	18	18
2-3 times/week	7	8	0	0	2	2	5	6
4-5 times/week	2	1	0	0	1	0	1	1
6+ times/week	1	0	0	0	0	0	1	0
Mean (times) ± S.E./week	.9 ± .2	.6 ± .1	.1 ± .1	.0 ± .0	.7 ± .3	.4 ± .2	1.2 ± .4	.9 ± .3

Table 8 (Continued)

Broccoli/Cabbage/Cauliflower								
0-1 times/week	29	23	3	6	14	8	12	9
2-3 times/week	20	22	5	3	4	10	11	9
4-5 times/week	3	5	1	0	1	0	1	5
6+ times/week	1	3	0	0	0	1	1	2
Mean (times) ± S.E./week	1.5 ± .2	1.9 ± .2	1.7 ± .4	1.2 ± .3	1.2 ± .3	1.6 ± .4	1.7 ± .3	2.4 ± .4
Orange/Grapefruit/Tangerine								
0-1 times/week	38	24	6	7	13	7	19	10
2-3 times/week	13	21	2	1	5	10	6	10
4-5 times/week	2	7	1	1	1	2	0	4
6+ times/week	0	1	0	0	0	0	0	1
Mean (times) ± S.E./week	1.0 ± .2	1.8 ± .2	1.3 ± .6	1.1 ± .5	1.0 ± .3	1.7 ± .3	.9 ± .2	2.1 ± .4
Cantaloupe/Honeydew								
0-1 times/week	44	44	8	9	17	15	19	20
2-3 times/week	7	8	0	0	1	3	6	5
4-5 times/week	2	0	1	0	1	0	0	0
6+ times/week	0	1	0	0	0	1	0	0
Mean (times) ± S.E./week	.9 ± .2	.6 ± .2	.8 ± .5	.0 ± .0	.8 ± .3	1.0 ± .4	1.0 ± .2	.6 ± .2
Leafy greens								
0-1 times/week	37	24	6	5	13	9	18	10
2-3 times/week	12	15	3	2	6	7	3	6
4-5 times/week	4	12	0	2	0	3	4	7
6+ times/week	0	2	0	0	0	0	0	2
Mean (times) ± S.E./week	1.1 ± .2	2.0 ± .3	.9 ± .5	1.6 ± .6	1.0 ± .2	1.8 ± .4	1.1 ± .4	2.4 ± .4
Corn								
0-1 times/week	39	33	8	5	11	12	20	16
2-3 times/week	12	17	0	3	8	6	4	8
4-5 times/week	2	3	1	1	0	1	1	1
6+ times/week	0	0	0	0	0	0	0	0
Mean (times) ± S.E./week	1.0 ± .1	1.2 ± .2	.9 ± .4	1.4 ± .4	1.1 ± .2	1.2 ± .3	1.0 ± .2	1.2 ± .2

Table 8 (Continued)

Cooked tomatoes								
0-1 times/week	33	20	6	2	12	7	15	11
2-3 times/week	13	23	1	4	7	9	5	10
4-5 times/week	5	8	2	3	0	2	3	3
6+ times/week	2	2	0	0	0	1	2	1
Mean (times) ± S.E./week	1.5 ± .2	2.1 ± .2	1.7 ± .5	2.5 ± .6	1.1 ± .2	2.1 ± .4	1.9 ± .4	2.0 ± .4
Spaghetti/Lasagna w/ tomato sauce								
0-1 times/week	41	37	6	5	15	13	20	19
2-3 times/week	11	14	3	4	4	5	4	5
4-5 times/week	1	2	0	0	0	1	1	1
6+ times/week	0	0	0	0	0	0	0	0
Mean (times) ± S.E./week	.9 ±.1	1.1 ± .1	1.3 ± .3	1.4 ± .3	.8 ± .2	1.1 ± .3	.8 ± .2	.9 ± .2
Fresh tomatoes								
0-1 times/week	27	31	3	7	11	12	13	12
2-3 times/week	16	11	4	1	6	4	6	6
4-5 times/week	7	9	2	1	1	2	4	6
6+ times/week	3	2	0	0	1	1	2	1
Mean (times) ± S.E./week	2.0 ± .3	1.6 ± .3	2.0 ± .6	.8 ± .5	1.6 ± .4	1.4 ± .5	2.4 ± .6	2.0 ± .4
Onions								
0-1 times/week	24	16	4	4	9	5	11	7
2-3 times/week	17	23	4	3	6	10	7	10
4-5 times/week	8	9	0	0	3	3	5	6
6+ times/week	4	5	1	2	1	1	2	2
Mean (times) ± S.E./week	2.3 ± .3	2.6 ± .3	2.1 ± .6	2.6 ± .7	2.2 ± .4	2.5 ± .4	2.5 ± .4	2.7 ± .4
Squash/Zucchini								
0-1 times/week	43	42	6	8	15	15	22	19
2-3 times/week	10	11	3	1	4	4	3	6
4-5 times/week	0	0	0	0	0	0	0	0
6+ times/week	0	0	0	0	0	0	0	0
Mean (times) ± S.E./week	.7 ± .1	.7 ± .1	.7 ± .3	.6 ± .3	.7 ± .2	.6 ± .2	.7 ± .2	.9 ± .2

Table 8 (Continued)

Spinach								
0-1 times/week	41	31	7	7	15	9	19	15
2-3 times/week	10	14	2	2	4	6	4	6
4-5 times/week	2	7	0	0	0	4	2	3
6+ times/week	0	1	0	0	0	0	0	1
Mean (times) ± S.E./week	.8 ± .2	1.6 ± .2	.7 ± .3	.9 ± .3	.7 ± .2	1.8 ± .4	.9 ± .3	1.7 ± .4
Sweet potatoes/Yams								
0-1 times/week	52	49	9	9	18	17	25	23
2-3 times/week	1	4	0	0	1	2	0	2
4-5 times/week	0	0	0	0	0	0	0	0
6+ times/week	0	0	0	0	0	0	0	0
Mean (times) ± S.E./week	.3 ± .1	.4 ± .1	.4 ± .2	.1 ± .1	.4 ± .1	.6 ± .2	.3 ± .1	.4 ± .2
Carrots								
0-1 times/week	23	15	4	3	8	7	11	5
2-3 times/week	21	24	4	3	9	7	8	14
4-5 times/week	7	8	1	2	2	4	4	2
6+ times/week	2	6	0	1	0	1	2	4
Mean (times) ± S.E./week	2.2 ± .3	2.6 ± .3	1.9 ± .4	2.9 ± .8	2.0 ± .3	2.4 ± .4	2.6 ± .6	2.8 ± .4
Legumes								
0-1 times/week	36	26	4	4	13	8	19	14
2-3 times/week	13	22	4	2	5	8	4	9
4-5 times/week	2	5	1	1	0	3	1	2
6+ times/week	2	0	0	2	1	0	1	0
Mean (times) ± S.E./week	1.2 ± .2	1.6 ± .2	1.5 ± .4	1.5 ± .4	1.2 ± .3	1.9 ± .3	1.0 ± .3	1.3 ± .2

Note. S.E. = standard error of the mean.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.

Table 9

Fruit and Vegetable Consumption as Snack, Dessert, Fresh, Frozen, or Canned

Variable Name and Description	Total sample (N = 53)		Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
How often do you eat fruits as a snack?								
0-1 times/week	19	7	3	4	7	2	9	1
2-3 times/week	18	17	3	2	4	8	11	7
4-5 times/week	6	13	2	1	3	2	1	10
6+ times/week	10	16	1	2	5	7	4	7
Mean (times) ± S.E./week	3.5 ± .5	5.0 ± .5	2.9 ± .7	2.8 ± .9	4.4 ± 1.1	5.5 ± 1.0	3.0 ± .6	5.4 ± .7
How often do you eat fruits as dessert?								
0-1 times/week	32	20	5	4	11	8	16	8
2-3 times/week	13	19	3	3	4	8	6	8
4-5 times/week	2	8	1	1	1	1	0	6
6+ times/week	6	6	0	1	3	2	3	3
Mean (times) ± S.E./week	1.9 ± .3	2.5 ± .3	1.6 ± .6	2.2 ± .8	2.1 ± .6	2.1 ± .5	1.9 ± .5	2.8 ± .4
How often do you eat vegetables as a snack?								
0-1 times/week	31	20	7	6	11	9	13	5
2-3 times/week	12	21	1	2	4	5	7	14
4-5 times/week	4	4	0	0	2	2	2	2
6+ times/week	6	8	1	1	2	3	3	4
Mean (times) ± S.E./week	2.2 ± .4	2.9 ± .5	1.2 ± .8	1.6 ± .7	2.4 ± .8	2.8 ± .8	2.3 ± .5	3.5 ± .7

Table 9 (Continued)

How often do you eat fresh fruits?								
0-1 times/week	10	5	1	1	5	3	4	1
2-3 times/week	20	16	4	4	6	6	10	6
4-5 times/week	9	12	2	3	3	3	4	6
6+ times/week	14	20	2	1	5	7	7	12
Mean (times) ± S.E./week	4.7 ± .6	5.6 ± .6	4.7 ± 1.3	3.2 ± .6	4.6 ± 1.1	5.5 ± 1.0	4.7 ± .9	6.5 ± .9
How often do you eat frozen fruits?								
0-1 times/week	46	36	8	7	17	15	21	14
2-3 times/week	5	15	0	2	1	3	4	10
4-5 times/week	1	1	1	0	0	0	0	1
6+ times/week	1	1	0	0	1	1	0	0
Mean (times) ± S.E./week	.6 ± .2	1.1 ± .2	.7 ± .5	.6 ± .3	.7 ± .4	1.0 ± .4	.5 ± .2	1.4 ± .2
How often do you eat canned fruits?								
0-1 times/week	46	36	9	8	16	14	21	14
2-3 times/week	7	16	0	1	3	5	4	10
4-5 times/week	0	1	0	0	0	0	0	1
6+ times/week	0	0	0	0	0	0	0	0
Mean (times) ± S.E./week	.6 ± .1	1.1 ± .2	.5 ± .2	.7 ± .3	.6 ± .2	.9 ± .2	.7 ± .2	1.4 ± .2
How often do you eat fresh vegetables?								
0-1 times/week	17	11	4	2	7	7	6	2
2-3 times/week	16	14	2	3	6	4	8	7
4-5 times/week	5	13	1	2	1	2	3	9
6+ times/week	15	15	2	2	5	6	8	7
Mean (times) ± S.E./week	4.5 ± .7	4.6 ± .5	4.2 ± 1.9	3.5 ± .7	4.3 ± 1.1	4.4 ± 1.1	4.8 ± .9	5.2 ± .7

Table 9 (Continued)

How often do you eat frozen vegetables?								
0-1 times/week	29	17	5	2	11	7	13	8
2-3 times/week	14	23	2	6	4	10	8	7
4-5 times/week	3	11	1	1	1	1	1	9
6+ times/week	7	2	1	0	3	1	3	1
Mean (times) ± S.E./week	2.1 ± .3	2.3 ± .2	2.1 ± .8	2.2 ± .5	2.1 ± .5	1.9 ± .4	2.1 ± .4	2.6 ± .4
How often do you eat canned vegetables?								
0-1 times/week	39	29	6	5	15	12	18	12
2-3 times/week	12	19	3	4	3	5	6	10
4-5 times/week	2	4	0	0	1	1	1	3
6+ times/week	0	1	0	0	0	1	0	0
Mean (times) ± S.E./week	1.0 ± .2	1.6 ± .2	1.0 ± .4	1.3 ± .4	1.0 ± .3	1.5 ± .4	1.0 ± .2	1.7 ± .3

Note. S.E. = standard error of the mean.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.

spaghetti/lasagna made with tomato sauce (77.4%), fresh tomatoes (50.9%), squash/zucchini (81.1%), spinach (77.4%), sweet potatoes/yams (98.1%), legumes (67.9%), fruits for dessert (60.4%), vegetables as a snack (58.5%), frozen fruits (86.8%), canned fruits (86.8%), frozen vegetables (54.7%), and canned vegetables (73.6%). The weekly mean frequency of intake of all fruits and vegetables for each intervention group are shown in Table 10. Frequency of consumption of all fruits and vegetables at pre-test was 17.5 times per week (2.5 times per day) among control group participants, 17.6 times per week (2.5 times per day) among education group participants, and 21.4 times per week (3.1 times per day) among fruit and vegetable group participants.

The following fruits and vegetables were self-reported as being consumed once a week or less by greater than or equal to 50% of all participants at post-test: orange juice (64.2%), cranberry/apple/grape juice (81.1%), nectarine/peach/apricot (83.0%), cantaloupe/honeydew (83.0%), corn (62.3%), spaghetti/lasagna made with tomato sauce (69.8%), fresh tomatoes (58.5%), squash/zucchini (79.2%), spinach (58.5%), sweet potatoes/yams (92.5%), frozen fruits (67.9%), canned fruits (67.9%), and canned vegetables (54.7%). At post-test, participants in the control group consumed fruits and vegetables 19.4 times per week (2.8 times per day) while those in the education group consumed fruits and vegetables 24.1 times per week (3.4 times per day). Frequency of consumption among fruit and vegetable group participants was 26.5 times per week (3.8 times per day). From pre-test to post-test, participants in the education group reported a significant mean increase of 0.9 time per day, $t(18) = 2.65$, $p = .02$, while participants in the fruit and vegetable group reported a significant mean increase of 0.7 time per day, $t(24) = 2.31$, $p = .03$. Participants in the control group reported a mean increase of 0.3 time per day but this change was not significant ($p = .43$).

Table 10

Fruit and Vegetable Consumption by Category

Variable Name	Total sample (N = 53)		Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Total fruits and vegetables								
0-13 times/week	22	9	4	3	7	5	11	1
14-20 times/week	10	14	3	3	5	3	2	8
21-28 times/week	11	14	1	1	6	5	4	8
29-34 times/week	5	8	0	2	1	1	4	5
≥35 times/week	5	8	1	0	0	5	4	3
Mean (times) ± S.E./week	19.4 ± 1.5	24.4 ± 1.6	17.5 ± 3.3	19.4 ± 2.9	17.6 ± 1.8	24.1 ± 2.9	21.4 ± 2.6	26.5 ± 2.4
Total fruits								
0-6 times/week	32	26	6	6	12	10	14	10
7-13 times/week	18	21	3	2	6	7	9	12
≥14 times/week	3	6	0	1	1	2	2	3
Mean (times) ± S.E./week	5.8 ± .6	7.5 ± .7	4.6 ± 1.3	4.9 ± 2.0	5.6 ± .9	8.1 ± 1.2	6.4 ± .9	8.0 ± .9
Total vegetables								
0-6 times/week	12	5	2	2	4	3	6	0
7-13 times/week	19	18	3	4	8	5	8	9
≥14 times/week	22	30	4	3	7	11	11	16
Mean (times) ± S.E./week	13.6 ± 1.2	16.9 ± 1.3	12.9 ± 2.6	14.4 ± 2.5	12.0 ± 1.4	16.1 ± 2.2	15.0 ± 2.1	18.5 ± 1.9
High in beta carotene								
0-6 times/week	41	28	7	5	16	10	18	13
≥7 times/week	12	25	2	4	3	9	7	12
Mean (times) ± S.E./week	4.4 ± .5	6.7 ± .6	3.8 ± .7	5.5 ± 1.2	4.0 ± .7	6.6 ± 1.0	4.9 ± 1.0	7.3 ± .9
High in vitamin C								
0-6 times/week	20	6	2	2	8	3	10	1
≥7 times/week	33	47	7	7	11	16	15	24
Mean (times) ± S.E./week	11.5 ± 1.1	15.7 ± 1.2	10.8 ± 2.7	10.8 ± 2.2	10.2 ± 1.4	15.8 ± 2.1	12.7 ± 1.8	17.5 ± 1.7

Table 10 (Continued)

High in lutein and zeaxanthin								
≤2 times/week	37	20	6	4	13	7	18	9
≥3 times/week	16	33	3	5	6	12	7	16
Mean (times) ± S.E./week	1.8 ± .3	3.6 ± .4	1.6 ± .5	2.4 ± .7	1.7 ± .4	3.6 ± .7	2.0 ± .6	4.1 ± .7
High in lycopene								
≤2 times/week	21	17	2	2	8	7	11	8
≥3 times/week	32	36	7	7	11	12	14	17
Mean (times) ± S.E./week	4.5 ± .6	1.8 ± .5	5.0 ± 1.2	4.6 ± .9	3.5 ± .6	4.6 ± .9	5.0 ± 1.0	4.9 ± .8

Note. S.E. = standard error of the mean.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.

When asked whether or not they increased their consumption of fruits and vegetables over the course of the study, the majority of all participants reported having increased their consumption of fruits (78.8%) and vegetables (68.6%) (data not shown). Twenty-two percent of participants in the control group reported increasing consumption of fruits while 90.7% of participants who received nutrition education reported having increased their fruit consumption (84.2% of education group participants, 95.8% of fruit and vegetable group participants) (data not shown). These findings are consistent with results of participants' responses on the food frequency questionnaire (Table 11). Paired sample t-tests indicated a significant mean increase in the weekly frequency of total fruit consumption from pre-test to post-test for the fruit and vegetable group, $t(24) = 2.16$, $p = .04$. Fruit intake also increased from pre- to post-test in the education group but did not reach statistical significance ($p = .09$).

A similar trend was observed in regard to vegetable consumption with 68.6% of all participants reporting an increase in vegetable consumption at the end of the study. Those reporting an increase were predominantly from the groups receiving nutrition education (68.4% in education and 87.0% in fruit and vegetable). However, 22.2% of control group participants also reported having increased their consumption of vegetables. Results of paired sample t-tests indicated a significant mean increase in total vegetables consumed by education group participants, $t(18) = 2.54$, $p = .02$, but not among fruit and vegetable group participants ($p = .06$) or control group participants ($p = .40$).

Changes in the frequency of consuming individual fruits and vegetables from pre-test to post-test were also indicated by participants in the different intervention groups (Table 12). Results of paired sample t-tests indicated a significant increase in weekly consumption of corn among participants in the control group, $t(8) = 2.53$, $p = .04$. In the education group, there were

Table 11

Mean Weekly Frequencies of Fruit and Vegetable Consumption by Category

Variable Name and Description	Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Total fruits and vegetables (times/week)						
Pre	17.5 ± 9.8	.43	17.6 ± 7.7	.02*	21.4 ± 13.2	.03*
Post	19.4 ± 8.8		24.1 ± 12.5		26.5 ± 12.0	
Total fruits (times/week)						
Pre	4.6 ± 3.9	.84	5.6 ± 3.8	.09	6.4 ± 4.6	.04*
Post	4.9 ± 6.1		8.1 ± 5.4		8.0 ± 4.3	
Total vegetables (times/week)						
Pre	12.9 ± 7.9	.40	12.0 ± 5.9	.02*	15.0 ± 10.5	.06
Post	14.4 ± 7.5		16.1 ± 9.4		18.5 ± 9.4	
High in beta carotene (times/week)						
Pre	3.8 ± 2.2	.12	4.0 ± 2.9	.02*	4.9 ± 4.9	.02*
Post	5.5 ± 3.6		6.6 ± 4.4		7.3 ± 4.3	
High in vitamin C (times/week)						
Pre	10.8 ± 8.2	.99	10.2 ± 6.0	.01*	12.7 ± 9.2	.01*
Post	10.8 ± 6.6		15.8 ± 9.3		17.5 ± 8.6	
High in lutein and zeaxanthin (times/week)						
Pre	1.6 ± 1.6	.11	1.7 ± 1.7	.01*	2.0 ± 3.0	.01*
Post	2.4 ± 2.1		3.6 ± 3.0		4.1 ± 3.3	
High in lycopene (times/week)						
Pre	5.0 ± 3.7	.65	3.5 ± 2.8	.10	5.0 ± 5.2	.96
Post	4.6 ± 2.7		4.6 ± 3.8		5.0 ± 3.8	

Note. S.D. = standard deviation.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.
*Indicates significant difference in the mean frequency consumed from pre-test to post-test.

Table 12

Mean Weekly Frequencies of Individual Fruit and Vegetable Consumption

Variable Name and Description	Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Orange juice (times/week)						
Pre	.1 ± .3	.28	1.1 ± 1.7	.20	1.3 ± 2.0	.11
Post	1.8 ± 4.6		1.5 ± 1.9		1.6 ± 2.2	
Cranberry/Apple/Grape juice (times/week)						
Pre	.9 ± 2.3	.36	.6 ± 1.2	.12	.7 ± 1.7	.51
Post	1.1 ± 2.4		1.2 ± 1.8		.6 ± 1.3	
Berries (times/week)						
Pre	1.2 ± 1.5	.35	1.4 ± 1.4	.19	1.4 ± 1.4	.01*
Post	.8 ± 1.2		2.3 ± 3.2		2.2 ± 1.8	
Nectarine/Peach/Apricot (times/week)						
Pre	.1 ± .3	.32	.7 ± 1.2	.28	1.2 ± 1.8	.29
Post	.0 ± .0		.4 ± .7		.9 ± 1.3	
Broccoli/Cabbage/Cauliflower (times/week)						
Pre	1.7 ± 1.2	.27	1.2 ± 1.2	.12	1.7 ± 1.5	.05^
Post	1.2 ± 1.0		1.6 ± 1.7		2.4 ± 1.9	
Orange/Grapefruit/Tangerine (times/week)						
Pre	1.3 ± 1.7	.71	1.0 ± 1.2	.06	.9 ± 1.0	.00*
Post	1.1 ± 1.6		1.7 ± 1.4		2.1 ± 1.9	
Cantaloupe/Honeydew (times/week)						
Pre	.8 ± 1.6	.20	.8 ± 1.2	.71	1.0 ± 1.2	.06
Post	.0 ± .0		.9 ± 1.7		.6 ± .9	
Leafy greens (times/week)						
Pre	.9 ± 1.4	.25	1.0 ± 1.1	.07	1.1 ± 1.8	.01*
Post	1.6 ± 1.7		1.8 ± 1.9		2.4 ± 2.2	
Corn (times/week)						
Pre	.9 ± 1.3	.04*	1.1 ± 1.0	.85	1.0 ± 1.1	.31
Post	1.4 ± 1.3		1.2 ± 1.2		1.2 ± 1.1	
Cooked tomatoes (times/week)						
Pre	1.7 ± 1.6	.06	1.1 ± 1.1	.02*	1.9 ± 2.1	.77
Post	2.5 ± 1.7		2.1 ± 1.7		2.0 ± 1.8	

Table 12 (Continued)

Spaghetti/Lasagna w/ tomato sauce (times/week)						
Pre	1.3 ± 1.1	.97	.8 ± 1.0	.17	.8 ± 1.0	.30
Post	1.4 ± 1.0		1.1 ± 1.1		.9 ± 1.0	
Fresh tomatoes (times/week)						
Pre	2.0 ± 1.8	.06	1.6 ± 1.8	.61	2.4 ± 3.1	.61
Post	.8 ± 1.4		1.4 ± 2.1		2.0 ± 2.0	
Onions (times/week)						
Pre	2.1 ± 1.8	.27	2.3 ± 1.7	.36	2.5 ± 2.1	.57
Post	2.6 ± 2.2		2.6 ± 1.7		2.7 ± 2.0	
Squash/Zucchini (times/week)						
Pre	.7 ± 1.0	.61	.7 ± 1.0	.54	.7 ± .8	.28
Post	.6 ± 1.0		.6 ± 1.0		.9 ± 1.0	
Spinach (times/week)						
Pre	.7 ± .9	.49	.7 ± .9	.01*	.9 ± 1.5	.02*
Post	.9 ± .9		1.8 ± 1.6		1.7 ± 1.8	
Sweet potatoes/Yams (times/week)						
Pre	.4 ± .5	.18	.4 ± .6	.22	.3 ± .4	.23
Post	.1 ± .3		.6 ± .8		.4 ± .8	
Carrots (times/week)						
Pre	1.9 ± 1.1	.22	2.0 ± .5	.26	2.6 ± 3.0	.70
Post	2.9 ± 2.3		2.4 ± 1.9		2.7 ± 1.8	
Legumes (times/week)						
Pre	1.5 ± 1.3	1.0	1.2 ± 1.5	.02*	1.0 ± 1.5	.31
Post	1.5 ± 1.2		1.9 ± 1.4		1.3 ± 1.2	

Note. S.D. = standard deviation.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.
*Indicates significant difference in mean frequency consumed from pre-test to post-test.
^Indicates trend towards significant difference in mean frequency consumed from pre-test to post-test.

significant mean increases in weekly consumption of cooked tomatoes ($t(18) = 2.55$, $p = .02$), spinach ($t(18) = 2.71$, $p = .01$), and legumes ($t(18) = 2.62$, $p = .02$). In the fruit and vegetable group, there were significant mean increases in weekly consumption of berries ($t(24) = 2.80$, $p = .01$), oranges/grapefruits/tangerines ($t(24) = 3.57$, $p = .00$), leafy greens ($t(24) = 3.05$, $p = .01$), and spinach ($t(24) = 2.46$, $p = .02$).

Paired sample t-tests also indicated significant differences in the frequency of consumption of fruit and vegetable categories from pre-test to post-test in the different intervention groups (Table 13). In the education group, there were significant mean increases in consumption of fruits and vegetables high in beta carotene ($t(18) = 2.58$, $p = .02$), vitamin C ($t(18) = 2.86$, $p = .01$), and lutein and zeaxanthin ($t(18) = 2.76$, $p = .01$). There was also a significant mean increase of fruits consumed as a snack, $t(18) = 2.41$, $p = .03$. In the fruit and vegetable group, there were significant weekly mean increases in fruits and vegetables high in beta carotene ($t(24) = 2.62$, $p = .02$), vitamin C ($t(24) = 2.82$, $p = .01$), and lutein and zeaxanthin ($t(24) = 3.05$, $p = .01$) consumed. There were also significant mean increases in consumption of the following: fruits as a snack ($t(24) = 2.94$, $p = .01$), frozen fruits ($t(24) = 4.08$, $p = .00$), canned fruits ($t(24) = 2.64$, $p = .01$), and canned vegetables ($t(24) = 2.87$, $p = .01$). No significant mean differences were observed in the control group.

One-sample t-tests were conducted in order to evaluate participants' actual consumption of fruits and vegetables, according to three day food records, compared to recommended servings of fruits and vegetables according to the U.S. Dietary Guidelines (HHS, 2010) (Table 14). The mean number of vegetable servings consumed were significantly lower than the mean recommended servings at both pre-test (control, $t(8) = -7.92$, $p = .00$; education, $t(18) = -5.81$, $p = .00$; fruit and vegetable, $t(24) = -10.57$, $p = .00$) and post-test (control, $t(8) = -9.13$, $p = .00$;

Table 13

Mean Weekly Frequencies of Fruit and Vegetable Consumption as Snack, Dessert, Fresh, Frozen, or Canned

Variable Name and Description	Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Mean ± S.D.	P value	Mean ± S.D.	P value	Mean ± S.D.	P value
How often do you eat fruits as a snack? (times/week)						
Pre	2.9 ± 2.1	.94	4.4 ± 4.7	.03*	3.0 ± 3.1	.01*
Post	2.8 ± 2.6		5.5 ± 4.2		5.4 ± 3.6	
How often do you eat fruits as dessert? (times/week)						
Pre	1.6 ± 1.8	.47	2.1 ± 2.5	.94	1.9 ± 2.3	.05^
Post	2.2 ± 2.3		2.1 ± 2.0		2.8 ± 2.2	
How often do you eat vegetables as a snack? (times/week)						
Pre	1.2 ± 2.3	.77	2.4 ± 3.4	.15	2.3 ± 2.3	.12
Post	1.6 ± 2.2		2.8 ± 3.6		3.5 ± 3.6	
How often do you eat fresh fruits? (times/week)						
Pre	4.7 ± 4.0	.27	4.6 ± 4.7	.31	4.7 ± 4.5	.07
Post	3.2 ± 1.9		5.5 ± 4.3		6.5 ± 4.6	
How often do you eat frozen fruits? (times/week)						
Pre	.7 ± 1.6	.84	.7 ± 1.7	.09	.5 ± .9	.00*
Post	.6 ± .9		1.0 ± 1.7		1.4 ± 1.1	
How often do you eat canned fruits? (times/week)						
Pre	.5 ± .5	.43	.6 ± .9	.23	.7 ± .9	.01*
Post	.7 ± 1.0		.9 ± .9		1.4 ± 1.2	
How often do you eat fresh vegetables? (times/week)						
Pre	4.2 ± 5.8	.62	4.3 ± 4.8	.92	4.8 ± 4.6	.72
Post	3.5 ± 2.2		4.4 ± 4.9		5.2 ± 3.7	

Table 13 (Continued)

How often do you eat frozen vegetables? (times/week)						
Pre	2.1 ± 2.5	.86	2.1 ± 2.3	.57	2.1 ± 2.2	.08
Post	2.2 ± 1.4		1.9 ± 1.7		2.6 ± 1.9	
How often do you eat canned vegetables? (times/week)						
Pre	1.0 ± 1.1	.34	1.0 ± 1.2	.24	1.0 ± 1.2	.01*
Post	1.3 ± 1.2		1.5 ± 1.9		1.7 ± 1.4	

Note. S.D. = standard deviation.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 6.
*Indicates significant difference in mean frequency consumed from pre-test to post-test.
^Indicates trend towards significant difference in mean frequency consumed from pre-test to post-test.

Table 14

Comparison of Recommended Servings of Fruits and Vegetables to Actual Servings Consumed

Variable Name and Description	Control group (n = 9)			Education group (n = 15)			Fruit and Vegetable group (n = 23)		
	Rec. Mean	Actual Mean	p value	Rec. Mean	Actual Mean	p value	Rec. Mean	Actual Mean	p value
Fruit servings									
Pre	2.2	1.4	.03*	2.2	1.2	.00*	2.2	1.5	.01*
Post	2.3	.8	.00*	2.2	1.5	.00*	2.2	2.2	.93
Vegetable servings									
Pre	3.4	1.4	.00*	3.5	1.8	.00*	3.3	1.6	.00*
Post	3.6	1.4	.00*	3.5	1.5	.02*	3.3	2.0	.00*

Note. Recommended number of servings was based on age, gender, height, weight, and activity level according to the U.S. Dietary Guidelines (HHS, 2010). Actual mean number of servings consumed was derived from average consumption as recorded on three-day food records. Three-day food record data were analyzed using The Food Processor® (ESHA Research, Salam, OR).
*Indicates a significant difference in the mean number of servings between recommendation and consumption.

education, $t(18) = -10.02$, $p = .00$; fruit and vegetable, $t(24) = -6.74$, $p = .00$) for participants in all three intervention groups. In addition, the mean number of fruit servings consumed by participants in the control and education groups was significantly lower than the mean recommended servings at both pre-test (control, $t(8) = -2.63$, $p = .03$; education, $t(18) = -4.08$, $p = .00$) and post-test (control, $t(8) = -6.79$, $p = .00$; education, $t(18) = -2.53$, $p = .02$). Participants in the fruit and vegetable group also consumed significantly fewer servings than recommended at pre-test ($t(22) = -2.94$, $p = .01$) but mean intake at post-test was less than 0.1 serving below than the recommended mean number of fruit servings ($t(22) = -.09$, $p = .93$).

Finally, one-way ANOVAs were conducted to evaluate differences in the frequency of fruit and vegetable consumption over time between the three intervention groups. The independent variable, intervention group, included three levels: control, education, and fruit and vegetable. The dependent variables were changes in frequency of consumption of fruits, vegetables, fruits and vegetables combined, as well as the different categories of fruit and vegetable consumption from pre-test to post-test. No significant differences between the three intervention groups were noted for any of the changes in fruit and vegetable consumption over time.

Discussion

This study investigated the effects of a 10-week nutrition education intervention with and without the provision of fruits and vegetables on changes in fruit and vegetable consumption among overweight and obese adults. The intervention focused on disease prevention awareness, nutrient profiles of specific fruits and vegetables, health benefits of consuming fruits and vegetables, decreasing barriers to consumption, and increasing participants' intake of fruits and vegetables.

Results from food records indicated that at pre-test, none of the participants were consuming the recommended five or more servings of fruits and vegetables per day (HHS, 2010). Inadequate consumption of fruits and vegetables is concerning because of previously documented associations between increased fruit and vegetable intake and prevention or postponement of chronic diseases. In a study of approximately 35,000 people, researchers found that after adjusting for age and sex, adequate consumption of fruits and vegetables, excluding juice, was associated with reduced risk of heart disease, other long-term conditions, and overall chronic disease (Quadir & Akhtar-Danesh, 2010). In the present study, increases in the frequency of consuming fruits and vegetables following the intervention were reported among participants in the education and fruit and vegetable groups but not in the control group. However, no additional increases were noted in fruit and vegetable group participants compared to education group participants. These findings suggest that nutrition education, but not provisions of fruits and vegetables, may have contributed to success in increasing fruit and vegetable consumption among overweight and obese adults. Such findings may have been influenced by the socioeconomic status of participants in this study.

While 26.4% of all participants at post-test reported consuming fruits and vegetables five or more times per week, participants actual consumption was still 0.3 to 1.3 servings below the current recommendations of two or more servings of fruits and three or more servings of vegetables each day (HHS, 2010). These rates of consumption are consistent with data collected at the national level. According to the CDC (2010, September 10), only 14% of U.S. adults consume the recommended goal of two or more servings of fruits and three or more servings of vegetables each day. Considering such a low rate of success in meeting daily fruit and vegetable intake recommendations, any improvement in consumption patterns of overweight and obese adults may signify positive progress.

In addition to increases in frequency of consumption of total fruits and vegetables among participants following the intervention, results indicated significant increases in frequency of consuming fruits and vegetables assigned to specific categories based on their nutrient content. Participants who received nutrition education, from which they learned about the nutrient content of various fruits and vegetables, reported significant increases in consumption of fruits and vegetables high in antioxidants, including beta carotene, vitamin C, and lutein and zeaxanthin. A great deal of emphasis has been placed on fruits and vegetables as key sources of antioxidants in the diet (Chun et al., 2010). In a study of estimated antioxidant intake in U.S. adults, researchers found that the major dietary sources of vitamin C included citrus fruit juices, potatoes, and tomatoes while major sources of carotene included deep-yellow and dark-green vegetables (Chun et al., 2010). In the present study, significant mean increases in consumption of berries, cruciferous vegetables, citrus fruits, and leafy greens were observed among participants who attended nutrition education sessions. These findings serve to demonstrate that recommendations to increase intake of certain types of fruits and vegetables, specifically those with the highest antioxidant content, can be effective and should be included in nutrition education interventions.

Throughout the nutrition education intervention, emphasis was placed on encouraging participants to replace energy-dense, nutrient-poor foods previously consumed with fruits and vegetables. This was emphasized in order to promote increased consumption of fruits and vegetables while maintaining and/or decreasing overall caloric intake. In the present study, participants in the education and fruit and vegetable groups reported increased consumption of fruits and vegetables as a snack. Since snack foods tend to be high in energy density while low in nutrients (Viskall-van Dongen, Kok, & de Graaf, 2010), substituting fruits and vegetables can help to both increase fruit and vegetable intake while decreasing consumption of less nutritious foods.

It has been shown that the cost of fruits and vegetables can be a barrier to consumption (Powell et al., 2010). However, much of the research on economic barriers pertains to fresh fruits and vegetables (Kidd & Peters, 2010; Powell et al., 2010). Fortunately, alternative forms such as canned and frozen also exist and have comparable nutritional benefits. In the present study, participants in the education and fruit and vegetable groups reported increased consumption of alternative forms of fruits and vegetables, including frozen and canned varieties, on a weekly basis. These increases were not observed among control group participants, indicating a potential benefit, both nutritionally and economically, of education encouraging consumption of different forms of fruits and vegetables.

Results of one-way ANOVAs failed to support the hypothesis that nutrition education and nutrition education with the provision of fruits and vegetables would have a differential effect on changes in fruit and vegetable consumption frequency over time compared to no intervention. Thus, while significant changes in the weekly fruit and vegetable consumption were observed among participants who received nutrition education and fruits and vegetables, these changes were not significantly different than those who did not receive either intervention. A possible reason for lack of differences between those who received nutrition education and those who did not may be due to the unequal sizes of the intervention groups and subsequent lack of statistical power. Other studies assessing outcomes of nutrition education on consumption of fruits and vegetables have yielded favorable results (Andreyeva et al., 2010; Guillaumie et al., 2010; Kidd & Peters, 2010). While not significantly different from the control group, weekly frequency of fruit and vegetable consumption increased among those who received the intervention, which suggested that nutrition education with or without the provision of fruits and vegetables positively influenced participants' consumption of fruits and vegetables.

Limitations

Limitations of this study existed and should be noted. First, this study utilized a convenience sample of overweight and obese adults, which may limit generalizability of results. However, recruitment from two communities and random assignment to the intervention groups served to correct for limitations associated with convenience sampling. Second, seasonal changes in availability of fruits and vegetables were not accounted for. The study was conducted during a period in which it might be expected that availability of fruits and vegetables would decrease (e.g., pre-test in fall and post-test in winter). However, significant increases in the frequency of fruit and vegetable consumption from pre-test to post-test were observed, which suggests that availability was not a factor. Third, dietary intake assessment was based on semi-quantitative food frequency questionnaires specific to fruits and vegetables and three-day food records. Awareness of the study purpose may have influenced participants to overestimate fruit and vegetable consumption on these instruments. Fourth, the final sample sizes of the intervention groups were unequal. A power calculation indicated that 16 participants were needed in each intervention group in order to detect statistical significance at an alpha level of .05 (Eng, 2003). However, more participants were assigned to the education and fruit and vegetable groups compared to the control group in order to account for attrition. Because of this, the final number of participants in the control group was below the required sample size, which may have prevented detection of significant differences. Fifth, follow-up data were not collected. Thus, it is unknown if improvements in the frequency of fruit and vegetable consumption were maintained after the conclusion of the study.

Conclusion

Findings from the present study suggest nutrition education was helpful in improving the consumption of fruits and vegetables, including those rich in antioxidants. However, provision of fruits and vegetables, while intended to help reduce barriers to consumption, had limited impact in increasing fruit and vegetable consumption. Despite being readily available, majority of participants failed to consume the recommended number of servings of fruits and vegetables per day, which suggests they chose other foods over fruits and vegetables. With only 42% and 59% of Americans consuming the recommended intake for fruits and vegetables (HHS, 2010) and rates of overweight and obesity rising (CDC, 2011, July 21; CDC, 2011, November 17), future interventions should focus not only on encouraging increased consumption of antioxidant-rich fruits and vegetables, but also discouraging consumption of high-energy, nutrient-poor foods.

Few studies have examined the long-term effects of nutrition education interventions on changes in fruit and vegetable consumption in overweight and obese adults. If maintained, improvements in fruit and vegetable consumption could potentially contribute to improved nutrient intake and ultimately decreased disease risk in overweight and obese adults. Study methodologies that include post-intervention follow ups to determine long-term effectiveness of nutrition education and changes in fruit and vegetable consumption are warranted.

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CHANGES IN FRUIT AND VEGETABLE CONSUMPTION ARE ASSOCIATED WITH IMPROVEMENTS IN BIOMARKERS OF CHRONIC DISEASE AMONG OVERWEIGHT AND OBESE ADULTS

Abstract

The growing prevalence of overweight and obesity is concerning because of the multitude of health conditions associated with excess weight. Body mass index (BMI), waist circumference, blood glucose, and blood lipids are often elevated as a result of excess weight and serve as indicators of chronic disease risk. Dietary changes, including adequate consumption of fruits and vegetables, have been associated with improvements in BMI, blood glucose, and lipids. However, conflicting evidence exists as to how much influence dietary measures alone have in reducing disease risk factors among overweight and obese individuals. This study was designed to determine the effectiveness of a community-based fruit and vegetable education program and provision of fruits and vegetables in increasing fruit and vegetable consumption and influencing subsequent changes in blood glucose, lipids, and anthropometrics among overweight and obese adults. Fifty-four adults (19 men/35 women; 44.7 ± 12.1 y; BMI 33.2 ± 7.7 kg/m^2) were randomly assigned to one of three intervention groups. The control group received no intervention, the education group attended weekly nutrition education lessons, and the fruit and vegetable group attended weekly nutrition education lessons and received one serving of fruits and two servings of vegetables per day for 10 weeks. Anthropometric measurements and fasting blood draws were conducted and fruit and vegetable consumption was assessed using semi-quantitative food frequency questionnaires and three-day food records. Results indicated associations between increased fruit and vegetable consumption and improvements in biomarkers of chronic disease. While nutrition education was helpful in increasing fruit and

vegetable consumption, promoting consumption of antioxidant-rich fruits and vegetables while concurrently emphasizing management of overall energy intake is recommended in order to allow for favorable changes in blood glucose, lipids, and anthropometrics.

Introduction

Approximately 34% of adults in the U.S. are overweight and 33.9% are obese based on their body mass index (BMI) (Centers for Disease Control and Prevention [CDC], 2011, November 17). According to the CDC (2010, June 21), a BMI between 25.0 and 29.9 kg/m^2 is indicative of overweight, and a BMI greater than or equal to 30.0 kg/m^2 is defined as obese. While BMIs in these ranges are associated with increased disease risk (CDC, 2011, March 3), BMI is not a specific indicator of body fat distribution, which is itself an risk factor for diseases related to excess weight (CDC, 2010, June 21; Klein et al., 2007). Specifically, excess abdominal or central fat has been associated with increased disease risk (CDC, 2010, June 21). Waist circumference is often used as a marker of abdominal fat with values above 102 centimeters in men and 88 centimeters in women being associated with increased risk for cardiometabolic diseases, including cardiovascular disease and type 2 diabetes mellitus (Han, Satta, & Lean, 2006; Klein et al., 2007).

Hyperlipidemia, a type of cardiovascular disease defined as an elevated concentration of blood lipids, is a common consequence of excess body fat (CDC, 2011, March 3). According to the American Heart Association (2011, December 2), elevated concentrations of total blood cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides, and a low concentration of high density lipoprotein (HDL) cholesterol are associated with increased disease risk. Unfortunately, 98.8 million adults have total blood cholesterol concentrations above the recommended 200 mg/dL. In addition, over 25% of non-Hispanic white, black, and Mexican

American men and women have LDL cholesterol concentrations above the recommended 130 mg/dL while 29.5% and 10.1% of non-Hispanic white men and women, 16.6% and 6.6% of non-Hispanic black men and women, and 31.7% and 12.2% of Mexican American men and women have HDL cholesterol concentrations below the recommended 40 mg/dL (Roger et al., 2012**)**. Hyperlipidemia is especially concerning because while the condition itself may be asymptomatic, it can significantly increase the risk of myocardial infarction and stroke (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2007).

Another cardiometabolic risk factor associated with excess weight is elevated fasting blood glucose, which is a risk factor for type 2 diabetes mellitus (Klein et al., 2007). Normal fasting plasma glucose concentration is below100 mg/dL. Concentrations between 100 and 125 mg/dL are indicative of prediabetes while fasting blood glucose greater than 126 mg/dL on two or more occasions is used as the diagnostic criteria for type 2 diabetes mellitus. More than 85% of people diagnosed with type 2 diabetes mellitus are overweight at time of diagnosis. Like hyperlipidemia, a diagnosis of type 2 diabetes is associated with increased risk of heart attack and stroke (NIDDK, 2007).

Changes in dietary intake are necessary in order to achieve weight loss and improve blood glucose and blood lipids in overweight and obese individuals. Fruits and vegetables, which are generally low in calories yet rich in antioxidants, phytochemicals, and fiber, are often recommended. When consumed in place of high energy-density foods, fruits and vegetables have been shown to greatly impact energy balance resulting in weight loss (Schroder, 2010) and improved blood lipids (Djousse et al., 2004; Dragsted et al., 2006). Despite many benefits, consumption of fruits and vegetables is poor compared to recommended amounts. In fact, only 14% of U.S. adults consume the recommended daily goal of two or more servings of fruits and three or more servings of vegetables (CDC, 2010, September 10). Inadequate consumption of fruits and vegetables has been observed among different adult cohorts, including those struggling with overweight and obesity (Schroder, 2010). In the U.S., rates of meeting daily fruit and vegetable recommendations among overweight and obese adults significantly decreased from 22.6% to 21.5% between 1996 and 2003 (Andreyeva, Long, Henderson, & Grode, 2010).

Dietary changes, including adequate consumption of fruits and vegetables, have been associated with improvements in body composition and blood lipids (Djousse et al., 2004; Dragsted et al., 2006; Schroder, 2010). For these reasons, fruit and vegetable consumption is recognized as an essential component of medical nutrition therapy for obesity-related diseases. However, conflicting evidence exists as to how much influence dietary measures alone have in reducing risk factors for disease among overweight and obese individuals. Therefore, this study was designed to determine the effectiveness of a community-based fruit and vegetable education program and provision of fruits and vegetables on changes in fruit and vegetable consumption and biomarkers of chronic disease among overweight and obese adults. Goals were to increase participants' consumption of fruits and vegetables and evaluate subsequent changes in blood glucose, blood lipids, anthropometrics, BMI, and body composition.

Methods

Participants

A convenience sample of male and female adults with a BMI of 25 kg/m^2 or greater was recruited from two neighboring communities with a combined population of approximately 135,000 residents. Information about the study, inclusion criteria, and contact information were posted on flyers that were distributed to businesses throughout the communities and sent out electronically via email. Exclusion criteria included being under18 years of age, a current smoker, having a BMI lower than 25 kg/m^2, or having a history of bariatric surgery. All participants were provided with information on the purpose, procedures, and potential benefits of the study, and written informed consent was obtained from each person. Study protocol was approved by the university institutional review board prior to implementation.

Sixty-seven participants enrolled in the study and were randomly assigned to intervention groups. Fifty-four participants completed the study, which represented an attrition of 13 participants (19.4%). Of the 13 participants who dropped out of the study, 10 dropped out immediately upon learning about which intervention group they were randomly assigned while the other three individuals dropped out because of an inability to attend the weekly education sessions due to conflicting schedules. No significant differences in gender, ethnicity, marital status, education completed, annual household income, or age existed between those who participated and those who dropped out. The final sample included 9 participants in the control group (18.2% attrition), 19 in the education group (34.5% attrition), and 26 in the fruit and vegetable group (3.7% attrition). No significant differences in anthropometrics, blood glucose, or blood lipids were noted between participants who completed the study and those that withdrew.

Procedures

The study was conducted in fall 2011 and consisted of three phases over a 14-week period: pre-testing (2 weeks), intervention (10 weeks), and post-testing (2 weeks). At pre-testing, demographic information was self-reported, and included age, gender, race/ethnicity, education level, annual income, and marital status. Participants were also asked to report medical history, use of prescription and over the counter medications, as well as intake of vitamin, mineral, or herbal supplements. In addition, participants were asked to report current physical activity, weight history, general eating habits, and frequency of smoking and alcohol consumption.

Food and nutrient intakes at pre- and post-testing were assessed using a three-day food record. Participants were provided with instructions and asked to record by hand everything they ate or drank over the course of two weekdays and a weekend day. To ensure accuracy, participants were encouraged to record foods and beverages as they consumed them over the three-day period. In addition, information about habitual fruit and vegetable intake was assessed using two questionnaires. These semi-quantitative food frequency questionnaires were developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia and are based on the Block Food Frequency Questionnaire, which has been demonstrated to have validity and reliability (Garcia, 2005). Modifications to the original questionnaires have been recommended previously (Garcia, 2005; Wade, 2003) and included the addition of foods to the food frequency questionnaire as well as questions assessing knowledge, attitudes, and behaviors regarding fruit and vegetable consumption. In addition, a tenth frequency category (0/week) was added. Modifications to the food frequency questionnaire included the addition of oranges, grapefruit, and tangerines and fresh tomatoes (Wade, 2003), and addition of ‘prepared with tomato or vegetable sauce’ to spaghetti or lasagna. On the pre-test, modifications included the addition of the following questions: (a) Do you eat more fresh fruits and vegetables when they are in season? If yes, which fruits and vegetables?; (b) Do you feel that fruits and vegetables are expensive?; (c) How are the fruits and vegetables that you eat usually prepared? (Wade, 2003); (d) Do you feel canned and frozen fruits and vegetables are just as good for you as fresh fruits and vegetables?; and (e) Are you concerned about chronic diseases, such as cancer or heart disease? (Garcia, 2005). Modifications to the post-test included the addition of the following: (a) Because of the information you learned in the lessons, do you think you are more willing to try different fruits and vegetables?; and (b) Because of the information you learned in the lessons, did you replace foods previously consumed with fruits and vegetables? (Garcia, 2005).

The modified pre-test and post-test food frequency questionnaires included 18 items, with six fruit items (100% orange juice, 100% cranberry/apple/purple grape juice, berries such as strawberries/blueberries/ blackberries, nectarines/peaches/apricots, oranges/grapefruits/tangerines, and cantaloupe/honeydew melon), and 12 vegetable items (broccoli/cabbage/cauliflower, leafy greens such as mustard greens/turnip greens/collard greens, corn, cooked or stewed tomatoes, spaghetti/lasagna with tomato or vegetable sauce, onions, squash/zucchini, spinach, sweet potatoes/yams, carrots, and baked beans/pintos/black-eyed peas/other beans). These particular fruits and vegetables were included on the questionnaires because they are known to contain a high concentration of antioxidants and consumption of them has been associated with reduced risk of chronic disease (Garcia, 2005). Frequencies were measured using 10 frequency categories (0/week, less than 1/week, 1/week, 2/week, 3/week, 4/week, 5/week, 6/week, 1/day, or 2/day) for each food item. Additional information about knowledge, attitudes, and access to fruits and vegetables was assessed by binary response (yes, no) to 21 questions/statements on the pre-test questionnaire. Six of these questions/statements were also included on the post-test questionnaire while the remaining 15 were specific to the pre-test questionnaire.

Anthropometric data collected included height, weight, body composition, waist circumference, and BMI. All measurements were conducted by the same researcher, trained in the proper techniques. Height was measured with participants' shoes off using a stadiometer (HR-200, Tanita Corporation of America, Inc., Arlington Heights, IL). Participants were instructed to stand with their feet together, looking straight ahead. Weight and body composition measures, including fat mass and fat free mass were measured with participants' in light clothing, with shoes and socks off, and with contents of pockets removed using a Tanita Body Composition Analyzer® (TBF-300A, Tanita Corporation of America, Inc., Arlington Heights, IL). Percent body fat was also calculated. Participants' waist circumference was measured at the top portion of the iliac crest, with a horizontal tape at the end of gentle exhalation. Body mass index was then calculated by the quotient between weight (kg) and the squared height (m^2). Values for BMI were then applied to categorize overweight (25.0-29.9 kg/m^2), obesity class I (30.0-34.9 kg/m^2), obesity class II (35.0-39.9 kg/m^2), and obesity class III ($\geq$ 40.0 kg/m^2), according to criteria established by the World Health Organization (WHO) (2006).

During pre-test and post-test, a total of 30 mL of venous whole blood sample was drawn after a 12-hour overnight fast. All blood draws were scheduled and performed by a phlebotomist at a local hospital. Total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, and glucose were measured at the local hospital.

Following pre-testing, participants were randomly assigned to one of three intervention groups: control, education, or fruit and vegetable. Random assignment was achieved using a table of random numbers (Thomas, Nelson, & Silverman, 2005). The final sample included 11 participants in control, 29 in education, and 27 in the fruit and vegetable group. Participants assigned to the control group received no intervention. However, they were given the option of receiving the information about fruits and vegetables provided to other participants after the intervention was over. Participants in the education group received weekly information about the antioxidant content of fruits and vegetables, health benefits of fruit and vegetable consumption in relation to chronic disease, and the current recommendations for fruit and vegetable consumption. Participants assigned to the fruit and vegetable group received the same information as participants in the education group. In addition, they received recommendations for incorporating fruits and vegetables into their current meal plan and samples of fruits and vegetables. The samples included fresh, frozen, or canned fruits and vegetables and were provided to participants at the weekly nutrition education sessions. The quantity provided to each fruit and vegetable group participant was the equivalent of one serving of fruits and two servings of vegetables per day for a week because on average, Americans fail to meet the recommended servings of fruits and vegetables by these amounts (CDC, 2007, March 16). Servings provided were consistent with the serving sizes listed in the 2010 U.S. Dietary Guidelines for Americans (U.S. Department of Health and Human Services [HHS], 2010). Participants in the fruit and vegetable group were encouraged to consume these fruits and vegetables as a supplement to their usual fruit and vegetable intake.

All weekly nutrition lessons were approximately 30 minutes in duration and were taught by licensed, registered dietitians. All education sessions were held at a local university. Curriculum materials, developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005; Johnson et al., 2003), were used for the nutrition lessons. This curriculum was chosen because it was consistent with the purpose of the study, had been used for previous research (Garcia, 2005; Hendrix et al., 2008; Wade, 2003), and was readily available to the public via the Internet (Johnson et al., 2003). Curriculum materials included handouts describing how to purchase and store fruits and vegetables, nutrient content of various fruits and vegetables, and suggestions for incorporating fruits and vegetables into meals and snacks.

After conclusion of the 10-week intervention, post-testing was initiated in order to evaluate changes in fruit and vegetable consumption, blood glucose, lipids, and anthropometrics.

The post-test questionnaire included the same listing of fruits and vegetables and six binary response questions as the pre-test questionnaire. In addition, the post-test questionnaire featured 12 binary response questions to assess behavior change.

Statistical Analysis

All statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL). Chi square analyses were used to assess differences between intervention groups in regard to demographics. The mean fruit and vegetable consumption frequency was calculated based on the conversion factor shown in Table 15.

Table 15

Calculations for the Mean Fruit and Vegetable Consumption Frequency

Frequency Indicated on FFQ	Conversion to Weekly Frequency for Statistical Analysis (x7)
Never	0
Less than 1 per week	.07
1 per week	.14
2 per week	.29
3 per week	.43
4 per week	.57
5 per week	.71
6 per week	.86
1 per day	1.0
2 per day	2.0

Note. FFQ = food frequency questionnaire.

Descriptive statistics, including frequencies, means, standard error of the mean, and standard deviations were generated for all participants completing both pre-test and post-test. Paired sample t-tests were used to evaluate mean differences in blood glucose, blood lipid profiles, BMI, and body composition from pre-test to post-test for all participants and within the three groups: control, nutrition education, and fruit and vegetable. Pearson correlation analysis was then used to evaluate relationships between changes in fruit and vegetable consumption and changes in blood glucose, blood lipids, BMI, waist circumference, and body composition from pre-test to post-test. Finally, one-way ANOVA analyses were used to test the hypothesis that nutrition education about antioxidant properties and content of fruits and vegetables with and without provision of fruits and vegetables had a differential effect on blood glucose, lipids, and anthropometrics from pre-test to post-test compared to no intervention. An alpha level of $< .05$ was selected to indicate statistical significance.

Results

Baseline characteristics for all participants are depicted in Table 16. Participants were predominantly female (64.8%), white (92.5%), married or partnered (75.9%), and reported an annual household income in the range of \$50,000-\$99,999 (44.4%). Chi square tests for independence did not indicate differences in proportions in regard to gender (male, female), ethnicity (white, non-white), relationship status (married, other), or reported annual household income (≤\$39,999, ≥\$40,000) between intervention groups.

The mean weekly consumption frequencies at both pre-test and post-test were calculated for fruits, vegetables, total fruits and vegetables, and fruits and vegetables high in beta carotene (leafy greens; spinach; sweet potatoes or yams; carrots), lutein and zeaxanthin (leafy greens; spinach), lycopene (cooked or stewed tomatoes; fresh tomatoes, spaghetti or lasagna prepared with tomato or vegetable sauce), and vitamin C (100% orange juice; berries; broccoli, cabbage, or cauliflower; oranges, grapefruit, or tangerines; cantaloupe or honeydew melon; leafy greens; cooked or stewed tomatoes; fresh tomatoes; sweet potatoes or yams). These values are depicted in Table 17.

Table 16

Characteristics of Study Participants

Characteristic	Total sample (N = 54)	Control group (n = 9)	Education group (n = 19)	Fruit and Vegetable group (n = 26)
	n	n	n	n
Gender				
Male	19	5	8	6
Female	35	4	11	20
Ethnicity				
White	50	7	19	24
Asian	3	2	0	1
Latin American	1	0	0	1
Marital status				
Single	7	1	2	4
Married/Partnered	41	7	14	20
Divorced	5	1	2	2
Widowed	1	0	1	0
Education completed				
High school/GED	3	0	3	0
Some college	6	2	2	2
2-year college degree	6	0	3	3
4-year college degree	18	3	5	10
Master's degree	14	2	5	7
Professional/Doctoral degree	7	2	1	4
Annual household income				
$10,000-$49,999	18	2	6	10
$50,000-$99,999	24	5	10	9
$100,000-$149,999	10	2	2	6
More than $150,000	2	0	1	1
Age (y, Mean ± S.D.)	44.7 ± 12.1	41.4 ± 13.3	45.5 ± 11.9	45.2 ± 12.1

Note. y = years; S.D. = standard deviation.

Table 17

Mean Weekly Frequencies of Fruit and Vegetable Consumption by Category

Variable Name and Description	Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 25)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Total fruits and vegetables (times/week)						
Pre	17.5 ± 9.8	.43	17.6 ± 7.7	.02*	21.4 ± 13.2	.03*
Post	19.4 ± 8.8		24.1 ± 12.5		26.5 ± 12.0	
Total fruits (times/week)						
Pre	4.6 ± 3.9	.84	5.6 ± 3.8	.09	6.4 ± 4.6	.04*
Post	4.9 ± 6.1		8.1 ± 5.4		8.0 ± 4.3	
Total vegetables (times/week)						
Pre	12.9 ± 7.9	.40	12.0 ± 5.9	.02*	15.0 ± 10.5	.06
Post	14.4 ± 7.5		16.1 ± 9.4		18.5 ± 9.4	
High in beta carotene (times/week)						
Pre	3.8 ± 2.2	.12	4.0 ± 2.9	.02*	4.9 ± 4.9	.02*
Post	5.5 ± 3.6		6.6 ± 4.4		7.3 ± 4.3	
High in vitamin C (times/week)						
Pre	10.8 ± 8.2	.99	10.2 ± 6.0	.01*	12.7 ± 9.2	.01*
Post	10.8 ± 6.6		15.8 ± 9.3		17.5 ± 8.6	
High in lutein and zeaxanthin (times/week)						
Pre	1.6 ± 1.6	.11	1.7 ± 1.7	.01*	2.0 ± 3.0	.01*
Post	2.4 ± 2.1		3.6 ± 3.0		4.1 ± 3.3	
High in lycopene (times/week)						
Pre	5.0 ± 3.7	.65	3.5 ± 2.8	.10	5.0 ± 5.2	.96
Post	4.6 ± 2.7		4.6 ± 3.8		5.0 ± 3.8	

Note. S.D. = standard deviation.
The mean frequency derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 15.
*Indicates significant difference in the mean frequency consumed from pre-test to post-test.

A total of 43 participants completed a blood draw at both pre-test and post-test. Of these, 7 participants were in the control group, 14 in the education group, and 22 in the fruit and vegetable group. Mean concentrations of total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, and fasting glucose at both pre-test and post-test are depicted in Table 18. When changes in blood glucose and lipids from pre- to post-test were analyzed by intervention group, no significant changes were noted for participants in the control group. In the education group, a paired sample t-test indicated a significant mean decrease in LDL cholesterol from pre-test (M = 95.79 mg/dL) to post-test (M = 86.86 mg/dL), $t(13) = -2.34$, $p = .04$. The 95% confidence interval for this difference was $.70 \leq \mu \leq 17.16$. An effect size, measured as Cohen's d, of .18 indicated that this was a small effect. No other significant changes from pre- to post-test were indicated for participants in the education group. A significant mean increase in blood glucose from pre-test (M = 95.68 mg/dL) to post-test (M = 102.64 mg/dL) was indicated for participants in the fruit and vegetable group, $t(21) = 2.43$, $p = .02$. The 95% confidence interval for this difference was $-12.90 \leq \mu \leq -1.01$. An effect size, as measured by Cohen's d, of .51 indicated that this was a medium effect. No significant mean differences in blood lipids were seen among participants in the fruit and vegetable group. The differences in blood glucose and lipids noted among all participants as well as individual intervention groups remained significant even after removing all concentrations greater than two standard deviations above or below the mean (data not shown).

Anthropometric measurements, including weight, BMI, percent body fat, fat mass, fat free mass, and waist circumference were also collected and calculated at both pre-test and post-test. Mean values of all measurements are depicted in Table 19. Results of paired sample t-tests

Table 18

Mean Concentrations of Blood Glucose and Blood Lipids

Variable Name and Description	Control group (n = 7)		Education group (n = 14)		Fruit and Vegetable group (n = 22)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Blood glucose (mg/dL)						
Pre	99.1 ± 9.6	.84	97.9 ± 11.6	.73	95.7 ± 14.2	.02*
Post	100.1 ± 13.6		97.1 ± 9.1		102.6 ± 23.0	
Total cholesterol (mg/dL)						
Pre	177.1 ± 26.7	.19	170.4 ± 34.2	.13	186.1 ± 32.0	.28
Post	168.3 ± 22.5		162.2 ± 35.3		180.8 ± 20.8	
Triglycerides (mg/dL)						
Pre	165.3 ± 157.2	.34	116.5 ± 54.0	.29	124.1 ± 68.8	.52
Post	145.6 ± 110.0		129.0 ± 79.4		129.7 ± 68.5	
HDL cholesterol (mg/dL)						
Pre	48.9 ± 11.5	.36	51.2 ± 14.3	.31	53.6 ± 12.6	.45
Post	46.7 ± 8.2		49.5 ± 12.8		52.8 ± 13.3	
LDL cholesterol (mg/dL)						
Pre	101.5 ± 19.0	.42	95.8 ± 27.2	.04*	103.8 ± 24.8	.41
Post	96.0 ± 19.0		86.9 ± 27.4		100.6 ± 17.1	

Note. mg/dL = milligrams per deciliter; S.D. = standard deviation.
*Indicates a significant mean difference from pre-test to post-test.

Table 19

Mean Anthropometric, BMI, and Body Composition Measures

Variable Name and Description	Control group (n = 9)		Education group (n = 19)		Fruit and Vegetable group (n = 26)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Weight (kg)						
Pre	93.9 ± 26.5	.51	99.5 ± 24.4	.47	99.1 ± 24.3	.42
Post	94.2 ± 26.2		99.0 ± 24.0		99.5 ± 24.1	
BMI (kg/m^2)						
Pre	33.0 ± 11.1	.68	32.5 ± 6.2	.45	33.8 ± 7.7	.43
Post	33.1 ± 10.9		32.3 ± 6.0		33.9 ± 7.6	
Body fat (%)						
Pre	33.9 ± 13.2	.13	38.4 ± 8.1	.52	40.4 ± 8.8	.09
Post	34.6 ± 13.3		38.8 ± 8.0		41.1 ± 8.9	
Fat mass (kg)						
Pre	34.1 ± 21.1	.14	38.5 ± 14.4	.57	40.9 ± 14.6	.20
Post	34.8 ± 21.2		39.0 ± 14.4		41.6 ± 14.6	
Fat free mass (kg)						
Pre	59.8 ± 11.8	.44	60.7 ± 14.8	.15	58.3 ± 14.4	.44
Post	59.4 ± 11.9		59.9 ± 13.8		57.9 ± 15.1	
Waist circumference (cm)						
Pre	110.8 ± 22.2	.74	114.1 ± 16.2	.86	117.5 ± 18.4	.07
Post	110.3 ± 19.0		113.8 ± 14.4		116.2 ± 18.3	

Note. kg = kilograms; m = meters; cm = centimeters; S.D. = standard deviation.

did not reveal significant differences in mean values of any of these measurements from pre-test to post-test in any of the intervention groups.

Mean changes in frequency of fruit and vegetable consumption, blood glucose, total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides from pre- to post-test are depicted in Table 20. Results of a Pearson correlation analysis indicated a small, moderately significant negative correlation between changes in consumption of fruits and vegetables high in lutein and zeaxanthin and LDL cholesterol ($r = -.31$, $p = .049$). No other correlations existed between changes in fruit and vegetable consumption and changes in blood glucose and lipid concentrations (Table 21).

Mean changes in fruit and vegetable consumption frequency, BMI, waist circumference, fat mass, and fat free mass from pre- to post-test are depicted in Table 22. Results of Pearson correlation analyses indicated small, negative correlations between change in total vegetable consumption and change in weight ($r = -.27$, $p = .047$) and BMI ($r = -.28$, $p = .045$). In addition, small, negative correlations existed between change in consumption of fruits and vegetables high in lycopene and change in weight ($r = -.38$, $p = .01$) and BMI ($r = -.39$, $p = .00$) (Table 23).

Finally, one-way ANOVAs were conducted to evaluate differences in blood glucose, lipids, and anthropometrics over time between the three intervention groups. The independent variable, intervention group, included three levels: control, education, and fruit and vegetable. The dependent variables were the changes in blood glucose, lipids, and anthropometrics from pre-test to post-test. No significant differences in changes in blood glucose, lipids, or anthropometrics over time between the three intervention groups were indicated.

Table 20

Mean Differences in Blood Glucose, Blood Lipids, and Fruit and Vegetable Consumption Frequency from Pre-Test to Post-Test

Variable Name and Description	Control group	Education group	Fruit and vegetable group
	Mean change	Mean change	Mean change
Blood glucose (mg/dL)	1.0	-.7	7.0
Total cholesterol (mg/dL)	-8.9	-8.1	-5.2
Triglycerides (mg/dL)	-19.7	12.5	5.5
HDL cholesterol (mg/dL)	-2.1	-1.7	-.9
LDL cholesterol (mg/dL)	-5.5	-8.9	-3.3
	n = 7	n = 14	n = 23
Total fruit and vegetable intake (times/week)	1.9	6.5	5.1
Fruit intake (times/week)	.3	2.5	1.6
Vegetable intake (times/week)	1.5	4.1	3.5
High in beta carotene (times/week)	1.7	2.6	2.4
High in vitamin C (times/week)	0	5.6	4.8
High in lutein and zeaxanthin (times/week)	.8	1.9	2.1
High in lycopene (times/week)	.4	1.1	0
	n = 9	n = 19	n = 25

Note. mg/dL = milligrams per deciliter; svgs = servings.
Negative values indicate a decrease from pre-test to post-test.
Mean differences in fruit and vegetable consumption frequencies derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 15.

Table 21

Correlations Among Changes in Fruit and Vegetable Consumption and Changes in Blood Glucose and Lipids

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Total fruit and vegetable intake	---	.71*	.91*	.63*	.60*	.72*	.91*	.04	-.16	-.02	.01	-.22
2. Fruit intake		---	.35*	.19	.23	.35*	.75*	.08	-.09	-.05	.04	-.12
3. Vegetable intake			---	.73*	.66*	.75*	.76*	-.01	-.16	.01	-.01	-.23
4. High in beta carotene				---	.82*	.23	.46*	-.09	-.19	-.15	.07	-.24
5. High in lutein and zeaxanthin					---	.30*	.53*	-.10	-.21	-.11	.12	-.31*
6. High in lycopene						---	.74*	.05	-.08	.05	-.00	-.17
7. High in vitamin C							---	.00	-.16	-.20	.08	-.16
8. Blood glucose								---	.15	.30	-.18	.11
9. Total cholesterol									---	.17	.62*	.90*
10. Triglycerides										---	-.22	-.21
11. HDL cholesterol											---	.48*
12. LDL cholesterol												---

Note. HDL = high density lipoprotein; LDL = low density lipoprotein.
*Indicates a significant correlation ($p \leq .05$).

Table 22

Mean Differences in Anthropometrics, BMI, Body Composition, and Fruit and Vegetable Consumption Frequency from Pre-Test to Post-Test

Variable Name and Description	Control group	Education group	Fruit and vegetable group
	Mean change	Mean change	Mean change
Weight (kg)	1.6	-.5	.4
BMI (kg/m^2)	.5	-.2	.1
Body fat (%)	1.7	.4	.7
Fat mass (kg)	1.8	.5	.7
Fat free mass (kg)	.7	-.8	-.3
Waist circumference (cm)	2.6	-.3	-1.7
	n = 9	n = 19	n = 26
Total fruit and vegetable intake (times/week)	1.9	6.5	5.1
Fruit intake (times/week)	.3	2.5	1.6
Vegetable intake (times/week)	1.5	4.1	3.5
High in beta carotene (times/week)	1.7	2.6	2.4
High in vitamin C (times/week)	0	5.6	4.8
High in lutein and zeaxanthin (times/week)	.8	1.9	2.1
High in lycopene (times/week)	.4	1.1	0
	n = 9	n = 19	n = 25

Note. kg = kilograms; m = meters; cm = centimeters; svgs = servings.
Negative values indicate a decrease from pre-test to post-test.
Mean differences in fruit and vegetable consumption frequencies derived from responses on food frequency questionnaires and calculated according to conversion depicted in Table 15.

Table 23

Correlations Among Changes in Fruit and Vegetable Consumption and Changes in Anthropometrics, BMI, and Body Composition Measures

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Total fruit and vegetable intake	---	.71*	.91*	.63*	.60*	.72*	.91*	-.26	-.25	-.16	-.15	-.08	-.17
2. Fruit intake		---	.35*	.19	.23	.35*	.75*	-.11	-.10	-.06	-.08	-.04	-.20
3. Vegetable intake			---	.73*	.66*	.75*	.76*	-.27*	-.28*	-.18	-.16	-.08	-.11
4. High in beta carotene				---	.82*	.23	.46*	-.03	-.03	-.02	.03	-.03	.02
5. High in lutein and zeaxanthin					---	.30*	.53*	-.08	-.09	-.05	-.00	-.06	.10
6. High in lycopene						---	.74*	-.38*	-.39*	-.21	-.25	-.10	-.08
7. High in vitamin C							---	-.25	-.24	-.15	-.16	-.07	-.17
8. Weight								---	1.0*	.56*	.70*	.16	.26
9. BMI									---	.54*	.68*	.18	.25
10. Body fat										---	.94*	-.69*	-.02
11. Fat mass											---	-.57*	.02
12. Fat free mass												---	.27*
13. Waist circumference													---

Note. BMI = body mass index.
*Indicates a significant correlation ($p \leq .05$)

Discussion

Findings from the present study indicated that at pre-test, participants' mean BMI of 33.22 kg/m^2 was indicative of obesity class I, according to the WHO (2006). Mean waist circumference among males was 118.44 centimeters (46.63 inches) and 113.71 centimeters (44.77 inches) among females. According to Han et al., (2006), a waist circumference of greater than or equal to 102 centimeters (40 inches) in men and greater than or equal to 88 centimeters (35 inches) in women is associated with a high level of risk for type 2 diabetes, cardiovascular disease, and hypertension. Thus, participants in this study were at increased risk for chronic disease secondary to elevated BMI and waist circumference.

According to the HHS (2009), goals for blood lipids include less than 200 mg/dL of total cholesterol, less than 100 mg/dL LDL cholesterol, greater than or equal to 60 mg/dL HDL cholesterol, and less than 150 mg/dL triglycerides. Participants' mean concentrations at pre-test indicated they met the guidelines for total cholesterol and triglycerides but were slightly above the recommendation for LDL cholesterol and below the target goal for HDL cholesterol, both of which put them at increased risk of heart disease. An evaluation of changes in blood glucose and lipids following the nutrition education intervention indicated a significant mean decrease in LDL cholesterol among participants in the education group. Fruit and vegetable intake has been inversely associated with LDL cholesterol (Djousse et al., 2004) and similar decreases in LDL cholesterol following consumption of fruits and vegetables were observed by Dragsted et al. (2006). Among fruit and vegetable group participants, a significant mean increase in blood glucose from pre-test to post-test was indicated. However, additional analysis with diabetic participants excluded showed no significant difference in mean blood glucose from pre-test to post-test. Thus, the mean increase likely reflected elevated morning glucose concentrations among participants diagnosed with diabetes mellitus prior to the study rather than a result of increased fruit and vegetable consumption over the intervention period. No other changes in blood glucose or lipids were noted among either education or fruit and vegetable group participants. Previous findings regarding fruit and vegetable consumption and blood lipids have been mixed. Some studies have reported associations between intake of fruits and vegetables and increased HDL cholesterol (Fisk II, Middaugh, Rhee, & Brunt, 2011) and decreased total cholesterol (Dragsted et al., 2006) while others have reported no effects of fruit and vegetable consumption on HDL cholesterol (Djousse et al., 2004). No changes in either blood glucose or lipids were observed from pre-test to post-test for participants in the control group.

Results failed to indicate significant changes in anthropometric measurements following the 10-week nutrition education intervention. Possible explanations for the lack of changes include the time of year in which the study was conducted and a lack of emphasis on weight and body composition throughout the nutrition education sessions. Participants began the study at the end of summer and were likely more active then at the end of the study, which occurred in the winter. In addition, the intervention focused on disease prevention awareness, the health benefits of consuming fruits and vegetables, decreasing barriers to consumption, and increasing participants' intake of fruits and vegetables. While recommended serving sizes were discussed, and replacement of previously consumed energy-dense, nutrient-poor foods with fruits and vegetables was encouraged, changes in weight and body composition were not included in the objectives. Such measures are difficult to alter without specific emphasis on controlling energy intake and expenditure (Seagle, Strain, Makris, & Reeves, 2009), neither of which were goals of the present study. It should also be noted that mean energy consumption among all participants did not differ from pre-test to post-test (data not shown).

While significant changes in anthropometrics were not observed from pre-test to post-test, significant increases in the frequency of fruit and vegetable consumption among education and fruit and vegetable group participants were observed following the nutrition education intervention. In addition, these increases were associated with decreased anthropometric measurements following the intervention. Specifically, an increase in total weekly vegetable consumption was associated with decreases in both weight and BMI. These findings are consistent with previous research indicating associations between increased consumption of fruits and vegetables, weight loss (Champagne et al., 2011; Hermsdorff, Zulet, Pachau, & Martinez, 2010; Schroder, 2010), and lower values of BMI and waist circumference (Hermsdorff et al., 2010). This suggests that promotion of fruit and vegetable consumption via nutrition education may be beneficial in weight loss interventions.

When broken down by nutrient content, associations were seen between increased weekly consumption of fruits and vegetables high in lycopene and decreased weight and BMI. In addition, increased consumption of fruits and vegetables high in lutein and zeaxanthin was associated with decreased LDL cholesterol. This finding emphasizes potential differences among fruits and vegetables in regard to nutrient content. Consuming fruits and vegetables with higher antioxidant content may produce more favorable changes in risk factors for chronic disease compared to fruits and vegetables with lower antioxidant content.

While significant changes in blood lipids over the course of the study were seen among participants who received nutrition education, significant differences between intervention groups were not observed. A possible reason for lack of differences between those who received the interventions and those who did not may be due to the small sample size of intervention groups and subsequent lack of statistical power. Other studies assessing outcomes of increased fruit and vegetable intake on biomarkers of chronic disease have produced favorable results (Djousse et al., 2004; Dragsted et al., 2006; Fisk II et al., 2011). While not significantly different from the control group, fruit and vegetable consumption increased among participants who received nutrition education with or without the provision of fruits and vegetables and associations existed between increased intake and improved blood lipids and anthropometrics.

Limitations

One limitation of this study was that it utilized a convenience sample of overweight and obese adults. However, the convenience sample was recruited from two communities with a combined population of 135,000 and all participants were randomly assigned to one of the three intervention groups. Another limitation was the unequal sample sizes of the intervention groups. According to an 80% power calculation, 16 participants were needed in each intervention group in order to detect statistical significance (Eng, 2003). While this was known prior to random assignment, researchers chose to assign more participants to the education and fruit and vegetable groups compared to the control group in order to account for probable attrition over the course of the study. Because of this, the final number of participants in the control group fell short of the required sample size, which may have prevented detection of significant differences. In addition, while use of lipid lowering medications was accounted for prior to data analysis, consumption of energy and individual macronutrients and micronutrients was not. These factors may have impacted weight, body composition, blood glucose, and blood lipid concentrations. Also, dietary intake assessment was based on three-day food records and semi-quantitative food frequency questionnaires. Knowledge of the study purpose may have influenced participants to overestimate consumption of fruits and vegetables on these instruments. A final limitation was a lack of follow-up following the study conclusion. Without post-intervention data, it is unknown if improvements in fruit and vegetable consumption and biomarkers of chronic disease were maintained after the conclusion of the intervention.

Conclusion

Participants in the present study were obese and at high risk for chronic disease as evidenced by BMIs and waist circumferences. In addition, mean LDL cholesterol and HDL cholesterol concentrations at pre-test combined with low fruit and vegetable consumption contributed to increased disease risk. Findings indicated that increased fruit and vegetable consumption frequency among participants was associated with improvements in biomarkers of chronic disease. While nutrition education was helpful in increasing fruit and vegetable consumption, it may be necessary to promote intake of antioxidant-rich fruits and vegetables while concurrently emphasizing management of overall energy intake in order to allow for favorable changes in blood glucose, lipids, and anthropometrics.

Research on the long-term effects of nutrition education interventions on changes in fruit and vegetable consumption and biomarkers of chronic disease in overweight and obese adults is limited. If maintained, improvements in fruit and vegetable consumption could potentially contribute to weight loss, improved blood glucose and lipids, and ultimately decreased disease risk in overweight and obese adults. Study methodologies that control for total energy consumption and include post-intervention follow ups to determine long-term effectiveness of nutrition education on changes in fruit and vegetable consumption and biomarkers of chronic disease are warranted.

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EFFECTIVENESS OF NUTRITION EDUCATION AND FRUIT AND VEGETABLE CONSUMPTION ON CHANGES IN BIOMARKERS OF INFLAMMATION AND OXIDATIVE STRESS AMONG OVERWEIGHT AND OBESE ADULTS

Abstract

The growing prevalence of overweight and obesity among adults is concerning because of the numerous health conditions associated with excess weight. Underlying mechanisms believed to contribute to these detrimental health outcomes are oxidative stress and inflammation. Fortunately, regulation of oxidative stress and inflammation is possible via antioxidants consumed through a diet adequate in fruits and vegetables. However, adults' consumption of fruits and vegetables is below recommended amounts, which places them at increased risk for chronic diseases. This study was designed to determine the effectiveness of a community-based fruit and vegetable education program and provision of fruits and vegetables on consumption of fruits, vegetables, antioxidants, and changes in biomarkers of inflammation and oxidative stress among overweight and obese adults. Forty-seven adults (16 men/31 women; 45.9 ± 11.8 y; BMI 32.7 kg/m^2) were randomly assigned to one of three intervention groups. The control group received no intervention, the education group attended weekly nutrition education lessons, and the fruit and vegetable group attended weekly nutrition education lessons and received one serving of fruits and two servings of vegetables per day for 10 weeks. Fasting blood draws were conducted and consumption of fruits, vegetables, and antioxidants were assessed using three-day food records. Results indicated that changes in consumption of fruits, vegetables, and antioxidants among participants were minimally associated with improvements in biomarkers of inflammation and oxidative stress. However, adequate and varied consumption of

fruits and vegetables is recommended to aid in the prevention and regulation of inflammation and oxidative stress.

Introduction

In the U.S., more than 60% of adults are overweight or obese (Centers for Disease Control and Prevention [CDC], 2011, November 17). The rising rates of overweight and obesity are particularly concerning because of the numerous health conditions associated with excess weight, including heart disease, type 2 diabetes mellitus, hypertension, hyperlipidemia, and stroke (CDC, 2009, August 19; National Heart, Lung, and Blood Institute, 2011). An underlying mechanism believed to contribute to these detrimental health outcomes is the inflammatory process (Dowd, Zajacova, & Aiello, 2010). Excess fat or adipose tissue contributes to disruption of metabolic homeostasis (Nguyen, Lane, Smith, & Nguyen, 2009) and leads to an accumulation of free radicals (Viera et al., 2009). The presence of free radicals perpetuates the secretion of proinflammatory cytokines, including tumor necrosis factor-alpha (TNF-α), which induce the release of C-reactive protein (CRP) from the liver (Camhi, Stefanick, Ridker, & Young, 2010; Federico et al., 2010; Marinou, Tousoulis, Antonopoulos, Stefanadi, & Stefanadis, 2010). The increased concentration of inflammatory cytokines and CRP result in a state of chronic, obesity-induced, low-grade inflammation, which is associated with increased disease risk (Stienstra, Duval, Muller, & Kersten, 2007). Fortunately, the body is able to prevent accumulation of free radicals via antioxidants, which donate electrons in order to stabilize free radicals and prevent oxidative damage (Jones & DeLong, 2000).

While some antioxidants are present in the body, others such as vitamins and minerals must be consumed through the diet (Cilla et al., 2009; Mayes & Botham, 2003). Plant foods, including fruits and vegetables, have a substantially higher antioxidant content compared to meat, fish, and other animal-based foods (Carlsen et al., 2010). Because of their excellent nutrient profiles, consumption of fruits and vegetables is widely encouraged (Hansen et al., 2010; Hermsdorff, Zulet, Pachau, & Martinez, 2010; Polidori et al., 2009). However, according to the CDC (2010, September 10), less than 15% of adults in the U.S. consume the recommended five or more servings per day of fruits and vegetables, with rates decreasing among some adult cohorts. Among overweight and obese adults, fruit and vegetable consumption was observed to significantly decrease from 22.6% to 21.5% over an eight-year period from 1996 to 2003 (Andreyeva, Long, Henderson, & Grode, 2010).

Previous studies have assessed the influence of educational interventions on fruit and vegetable consumption (Chapman, 2010; Guillaumie, Godin, & Vezina-Im, 2010; Ransley et al., 2010), antioxidant consumption (Chun et al., 2010; Kusano & Ferrari, 2008), role of antioxidants in oxidative stress (Carlsen et al., 2010; Dilis & Trichopoulou, 2010; McAnulty et al., 2010; Vertuani et al., 2004), and the correlation between fruit and vegetable consumption and inflammation in healthy individuals (Hermsdorff et al., 2010; Polidori et al., 2009; Talegawkar et al., 2009) and found favorable results. However, research examining the effects of both nutrition education and provision of fruits and vegetables on biomarkers of inflammation and oxidative stress is lacking. Therefore, this study was designed to determine the effectiveness of a community-based fruit and vegetable education program and provision of fruits and vegetables on consumption of fruits, vegetables, antioxidants, and changes in biomarkers of inflammation and oxidative stress among overweight and obese adults. Goals were to increase participants' consumption of fruits and vegetables and evaluate subsequent changes in antioxidant consumption and inflammatory and oxidative stress biomarkers.

Methods

Participants

A convenience sample of male and female adults with a body mass index (BMI) of 25 kg/m^2 or greater was recruited from two neighboring communities with a combined population of approximately 135,000 residents. Information about the study, inclusion criteria, and contact information were posted on flyers that were distributed to businesses throughout the communities and sent out electronically via email. Additional information about the study was provided upon request. Exclusion criteria included being under18 years of age, a current smoker, having a BMI lower than 25 kg/m^2, or having a history of bariatric surgery. All participants were provided with information on the purpose, procedures, and potential benefits of the study, and written informed consent was obtained from each person. Study protocol was approved by the university's Institutional Review Board prior to implementation.

Procedures

The study was conducted in fall 2011 and consisted of three phases over a 14-week period: pre-testing (2 weeks), intervention (10 weeks), and post-testing (2 weeks). Sixty-seven participants were originally enrolled in the study. A total of 47 completed both pre-test and post-test food records. Of these, 8 participants were in the control group, 15 were in the education group, and 24 were in the fruit and vegetable group. At pre-testing, demographic information was self-reported, and included age, gender, race/ethnicity, education level, annual income, and marital status. Participants were also asked to report medical history and used of prescription and over the counter medications, as inflammatory conditions or use of anti-inflammatory medications needed to be accounted for prior to data analysis. Information about habitual fruit and vegetable intake was also assessed. Participants reported fruit and vegetable consumption at both pre-test and post-test, using modified versions of two semi-quantitative food frequency questionnaires developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005).

Food and nutrient intake at pre- and post-testing were assessed using a three-day food record. Validity of food records in assessment of energy and nutrient intake has been demonstrated in previous studies of adults (Comrie, Masson, & McNeill, 2009; Drapeau et al., 2007; Shuaibi, Sevenhuysen, & House, 2008). Three-day food records have been observed to provide comparable accuracy as seven-day food records, require less participant burden, and have been shown to result in improved compliance (Larkin, Metzner, & Guire, 1991). Participants were provided with instructions and asked to record by hand everything they ate or drank over the course of two weekdays and a weekend day. To ensure accuracy, participants were encouraged to record foods and beverages as they consumed them over the three-day period. Data collected from the three-day food records were analyzed using The Food Processor® (ESHA Research, Salam, OR). A Registered Dietitian entered the food type and quantity recorded into the program for analysis. To ensure validity, all data were entered by the same individual. Participant's age, gender, height, weight, and physical activity level were also entered into the program to allow for comparison with U.S. Dietary Guideline recommendations (U.S. Department of Health and Human Services [HHS], 2010) for servings from each food group.

During pre-test and post-test, anthropometric data were collected, including height, weight, waist circumference, and body mass index. In addition, a total of 30 mL of venous whole blood sample was drawn after a 12-hour overnight fast. Blood samples at both pre-test and post-test were collected from a total of 40 participants (6 in the control group, 12 in the education group, and 22 in the fruit and vegetable group). All blood draws were scheduled and performed by a phlebotomist at a local hospital. Within 30 minutes of blood being drawn, EDTA-plasma samples were separated from whole blood by laboratory staff at the hospital and frozen immediately at -80 degrees Celsius (C). Samples were transferred from the local hospital to the university in ice and stored in a freezer at -80 degrees C.

Following pre-testing, participants were randomly assigned to one of three intervention groups: control, education, or fruit and vegetable. Random assignment was achieved using a table of random numbers (Thomas, Nelson, & Silverman, 2005). The final sample included 11 participants in control, 29 in education, and 27 in the fruit and vegetable group. The study intervention was 10 weeks in duration. Participants assigned to the control group received no intervention. However, they were given the option of receiving the information about fruits and vegetables provided to other participants after the intervention was over. Participants in the education group received weekly information about the antioxidant content of fruits and vegetables, the role of antioxidants in the inflammatory process, and the current recommendations for fruit and vegetable consumption. Participants assigned to the fruit and vegetable group received the same information as participants in the education group. In addition, they received recommendations for incorporating fruits and vegetables into their current meal plan and samples of fruits and vegetables. The samples of fruits and vegetables included fresh, frozen, or canned fruits and vegetables and were provided to participants at the weekly nutrition education sessions. The quantity provided to each fruit and vegetable group participant was the equivalent of one serving of fruits and two servings of vegetables per day for a week because on average, Americans fail to meet the recommended servings of fruits and vegetables by these amounts (CDC, 2007, March 16). Servings provided were consistent with the serving sizes listed in the 2010 U.S. Dietary Guidelines for Americans (HHS, 2010). Participants in the fruit and vegetable group were encouraged to consume these fruits and vegetables as a supplement to their usual fruit and vegetable intake.

All nutrition education was taught by licensed, registered dietitians. Nutrition lessons, approximately 30 minutes in duration, were provided weekly. All education sessions were held at a local university. Curriculum materials, developed by nutrition experts in the Department of Food and Nutrition at The University of Georgia (Garcia, 2005; Johnson et al., 2003), were used for the nutrition lessons. This curriculum was chosen because it was consistent with the purpose of the study, had been used for previous research (Garcia, 2005; Hendrix et al., 2008; Wade, 2003), and was readily available to the public via the Internet (Johnson et al., 2003). Curriculum materials included handouts describing how to purchase and store fruits and vegetables, nutrient content of various fruits and vegetables, and suggestions for incorporating fruits and vegetables into meals and snacks.

After conclusion of the 10-week intervention, post-testing was initiated in order to evaluate changes in consumption of fruits, vegetables, antioxidants as well as changes in biomarkers of inflammation and oxidative stress. Intake of fruits, vegetables, and antioxidants was again assessed using three-day food records.

Biochemical Analysis

Once all samples were collected, samples were slowly thawed to room temperature and plasma concentrations of CRP and TNF-α were measured using Enzyme Linked- Immuno-Sorbent Assay (ELISA) kits. Oxidative stress was measured using a thiobarbituric acid reactive substances (TBARS) kit. All standards and samples were run in duplicate for the CRP and TNF-α assays and in triplicate for the TBARS assay.

CRP concentration was measured using a human C-reactive protein ELISA kit (Cayman Chemical Company, catalog number 10011236, Ann Arbor, MI). Measurement of CRP concentration involved adding 100 µL of standard or sample to wells of a microtiter plate, incubating for 60 minutes at room temperature on an orbital shaker (MTS 2/4 D S1, IKA® Works, Inc., Wilmington, NC), and then washing four times and removing any moisture from the plate. Anti-CRP conjugate (100 µL) was then added to each well, incubated for 30 minutes at room temperature on an orbital shaker, and then washed four times. Following washing and removal of moisture, 100 µL of CRP tetramethylbenzidine (TMB) substrate solution was added to each well and incubated on an orbital shaker for 15 minutes at room temperature in the dark. Following incubation, 100 µL of CRP horseradish peroxidase (HRP) stop solution was added to each well to stop the reaction. Plates were then read by a microtiter plate reader (ELx 808 IU, Bio-Tek Instruments, Inc., Winooski, VT) at 550 nm. Results were expressed as pg CRP/mL and then converted to mg CRP/L.

Tumor Necrosis Factor-Alpha was measured with a human TNF-α UltraSensitive (US) ELISA Kit (Invitrogen Corporation, Catalog number KHC3013, Camarillo, CA). For this assay, 50 µL of buffered protein base containing 8 mM sodium azide, 100 µL of each standard or sample, and 50 µL of human TNF-α US biotin conjugate were pipetted into each well, incubated for two hours at 37 degrees C, and then aspirated and washed four times. Following washes, 100 µL of streptavidin-HRP working solution was added to each well, incubated for 30 minutes at room temperature, and washed four times. Following washes, 100 µL of stabilized chromogen TMB was added to each well and incubated for 30 minutes at room temperature in the dark. Finally, 100 µL of stop solution was added to stop the reaction. Plates were read at 550 nm and results expressed as pg TNF/mL.

Concentration of lipid peroxides in plasma, which is an indicator of oxidative stress, was determined using a TBARS kit. For this assay, 100 µL of each standard or sample and 100 µL of sodium dodecyl sulfate were mixed in 5 mL vials. Color reagent (4 mL), containing thiobarbituric acid, acetic acid, and sodium hydroxide, was added to each vial and vortexed. Vials were then incubated in 95 degree C water bath for 65 minutes and then immediately transferred to an ice bath to stop the reaction. Following incubation in the ice bath for 10 minutes, vials were centrifuged for 15 minutes at 3,000 RPMs at 4 degrees C. Finally, 150 µL of each standard or sample were pipetted onto a microtiter plate and read at 550 nm. Results reflected the concentration of malondialdehyde (MDA), which is a byproduct of lipid peroxidation (Yagi, 1998). Results were expressed as MDA equivalent content (nmol MDA/mL plasma), with higher values indicating a higher degree of oxidative stress.

Statistical Analysis

All statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL). Chi square analyses were used to assess differences among intervention groups in regard to demographics. Descriptive statistics, including frequencies, means, standard error of the mean, and standard deviations were generated for all participants completing both pre-test and post-test. Paired sample t-tests were used to evaluate mean differences in weight, BMI, CRP, TNF-α, and TBARS concentrations from pre-test to post-test for all participants and within the three groups: control, nutrition education, and fruit and vegetable. Pearson correlation analysis was then used to evaluate relationships between changes in fruit and vegetable consumption and changes in biomarkers of inflammation and oxidative stress from pre-test to post-test. Finally, one-way ANOVA analyses were used to test the hypothesis that nutrition education about antioxidant properties and content of fruits and vegetables with and without provision of fruits and vegetables had a differential effect on CRP, TNF-α, and TBARS concentrations from pre-test to post-test compared to no intervention (control group). An alpha level of $< .05$ was selected to indicate statistical significance.

Results

Baseline characteristics for all participants are depicted in Table 24. Participants were predominantly female (66.0%), white (91.5%), married or partnered (78.7%), and reported an annual household income in the range of \$50,000-\$99,999 (44.7%). Chi square tests for independence did not indicate differences in proportions in regard to gender (male, female), ethnicity (white, non-white), relationship status (married, other), or reported annual household income (≤\$39,999, ≥\$40,000) between treatment groups. The mean BMI among all participants at pre-test was 32.7 kg/m^2. Results of paired sample t-tests indicated no significant differences in weight and BMI from pre-test to post-test (data not shown).

Changes in use of anti-inflammatory medications from pre-test to post-test were accounted for and plasma concentrations beyond two standard deviations above or below the mean were eliminated prior to data analysis. One-way ANOVAs indicated no significant differences in antioxidant consumption or concentrations of CRP, TNF-α, or TBARS between intervention groups at pre-test.

Results of paired sample t-tests indicated significant mean differences in biomarkers of inflammation and oxidative stress from pre-test to post-test (Table 25). Among all participants, mean TNF-α concentration decreased to an undetectable concentration at post-test. No significant differences in plasma TBARS concentrations from pre-test to post-test were indicated among control, education, or fruit and vegetable group participants. While differences in CRP concentrations between pre-test to post-test were not significantly different for participants in

Table 24

Characteristics of Study Participants

Characteristic	Total sample (N = 47)	Control group (n = 8)	Education group (n = 15)	Fruit and Vegetable group (n = 24)
	N	n	n	n
Gender				
Male	16	5	6	5
Female	31	3	9	19
Ethnicity				
White	43	6	15	22
Asian	3	2	0	1
Latin American	1	0	0	1
Marital status				
Single	5	1	1	3
Married/Partnered	37	6	12	19
Divorced	4	1	1	2
Widowed	1	0	1	0
Education completed				
High school/GED	2	0	2	0
Some college	5	2	1	2
2-year college degree	5	0	2	3
4-year college degree	16	2	5	9
Master's degree	12	2	4	6
Professional/Doctoral degree	7	2	1	4
Annual household income				
$10,000-$49,999	15	2	4	9
$50,000-$99,999	21	4	8	9
$100,000-$149,999	10	2	2	6
More than $150,000	1	0	1	0
Age (y, mean ± S.D.)	45.9 ± 11.8	42.1 ± 14.2	47.7 ± 10.7	46.0 ± 11.9

Note. y = years; S.D. = standard deviation.

Table 25

Mean Concentrations of Biomarkers of Inflammation and Oxidative Stress

Variable Name and Description	Control group (n = 5)		Education group (n = 12)		Fruit and Vegetable group (n = 20)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
CRP[a] (N = 35[b])						
Pre	4.34 ± 2.60	.98	2.34 ± 2.25	.73	2.89 ± 3.61	.07
Post	4.31 ± 2.31		2.11 ± 2.63		1.52 ± 1.48	
TNF-α[c] (N = 37)						
Pre	5.90 ± 2.78	N/A	5.14 ± 3.04	N/A	5.94 ± 2.96	N/A
Post	undetectable		undetectable		undetectable	
TBARS[d] (N = 37)						
Pre	13.09 ± 3.67	.09	16.54 ± 11.04	.13	13.63 ± 5.13	.07
Post	7.94 ± 4.34		11.71 ± 8.95		10.56 ± 6.33	

Note. CRP = C-reactive protein; TNF-α = tumor necrosis factor-alpha; TBARS = thiobarbituric acid reactive substances (measured as malondialdehyde equivalents); S.D. = standard deviation; N/A = not applicable.
[a]milligrams per liter.
[b]Difference in total sample size due to two outliers being eliminated from fruit and vegetable group.
[c]picograms per milliliter.
[d]nanomoles per milliliter.

any of the intervention groups, the largest decrease was observed among fruit and vegetable group participants, $t(21) = -1.96$, $p = .07$.

Changes in consumption of fruits and vegetables were indicated by participants' three-day food records (Table 26). Results of paired sample t-tests indicated a significant increase in consumption of fruit from pre-test to post-test was observed among fruit and vegetable group participants, $t(22) = 2.69$, $p = .01$. In addition, results showed a significant mean decrease in the number of fruit servings consumed from pre-test to post-test for control group participants, $t(8) = -2.89$, $p = .02$. An increase in fruit servings consumed at post-test compared to pre-test was also noted among education group participants but this increase did not represent a significant difference, $t(14) = 1.72$, $p = .11$. Similarly, no significant differences in vegetable consumption existed from pre-test to post-test for participants in any of the intervention groups. Vegetable consumption was the same for control group participants, decreased by 0.3 serving among education group participants, and increased by 0.4 serving among participants in the fruit and vegetable group.

Mean amounts of beta carotene, vitamin C, vitamin E, and selenium consumed at pre-test and post-test are depicted in Table 27. Results of paired sample t-tests failed to indicate significant mean differences in antioxidant consumption from pre-test to post-test among the total sample and the different intervention groups. Despite absence of significant differences, a consistent increase in consumption of beta carotene from pre-test to post-test was observed among all groups. In fact, increased consumption of beta carotene among fruit and vegetable group participants trended towards significance, $t(22) = 2.04$, $p = .05$. However, changes in consumption of other antioxidants among the different intervention groups were inconsistent. Increases in vitamin C consumption were indicated among participants in the control and fruit

Table 26

Mean Servings of Fruits and Vegetables Consumed at Pre-Test and Post-Test

Variable Name and Description	Control group (n = 9)		Education group (n = 15)		Fruit and Vegetable group (n = 23)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Total fruits (svgs)						
Pre	1.4 ± 1.0	.02*	1.2 ± 1.0	.11	1.5 ± 1.1	.01*
Post	.8 ± .7		1.5 ± 1.1		2.2 ± 1.0	
Total vegetables (svgs)						
Pre	1.4 ± .8	.98	1.8 ± 1.1	.20	1.6 ± .8	.13
Post	1.4 ± .7		1.5 ± .8		2.0 ± 1.0	

Note. svgs = servings; S.D. = standard deviation.
Mean number of servings consumed was derived from average consumption as recorded on three-day food records. Three-day food record data were analyzed using The Food Processor® (ESHA Research, Salam, OR).
*Indicates significant mean difference from pre-test to post-test.

Table 27

Mean Consumption of Antioxidants at Pre-Test and Post-Test

Variable Name and Description	Control group (n = 9)		Education group (n = 15)		Fruit and Vegetable group (n = 23)	
	Mean ± S.D.	p value	Mean ± S.D.	p value	Mean ± S.D.	p value
Beta Carotene (µg)						
Pre	1351.1 ± 1945.3	.54	1788.2 ± 2826.5	.59	2101.8 ± 1863.6	.05^
Post	2226.1 ± 2998.8		2358.5 ± 3149.6		3731.9 ± 3486.6	
Vitamin C (mg)						
Pre	56.6 ± 35.1	.29	103.5 ± 93.5	.64	90.5 ± 66.7	.10
Post	80.8 ± 64.6		90.7 ± 57.6		115.0 ± 52.0	
Vitamin E (mg)						
Pre	4.9 ± 4.9	.82	5.7 ± 4.9	.18	4.2 ± 3.4	.64
Post	5.1 ± 6.3		4.7 ± 5.3		3.9 ± 2.8	
Selenium (µg)						
Pre	70.2 ± 31.3	.62	59.4 ± 22.8	.53	61.7 ± 32.5	.33
Post	80.7 ± 44.4		53.8 ± 33.4		54.6 ± 27.5	

Note. IU = International units; µg = micrograms; mg = milligrams; S.D. = standard deviation.
Mean consumption of antioxidants was derived from average consumption as recorded on three-day food records. Three-day food record data were analyzed using The Food Processor® (ESHA Research, Salam, OR).
^Indicates trend towards a significant mean difference from pre-test to post-test.

and vegetable group but not in the education group. Consumption of vitamin E and selenium increased among control group participants but decreased among education and fruit and vegetable group participants.

Pearson correlation analyses were conducted to evaluate relationships between changes in fruit and vegetable consumption and changes in antioxidant consumption and biomarkers of inflammation and oxidative stress (Table 28). Results indicated a medium positive correlation between a change in vegetable consumption and change in beta carotene intake ($r = .43$, $p = .00$). However, no other correlations between changes in consumption of fruits, vegetables, or antioxidants were noted. In addition, no significant relationships were indicated between changes in fruit, vegetable, or antioxidant consumption and changes in concentrations of CRP, TNF-α, or TBARS.

Finally, one-way ANOVAs were conducted to evaluate differences in biomarkers of inflammation and oxidative stress from pre-test to post-test between the intervention groups. The independent variable, intervention group, included three levels: control, education, and fruit and vegetable. The dependent variables were the changes in CRP, TNF-α, and TBARS concentrations from pre-test to post-test. No significant differences between the three intervention groups were noted regarding changes in CRP, TNF-α, or TBARS concentrations over time.

Discussion

Previous research has noted associations between overweight and obesity and increased inflammation and oxidative stress (Nguyen et al., 2009; Stienstra et al., 2007). Specifically, excess fat tissue has been shown to contribute to metabolic disruptions that promote accumulation of free radicals, which leads to oxidative damage and inflammation (Federico et

Table 28

Correlations Among Changes in Fruit and Vegetable Consumption, Antioxidant Consumption, and Biomarkers of Inflammation and Oxidative Stress

Variable	1	2	3	4	5	6	7	8	9
1. Total fruits	---	.21	.17	.18	-.26	-.09	-.14	.10	.06
2. Total vegetables		---	.43*	.21	.15	.19	-.10	.19	.09
3. Beta carotene			---	.01	.06	.08	-.26	.31	.11
4. Vitamin C				---	.15	-.10	-.20	.32	-.05
5. Vitamin E					---	.12	-.28	-.10	-.02
6. Selenium						---	.14	.26	-.00
7. CRP							---	.13	.06
8. TNF-α								---	-.08
9. TBARS									---

Note. CRP = C-reactive protein; TNF-α = tumor necrosis alpha; TBARS = thiobarbituric acid reactive substances
*Indicates a significant correlation ($p \leq .05$).

al., 2010; Marinou et al., 2010; Viera et al., 2009). Elevated plasma concentrations of CRP and TNF-α are indicators of inflammation while an elevated plasma TBARS concentration is an indicator of oxidative stress. Normal ranges of CRP include 0.0 to 3.0 mg/L with a concentration between 1.0 and 3.0 mg/L being indicative of moderate cardiovascular disease risk (Pearson et al., 2003). TBARS concentration between 1.86-3.94 nmol/mL MDA equivalents is considered normal with levels above 3.94 nmol/mL indicating increased oxidative stress (Yagi, 1998).

This study investigated the effects of a 10-week nutrition education program and provision of fruits and vegetables on fruit and vegetable consumption and subsequent changes in biomarkers of inflammation and oxidative stress among overweight and obese adults. Results indicated that at pre-test, participants' were obese, with a mean BMI of 32.7 kg/m^2 (World Health Organization, 2006), and experiencing a moderate degree of inflammation and high degree oxidative stress as evidenced by mean plasma concentrations (CRP = 2.91 mg/L; TNF-α = 5.70 pg/mL; TBARS = 14.50 nmol/mL). In addition, participants' mean weekly consumption of fruits and vegetables was below the current recommendations to consume five or more servings each day (CDC, 2010, September 10). Inadequate consumption of fruits and vegetables is particularly concerning because research has demonstrated that consumption of fruits and vegetables has been associated with improved antioxidant consumption (Chun et al., 2010). Adequate consumption of antioxidants, which include beta carotene, vitamin C, vitamin E, and selenium, has been associated with a reduction in both inflammation and oxidative stress (Jones & DeLong, 2000; McAnulty et al., 2010; Sureda et al., 2008; Vertuani et al., 2004).

Increased consumption of fruits, but not vegetables, was indicated among participants who received nutrition education and samples of fruits and vegetables. Alternatively, a decrease in fruit consumption from pre-test to post-test was noted among control group participants. In addition, increases in vegetable intake were only noted among participants in the fruit and vegetable group. These findings suggest that provision of fruits and vegetables was effective at increasing fruit and vegetable consumption. This is the first study to examine the effects of providing fruits and vegetables on consumption patterns of overweight and obese adults. However, availability and exposure to fruits and vegetables have been previously identified as possible determinants of fruit and vegetable consumption (Kidd & Peters, 2010; Powell, Kazlauskaite, Shima, & Appelhans, 2010).

While changes in vegetable consumption were related to change in beta carotene intake, it was not related to changes in intake of other antioxidants. Similarly, consumption of fruits was not associated with changes in antioxidant consumption. These findings are in opposition to existing literature that identifies fruits and vegetables as key sources of antioxidants, including vitamin C and beta carotene, in the diet (Chun et al., 2010). A possible explanation for these findings is that participants' consumption of fruits (M = 1.7 servings) and vegetables (M = 1.7 servings) was below the recommended two or more servings of fruits and three or more servings of vegetables daily. Failure to consume an adequate quantity of fruits and vegetables may have hindered participants' consumption of antioxidants. In addition, consumption of other sources of antioxidants, including whole grains and vegetable oil (vitamin E), may have contributed to changes in antioxidant consumption more so than intake of fruits and vegetables.

Since minimal changes in fruit, vegetable, and antioxidant consumption from pre-test to post-test were observed, relationships between these variables and changes in CRP, TNF-α, and TBARS concentrations were not expected nor indicated following correlation analyses. Alternatively, changes in concentrations of CRP, TNF-α, and TBARS over time and among different intervention groups were noted, despite absence of significant weight changes.

Concentrations of TNF-α in all groups were undetectable at post-test, meaning all concentrations were below the minimum detectable concentration (.009 pg/mL) of the ELISA kit used. Decreases in concentrations of CRP were greatest among participants in the fruit and vegetable group, which suggests a possible benefit of provision of fruits and vegetables on decreased inflammation. Previous research has suggested associations between dietary fiber (Hermsdorff et al., 2010), omega-3 fatty acids (McAnulty et al., 2010), and reductions in markers of inflammation. While intake of these dietary components was not a focus of the present study, potential of these factors to impact markers of inflammation did exist.

Similar outcomes were observed in regard to oxidative stress. Trends toward a significant decrease in TBARS concentration were noted among fruit and vegetable and control group participants more so than education group participants. While a significant relationship was not observed, increased consumption of vitamin C among these two groups compared to decreased consumption among the education group serves as a possible explanation for these results. As an antioxidant, vitamin C is especially effective at protecting against lipid peroxidation (Bender & Mayes, 2003; Jones & DeLong, 2000) and thus, helps to explain why decreased concentrations of TBARS were observed among the groups with higher vitamin C consumption.

While changes in CRP, TNF-α, and TBARS concentrations were observed from pre-test to post-test, these changes were not significantly different among participants who received the intervention compared to those who did not. These findings are contradictory to literature indicating associations between increased fruit and vegetable consumption and improvements in biomarkers of inflammation and oxidative stress (Hermsdorff et al., 2010; Polidori et al., 2009; Talegawkar et al., 2009). A possible reason for lack of differences between participants in the education and fruit and vegetable groups and those in the control group may be due to the unequal sizes of the intervention groups and subsequent lack of statistical power.

Limitations

Potential limitations to the present study included the use of a convenience sample, presence of potential confounding variables, small sample size, and absence of follow-up. First, recruiting a convenience sample may have limited the generalizability of the results. Second, while use of anti-inflammatory medications was controlled for, dietary components other than antioxidants were not accounted for and may have impacted the results. Third, dietary intake was assessed using three-day food records, which may or may not have represented typical consumption patterns. Fourth, the final control group sample size fell short of the required 16 participants needed to detect statistical significant according to an 80% power calculation. This was due to purposeful inclusion of more participants in the education and fruit and vegetable groups compared to the control group in anticipation of attrition. Because of this, the final number of participants in the control group was below the required sample size, which may have prevented detection of significant differences. Fifth, concentrations of TNF-α at post-test were below the specificity of the ELISA kit used and therefore, undetectable. This prevented evaluation of changes from pre-test to post-test and among the different intervention groups. A possible solution would be to measure TNF-α expression by immunoblotting techniques or gene expression instead of ELISA. Sixth, follow-up data on fruit, vegetable, antioxidant consumption, and plasma concentrations of CRP, TNF-α, and TBARS were not collected. Therefore, it is unknown if changes in consumption of fruits, vegetables, antioxidants, and biomarkers of inflammation and oxidative stress were maintained following the conclusion of the study.

Conclusion

Participants in the present study were obese and experiencing inflammation and oxidative stress, which contributed to increased disease risk. Findings of the present study indicated that changes in consumption of fruits, vegetables, and antioxidants among participants were minimally associated with improvements in biomarkers of inflammation and oxidative stress. Also, other factors such as changes in anthropometrics, physical activity, and macronutrient intake may have impacted these measures (Desroches et al., 2006; Rankin & Turpyn, 2007; van Dijk et al., 2008). Despite the present findings, evidence suggests that a balanced diet, including antioxidant-rich fruits and vegetables, is beneficial in helping individuals maintain adequate antioxidant concentrations in order to aid in the prevention and regulation of inflammation and oxidative stress (Chun et al., 2010; Quadir & Akhtar-Danesh, 2010). Therefore, adequate and varied consumption of fruits and vegetables is recommended.

Results of the present study highlight a need for additional research, including long-term studies, evaluating the effects of nutrition education interventions with provision of fruits and vegetables on changes in consumption of fruits, vegetables, antioxidants, and biomarkers of inflammation and oxidative stress in overweight and obese adults. Previous research suggests that improvements in fruit and vegetable consumption could potentially contribute to improved antioxidant intake, reduced inflammation and oxidative stress, and ultimately decreased disease risk in overweight and obese adults. Therefore, additional research that controls for confounding variables and includes long-term follow-up is warranted.

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GENERAL CONCLUSIONS

The objectives of this study were to examine the effects of nutrition education and fruit and vegetable consumption on interest and knowledge related to antioxidants; consumption patterns; weight, body mass index (BMI), body composition, blood lipids, and blood glucose; and biomarkers of oxidative stress and inflammation. Findings of this research support the first two hypotheses, which stated that over 50% of participants in the education and fruit and vegetable groups would express interest in learning about antioxidants and that there would be a significant increase in the number of education and fruit and vegetable group participants who correctly answered knowledge-based questions about antioxidants at the conclusion of the intervention. The majority of participants expressed interest in receiving information about antioxidants. In addition, increased knowledge and improved attitudes regarding fruit and vegetable consumption were indicated, particularly among those who received nutrition education. These changes in knowledge and attitudes contributed to positive changes in behavior among participants, including following a healthier diet, replacing energy-dense, nutrient-poor foods with fruits and vegetables, and increasing overall intake of fruits and vegetables.

In regard to consumption, it was hypothesized that there would be significant increases in fruit, vegetable, and antioxidant consumption among fruit and vegetable group participants but not education or control group participants. Results indicated that the nutrition education intervention was helpful in improving participants' consumption of fruits and vegetables, including those rich in antioxidants. However, provision of fruits and vegetables, while intended to help reduce barriers to consumption, had limited impact in increasing fruit and vegetable consumption. Increases in fruit, vegetable, and antioxidant consumption were also noted among participants in the education group.

The absence of significant changes in anthropometric measurements among participants over the course of the study confirms the hypothesis that no significant changes in BMI and body composition would occur from pre-test to post-test. In addition, no significant changes in total cholesterol were indicated among participants in the fruit and vegetable group, thereby confirming the hypothesis that a change in total cholesterol would not occur. However, decreases were observed in all groups culminating in a significant mean decrease in total cholesterol for the total sample. Despite minimal changes in anthropometrics and blood lipids from pre-test to post-test, associations between increased fruit and vegetable consumption and improvements in biomarkers of chronic disease were noted, particularly among those who received nutrition education.

Finally, it was hypothesized that there would be significant decreases in markers of inflammation in fruit and vegetable group participants but not in control and education group participants. While not significant, a decrease in inflammatory biomarkers was indicated among all participants with the greatest reduction observed among fruit and vegetable participants. However, findings indicated that changes in consumption of fruits, vegetables, and antioxidants were minimally associated with improvements in biomarkers of inflammation and oxidative stress.

Overall, findings suggest that community-based nutrition education is beneficial in improving fruit and vegetable-related knowledge, attitudes, and behaviors, including increased consumption. However, provision of fruits and vegetables, while intended to help reduce barriers to consumption, had limited impact on fruit and vegetable intake and subsequent changes in biomarkers of chronic disease.

Implications and Suggestions for Future Research

These findings add to the literature examining the effects of nutrition education and fruit, vegetable, and antioxidant consumption on risk factors of chronic disease. Specifically, findings from this study can be used to develop future interventions aimed at reducing chronic disease risk factors among overweight and obese adults. In order to be most effective, it is recommended that future interventions include an education component that thoroughly addresses participants' fruit and vegetable-related knowledge and attitudes and provides exposure to fruits and vegetables. Such exposure may include cooking demonstrations and taste-testing. Also, efforts to increase consumption should focus on encouraging intake of a variety of fruits and vegetables, particularly those with the highest antioxidant content. In addition to encouraging adequate consumption of antioxidant-rich fruits and vegetables, it is necessary to emphasize management of overall energy intake, including decreased consumption of high-energy, nutrient poor foods.

The methodology for this study was deemed to be sound and is recommended for future research. Suggested modifications include recruiting a larger sample and including participants of lower socioeconomic status. It is also necessary to note the substantial costs that were associated with this study. Expenses included the cost of weekly fruit and vegetable samples, printing of handouts and study-related materials, blood draws and analyses, laboratory assay kits, as well as other laboratory supplies. Financial assistance was required for this study, sought out, and received in the form of scholarships and grants. Duplication of this study would require access to a substantial funding source(s).

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APPENDIX A. INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

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
Fargo, ND 58108-6050

701.231.8995
Fax 701.231.8098

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

NDSU is an equal opportunity institution.

APPENDIX B. INSTITUTIONAL BIOSAFETY COMMITTEE APPROVAL LETTER

NDSU NORTH DAKOTA STATE UNIVERSITY

701.231.9714
Fax 701.231.8098

Institutional Biosafety Committee

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
Fargo, ND 58108-6050

July 13, 2011

Dr. Yeong Rhee
Dept. of Health, Nutrition, & Exercise Science
EML 351

Re: IBC Project **#B11009: "Effects of Fruit and Vegetable Consumption on Health"**

Approval Date: July 12, 2011

Co-Investigators and research team: Yeong Rhee, Meredith Wagner, Kerrie Hert, Jamie Levine

The project referenced above has been reviewed and accepted under the categorization of "***human blood and tissue***" by the Institutional Biosafety Committee (IBC). A copy of the *IBC Protocol Form* is being forwarded to you with the committee approval.

No further reporting to the NDSU IBC is required for this project unless there are unexpected events concerning exposure or containment of the agent(s) involved, or you decide to make a change in the project. Although, no further reporting is necessary an annual update will be sent to you to help track and monitor the work over the course of the project. If you decide to make changes, please notify the NDSU IBC before any change is implemented.

Thank you for complying with NDSU IBC procedures, and best wishes for success with your project.

NDSU, Institutional Biosafety Committee

NDSU is an equal opportunity institution.

APPENDIX C. PARTICIPANT 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
701-269-2164 or 701-231-9615

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APPENDIX D. PARTICIPANT RECRUITMENT BULLETIN/EMAIL

We are seeking individuals (18 years of age or older) from the Fargo-Moorhead community to participate in a research study. The program is being conducted by Meredith Wagner, MS, RD, LRD and Yeong Rhee, PhD, RD in the Health, Nutrition, and Exercise Sciences Department at North Dakota State University. Participation involves a 14-week research study where nutrition education, 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)), and samples of fresh, frozen, or canned fruits and vegetables may be provided to participants. We are specifically interested in demonstrating how consumption of fruits and vegetables can influence oxidative stress and inflammation in the body. 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. Individuals who are overweight and do not have a history of bariatric surgery (e.g., stomach stapling, stomach banding), do not currently smoke, and are not pregnant/lactating are invited to participate. The protocol for this research study has been reviewed and approved by the NDSU Institutional Review Board. If you are interested in participating, please contact Meredith Wagner (Email: meredith.stromsborg@my.ndsu.edu; Phone: 701-269-2164 or 701-231-9615) to schedule an informational meeting.

APPENDIX E. PROPOSED TIMELINE

	Week 1	Week 2	Week 3	Week 4
Aug	Recruitment for study	Recruitment for study	Recruitment for study	Recruitment for study
Sept	Recruitment for study	Pre-testing---	---	Group mtg: Educ – receive education F/V – receive education & FV
Oct	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV
Nov	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV	Group mtg: Educ – receive education F/V – receive education & FV
Dec	Group mtg: Educ – receive education F/V – receive education & FV	Post-testing---	---	Compile data---
Jan	---	---	Data analysis---	---
Feb	Write up results/ discussion---	---	---	---
Mar	---	---	---	Study defense

Educ = education group F/V = fruit/vegetable group FV = fruit and vegetable samples

APPENDIX F. CONSENT FORM

NDSU North Dakota State University
Dept. of Health, Nutrition, and Exercise Sciences
PO Box 6050
Fargo, ND 58108-6050
(701) 231-7487

Title of Research Study: Effects of Fruit and Vegetable Consumption on Health

This study is being conducted by: Yeong Rhee, PhD, RD (701) 231-7476
Meredith Wagner, MS, RD, LRD (701) 231-9615

Why am I being asked to take part in this research study? You are being asked to participate in this study because you: (1) are an adult over the age of 18, (2) have a body mass index (BMI) greater than or equal to 30 kg/m^2, (3) have no history of bariatric surgery (e.g., stomach stapling, stomach banding), (4) do not currently smoke, and (5) are not pregnant/lactating. If you are known to have any food allergies or sensitivities to fruits and vegetables, you should not take part in this study.

What is the reason for doing the study? The purpose of this study is to examine the effects of fruit and vegetable intake on oxidative stress and inflammation as it relates to chronic disease. 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. This study may help to demonstrate the role of fruit and vegetable consumption as a mechanism for decreasing inflammation associated with chronic disease.

What will I be asked to do? You will be asked to complete the following:

- Attend an introductory meeting, where the study will be explained and the researchers will be available to answer questions

- Provide written consent by signing your name to the end of this form

- Complete three questionnaires on two separate occasions (at the beginning of the study and at the end of the study). The questionnaires include questions about your age, living situation, interest in health-related information, health history (e.g., do you have a history of diabetes, high blood pressure, etc.? do you have any food allergies?, etc.), use of medications and supplements, as well as questions assessing your nutrition-related knowledge

- Have your blood drawn by a trained phlebotomist (person experienced in taking blood samples) at Sanford Health on two separate occasions (at the beginning of the study and at the end of the study)

- Have your height, weight, and waist circumference (measure of your waist) measured by the researcher on two separate occasions (at the beginning of the study and at the end of the study)

- Once all pretest data (questionnaires, blood sample, and measurements mentioned above) are complete, you will be randomly assigned to one of three experimental groups: control group, nutrition education group, or nutrition education plus fruit and vegetable group.

- If you are in the control group, you will be asked to continue your normal routine.

  If you are in the nutrition education group, you will receive nutrition education, including information about fruits and vegetables, antioxidants (nutrients found in plant foods), and inflammation, from a Licensed, Registered Dietitian (expert in food and nutrition). These educational sessions will take place weekly at North Dakota State University.

  If you are in the nutrition education plus fruit and vegetable group, you will receive nutrition education, including information about fruits and vegetables, antioxidants, and inflammation, from a Licensed, Registered Dietitian (expert in food and nutrition). In addition, you will be provided with samples of fresh, frozen, or canned fruits and vegetables (equivalent to one serving of fruit and two servings of vegetables per day for a two week period) to incorporate into your current meal plan. Samples of fruits and vegetables will be provided to all nutrition education plus fruit and vegetable group participants at each nutrition education session.

Where is the study going to take place, and how long will it take? You will report to North Dakota State University, Family Life Center, Room 312, for all measurements (height, weight, waist circumference) and nutrition education sessions. You will report to the Sanford Laboratory (737 Broadway, Fargo, ND 58122) for both blood draws (before and after the study). There will be a total of 10 nutrition education sessions and 2 laboratory appointments. Nutrition education sessions will occur once per week (total of 10 weeks). All sessions will last approximately one hour. Total participation time for this study will be about 23 hours over the course of 14 weeks.

What are the risks and discomforts? The main risk associated with this study is that you could develop an infection at the site where blood is drawn. This risk will be near zero because universal precautions will be taken when drawing your blood. All blood draws will be performed by a trained phlebotomist (person experienced in taking blood samples) at Sanford Health. If you are known to have sensitivity to any food or food ingredient, or have had violent allergic reactions to food ingredients, you should not take part in this study.

What are the benefits to me? Potential benefits to all participants in this study include two free (paid for by the researchers) blood draws and blood analyses with the results of these tests provided to you at the conclusion of the study. The blood analyses will provide information about your total cholesterol, high density lipoprotein ("good" cholesterol), low density lipoprotein ("bad" cholesterol), triglycerides (amount of fat floating around in your blood), blood glucose (blood sugar), C-reactive protein (measure of inflammation), tumor necrosis factor alpha (measure of inflammation), interleukin 6 (measure of inflammation), as well as a measure of oxidative stress.

Another potential benefit for those individuals assigned to the nutrition education plus fruit and vegetable group will be the provision of free (paid for by the researchers) samples of fruits and vegetables.

What are the benefits to other people? This research may potentially provide advancement of knowledge of the relationship between antioxidant consumption and inflammation.

Do I have to take part in the study? Your participation in this research is your choice. If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled.

What will it cost me to participate? There is no monetary cost to you. This study will require about 23 hours of your time over the course of 14 weeks.

What are the alternatives to being in this research study? Instead of being in this research study, you can choose not to participate.

Who will see the information that I give? We will keep private all research records that identify you. Your information will be combined with information from other people taking part in the study. When we write about the study, we will write about the combined information that we have gathered. We may publish the results of the study; however, we will keep your name and other identifying information private. We will make every effort to prevent anyone who is not on the research team from knowing your information or even that you gave us information. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key.

Can my taking part in the study end early? If you fail to show up to at least 75% of the sessions you may be removed from the study.

Will I receive any compensation for taking part in this study? No compensation will be offered for taking part in this study.

What happens if I am injured because of this research? If you receive an injury in the course of taking part in the research, you should contact Dr. Yeong Rhee at the following phone number (701) 231-7476. Treatment for the injury will be available including first aid, emergency treatment and follow-up care as needed. Payment for this treatment must be provided by you and your third party payer (such as health insurance or Medicare). This does not mean that you are releasing or waiving any legal right you might have against the researcher or NDSU as a result of your participation in this research.

What if I have questions?
Before you decide whether to accept this invitation to take part in the research study, please ask any questions that might come to mind now. Later, if you have any questions about the study, you can contact the researchers, Dr. Yeong Rhee and Meredith Wagner, at 701-231-7476 or 701-231-9615.

What are my rights as a research participant?
You have rights as a participant in research. If you have questions about your rights, or complaints about this research or to report a research-related injury, you may talk to the researcher or contact the NDSU Human Research Protection Program by:

- Telephone: 701.231.8908
- Email: ndsu.irb@ndsu.edu

- Mail: NDSU HRPP Office, NDSU Dept. 4000, PO Box 6050, Fargo, ND 58108-6050.

The role of the Human Research Protection Program is to see that your rights are protected in this research; more information about your rights can be found at: www.ndsu.edu/research/irb
.

Documentation of Informed Consent:
You are freely making a decision whether to be in this research study. Signing this form means that

1. you have read and understood this consent form
2. you have had your questions answered, and
3. you have decided to be in the study.

You will be given a copy of this consent form to keep.

____ _______________
Your signature Date

____
Your printed name

____ _______________
Signature of researcher explaining study Date

____
Printed name of researcher explaining study

APPENDIX G. INSTRUCTIONS FOR BLOOD DRAW

Fruit and Vegetable Study - Instructions for Blood Draw

Now that you have completed the measurement portion of post-testing, we ask that you go over to Sanford Health (737 Broadway, Fargo) for the blood draw (directions are included below). When you arrive, go to Desk 22, tell them you are in the NDSU Fruit and Vegetable Study, give them your name, date of birth, and the three required documents (Sample Collection and Processing Instructions, NDSU campus map, Sanford Laboratory Outreach requisition) you were provided during post-testing. The clinic opens at 7:00 a.m., Monday through Friday. You do not need an appointment. <u>Important: You must not eat or drink anything (other than plain water) 12 hours before you have your blood drawn</u>. For example, if you plan to have your blood drawn at 7:00 a.m., you should not have anything to eat or drink (other than plain water) after 7:00 p.m. the night before. If you have had anything to eat or drink (other than plain water) when you arrive, Sanford staff will not be able to draw your blood. It is important to be well-hydrated prior to your blood draw so please drink plenty of plain water beforehand.

Thank you for your willingness to participate in this study! Please contact us if you have any questions.

Meredith Wagner
meredith.stromsborg@my.ndsu.edu
(701) 269-2164 or (701) 231-9615

Directions from NDSU (12 Ave. N) to Sanford Health (737 Broadway N, Fargo):

1. Turn onto University Dr. N (this is a one way street going south) and travel approximately 0.5 mile.

2. Turn LEFT onto 8th Ave. N and travel approximately 0.5 mile.

3. Turn RIGHT onto Broadway N and you will see Sanford. You may park in the parking ramp located just North of the hospital (LEFT turn off of Broadway N).

APPENDIX H. PRE-TEST 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 I. PRE-TEST FOOD FREQUENCY QUESTIONNAIRE

PRE-TEST: Fruit and Vegetable Intake

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
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 fresh fruit?	<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 frozen fruit?	<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 canned fruit?	<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 fresh vegetables?	<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 frozen vegetables?	<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 canned vegetables?	<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

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APPENDIX J. KNOWLEDGE AND PERCEPTIONS QUESTIONNAIRE

Name: ____

Have you received information on the following topics from a health care provider?

	No	Yes
Healthy Eating		
Weight Management		
Cooking		
Antioxidants		
Physical Activity		

If you responded 'Yes' to the previous question, please indicate the type(s) of information you received regarding each topic.

	Verbal (from a healthcare professional)	Written pamphlet (from a healthcare professional)	Written handout (from a healthcare professional)	Other (please specify)	Verbal (from a family member, friend, neighbor)
Healthy Eating					
Weight Management					
Cooking					
Antioxidants					
Physical Activity					

Are you interested in receiving information on the following topics from a health care provider?

	No	Yes
Healthy Eating		
Weight Management		
Cooking		
Antioxidants		
Physical Activity		

For the remaining questions, please use a pencil to indicate your responses on the Opscan form provided.

Please put your name on the form, one letter per box. Also, make sure to darken the circles for the corresponding letters of your name.

Answer the following questions by filling in the appropriate circle on the Opscan form.

1. **How would you describe your general health?**

   (a) Excellent (b) Very Good (c) Good (d) Fair (e) Poor

2. **To you personally, how important is it to eat a variety of foods?**

   (a) Very important (b) Somewhat important (c) Not too important (d) Not at all important

3. **To you personally, how important is it to choose a diet with plenty of fruits and vegetables?**

   (a) Very important (b) Somewhat important (c) Not too important (d) Not at all important

4. **How many servings from the fruit group would you say a person of your age and gender should eat each day for good health?**

   (a) one or less (b) two (c) three (d) four (e) five or more

5. **How many servings from the vegetable group would you say a person of your age and gender should eat each day for good health?**

   (a) one or less (b) two (c) three (d) four (e) five or more

6. **Compared to what is healthy, do you think your diet is too low, too high, or about right in sugar and sweets?**

   (a) Too low (b) Too high (c) About right (d) Don't know

7. **What you eat can make a big difference in your chance of getting a disease like heart disease or cancer.**

   (a) Strongly agree (b) Somewhat agree (c) Somewhat disagree (d) Strongly disagree

8. Eating a variety of foods each day probably gives you all the vitamins and minerals you need.

(a) Strongly agree (b) Somewhat agree (c) Somewhat disagree (d) Strongly disagree

9. I know what antioxidants are.

(a) Strongly agree (b) Somewhat agree (c) Somewhat disagree (d) Strongly disagree

10. I understand the effects of antioxidants in the body.

(a) Strongly agree (b) Somewhat agree (c) Somewhat disagree (d) Strongly disagree

11. Based on your knowledge, which of the following is considered to be an antioxidant?

(a) Vitamin B12 (b) Calcium (c) Vitamin E (d) Zinc (e) None of these

We will be notifying you about your assignment to one of the three study groups. If assigned to one of the nutrition education groups, what days and times would be most convenient for you to attend weekly education sessions?

Days	Times
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

APPENDIX K. THREE-DAY FOOD RECORD

Food Diary

Directions for Using the 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 L. POST-TEST 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:________________________

<u>Including you</u>, 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 M. POST-TEST FOOD FREQUENCY QUESTIONNAIRE

POST-TEST: Fruit and Vegetable Intake

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
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
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 fresh fruit?	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 frozen fruit?	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 canned fruit?	0	<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 fresh 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 frozen 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 canned 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 cancer?	No	Yes	Don't know
	29. Do you think that eating more fruits and vegetables will help reduce your risk of heart disease?	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*			

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APPENDIX N. NUTRITION EDUCATION EVALUATION

Which group were you randomly assigned to for this study?

Nutrition Education Group   Fruit and Vegetable + Nutrition Education Group

How satisfied were you with the nutrition education sessions?

Strongly dissatisfied   Dissatisfied   Neutral   Satisfied   Strongly Satisfied

On average, the nutrition education sessions were 20 minutes in duration. Which of the following best describes your feeling regarding the length of the nutrition education sessions?

Too short   Just right   Too long

What did you enjoy <u>most</u> about the nutrition education sessions?

What did you enjoy <u>least</u> about the nutrition education sessions?

Please include any comments about the nutrition education sessions in the space below.

If you were assigned to the group that received fruits and vegetables each week, please complete the following section.

On average, how much of the 7 servings of fruits provided each week did you consume?

0%   25%   50%   75%   100%

On average, how much of the 14 servings of vegetables provided each week did you consume?

0%   25%   50%   75%   100%

What reasons, if any, prohibited you from consuming 100% of the fruits and vegetables provided each week? *Circle all that apply.*

Did not like it   Did not have time

Family/friend ate it before I could eat it   Produce went bad

Did not know how to prepare it   Other:________________________

APPENDIX O. LISTING OF FRUIT AND VEGETABLE SAMPLES

Week	Fruits	Quantity Provided	Vegetables	Quantity Provided
1	Apple (fresh) Nectarine (fresh) Strawberries (frozen) Cantaloupe (fresh)	1 medium 2 medium 2 cups ½ melon	Corn (frozen) Bell Pepper (fresh) Romaine Lettuce (fresh)	3 cobs 1 pepper 9 cups
2	Strawberries (frozen) Blueberries (frozen) Peach (fresh) Apple (fresh)	4 cups 1 cup 1 medium 1 medium	Mixed Vegetables (frozen) Corn (frozen) Cucumber (fresh) Tomato (fresh)	1 bag 1 cob 1 cucumber 1 medium
3	Grapefruit (fresh) Orange (fresh) Pear (fresh) Apple (fresh)	1 grapefruit 3 medium 1 medium 1 medium	Sweet Potato (fresh) Green Peas (canned) Baby Carrots (fresh)	1 potato 2 cans 1 bag
4	Pineapple (canned) Apple (fresh)	1 can 2 medium	Tomato (canned) Black Beans (canned) Potato (fresh) Onion (fresh) Roma Tomato (fresh)	2 cans 1 can 1 potato 1 medium 2 tomatoes
5	Peach (canned) Mandarin Oranges (canned) Kiwi (fresh)	1 can 1 can 2 kiwi	Broccoli and Cauliflower (frozen) Green Beans (canned) Potato (fresh)	1 bag 1 can 1 medium
6	Green Grapes (fresh) Applesauce	2 cups 3 containers	Spinach (fresh) Cucumber (fresh) Corn (canned)	9 cups 1 cucumber 1 can

7	Banana (fresh) Orange (fresh)	3 large 1 medium	Stir-fry Blend Vegetables (frozen) Green Beans (canned) Potato (fresh)	1 bag 1 can 1 medium
8	Red Grapes (fresh) Applesauce	2 cups 3 containers	Tomato Pasta Sauce Baby Carrots (fresh) Acorn Squash (fresh)	1 jar 1 bag 1 squash
9	Pineapple (canned) Banana (fresh)	1 can 1 large	Garbanzo Beans (canned) Great Northern Beans (canned) Kidney Beans (canned) Cucumber (fresh) Green Bell Pepper (fresh)	1 can 1 can 1 can 1 cucumber 1 pepper
10	Strawberries (frozen) Apple (fresh)	3 cups 4 medium	Tomato (canned) Onion (fresh) Garlic (fresh)	2 cans 2 medium 2 cloves

APPENDIX P. FRUIT AND VEGETABLE SAMPLE TRACKER FORM

Participant Name:____ Date:

Fruit	Serving	Method(s) of Preparation	Number of Servings Eaten
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O

Vegetable	Serving	Method(s) of Preparation	Number of Servings Eaten
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O
			O O O O O O O O O O O O O

APPENDIX Q. NUTRITION EDUCATION CURRICULUM SCHEDULE

Lesson	Dates	Topic	Fruit/Vegetable
1	September 19-23	Introduction	F=Apples, Nectarines, Strawberries, Melons V=Corn, Bell Peppers, Lettuce
2	September 26-30	Berries	F=Strawberries, Blueberries, Peaches, Apples V=Mixed Vegetables, Corn, Cucumbers, Tomatoes
3	October 3-7 DEMO - Quick Fruit Salad	Citrus Fruits	F=Oranges, Grapefruit, Pears, Apples V=Sweet Potatoes, Green Peas, Baby Carrots
4	October 10-14	Tomatoes	F= Pineapple, Apples V=Tomatoes, Black Beans, Potatoes, Onions
5	October 17-21	Canned and Frozen F/V	F=Peaches, Mandarin Oranges, Kiwi V=Green Beans, Broccoli, Cauliflower, Potatoes
6	October 24-28 DEMO - Spinach/Orange/Poppyseed Salad	Leafy Greens	F=Green Grapes, Applesauce V=Spinach, Cucumbers, Corn

Lesson	Dates	Topic	Fruit/Vegetable
7	Oct 31-Nov 4	Cruciferous Vegetables	F=Bananas, Oranges V=Stir-fry Blend Vegetables, Green Beans, Potatoes
8	November 7-11	Squash and Pumpkin	F=Red Grapes, Applesauce V=Tomato Pasta Sauce, Baby Carrots, Acorn Squash
9	November 14-18 DEMO – Black Bean Dip	Beans	F= Pineapple, Bananas V=Garbanzo Beans, Great Northern Beans, Kidney Beans, Cucumbers, Bell Peppers
10	November 28-Dec 2 DEMO – Salsa	Garlic and Onions	F=Strawberries, Apples V=Tomatoes, Onions, Garlic

APPENDIX R. LESSION 1: INTRODUCTION – LESSON PLAN

Fruits and Vegetables
Introduction

Getting Ready

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Food Sources of Vitamins*
   b. *Getting the Most for Your Money*
   c. *Eat Your Colors the Easy Way*
   d. Recipe – Garden Vegetable Slaw
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Handouts
2. Recipes
3. Activity supplies:
   a. Fruit and vegetable food models
   b. Colored pieces of paper
   c. Basket
4. Ingredients to prepare the recipe.
5. Supplies for tasting recipe, such as plates, forks or spoons, and napkins.

Beginning the Lesson

1. Introduce yourself.
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Understand the benefits of eating a variety of colorful fruits and vegetables.
2. Learn the benefits of phytochemicals in fruits and vegetables.
3. Understand where fruits and vegetables fit in the Food Guide Pyramid, know how many servings are recommended and appropriate serving sizes.
4. Identify which fruits and vegetables are in season and why it is best to buy produce in season.

Script

Introduction
(Display food models to refer to during lesson.)

Imagine with me, if you will, that you woke up this morning and picked up your daily newspaper. You open it to a big headline. It reads: **Scientists discover the secret to staying healthy and fit as we age!** *(Hold up Noah News headline)* It goes on to say this discovery may help:

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight the effects of aging** (on eyesight, memory, immune function and painful inflammation).

Would you be interested? What if it turns out this discovery is actually inexpensive and available to everyone? In fact, it has practically been under our noses for ages!
Are you ready to know this timeless formula for health? **It is simply this, eating 5 to 9 servings of colorful fruits and vegetables every day – 5 A Day the Color Way.** If there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit!**

Staying Healthy and Fit the Color Way - Activity
Note to the speaker: Place the pieces of colored paper (red, green, yellow, orange, blue, purple and white) in the basket.
What are the colors of health? It is more fun to think about a rainbow of colors when you choose your daily fruits and vegetables. Think **5 A Day the Color Way** to stay healthy and fit by choosing foods daily from these colors (*pick up pieces of colored paper, one at a time and call out the colors*): **blue-purple, green, white, yellow-orange, and red**.

Pass the basket around the group and let 5 volunteer participants select a color and name a fruit or vegetable in this color group, then let others in the group name additional fruit and vegetables in this color group. You may also encourage each volunteer to tell everyone the last time he or she ate this fruit or vegetable. You will name other fruits and vegetables in this color category and describe the benefits of this color category (see below).

Blue-purple: blackberries, blueberries, dried plums (*or prunes*), purple/black grapes, plums, raisins, eggplant, peppers, and blue potatoes.

Your blues may help reduce your risk of some cancers, keep your urinary tract healthy, help with memory, and help with healthy aging.

Green: avocados, green-skin apples, green grapes, honeydew melon, kiwi, green-skin pears, limes, green grapes, artichokes, asparagus, broccoli, Brussels sprouts, cabbage, green beans, celery, cucumbers, leafy greens, Romaine lettuce, okra, peas, peppers, spinach, and zucchini.

Eat your greens to reduce your risk of cancer, to protect your eyes from cataracts and macular degeneration, and to help keep bones and teeth strong.

White: bananas, white nectarines or peaches, cauliflower, garlic, ginger, jicama, mushrooms, onions, potatoes, and turnips.

Even white has "phyte" and can help you have a healthy heart and reduce risk of some cancers.

Yellow-orange: Yellow-skin apples, apricots, cantaloupe, grapefruit, lemons, mangos, nectarines, oranges, papayas, peaches, yellow pears, pineapples, tangerines, butternut squash, pumpkin, peppers, carrots, rutabagas, summer squash, corn, and sweet potatoes.

Include fruits and vegetables like these for a healthy heart and immune system, to protect your eyes from cataracts and macular degeneration, and to reduce your risk of some cancers.

Red: Red-skin apples, cherries, cranberries, red grapes, pink grapefruit, red-skin pears, raspberries, strawberries, watermelon, beets, red cabbage, peppers, radishes, radicchio, rhubarb, and tomatoes.

Think red-hot and healthy with these bright foods because they may help with memory, your urinary tract healthy, protect your heart, and reduce risk of some cancers.

So **5 A Day the Color Way** means choosing your fruits and vegetables from all colors to stay healthy and fit.

Disease Fighters in Colorful Fruits and Vegetables
(*Pick up the basket of food models.*) What makes these colorful fruits and vegetables a key part of staying healthy and fit as you age (*hold up different pieces of produce from basket*)? These deeply colored fruits and vegetables supply a wide range of **vitamins** and **minerals**, **fiber** and special disease fighters called **phytochemicals** that your body needs to stay healthy and help fight diseases. Sounds like colorful fruits and vegetables are practically nature's pharmacy. You just have to eat them – **5 to 9 servings of fruits and vegetables every day.**

Colorful fruits and vegetables are the prescription for getting some of the **vitamins** and **minerals** important for older adults:

1. **Vitamin A** for healthy eyes, lungs and skin and to help resist infections.
2. **Vitamin C** for healthy gums, for healing cuts and burns, and to help resist infections.
3. **Vitamin K** for normal blood clotting and healthy bones.
4. **Vitamin E** to protect our body's cells and tissues from damage.
5. **Folate** for healthy red blood cells and a healthy heart.

6. **Calcium** for strong bones and blood pressure control.
7. **Potassium** and **Magnesium** for blood pressure control.

Everyone needs at least one vitamin-A-rich and one to two vitamin C-rich fruits or vegetables each day. You can do this if you eat your **5 A Day the Color Way.**

Fiber
Fiber is another benefit we get from eating fruits and vegetables. Why is fiber important? Fiber helps keep us "regular" by preventing constipation. Diets high in fiber can help lower cholesterol and reduce risk of some cancers. Fiber works best when you drink plenty of fluids, so drink eight glasses (two quarts) of water or other fluids every day.

Older adults should eat between 21 grams and 30 grams of fiber daily (*21 grams/day for women age 51 and older; 30 grams/day for men age 51 and older; NAS 2002*). If you eat 5 or more servings of fruits and vegetables daily and choose whole grain foods, you'll get enough fiber and won't have to count exactly how many grams you are eating each day.

Phytochemicals
Now, the vitamins, minerals and fiber that fruits and vegetables supply are very important. But the superstar right now may be the phytochemicals. What are phytochemicals you may ask? *Phyto* means plant in Greek. Phytochemicals are the natural plant compounds that give fruits and vegetables their deep, dark colors (like collards, sweet potatoes, cherries and blueberries), and their distinctive odors (like cabbages, onions, garlic and herbs). They are the very things plants use to protect themselves from pests (*or bugs/insects*) and sun damage. They also protect us when we eat fruits and vegetables. In fact, they may be very strong disease fighters – or "*phyters*" – and help fight cancer, heart disease, cataracts and diabetes complications (*write on flip chart – phytochemicals: disease "phyters")*. They may also help slow the effects of aging on memory, immune function, and inflammation. Like I said, veggies and fruits are practically nature's pharmacy. How can you not eat these beautiful and powerful foods? Phytochemicals are also found in grains and beans, but they are not found in vitamin or mineral supplements. So, this is one more reason to choose a wide variety of colorful fruits and vegetables every day rather than depending on only a few foods or on vitamin tablets.

Finding Five
So, how many servings of fruits and vegetables are recommended? (*5 to 9 servings every day*) How can you tell which fruits and vegetables are disease fighters? (**the most colorful ones – 5 A Day the Color Way**) What does 5 or more servings of fruits and vegetables look like? It is not as much as you think. Let's look at what an actual serving size is (*Use food models to show serving sizes)*:

1. **One fruit serving =**
   a. 1 medium-sized piece of fruit (an apple or orange the size of a tennis ball).
   b. ¾ cup (6 ounces) 100% fruit juice (diabetes serving size = ½ cup or 4 ounces).
   c. ½ cup frozen, canned, or fresh cut-up fruit.
   d. ¼ cup dried fruit.

2. **One vegetable serving =**
    a. ½ cup raw or cooked vegetables.
    b. ¾ cup (6 oz) 100% vegetable juice.
    c. 1-cup raw, leafy vegetables (like lettuces, spinach).

How can you make more colorful choices and eat **5 A Day the Color Way**? *(Refer to "Eat Your Colors The Easy Way" handout. (Use food models and paper plates/bowls and let a couple volunteers build colorful meals.)*

1. **Have two servings at breakfast**:
    a. Drink a glass of 100% orange, cranberry or tomato juice with breakfast.
    b. Top cereal or pancakes with berries or sliced bananas.
    c. Scramble eggs with chopped vegetables.
    d. Have a smoothie made with fresh, frozen or canned fruit.

2. **Choose two different colored vegetables at lunch and supper**:
    a. Eat salads with Romaine lettuce, dark leafy lettuce or spinach instead of iceberg lettuce; top salads with chopped, colorful veggies.
    b. Try baked or mashed sweet potatoes instead of white potatoes.
    c. Stir colorful mixed veggies into soups, stews or casseroles.
    d. Have spaghetti with tomato sauce (stir in extra vegetables also).
    e. Treat yourself to a fruit salad for dessert.
    f. Season foods with onions, garlic, chives, parsley or other herbs, and peppers.

3. **Have colorful, healthy snacks**:
    a. Grab apples, grapes, oranges, pears or peaches for quick snacks.
    b. Make a smoothie with fresh, frozen or canned fruit.
    c. Munch on raw veggies and lowfat dip.
    d. Try dried fruit with nuts and dry cereal.

Seasonal Fruits and Vegetables
Take advantage of seasonal produce for best flavor and better prices. You can usually get most fruits and vegetables throughout the year, but they can be more expensive when they are not in season. Canned and frozen produce or dried fruits are just as nutritious as fresh. They are convenient and are usually better priced than off-season produce.

Compare prices for ready-to-eat produce like bagged pre-washed salads or pre-cut veggies with whole produce. Sometimes the prices are not too bad when you consider the time you spend and the produce you waste when you prepare your own. Let's take a look at the handout, "Getting the Most for Your Money."

Let's review. How can you stay healthy and fit? **Eat 5 A Day the Color Way – 5 to 9 servings of colorful fruits and vegetables each day to stay healthy and fit**. What can eating 5 A Day the Color Way do for you? **Help fight cancer, heart disease and the effects of aging on my body.** Now, what are you going to do? **Eat 5 A Day the Color Way!**

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Nix, S., Stone, S., Wright, M.O., Fruits and Vegetables, 2003.

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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APPENDIX S. LESSON 1: INTRODUCTION – HANDOUTS

Eat Your Colors The Easy Way
5 Colorful Fruits and Vegetables Each Day

Have 2 Servings at Breakfast

- Scramble eggs with chopped vegetables.
- Top cereal, toast or pancakes with berries.
- Make a smoothie with fresh, frozen or canned fruit.

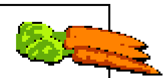
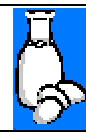
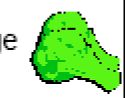
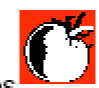
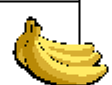
Choose 2 Servings at Lunch or Supper

- Choose two different colored vegetables at each meal.
- Make salads with Romaine, dark leaf lettuce or spinach.
- Top salads with chopped colorful veggies.
- Have fruit salad for dessert.
- Stir colorful mixed veggies into soups, stews or casseroles.
- Add raisins, apples, pineapple or grapes to chicken/tuna salad.
- Have baked or mashed sweet potatoes instead of white potatoes.

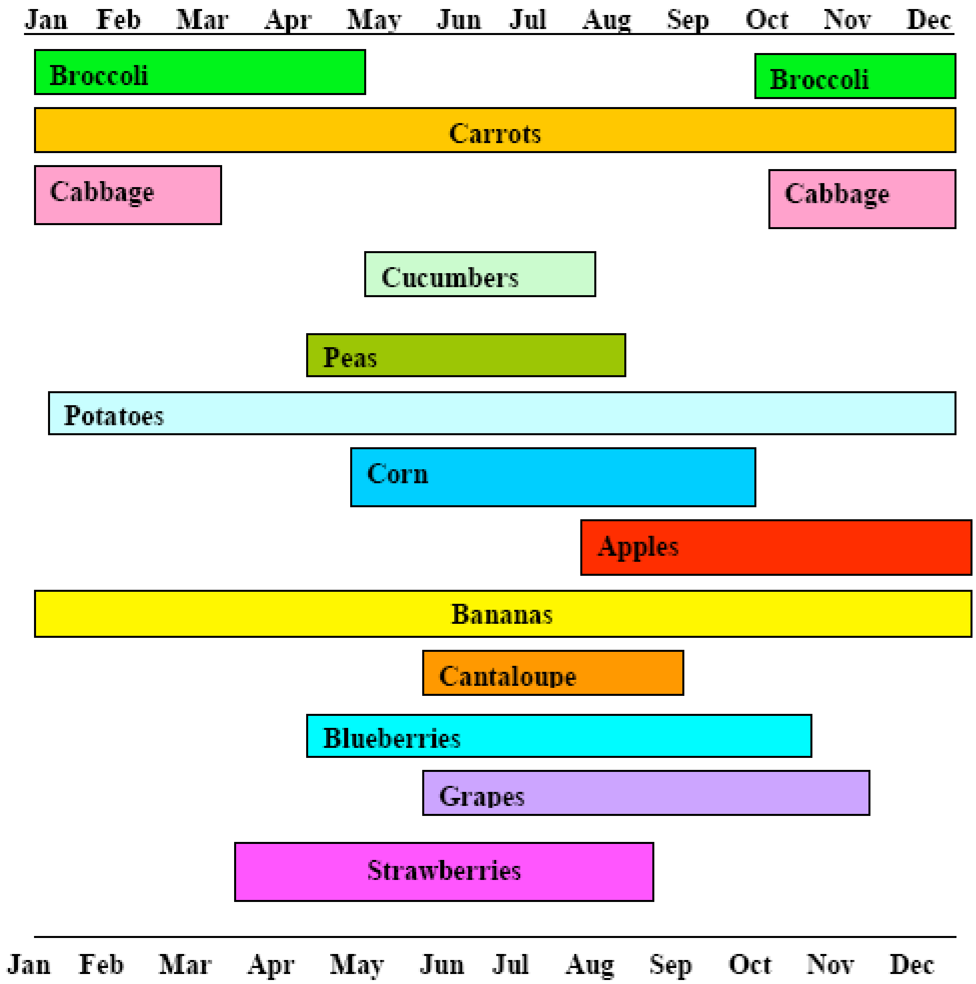
Pick Colorful, Healthy Snacks

- Grab apples, grapes, pears, peaches, or plums.
- Munch on raw veggies and low-fat dip.
- Make a parfait with low-fat yogurt, berries, melon, or peaches.

Food Sources of Vitamins

Vitamin	*Benefits*	*Sources*	
Vitamin A	Night vision Immune health	Sweet potato Spinach Mangos	Carrots Pumpkin Peppers 
Vitamin D	Bone health	Salmon Sardines Egg yolk 	Milk Liver
Vitamin K	Blood clotting Bone health	Spinach Broccoli Turnip greens	Kale Cabbage Lettuce 
Vitamin C	Antioxidant Immune health	Peppers Broccoli Strawberries 	Oranges Kiwi Tomatoes
Vitamin E	Antioxidant Helps protect blood cells	Vegetable oils Tomato paste Wheat germ	Nuts Seeds Peanut butter
Vitamin B6	Metabolism Energy use	Liver, beef Banana Brown rice	Oatmeal Potatoes 
Folate	Formation of red and white blood cells	Beans/peas Broccoli Okra	Leafy greens Oranges Avocado

Getting the Most for Your Money
When to Buy Seasonal Produce



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Nix, S., Stone, S. & Wright, M.O., Fruits and Vegetables, 2003.

Fruits

• Apples	Aug - Jan
• Oranges	Dec-Mar
• Grapefruit, Florida	Oct-Jun
• Peaches	Jul-Sep
• Strawberries	Mar-Apr
• Apricots	Jun-Aug
• Plums	May-Sep
• Watermelon	Jul-Aug
• Pineapple	Mar-Jun
• Cantaloupes	Jun- Aug

Vegetables

• Broccoli	Mar–Apr
• Cabbage	Jan-May
• Carrots	May-Jul
• Cauliflower	Jan-Mar
• Sweet Potato	Oct-Feb
• Lettuce	All year
• Onion, dry	May-Jun
• Bell Pepper	Aug-Nov
• Tomatoes	Jul-Oct
• Cucumbers	Apr-Sep

http://www.5aday.com/html/colorway/colorway_home.php

APPENDIX T. LESSON 1: INTRODUCTION – RECIPES

Garden Vegetable Slaw

2 cups shredded cabbage	2 tsp Dijon-style mustard
½ cup raw broccoli florets	2 Tbsp olive oil
¼ cup chopped celery	2 Tbsp vinegar
½ cup cherry tomatoes	1 tsp garlic powder

1. Combine cabbage, broccoli, celery and tomatoes in a large serving bowl.

2. Wisk together oil, vinegar, mustard and garlic powder in small bowl. Pour over vegetables and stir to mix well. Refrigerate before serving to allow flavors to blend. Makes 4 servings.

Nutrition Facts per serving (serving size = about ¾ cup)	
Calories	79
Total fat	7 grams
Total carbohydrate	5 grams

APPENDIX U. LESSON 2: BERRIES – LESSON PLAN

Fruits and Vegetables
Lesson 2: Berries

Getting Started
1. Review lesson plan before each session.
2. Copy handouts:
    a. *Staying Healthy and Fit with Colorful Berries*
    b. *Berry Expensive or a Berry Good Buy?*
    c. *Berry Delicious Treats for 5 A Day the Color Way*
    d. Recipes (4)
3. Gather supplies needed for lesson and activities.

Supplies Needed
1. Ingredients for recipe demonstration.
2. Supplies for tasting recipe, such as plates, forks or spoons, and napkins.
3. Food models of berries to display and refer to during lesson.

Beginning the Lesson
1. Introduce yourself
2. Summarize the lesson by reading the objectives.
3. Let the group know the lesson will be informal and they can ask questions any time.

Objectives: The participants will:
1. Understand the nutrition benefits of berries.
2. Learn new ways to prepare and eat berries.
3. Learn how to select and store berries.
4. Learn the protective effects of berries against heart disease and cancer.

Script

Introduction
(Display food models to refer to during lesson)

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day is our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you can reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit**

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **5 A Day the Color Way**!

Today we are going to talk about some of the smallest, but among the brightest colored fruit you may eat. They are so brightly colored they may stain your tongue when you eat them – any guesses? Yes, berries, brightly colored berries - red strawberries, blue blueberries and purple-black blackberries.

(Introduce and ask participants if they eat berries, how often they eat berries, and their favorite way to eat berries.)

Nutrition Benefits of Berries *(Refer to Staying Healthy and Fit with Colorful Berries handout.)* People have been eating strawberries, blackberries and blueberries for centuries. According to folklore, strawberries were considered a love potion, to show perfection and righteousness, symbolize peace and prosperity and to hold healing powers. Blueberries and blackberries are plants native to America and were around when the Pilgrims came from England. Both blueberries and blackberries had medicinal uses by Native Americans. Seems like folks centuries ago knew what scientists now think about all these berries - they may be disease fighters.

Disease fighters, indeed, these berries pack the nutrition benefits in their small packages. Berries are:

1. Rich in **vitamin C**, which helps you fight infections, have healthy gums, help wounds heal, and may help protect aging eyes from cataracts. One cup of whole strawberries (about 8 medium berries) supplies nearly 100 mg vitamin C – more than 100% of the RDA and more vitamin C than a medium orange supplies!
2. A good source of **folate**, a B-vitamin that is may be needed to help reduce risk of heart disease and colon cancer.
3. A good source of **potassium** – diets rich in potassium may help reduce the risk of high blood pressure and stroke.
4. A good source of **fiber** to help prevent constipation, and to help reduce risk of heart disease and some cancers. All these berries supply about 4 g fiber in a one-cup serving.

Berries supply **antioxidants**, one of which is vitamin C, which may help protect your body's cells and tissues from damage. (*If need to explain - What does this mean? Think of it this way – when you cut an apple and let it set, it will turn brown. You can say this is oxidation, similar to the damage that can happen in our bodies under different conditions. You can prevent the cut apple from turning brown by dipping it in lemon juice or orange juice, similar to how vitamin C acts as an antioxidant to help protect us from cancer, heart disease and maybe other conditions as we grow older. You can illustrate this with a cut apple if desired; cut before lesson and dip some slices in lemon or orange juice; see citrus lesson for more details.*)

Berries also contain phytochemicals, which are special disease fighters, or "phyters" in colorful fruits and vegetables (*illustrate the play on spelling out on a piece of paper*). These phytochemicals have fancy scientific names and are thought to be **antioxidants**, but it is easy to remember them this way – some are what make strawberries red, blackberries black-purple and blueberries blue. *Demonstrate by mashing a strawberry, blackberry and/or blueberry on a white paper plate or napkin and allowing it to be stained.* Just like sunscreen protects your skin from sunburn, it appears the staining colors of berries helps protect you against diseases. For example, scientists are discovering:

1. Blueberries rank as number one in **antioxidant** activity among forty fresh fruits and vegetables tested by scientists. This means they have high disease-fighting potential.
2. Blueberries and strawberries can help aging rats show improvements in memory and thinking, and in how they move and walk around. It is possible the berries may help humans with these activities also.
3. Blueberries contain phytochemicals that have been shown to help prevent urinary tract infections (*just like cranberries and cranberry juice – helps prevent bacteria from sticking to urinary tract*).
4. Berries similar to blueberries, called the bilberries, may help with eyesight.

"Berry" Expensive or a "Berry" Good Buy? *(Refer participants to the "Berry Expensive or a Berry Good Buy?" handout.)*
How many of you like to eat berries in spring and summer? *(wait for audience to respond)* How about in the winter? *(wait for audience to respond)* Many of us will eat berries in spring and summer because they are less expensive this time of year. They are in season. Even though we might think berries are expensive, think about the nutrition benefits we just talked about. Berries may protect our bodies in many ways. What about other foods that have similar costs—maybe a bag of potato chips, a box of snack crackers, or a 6-pack of soft drinks. Do you think these are too expensive if you buy them? *(wait for audience to respond)* We often don't think of those foods in the same way as fruits and vegetables. For example, it would take 11 ounces of potato chips (more than one large bag, supplying more than 1,600 calories) to supply the amount of vitamin C in 1 cup of strawberries (8 medium berries, 50 calories). Try to think of berries as a good investment for your health. Let's talk for a moment about some ways to save money when buying berries.

1. Look for sales on berries in your local grocery sale papers. Don't forget to check prices at local Farmers Markets or produce stands.

2. Stock up on fresh strawberries in spring and fresh blueberries and blackberries in the summer, when they're in season and cost less. Freeze extra by spreading unwashed berries out on a cookie sheet, allow to freeze, and then placing the frozen berries in a freezer bag. This way they won't stick together. Now you can have the fresh taste of summer berries all winter long! Rinse frozen berries just before using. *(Note: A good "prize" for participants in the summer would be freezer bags.)*

3. Buy berries from "U-Pick" farms, whether you pick them yourself or buy them fresh picked. Freeze extra berries for later (see above).

4. Buy frozen berries—they may cost less than fresh berries, stay fresh in your freezer, taste yummy and are good for you too! Keep extra berries in your freezer and eat several times a week.

"Berry" Delicious Treats *(Refer Berry Delicious Treats for 5 A Day the Color Way handout.)*

Berries are a healthy way to satisfy your sweet tooth! Even though strawberries, blueberries, and blackberries are delicious alone, you can add them to recipes to make them tastier and more colorful. Let's talk about some fun, easy, and delicious ways to fit berries in our diets. With all the nutrition benefits we talked about, you'll want to eat berries everyday! These ideas work with both fresh and frozen berries *(emphasize this)*.

- Keep it easy – take a handful of berries and pop in your mouth for an easy snack.
- Stir berries into your favorite flavor of yogurt, low-fat ice cream, or low-fat frozen yogurt.
- Spoon berries onto your favorite cold cereal or oatmeal.
- Add berries to a can of fruit cocktail for a more colorful fruit salad.
- Sprinkle blueberries or sliced strawberries onto a green salad.
- Add blueberries or blackberries to muffin batter or make berry cobblers.
- Dip whole strawberries in chocolate syrup for dessert.
- Mix up a creamy fruit smoothie with frozen berries, milk or yogurt, and orange juice.
- Make a berry sauce to top pancakes, waffles, biscuits or angel food cake: combine one cup of sliced strawberries or one cup of blueberries or blackberries (or combination of the three), 2 tablespoons lemon juice or orange juice and 1 to 2 tablespoons of sugar (or to taste). Let chill for a few minutes to form more juice before serving as a topping.
- Make fruit skewers by spearing together strawberries and other chunks of fruit, such as kiwi, bananas, melon, grapes, or pineapple. Serve with flavored yogurt for a dip.
- Make a fruit salad with blueberries and/or strawberries, peach slices, pineapple chunks, and cantaloupe or honeydew pieces (or other fresh or canned fruit).
- Try berry-yogurt popsicles: mix together 2 cups of berries and 2 cups low-fat lemon or vanilla yogurt. Pour into 12 popsicle molds or small paper cups. If using paper cups, place on a cookie sheet and cover with plastic wrap or wax paper; insert sticks or spoons through the wrap. Freeze popsicles for 1 to 2 hours or until firm. Enjoy! *(this is in the recipe handouts)*

Selecting and Storing Fresh Berries

Look for firm, plump berries for best flavor and quality. Berries should not be soft, shriveled or leaking from their container. Look for bright red strawberries with bright green tops—this means they are fresh. Strawberries that are white around the top may not be as ripe or sweet. The skin of blueberries and blackberries should not be torn. Look for firm, plump blueberries with light powdery-gray skins.

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Wade, J., & Wright, M.O., Berries, 2003.

Store berries in the produce drawer of your refrigerator. For fresher strawberries, store in a large container in a single layer with a dry paper towel on the bottom. Do not wash berries before storing and do not remove the green caps of strawberries until just before use. Fresh strawberries should be eaten within a week to 10 days after purchase. Blueberries may keep longer (about 2 weeks) if stored properly. When you're ready to use them, simply rinse berries with running water. For best flavor, allow berries to reach room temperature before serving. Remember you can freeze berries if you don't want to use them right away.

Activity - Okay, let's review before we try a tasty berry recipe. *(Prepare one recipe in advance for participants to sample, or demonstrate how to make the recipe)*

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating colorful berries do for you? *Help you stay healthy and fit – help with memory, reduce risk of high blood pressure, stroke, heart disease, cancer, cataracts, etc.*
3. Berries are a rich source of which vitamin? *Vitamin C*

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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Graphic artist: Wendy Gout

APPENDIX V. LESSON 2: BERRIES – HANDOUTS

Berry Delicious Treats for 5 A Day the Color Way!

- Keep it easy – take a handful of berries and pop in your mouth for an easy snack.
- Stir berries into your favorite flavor of yogurt, low-fat ice cream, or low-fat frozen yogurt.
- Spoon berries onto your favorite cold cereal or oatmeal.
- Combine berries and fruit cocktail for a fruit salad.
- Make a berry sauce to top pancakes, waffles, biscuits or angel food cake: combine 1 cup berries, 2 tablespoons lemon juice and 1 tablespoon sugar. Let chill to form juices, then serve.
- Make fruit skewers by spearing strawberries and other chunks of fruit, such as kiwi, bananas, grapes, or pineapple. Serve with flavored yogurt for a dip.
- Sprinkle blueberries or sliced strawberries onto a green salad.
- Add blueberries or blackberries to muffin batter or cobblers.
- Make fruit salad with blueberries and/or strawberries, peach slices, pineapple chunks and melon pieces (or other favorite fresh or canned fruit).

Berry Expensive or a *Berry* Good Buy?

- Look for sales on berries in your local grocery sales papers.

- Check out berry prices at local Farmers Markets or produce stands.

- Stock up on fresh strawberries in spring and fresh blueberries and blackberries in the summer, when they're in season and cost less.

- Freeze fresh, unwashed berries by spreading them out on a cookie sheet, freeze until firm, and then place in a freezer bag. This way they won't stick together and you can have the fresh taste of summer berries all winter long! Rinse frozen berries before using.

- Buy berries from *U-Pick* farms, whether you pick them yourself or buy them fresh picked. Buy extra berries and freeze for later use.

- Buy frozen berries - they cost less than fresh berries, stay fresh in your freezer, taste yummy and are good for you too! Keep extra berries in your freezer and eat several times a week.

Staying Healthy and Fit with Colorful Berries

Blackberries, blueberries and strawberries pack a lot of disease-fighting nutrients into their small packages. Berries are rich in **vitamin C** and are a good source of **folate**, **potassium** and **fiber**. Eat berries several times a week, if not every day to help:

- Fight infections, have healthy gums, help wounds heal and help protect aging eyes from cataracts.
- Reduce risk of heart disease and some cancers.
- Reduce risk of high blood pressure and stroke.

Berries are also packed with **antioxidants** and **phytochemicals**, special disease fighters (or "phyters") that give berries their bright colors and give you more reasons to eat berries:

- Blueberries and strawberries may help improve memory, thinking and how you move around as you age.
- Blueberries may help prevent urinary tract infections.
- Blueberries may help with eyesight.

Remember, eat by the rainbow – eat 5 or more colorful fruits and vegetable each day – and pick colorful berries to stay healthy and fit.

APPENDIX W. LESSON 2: BERRIES – RECIPES

Fruit and Juice Breakfast Shake

1 banana, peeled	¾ cup orange juice*
½ cup low-fat vanilla yogurt	½ cup fresh or frozen blueberries or strawberries

1. Break banana into small pieces and place in a blender container.

2. Add orange juice, yogurt, and berries to blender. Place lid on blender container and blend on medium speed until smooth. Serve immediately. Makes 2 servings.

*Can substitute pineapple or purple grape juice for orange juice.

Nutrition Facts per serving (serving size = 1 cup)	
Calories	168
Total fat	1 gram
Total carbohydrate	35 grams

Adapted from AboutProduce.Com, www.aboutproduce.com/recipes

APPENDIX X. LESSON 3: CITRUS FRUITS – LESSON PLAN

Fruit and Vegetable
Lesson 3: Citrus Fruits

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Staying Healthy and Fit with Citrus Fruits*
   b. *Best Bets for Fruity Drinking and Eating & 5 A Day the Color Way*
   c. *Selecting and Storing Citrus Fruits*
   d. *Vitamin C-Rich Fruits and Vegetables*
   e. Recipes (2)
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Handouts.
2. One apple to be sliced plus juice.
3. Juice and assorted glass sizes (4-, 6-, 8-, and 12-oz sizes if possible) OR food models
4. Ingredients for the recipe you prepare.
5. Supplies for tasting recipe, such as plates, forks or spoons, and napkins.

Beginning the Lesson

1. Introduce yourself
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Understand the nutrient benefits of citrus fruits.
2. Learn how to make healthy fruit juice choices.
3. Learn how to choose and store citrus fruits.
4. Understand the protective effects of citrus fruits against heart disease and cancer.

Script

Introduction
(*Display a basket/bowl of citrus fruit food models to refer during lesson.*

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day is our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight the effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit**

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **at least 5 servings of colorful fruits and vegetables every day.**

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Coffman, K., & Wright, M.O., Citrus Fruits, 2003.

Today we are going to talk about some of the yellow-orange fruits – citrus fruits. Eating these fruits may help reduce your risk of heart disease and some cancers, and help you avoid infections.

More specifically, we are going to talk about oranges, grapefruit, and lemons.

(Tell the fruit's name and ask the participants if they regularly eat this fruit, how often they eat it, why it might be their favorite, how they like to eat it or if they eat it all.)

I bet some of you drank orange or grapefruit juice this morning (*allow for show of hands*). You all have taken a step toward staying healthy by doing this. Citrus fruits are really nutrition superstars – from oranges and orange juice to grapefruits, tangerines, tangelos, clementines, lemons and limes.

Nutrition Benefits

Can anyone tell me what makes these citrus fruits nutrition superstars (*allow for answers*)? That's right, citrus fruits are a rich source of vitamin C. Vitamin C is an **antioxidant** that may help protect your body's cells and tissues from damage. What does this mean? Think of it this way – when you cut an apple and let it set, it will turn brown. You can say this is oxidation, similar to the damage that can happen in our bodies under different conditions. You can prevent the cut apple from turning brown by dipping it in lemon juice or orange juice, similar to how vitamin C acts as an antioxidant to help protect us from cancer, heart disease and maybe other conditions as we grow older. (*Can illustrate this with a cut apple if desired; cut apple before lesson and dip some slices in lemon or orange juice. Do not dip some slices to let turn brown.*)

We also need vitamin C daily for our immune system to stay healthy and help us fight infections, to have healthy gums, and help wounds heal. But vitamin C is not the only reason you should eat citrus fruits. Diets that include citrus fruits may help:

1. Reduce the risk of high blood pressure and stroke because they are a good source of **potassium**. (*FDA approved health claim states: Diets containing foods that are good sources of potassium and low in sodium may reduce the risk of high blood pressure and stroke. You may now see this claim on orange juice containers.*)

2. Lower cholesterol because they supply s**oluble fiber, or pectin**; this type of fiber can help the body get rid of excess cholesterol. (*FDA approved health claim states: Diets low in saturated fat and cholesterol and rich in fruits and vegetables that contain certain types of dietary fiber may reduce the risk of coronary heart disease.*)

3. Reduce risk of heart disease because they are a good source of the B-vitamin **folate** (folic acid), which can help lower harmful homocysteine levels; and because they supply vitamin C, potassium, and fiber (*see above*).

4. Reduce risk of some cancers because they are a good source of fiber, folate, **antioxidants**, like vitamin C, and special disease fighters called phytochemicals.

5. Reduce risk of blindness caused by age-related macular degeneration (AMD), because they are rich in **vitamin C**, which helps protect eyes because it is an **antioxidant**. Vitamin C may also play a role in reducing your risk of cataracts.

So are you convinced you should eat your citrus fruits or drink your citrus fruit juices to get the vitamin C and other superstar nutrients to stay healthy and fit? Great! So how much citrus fruit should you eat or citrus juice should you drink to get the vitamin C you need? As a rule of thumb, if you eat at least one to two vitamin C-rich fruits or veggies as some of your 5 A Day servings, you should be in good shape.

The Recommended Dietary Allowance (RDA) for vitamin C is 90 mg/day for adult men and 75 mg/day for adult women. Compare this to the amount of vitamin C supplied by these citrus fruits:

8 ounces 100% orange juice from concentrate	80 mg
8 ounces 100% grapefruit juice from concentrate	80 mg
1 medium orange	70 mg
½ grapefruit	50 mg
2 tangerines	50 mg
1 cup mandarin orange slices (canned)	50 mg

You see one to two servings of citrus fruits or juices can supply enough vitamin C. Of course, other fruits and veggies are good sources of vitamin C, and we will mention these in a moment. And it is not harmful to get more vitamin C-rich foods in your diet. Some research suggests that 200 mg of vitamin C a day is a healthy amount. You can get this much by eating several vitamin C-rich fruits and vegetables daily.

Now, let's talk about how you can eat more citrus fruits. *(Refer to Best Bets for Fruity Drinking and Eating 5 A Day the Color Way handout)*

1. Start your day with a glass of 100% orange or grapefruit juice (stick to 4 ounce servings if you have diabetes).

2. Have ½ grapefruit with breakfast.

3. Add orange or grapefruit sections to tossed salad.

4. Keep a bowl of oranges, tangerines and grapefruit on your counter to remind you to eat fruit with meals or as a snack.

5. Buy tangerines and tangelos for eat-out-of your hand snacks – these are easy to peel.

6. Keep cut-up orange quarters in a zip-top bag in your refrigerator for a ready-to-eat snack or dessert.

7. Add lemon or lime slices or juice to water, tea or other beverages for a tangy splash of flavor and vitamin C.

8. Season cooked vegetables with a mixture of 1Tbsp lemon or lime juice and 1 Tbsp vegetable oil. Add herbs to taste.

9. Keep canned mandarin oranges on hand to add to fruit salads, toss with green salads, top cottage cheese, or serve as a finger-food snack to grandchildren.

10. Buy chilled jars of grapefruit or orange sections for a trouble-free way to eat citrus.

11. Have ambrosia or other fruit salad with orange or grapefruit sections for dessert.

Do any of you have other suggestions *(allow for suggestions)*? How many of you seem to drink more fruit juice than you eat whole fruit? (*count hands*) How many of you eat more whole fruit than you drink fruit juice? (*count hands*) Fruit juice can definitely help you meet your 5 A Day servings, especially if you stick to 100% fruit juices. However, don't forget to eat whole fruit (fresh whole or cut, or canned). Whole fruit supplies fiber. Juice does not. Also keep in mind that juice tends to raise blood sugar levels more than whole fruit if you have diabetes or are at risk for high blood sugar levels. Let's go over a few tips for drinking fruit juice.

1. Select 100% fruit juices.
2. Drink no more than one to two servings of 100% fruit juice daily for your fruit servings. Remember to select whole fruit or cut up fruit also. (*Reminder – it's okay to drink more juice when sick and/or instructed by doctor to drink more fluids.*)
3. Remember that a serving size is six ounces, or ¾ cup.
4. If you have diabetes, limit your fruit juice serving to four ounces, or ½ cup. Drink your juice with meals, not by itself.

Demonstrate what four, six, eight and 12 ounces of juice look like with different size glasses.

Selecting and Storing Citrus Fruits
Look for citrus fruits that are heavy for their size and are well shaped. Store in your refrigerator. Citrus fruits will keep at room temperature for only a few days.

Grapefruit: Look for grapefruit with smooth, firm outer peel. Grapefruit may show some green skin; this is okay.

Tangerines and tangelos: Look for fruit heavy for its size. Because these are easy to peel, tangerines and tangelos make ideal snacks.

Oranges: Select oranges that are firm and heavy. Avoid fruit that is bruised, shriveled or moldy. Navel oranges are easier to peel, but other oranges may have better flavor.

Lemons: The best tasting lemons are heavy for their size and have smooth skin. Deep yellow lemons are usually riper than lighter yellow lemons. Let lemons sit at room temperature if you want to juice them (juice is easier to remove).

Limes: Choose firm, heavy limes for more juice. Limes are more fragrant and less acidic than lemons. Use lime juice to flavor or season foods and beverages.

Activity/Review

Okay, let's review before we try a tasty citrus recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating colorful citrus fruits do for you? *Help you stay healthy and fit – reduce risk of high blood pressure, stroke, heart disease, cancer, cataracts, etc.*
3. Citrus fruits are a rich source of which vitamin? *Vitamin C.*

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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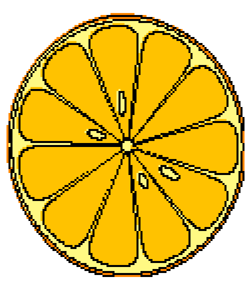
APPENDIX Y. LESSON 3: CITRUS FRUITS – HANDOUTS

Best Bets for Eating Citrus

- Start your day with a glass of 100% orange or grapefruit juice (stick to a 4 oz serving).
- Add orange or grapefruit sections to tossed salad.
- Have ½ grapefruit with breakfast.
- Buy easy-to-peel tangerines and tangelos for snacks.
- Add lemon or lime slices or juice to water, tea or other beverages.
- Keep cut-up orange quarters in a zip bag in your refrigerator for a ready-to-eat snack or dessert.
- Season cooked vegetables with a 1 Tbsp lemon or lime juice and 1 Tbsp vegetable oil. Add herbs to taste.
- Keep canned mandarin oranges on hand to add to fruit salads, top cottage cheese, or eat as a snack.
- Have ambrosia or other fruit salad with citrus sections for dessert.
- Keep a bowl of oranges, tangerines and grapefruit on your counter to remind you to eat fruit with meals or as a snack.



Selecting & Storing Citrus Fruits

All citrus
Look for fruit heavy for its size and well shaped. Store in your refrigerator. Citrus will keep at room temperature only a few days.

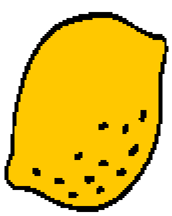
Grapefruit
- Look for grapefruit with smooth, firm outer peel. Grapefruit may show some green skin. This is okay.

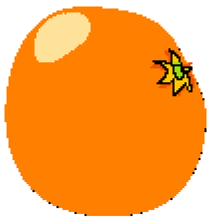
Tangerines/tangelos
- Because they're easy to peel, tangerines and tangelos make ideal out-of-hand snacks. Look for fruit heavy for its size.

Oranges
- Select oranges that are firm and heavy. Avoid bruised, shriveled or moldy fruit.

Lemons
- The best tasting lemons are heavy for their size and have a smooth skin. Deep yellow lemons are usually riper than lighter yellow lemons. Let sit at room temperature if want to juice.

Limes
- Limes are more fragrant and less acidic than lemons. Lime juice is often used to flavor or season foods and beverages. Choose firm and heavy limes for more juice.





Vitamin C-Rich Fruits and Vegetables
Choose 1 – 2 Servings Daily

Fruits	Vegetables
Guava, 1 medium	Red bell pepper, ½ cup
Papaya, 1 medium	Broccoli, ½ cup
Orange juice, 6 ounces	Green bell pepper, ½ cup
Orange, 1 medium	Tomato juice, 6 ounces
Cranberry juice, 6 ounces	Baked potato with skin, 1 medium
Strawberries, ½ cup	Tomato, 1 medium
Grapefruit, ½ half	Collard greens, ½ cup
Cantaloupe, ½ cup	Fresh spinach, 1 cup
Mango, ½ medium	Sweet potato with skin, 1 medium
Tangerine, 1 medium	Turnip greens, ½ cup
Watermelon cubes, 1 cup	Kale, ½ cup
Honeydew melon cubes, ½ cup	Butternut squash, ½ cup

Images from http://www.v-com.com/product/me_sample_site/page8.htm and http://www.orchidmall.com/arla/baskets.htm

Staying Healthy and Fit with Citrus Fruits

Citrus fruits and citrus juices are nutrition superstars that supply vitamin C, folate, potassium, fiber and phytochemicals that may help you stay healthy and fit. Eat citrus fruits to help:

- Fight infections with a healthy immune system.
- Reduce risk of high blood pressure and stroke.
- Reduce risk of heart disease.
- Lower cholesterol levels.
- Reduce risk of certain cancers.
- Protect eyes from cataracts and macular degeneration.

Meet your vitamin C needs with at least 1 – 2 servings of citrus fruits/ juices daily (for example, one orange or 8 ounces of orange juice supplies 70 - 80 mg of vitamin C).

RDA – adult men	90 mg
RDA – adult women	75 mg
RDA - smokers	125 mg (men) and 110 mg (women)

Vitamin C-Rich Fruits and Vegetables
Choose 1 – 2 Servings Daily

Fruits	Vegetables
Guava, 1 medium	Red bell pepper, ½ cup
Papaya, 1 medium	Broccoli, ½ cup
Orange juice, 6 ounces	Green bell pepper, ½ cup
Orange, 1 medium	Tomato juice, 6 ounces
Cranberry juice, 6 ounces	Baked potato with skin, 1 medium
Strawberries, ½ cup	Tomato, 1 medium
Grapefruit, ½ half	Collard greens, ½ cup
Cantaloupe, ½ cup	Fresh spinach, 1 cup
Mango, ½ medium	Sweet potato with skin, 1 medium
Tangerine, 1 medium	Turnip greens, ½ cup
Watermelon cubes, 1 cup	Kale, ½ cup
Honeydew melon cubes, ½ cup	Butternut squash, ½ cup

APPENDIX Z. LESSON 3: CITRUS FRUITS – RECIPES

Candace's Fruit Delight

2 Tbsp honey	2 ½ cups watermelon cubes
3 Tbsp lemon or orange juice	½ cup orange sections
1 ¼ tsp ground cinnamon	1 cup sliced strawberries
½ cup halved seedless grapes	

1. Combine honey, lemon juice and cinnamon in a small bowl and mix well. Cover and chill.

2. Meanwhile, combine all the fruit in a medium-serving bowl with lid. Toss with chilled dressing. Makes 6 servings.

Nutrition Facts per serving (serving size = ¾ cup)	
Calories	67
Total fat	0 grams
Total carbohydrate	17 grams

Adapted from *The New Soul Food Cookbook for People with Diabetes*, by F. D. Gaines and R. Weaver.

APPENDIX AA. LESSON 4: TOMATOES – LESSON PLAN

Fruits and Vegetables
Lesson 4: Tomatoes

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Staying Healthy and Fit with Tomatoes & 5 A Day the Color Way*
   b. *Buying and Storing the Best Tomatoes*
   c. Recipes (3)
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. One whole tomato (or ketchup packet) and white napkin to demonstrate lycopene.
2. Assorted fresh tomatoes and/or canned tomato products to display during lesson.
3. Ingredients for recipe demonstration (your choice of recipe).
4. Supplies needed for tasting recipe, such as plates, forks or spoons, and napkins.

Beginning the Lesson

1. Introduce yourself.
2. Summarize the lesson by reading the objectives.
3. Let the group know the lesson will be informal and they can ask questions any time.

Objectives – The participants will:

1. Understand the nutrition benefits of tomatoes.
2. Learn new ways to prepare and eat tomatoes and tomato products.
3. Learn how to select and store tomatoes and tomato products.
4. Understand the relationship of eating tomatoes and tomato products with reduced disease risk.

Script

Introduction
(Set up display of fresh tomatoes and/or tomato products to refer to at different times during lesson.)

Review: What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day is our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight the effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you can reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? Say it with me – **5 A Day the Color Way, eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit** *(hold up handout/show overhead)*.

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that may help you stay healthy and fit. That is why we need **5 A Day the Color Way**!

Today we are going to talk about red hot and healthy tomatoes. Before we talk about all the health benefits of tomatoes, we need to settle an old argument. How many of you think tomatoes are a vegetable? (*count*) How many of you think tomatoes are a fruit? (*count*) Both answers are sort of correct. Let me tell you a story so you can decide who is more correct.

Scientists say tomatoes are fruits. They meet the definition of a fruit because the edible part of tomatoes contains the seeds, as do all other fruits. However, in 1893, the U.S. Supreme Court ruled tomatoes to be legally a vegetable. The justices ruled them to be vegetables because they are eaten with the main part of the meal instead of at the end. Of course, this ruling made tomatoes subject to the tax on vegetables in place at the time. So what say you? Vegetable or fruit?

No matter what you call it, vegetable or fruit, or how you say it, "tuhmaytoe" or "tuhmahttoe," make sure you eat plenty of them.

(Ask the participants if they regularly eat tomatoes and tomato products, how often they eat either, and how they like to eat tomatoes and tomato products.)

Nutrition Benefits of Tomatoes *(Refer to handout)*
Tomatoes can be eaten in a lot of different ways. They can be eaten raw, stewed, roasted, grilled or made into sauces. Sandwiches, hamburgers, salads, chili and spaghetti wouldn't be the same without tomatoes. I know some of you said these are among your favorite ways to eat tomatoes. Now let's talk more about what makes tomatoes so good for you.

Tomatoes are loaded with vitamins, minerals, **antioxidants** and phytochemicals that all work together to help you stay healthy and fit. They are a rich source of vitamin C and a good source of vitamin A and potassium. These nutrients can help you:

1. Fight infections and heal wounds.
2. Reduce risk of heart disease and cancer.
3. Reduce risk of high blood pressure and stroke.
4. Have healthy eyes.

Tomatoes are also a rich source of a substance called lycopene (lie-co-peen). It is what gives tomatoes their rich red color (*If possible, squeeze a tomato onto a white napkin and show stain, or squeeze a ketchup package*). It also gives red color to watermelon and pink grapefruit, but tomatoes and tomato products are the richest sources of lycopene.

Lycopene is a rising superstar in the nutrition world. Just like a coat of red paint protects a bicycle from rust, this red lycopene seems to protect our body from disease. A lot of research suggests diets rich in lycopene may reduce the risk of prostate cancer. Not to worry ladies, diets rich in lycopene may also reduce the risk of lung, breast, colon and cervical cancers. Lycopene also seems to protect your heart and eyes from damage.

One large study found older adults with the highest amounts of lycopene in their bodies could do daily tasks better than those with lower levels of lycopene. They did better on tests of physical

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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Graphic artist: Wendy Gout

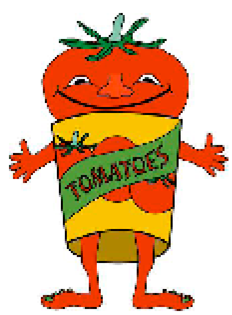
Buying and Storing the Best Tomatoes

Fresh Tomatoes

- Good quality ripe tomatoes should have a shiny skin and firm flesh. Look for tomatoes without marks or cracked skin. Avoid any that are too soft or with poor color.
- Fresh tomatoes should **always** be stored at room temperature. Tomatoes stored in the refrigerator will turn mushy and loose flavor fast.
- Store tomatoes out of sunlight and with the stem end up.

Tomato Products

- Stock up on prepared tomato products. They supply more lycopene per serving than fresh tomatoes.
- Try tomato sauce, spaghetti sauce, stewed tomatoes, diced tomatoes, tomato juice, tomato soup, salsa and even ketchup.
- Look for low-salt or low-sodium varieties when available.



Staying Healthy and Fit with Tomatoes & 5 A Day the Color Way

- Serve fresh tomato salsa with tortilla chips for a snack or spoon over grilled chicken or other meats. Make your own salsa or use bottled salsa.
- Add chopped fresh tomatoes to spaghetti sauce, soups, chili, stews and casseroles to add fresh taste and a nutrition boost.
- Enjoy pizza topped with your favorite vegetables.
- Have tomato soup for a quick lunch.
- Enjoy favorite dishes like tomatoes and rice, okra and tomatoes or tomatoes and zucchini.
- Add an extra can of stewed or diced tomatoes to chili.
- Have tomato juice for breakfast or with other meals.
- Top salads with tomato wedges or cherry tomatoes.
- Eat grape tomatoes out of your hand, with dip or add to salads.
- Try BLTs occasionally in summer when you have fresh or homegrown tomatoes (more Tomato, less Bacon).
- Make a quick side dish with sliced tomatoes, cucumbers, onions and your favorite dressing or marinade.
- Roast whole cherry tomatoes or tomato halves in hot oven for flavorful cooked tomatoes (425°F for 20-25 minutes).

APPENDIX CC. LESSON 4: TOMATOES – RECIPES

Macaroni, Beef, & Tomato Soup

½ pound ground beef	3 cans (11 oz) low-sodium tomato soup
1 medium onion, chopped	4 cups water
1 small green pepper, chopped	2 tsp lemon juice
½ tsp dried basil	½ tsp dried oregano
4 cups cooked elbow macaroni (2 cups uncooked)	

In a large pot over medium-high heat, cook beef, onion and pepper until beef is browned. Pour off fat.

Add basil, oregano, soup, water, lemon juice and macaroni to beef mixture. Reduce heat to low and cook until heated through. Makes 8 servings.

Nutrition Facts per serving (serving size = about 1.5 cups)	
Calories	190
Total fat	6 grams
Total carbohydrate	22 grams

Recipe adapted from Campbell's at www.campbellkitchen.com/GetRecipe

Stewed Green Beans and Tomatoes

1 Tbsp olive oil or canola oil	1 pound green beans, ends off
1 small onion, diced	2 medium garlic cloves, minced
salt and group pepper to taste	1 cup diced canned tomatoes
2 tsp parsley flakes	

1. Heat oil in large skillet over medium heat. Add onion and cook until softened, about 5 minutes. Add minced garlic and cook 1 minute.
2. Add tomatoes to skillet and simmer until juices thicken slightly, about 5 minutes.
3. Add green beans and salt and pepper, if desired. Stir, then cover and cook, stir occasionally. Cook until green beans are crisp tender, about 20 minutes. Cook an additional 10 minutes if softer green beans are desired. Stir in parsley when done and serve immediately. Makes 4 servings.

Nutrition Facts per serving (serving size = about ¾ cup)	
Calories	69
Total fat	3 grams
Total carbohydrate	10 grams

Adapted from *Cook's Illustrated*, Nov/Dec 1996, www.cooksillustrated.com.

APPENDIX DD. LESSON 5: CANNED AND FROZEN VEGETABLES AND FRUITS – LESSON PLAN

Fruit and Vegetable

Lesson 5: Canned and Frozen Vegetables and Fruits

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Can-Do Nutrition*
   b. *A Can-Do Plan to Get Your 5 A Day the Color Way*
   c. *Pack the Pantry*
   d. Recipe (1)
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Ingredients to prepare recipe.
2. Supplies for tasting recipe, such as plates, forks or spoons, and napkins.
3. Assorted canned and/or frozen vegetables to display and refer to during lesson

Beginning the Lesson

1. Introduce yourself.
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Know how to shop for nutritious and convenient frozen and canned fruits and vegetables.
2. Learn how to stock their pantry and freezer with nutritious and convenient canned and frozen fruits and vegetables.
3. Make a personal plan to eat five fruits and vegetables a day.
4. Understand the protective effects of eating five fruits and vegetables against heart disease and cancer.

Script

Introduction
(Display a variety of canned and/or frozen fruits and vegetables during lesson)

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day – 5 A Day the Color Way, our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit** (*hold up handout/show overhead)*.

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **5 A Day the Color Way**!

We are going to talk about eating canned and frozen fruits and vegetables to get your **5 to 9 servings of fruits and vegetables.**

(Display and tell the food names and ask the participants if they regularly eat these foods, how often they eat them, how they like to eat them or if they eat them all.)

Canned and Frozen Vegetables and Fruits *(Refer to Can Do Nutrition handout.)*
Now let's talk about why and how to shop for nutritious and convenient frozen and canned fruits and vegetables. But first, did you know that canned and frozen fruits and vegetables start as fresh produce picked at the peak of ripeness? This fresh picked produce travels a few miles to the cannery or freezing plant and is processed within hours of harvest.

1. Canned and frozen fruits and vegetables are packed full of nutrition – for the most part they are equally or even more nutritious than fresh produce.
2. The most colorful fruits and vegetables, which are the strongest disease fighters, are also available as canned and frozen.
3. Canned and frozen fruits and vegetables are always in season – because they are available year round.
4. Canned and frozen fruits and vegetables are an inexpensive way to get your 5 or more fruit and vegetable servings daily when out-of-season fresh produce is expensive (and poor quality).
5. Canned and frozen fruits and vegetables are easy to use in your favorite recipes and can help save preparation time (less chopping, dicing, peeling). They are the original fast food!
6. Choose canned vegetables or soups labeled, "No Salt Added" or "Reduced-Sodium" for less salt/sodium in your meals.
7. Choose canned fruits packed in their own juices, in light syrup or in water to save calories and for less sugar in your meals.
8. Look for canned fruits and vegetables that have no leaks or bulging ends. Small dents usually are not harmful as long as there are no leaks or bulges.
9. Look for frozen fruits and vegetables with firm packages. Avoid those that look like they have been thawed and refrozen.
10. Choose frozen plain frozen vegetables instead, of vegetables with cream, cheese or butter sauces, for less salt, fat and calories. Season yourself and enjoy.

Pantry Necessities *(Refer to Pack the Pantry handout.)*
STOCK UP! Make sure you always have convenient, nutrition-packed canned and frozen produce, as well as other convenient staples in your pantry to help you make quick, easy and nutritious meals anytime! Follow these helpful tips to STOCK UP your pantry!

1. **Canned or Frozen Fruits**: canned pineapple, peaches, pears, plums, cherries, mandarin oranges, or tropical fruit salad; frozen blueberries, blackberries, strawberries, raspberries, raspberries, peaches and melon.
2. **Canned Meats and Seafood**: tuna, turkey and chicken, packed in water or broth. Also consider canned/bottled clams, cod, crabmeat, haddock, oysters, salmon and shrimp.

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Coffman, K., & Wright, M.O., Canned and Frozen Vegetables and Fruit, 2003.

3. **Canned Vegetables**: tomatoes, tomato sauces and tomato pastes; green beans, peas, corn, carrots, mixed vegetables, sweet potatoes, spinach and beans; artichoke hearts, asparagus, beets, garbanzo beans and mushrooms are all terrific as salad toppers or recipe ingredients.
4. **Frozen Vegetables**: spinach, collards, turnip greens, broccoli, cauliflower, peas, corn, stir-fry veggies, mixed veggies, carrots, sugar snaps, lima beans, green beans, asparagus, and more.
5. **Soups**: keep favorites on hand, including those made with lots of vegetables. Try the lower-salt varieties. Keep broths on hand as a base for your own soups.
6. **Beverages**: stock up on 100% fruit and vegetable juices and canned evaporated milk.

Store your pantry items properly. Canned foods keep well at moderate room temperature (about 75°F or cooler). Canned foods have a shelf life of at least 2 years from the processing date on the can (which may be hard to find). Most cans now have a *for best quality use by* date stamped on the top or bottom. Refrigerate any unused portions of canned food in the refrigerator, but first place in a storage container with a lid. Do not store opened canned foods in the refrigerator in the can.

Rust or small dents on canned foods may not harm the contents as long as the can is not leaking. However, throw away any canned foods that are leaking or have bulging ends. Also, do not use any cans that hiss loudly or spew contents when opened because these may be spoiled.

Don't Forget 5 A Day the Color Way with Canned and Frozen Produce
(Refer A Can-Do Plan to Get Your 5 A Day the Color Way handout.)
Using canned and frozen fruits and vegetables can help you eat your recommended number of servings. Help me out here, how many servings of fruits and vegetables are recommended? (*5 to 9 servings every day*) Why do you need to eat 5 to 9 servings of fruits and vegetables daily? *So you can stay healthy and fit and reduce risk of cancer, heart disease, eye disease and other diseases of aging.* Which ones are the most beneficial? The most colorful fruits and vegetables – red, green, white, yellow-orange, blue-purple. So, get your 5 A Day the Color Way – 5 to 9 servings of colorful fruits and vegetables, even as canned or frozen.

Let's review, what counts as a fruit or vegetable serving?
1. One medium-sized piece of fruit (an apple or orange the size of a tennis ball).
2. One-half cup frozen, canned or fresh cut-up fruit.
3. One-half cup raw or cooked vegetables.
4. One cup raw, leafy vegetables (like lettuces, spinach).
5. Three-fourths (3/4) cup (6 ounces) 100% fruit juice or vegetable juice; four ounces (1/2 cup) if you have diabetes.
6. One-fourth (1/4) cup dried fruit.

Make a personal plan for getting your 5 A Day the Color Way:

Have 2 servings at breakfast:
1. Drink a glass (3/4 cup or 6 ounces) of 100% fruit juice with breakfast (1/2 cup or 4 ounces for anyone with diabetes).

2. Top cereal, pancakes or toast with 1/2 cup of a canned or frozen fruit, such as peaches, pears, pineapples, blueberries or strawberries.

Have 2 different colored vegetables at lunch and supper:

1. Thaw and drain frozen veggies (corn, peas, beans) and add to green salads.
2. Pour out a serving of two frozen veggies and microwave for quick side dishes.
3. Stir colorful mixed veggies (canned or frozen) into soups, stews or casseroles.
4. Have spaghetti and tomato sauce.
5. Heat canned reduced-salt vegetable soup or minestrone for a quick meal.
6. Treat yourself to a quick fruit salad for dessert (canned or frozen fruit).
7. Keep frozen chopped spinach on hand to thaw and add to dishes (spaghetti sauce, soups, stews, casseroles, quesadillas, etc.).

Go for colorful, healthy snacks:

1. Make a smoothie with frozen or canned fruit (chill canned fruit first).
2. Try applesauce and gingersnaps.
3. Eat pineapple tidbits and cheese.
4. Munch on dried fruit and nuts.

Resources

About Canned Foods, Perfect Pantry Checklist and Health and Nutrition. The Canned Food Alliance. 23 April 2003 <http://www.mealtime.org/>.

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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APPENDIX EE. LESSON 5: CANNED AND FROZEN VEGETABLES AND FRUITS – HANDOUTS

A Can-Do Plan to Get Your 5 A Day the Color Way

Have 2 fruit or vegetable servings at breakfast

- Top cereal, pancakes or toast with ½ cup of a canned or frozen fruit, such as peaches, pears, pineapples, blueberries or strawberries.

Have 2 different colored vegetables at lunch and supper

- Thaw and drain frozen veggies (corn, peas, beans) and add to green salads.
- Pour out a serving of two frozen veggies and microwave for quick side dishes.
- Stir colorful mixed veggies (canned or frozen) into soups, stews or casseroles.
- Have spaghetti with tomato sauce.
- Heat canned reduced-salt vegetable soup or minestrone for a quick meal.
- Keep frozen chopped spinach on hand to thaw and add to dishes (spaghetti sauce, soups, stews, casseroles, quesadillas).
- Treat yourself to a quick fruit salad for dessert.

Go for colorful, healthy snacks

- Make a smoothie with frozen or chilled canned fruit.
- Try applesauce and gingersnaps.
- Eat pineapple tidbits and cheese.

Can-Do Nutrition!
5 A Day the Color Way with Canned Fruits and Vegetables

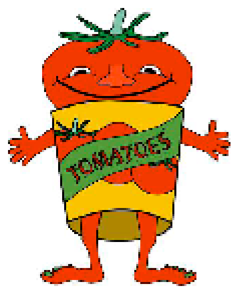
- The most colorful fruits and vegetables, the strongest disease fighters, are also available canned and frozen.
- Canned and frozen fruits and vegetables are packed full of nutrition – equally or even more nutritious than fresh.
- Canned and frozen fruits and vegetables are an inexpensive way to get your 5 or more fruit and vegetable servings daily.
- Canned and frozen fruits and vegetables are easy to use in your favorite recipes and can help save preparation time (less chopping, dicing, peeling). They are the original fast food!
- Choose canned vegetables or soups labeled, "No Salt Added" or "Reduced-Sodium" for less salt or sodium.
- Choose canned fruits packed in their own juices or in water to save calories and for less sugar.
- Look for canned fruits and vegetables that have no leaks or bulging ends. Small dents usually are not harmful as long as there are no leaks or bulges.
- Look for frozen fruits and vegetables with firm packages. Avoid those that look like they have been thawed and refrozen.
- Choose plain frozen vegetables, instead of those with cream, butter or cheese sauces, for less salt and fat, and fewer calories. Season yourself and enjoy.

Pack The Pantry

Stock your pantry with canned fruits and vegetables and other staples for quick, easy meals anytime.

Canned Vegetables
Tomatoes
Tomato sauce, paste
Green beans
Corn
Peas
Beans
Sweet potatoes
Mixed vegetables
Carrots
Spinach
Beets
Artichoke heart
Potatoes

Canned Meats/Nuts
Salmon
Tuna
Chicken
Mackerel
Sardines
Assorted nuts
Peanut butter



Canned Fruits
Pineapple
Peaches
Pears
Plums
Mandarin oranges
Tropical fruit salad
Fruit cocktail
Berries
Cherries

Soups, Stew, Broth
Vegetable soups
Vegetable stews
Tomato soup
Chicken, beef broths
Vegetable broth
Noodle soups
Chili
Bean soups
Bouillon

Staples
Jams, jellies
Evaporated milk
100% juices
Brown rice
Pasta
Herbs, spices
Coffee, tea
Flour, sugar

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APPENDIX FF. LESSON 5: CANNED AND FROZEN VEGETABLES AND FRUITS – RECIPES

Quick Fruit Salad

1 can (11 oz) mandarin oranges, drained	1 can (20 oz) pineapple tidbits, drained
1 can (10 oz) tropical fruit salad, drained	½ cup (4 oz) vanilla yogurt
2 Tbsp chopped nuts	Dash ground nutmeg or cinnamon

1. Combine drained, canned fruit in bowl with lid.
2. Stir in vanilla, chopped nuts, and nutmeg, if desired.
3. Chill and serve, or serve immediately.
4. Store leftovers in refrigerator and use within 5 days. Makes 6 servings.

Serve as dessert with a meal or have as a snack. Can use any combination of canned, drained fruits to make fruit salad. Choose canned fruits packed in juice or light syrup for fewer calories and less added sugar. Stir in chopped fresh apple or pear to add crunch, if desired.

Nutrition Facts per serving (serving size = about ¾ cup)	
Calories	128
Total fat	2.3 grams
Total carbohydrate	28 grams

APPENDIX GG. LESSON 6: LEAFY GREENS – LESSON PLAN

Fruits and Vegetables
Lesson 6: Leafy Greens

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
    a. *Eat Leafy Greens Several Times a Week.*
    b. *Choosing and Preparing Leafy Greens*
    c. *Salad Savvy*
    d. Recipes (4)
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Ingredients for a specific recipe you choose to prepare.
2. Supplies for tasting recipe, such as plates, forks or spoons, and napkins.
3. Fresh, pre-washed and bagged, canned and/or frozen greens to display and refer to during lesson

Beginning the Lesson

1. Introduce yourself.
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions any time.

Objectives – The participants will:

1. Understand the nutrition benefits of eating leafy greens.
2. Learn new ways to cook and prepare leafy greens.
3. Know how to choose and store leafy greens.
4. Understand the protective effects of leafy greens against heart disease and cancer.

Script

Introduction
(*Display fresh, pre-washed and bagged, canned and/or frozen greens to refer to during lesson.)*

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day – 5 A Day the Color Way, our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit**

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli, spinach, collards and turnip greens

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **5 A Day the Color Way**!

Today we are going to talk about some of the green vegetables – in fact, leafy greens. Green is thought to be the color of life. Eating leafy greens may help maintain eye health, help reduce risk of some cancers and help keep bones and teeth strong.

(Display the leafy green foods while you are talking. Ask the participants if they regularly eat these greens, how often they eat them, if any are their favorite and how they like to prepare leafy greens, if at all.)

Spinach, collards, turnip greens, kale, mustard greens and dark salad greens hold a lot of nutrients in their lush green leaves. What could they be packing in all those green leaves? (*Wait for responses.)* Yes, they do pack in many vitamins and minerals, which we will talk about in a moment. Did you know, the very things that make leafy greens DARK GREEN also makes them so nutritious and good for us. Let's take a closer look at the nutrition benefits found in our leafy greens.

Nutrition Benefits (*Refer to handout, Eat Leafy Greens Several Times a Week.*)
Leafy greens supply many vitamins and minerals we need to stay healthy and fit. They are a rich source of vitamin A (*from carotenoids*), vitamin C, and folate (*one of the B-vitamins*). Spinach is rich in vitamin K, while other leafy greens are a good source of vitamin K. Vitamin K is needed for normal blood clotting and healthy bones.

That's not all. The very things that give leafy greens their rich color help reduce risk of diseases. These **antioxidants** and phytochemicals are thought to be strong disease fighters. In part, they are also what cause the cooking water to turn yellow-green and the whole house to smell when you cook them.

Leafy greens are green in part because of the lutein (lou-teen) and zeaxanthine (zee-uh-zan-theen) they contain. These two substances may help protect your eyes from cataracts and macular degeneration, a leading cause of blindness in older adults.

You should eat leafy greens several times a week, if not every day, to have the benefits provided by greens:

1. Helps maintain healthy eyes and vision.
2. Helps keep immune system healthy to fight infections.
3. Helps reduce risk of cancer and heart disease.
4. Helps reduce risk of high blood pressure and stroke.
5. Helps reduce risk of cataracts and macular degeneration.
6. Helps keep bones and teeth strong, along with diet with enough calcium and vitamin D.

(Tell the audience that age-related macular degeneration is an eye disease that can develop with age. It is the leading cause of blindness in older adults in America.)

Choosing and Preparing Leafy Greens
Remember to eat leafy greens several times a week, if not every day, to help you stay healthy and fit. Now let's talk about how to choose and prepare these leafy greens. *(Refer to handout, Choosing and Preparing Leafy Greens)*

Spinach: Good quality spinach will appear fresh and clean. Its leaves should be fairly crisp and have good green coloring. Avoid wilted spinach. Refrigerate spinach in your vegetable crisper drawer of your refrigerator. Do not wash spinach until you are ready cook or serve it.

Fresh spinach can hold sand or dirt. It should be washed in several changes of water. Spinach is clean when there is no more sand in the bottom of the sink. Dry the spinach in a spinner or with paper towels.

You can buy pre-washed fresh spinach in bags. Bagged spinach can be a great buy and a time saver (*show a bag of pre-washed spinach and be prepared to tell how much it cost and how many servings it contains)*. How many of you have tried pre-washed spinach in bags? It may seem like a luxury item. Watch your grocery ads because it is often on sale. You may also find it is a good buy because you do not have to wash it and it may help you eat more spinach. You can use bagged spinach to make salads. You can also cook with it.

Spinach can also be bought frozen or canned. Frozen spinach is one item you should keep in your freezer. How many of you keep frozen spinach on hand? How do you use it? (*Allow for suggestions then add these*) Thaw and drain frozen spinach and use these ways:

1. Add to simmering spaghetti sauce for a quick veggie-loaded spaghetti.
2. Add to soups near the end of cooking (last 15 – 20 minutes).
3. Add to the cheese filling for lasagna to make spinach lasagna.
4. Fill a tortilla with cheese and spinach to make spinach quesadillas.
5. Stir a few tablespoons into scrambled eggs or omelets.
6. Add to casseroles.

Turnip and Mustard Greens: Turnip greens are slightly sweet when young, but can become tough and have a stronger taste as they age. Mustard greens have a slight peppery taste. Choose greens that are crisp with a good even color. Avoid greens that are wilted, discolored or slimy. Refrigerate in a plastic bag for up to three days. Thoroughly wash and remove any thick ribs before preparing.

Turnip and mustard greens may be cooked in a variety of ways including boiling, sautéing or braising, steaming and stir-frying. They can also be served alone as a vegetable or cooked and served with other greens. Canned and frozen greens are also available. Some grocery stores also carry pre-washed bagged turnip greens. What a time-saver!

Try healthy ways to cook and season greens. Cook in broth with lean ham instead of with fatback or bacon grease. Add onions, garlic and/or pepper vinegar to cooking greens for extra flavor.

Collard Greens and Kale: Kale has dark green leaves that are very curly on the ends. Collard greens have large dark green leaves. Some varieties of kale taste strong. Others are milder and may have a buttery taste. Collard greens have a sweeter taste than kale. Cook the two greens together to balance their flavors, though some of you may like the stronger taste of kale.

Kale and collard greens are available canned and frozen. Fresh leafy greens are in season from mid-winter to early spring, but can usually be found year-round. They are also available pre-washed in bags.

Store kale and collard greens in dry plastic bags for no more than 3 days in the refrigerator. You can also cook the greens and store them in the freezer in sealed plastic bags. How many of you cook a pot of greens and freeze them? *(Wait for responses.)* They keep in the freezer for months so you can use them in soups and casseroles when you don't have time to go to the store.

How many of you have grown your own greens in your garden? (*Wait for a show of hands*). What greens have you grown in your gardens? When do you usually grow your greens? Do/did you eat more greens when you grew them yourself?

Salad Greens: Dark colored salad greens pack more nutrition in each tasty leaf. Don't even think of only using pale iceberg lettuce in your salads or on your sandwiches. Try salad greens like Romaine lettuce, green leaf lettuce, red leaf lettuce, Boston, bibb or butterhead lettuce, tender field salad greens, radicchio (a small red/purple lettuce) and more. You can buy most of these pre-washed in bags. Salad in a flash!

Review and Activity

Look at your last handout, "Salad Savvy", and let's talk for a minute about all the different ways to give our green salads a makeover. Can you think of any more ingredients to add? Do you see anything that you hadn't thought of putting on a salad?

Okay, let's review before we try our tasty recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating dark leafy greens do for you? *Help you stay healthy and fit – reduce risk of high blood pressure, stroke, heart disease, cancer, cataracts, macular degenerations, etc.*

Prepare one recipe in advance for participants to taste test or choose one recipe to demonstrate in front of the participants for taste testing.

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Azain, L., Wade, J., & Wright, M.O., Leafy Greens, 2003.

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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APPENDIX HH. LESSON 6: LEAFY GREENS – HANDOUTS

Choosing and Preparing Leafy Greens

Fresh spinach – Look for crisp leaves with good green coloring. Avoid any wilted or slimy leaves. Store in your vegetable crisper. Do not wash until ready to use. Use to make salads or lightly cook for a side dish.

- **Fresh salad greens** – Look for clean, crisp leaves with good green coloring. Avoid lettuce that is wilted or has slimy spots. Store in your vegetable crisper drawer and wash just before using. Choose darker salad greens for more disease fighting benefits.
- **Turnip and mustard greens** - Choose greens that are crisp with a good even color. Wash greens well and remove any thick ribs before cooking. Greens may be cooked many ways - boiled, sautéed, steamed, or braised.
- **Collards and kale** – Choose dark green leaves that are crisp. Avoid any wilted or slimy greens. Cook collards and kale with other greens to balance flavors. Try braising or sautéing them with onions, garlic and pepper for a flavorful dish.
- **Pre-washed bagged lettuces and greens** – Salad greens, spinach and greens can be bought pre-washed and ready to eat or cook. Try these to save prep time. They can make it easier to eat your 5 or more servings of fruits and vegetables.
- **Frozen and canned spinach and greens** – These can save prep time and are just as nutritious. They are always in season and can help you eat leafy greens several times a week.

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Azain, L., Wade, J., & Wright, M.O., Leafy Greens, 2003.

Stay Healthy & Fit with 5 A Day the Color Way
Eat Leafy Greens Several Times a Week

Benefits of eating leafy greens include:

- Helps maintain healthy eyes and vision.
- Helps keep skin and tissues healthy.
- Helps keep your immune system strong to fight infections.
- Helps reduce risk of high blood pressure and stroke.
- Helps reduce risk of heart disease and cancer.
- Helps reduce risk of cataracts and macular degeneration.

Choose from a variety of leafy greens to stay healthy and fit.

- Red leaf or green leaf lettuce
- Romaine lettuce
- Boston or Bibb lettuce
- Kale
- Fresh spinach
- Radicchio (red lettuce)
- Green or red cabbage
- Turnip greens
- Collard greens
- Frozen spinach
- Frozen mustard, collard or turnip greens

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Azain, L., Wade, J., & Wright, M.O., Leafy Greens, 2003.

Salad Savvy

1. Choose one or more greens.	2. Choose one protein source.	3. Choose 2 or 3 fruits or vegetables.	4. Choose a dressing.
• Red or green leaf lettuce • Romaine lettuce • Boston or Bibb lettuce • Broccoli slaw • Spinach • Raddichio (red lettuce) • Shredded cabbage • Pre-washed variety lettuce mix 	• Walnuts • Almonds • Pecans • Peanuts • Boiled Egg • Sunflower seeds • Diced turkey • Diced ham • Grilled chicken breast • Shredded cheese • Tofu • Chickpeas • Kidney beans	• Cucumber • Carrots • Raisins • Pineapple chunks • Tomatoes • Cherry Tomatoes • Beets • Mandarin oranges • Mango • Apple • Purple cabbage • Onions Black olives • Mushrooms • Artichokes • Berries • Broccoli • Cauliflower	• Italian • Poppyseed • Ranch • French • Blue Cheese • Honey Mustard • Tomato Vinaigrette • Oil & Vinegar • Vidalia Onion • Caesar • Sweet & Sour *Most dressings are available in reduced-fat or fat-free versions.*

APPENDIX II. LESSON 6: LEAFY GREENS – RECIPES

Spinach & Orange Salad

2 Tbsp chopped pecans	¼ cup dried cranberries or raisins
8 cups (10 oz bag) fresh spinach, washed	½ cup raspberry vinaigrette
2 oranges, cut in sections, or 2 cans (11 oz) mandarin oranges, drained	4 Tbsp shredded cheddar cheese, optional

1. Toast pecans in a nonstick skillet over medium heat until lightly browned, about 3 minutes. Set aside.
2. Arrange 2 cups spinach each on 4 plates or salad bowls. Arrange ½ cup orange sections over spinach.
3. Top each salad with 1-tablespoon cranberries or raisins and 1 tablespoon of cheese, if using.
4. Drizzle vinaigrette over each salad. Serve immediately. Makes 4 servings.

Nutrition Facts per serving (serving size = 1 salad/about 2 ½ cups)

Calories	139
Total fat	3 grams
Total carbohydrate	27 grams

This is an official 5 A Day recipe adapted from NewStar/Ceres Fresh Foods, LLC.

Braised Greens with Garlic

Vegetable cooking spray	4 cups chopped, washed greens (try kale, collard or spinach)
1 Tbsp olive or canola oil	salt and pepper to taste, optional
¼ tsp red pepper flakes	vinegar
2 cloves garlic, minced	

1. Spray large skillet with vegetable cooking spray. Add olive oil to skillet and heat over medium-high heat.
2. Add red pepper flakes and garlic to heated oil and cook until garlic starts to sizzle, about 1 to 2 minutes.
3. Add greens and cook, stirring frequently, until greens are wilted and tender, about 5 minutes.
4. Season with salt and pepper, if desired, and splash with pepper vinegar or red wine vinegar. Serve immediately. Makes 4 servings.

Nutrition Facts per serving (serving size = about 3/4 cup)

Calories	46
Total fat	4 grams
Total carbohydrate	4 grams

Adapted from *The Color Code* (recipes section), by J.A. Joseph, D.A. Nadeau and A. Underwood.

APPENDIX JJ. LESSON 7: CRUCIFEROUS VEGETABLES – LESSON PLAN

Fruits and Vegetables
Lesson 7: Cruciferous Vegetables

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Fruits and Veggies – The Original Fast Food*
   b. *Shopping Tips*
   c. *Steamed Vegetables*
   d. Recipes
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Handouts.

Beginning the Session

1. Introduce yourself
2. Summarize the lesson by reviewing the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Know the nutrition benefits of broccoli, Brussels sprouts, cauliflower and cabbage.
2. Identify new ways to prepare and eat broccoli, Brussels sprouts, cauliflower and cabbage.
3. Learn how to select and store cruciferous vegetables.
4. Understand the protective effects of cruciferous vegetables against heart disease and cancer.

Script

Introduction

Let's review. What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day is our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit**

What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli, cabbage, Brussels sprouts and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that may help you stay healthy and fit. That is why we need **at least 5 servings of colorful fruits and veggies**!

We are going to talk about some of the green and white vegetables today – vegetables that may help reduce your risk of cancer and heart disease, help protect your eyes from cataracts and macular degeneration, and help keep bones and teeth strong.

More specifically, we're going to talk about **Broccoli**, **Cauliflower** and **Cabbage**.

(Introduce these three members of the cruciferous vegetable family. Tell the participants the vegetable's name and ask the participants which of these vegetables they regularly eat, how often they eat them, which is their favorite, how they like to prepare them or if they eat them at all.)

These three vegetables are from the cabbage or cruciferous vegetable family. Vegetables from the cruciferous family have flowers that form the shape of a cross. Isn't that neat? Brussels sprouts, kale, collards, mustard greens and rutabagas are also cruciferous veggies. All these vegetables can help protect you from the diseases we listed. We will also look at many easy ways to prepare, cook and serve these vegetables that are healthy and taste great too! Let's begin by learning about their nutrition benefits.

Nutrition Benefits

Broccoli, Brussels sprouts, cauliflower and cabbage should be known as nutrition superstars. These vegetables are rich in vitamin C and are good sources of folate and disease-fighting **phytochemicals**. Raise your hand if you know what phytochemicals can do for your body. (*Let participants tell what they know about phytochemicals.)* Phytochemicals are the natural plant compounds that give fruits and vegetables their deep, dark colors (dark green broccoli, red cabbage), and their distinctive odors (like cooked cabbage or cauliflower). They are the very things plants use to protect themselves from pests (*or bugs/insects*) and sun damage. They also protect us when we eat fruits and vegetables. In fact, they may be very strong disease fighters – or "*phyters*" – and help fight cancer, heart disease, cataracts, diabetes complications. They may also help slow the effects of aging on memory, immune function, and inflammation. The phytochemicals in broccoli, Brussels sprouts, cauliflower and cabbages may help reduce cancer risk and protect your heart. These vegetables are also rich in vitamin C, which we all need to help fight infections. You just need to eat them several times a week for these benefits!

Vegetables and Fruits - The Original Fast Food

What kinds of foods come to mind when I say fast food? *(Allow time for answers)* What about vegetables? Why not! While most people may visit the vending machine or a fast food restaurant when they want quick, cheap food, they may pay the price in the long run. It is not cheap to treat obesity, heart disease, cancer, high blood pressure or diabetes. Think about it this way, "Those who think they have no time for healthy eating will sooner or later have to find time for illness," (*attributed to Edward Stanley, 1826-1893, from the Conduct of Life)*. That is something to think about!

Vegetables and fruits are nature's original fast food anyway. Think how easy it is to keep fresh fruit in the house – just grab and eat for a snack, no waiting. Vegetables are easy, also. From frozen to canned veggies for quick cooking, to bags of baby carrots and other cut vegetables, and bags of pre-washed salad greens, your quick, easy choices are many (*show examples of these types of convenient vegetables/fruits)*. Eating **fruits and vegetable**s can be quick and easy if you

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Coffman, K., & Wright, M.O., Cruciferous Vegetables, 2003.

keep these foods on hand. Now, let's look at some ways you can eat broccoli, Brussels sprouts, cabbage, and cauliflower. (*Refer to Fruits and Veggies – The Original Fast Food handout.)*

1. Microwave or steam fresh or frozen broccoli, cauliflower or Brussels sprouts and serve as a side dish.
   - Sprinkle with 1 Tbsp shredded cheese or melted cheese for extra flavor.
   - Season with 1 Tbsp each of olive oil and lemon juice for zesty flavor.

2. Serve raw broccoli and cauliflower florets with dip for a snack or appetizer.

3. Make a tortilla wrap or burrito with cooked shredded cabbage and other vegetables.

4. Use frozen broccoli, cauliflower, carrot blend vegetables in a stir-fry. Serve with cooked rice or on top of cornbread.

5. Marinate thawed broccoli-cauliflower blend vegetables in Italian salad dressing and serve as a side dish or vegetable salad.

6. Buy pre-cut fresh broccoli and cauliflower when on sale for quick recipes.

7. Top hot baked potatoes with cooked broccoli and 1 Tbsp of melted cheese.

8. Buy pre-shredded cabbage for quick slaw or to add to soups or casseroles.

Shopping Tips - Buying Fresh Produce (*Refer to Shopping Tips handout*)
Broccoli: Good quality fresh broccoli will have fresh-looking, firm, light green stalks. The florets will be tightly closed and have a dark green to bluish-green color. Florets that are starting to open and look yellowish are old and will not taste good.

Brussels Sprouts: Fresh Brussels sprouts should be firm and green with tightly closed leaves. Avoid if leaves are yellow or have dark spots. Do not overcook to avoid a bitter taste.

Cabbage: Cabbage is a great buy in cooler months when other vegetables are in limited supply. Choose evenly colored, heavy, firm heads. Leaves should be tightly packed together and fairly smooth. Avoid if leaves appear wilted.

Cauliflower: Choose cauliflower that is creamy white with firm, compact florets and bright green leaves. Avoid cauliflower with lots of dark spots and wilted, yellow leaves.

Remember, frozen broccoli, Brussels sprouts and cauliflower are available year round, are just as nutritious, and are easy to prepare for a quick side dish.

Storing Fresh Produce
Vegetables will stay fresh longer if properly stored. Broccoli, Brussels sprouts, cauliflower and cabbage should be stored in your refrigerator's vegetable crisper. Do not wash before storing. You can also store these in a plastic bag in the refrigerator. Cabbage may stay fresh in the refrigerator for up to 2 weeks. The rest will stay fresh for up to 5 days. Store pre-cut, pre-

washed bags of vegetables in the original bag. This bag is designed to keep produce fresh much longer.

Washing and Trimming Produce
Wash these vegetables under cool, running water. Use a colander or strainer for easier washing. (*Can demonstrate the following if desired, especially if you demonstrate how to steam vegetables.*)

Broccoli: Trim large leaves and remove tough ends of stalks. Cut broccoli head into spears or florets. Peel the remaining stalks and cut into even sized pieces and cook with spears or florets.

Brussels Sprouts: Remove loose or discolored leaves. Cut off stem ends, careful to leave head intact. Cut any large sprouts in half before cooking.

Cauliflower: Remove leaves and cut off stalk. Cut and separate into even-sized florets or leave head whole to cook.

Cabbage: Remove outer leaves and cut out core. Then cut into 4 wedges or shred before cooking.

Activity/Review
(*Demonstrate in kitchen area if available, or demonstrate steps with supplies, with veggies prepared in advance. Alternately, prepare another recipe in advance and let participants taste. Refer to Steaming Vegetables handout.*)
How many of you have tried steaming vegetables? Microwaving vegetables? Both are quick and easy ways to prepare vegetables and not loose as many nutrients. First, you need a pot with a lid and steamer basket (or a metal colander that fits in a pot, but does not touch the bottom). Place the vegetables in a steamer basket or a colander. Add about ½ inch of water in a pot (or enough so water does not touch bottom of steamer basket or colander). You can add dried herbs, pepper flakes, or lemon/orange slices to season the water. You can also use broth instead of water. Place steamer basket of vegetables in pot and cover with lid. Cook at high heat until boiling. Then lower heat to low and cook until vegetables are crisp tender (*refer to timetable in handout*). Cook each vegetable about 2 minutes longer, or as needed, if more a tender vegetable desired (more nutrients lost with longer cooking).

Be careful when you remove the steamed vegetables from the pot. Pour into a serving dish and season. A mixture of 1 Tbsp of lemon juice, 2 tsp olive oil, butter or margarine, ground pepper and herbs season these vegetables nicely (use salt in small amounts if desired). You can also top hot, steamed vegetables with a small amount of shredded cheese.

Okay, let's review before we try a tasty recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating colorful cruciferous vegetables do for you? *Help you stay healthy and fit – reduce risk of heart disease and cancer, etc.*

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The Food Stamp Program provides nutrition assistance to people with low income. It can help buy nutritious foods for a better diet. To find out more, contact your local food stamp office, food bank, or senior center.

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APPENDIX KK. LESSON 7: CRUCIFEROUS VEGETABLES – HANDOUTS

Fruits and Veggies – The Original Fast Food
5 A Day the Fast & Easy Color Way

- Microwave or steam fresh/frozen broccoli, cauliflower or Brussels sprouts and serve as a side dish.
  - Toss cooked vegetables with 1 Tbsp each olive oil and lemon juice for zesty flavor.
  - Top cooked vegetables with 1 Tbsp melted cheese or 1 Tbsp shredded cheese for extra flavor.

- Serve raw broccoli and cauliflower florets with low-fat dip for a snack or appetizer.
- Make a tortilla wrap or burrito with cooked shredded cabbage, other vegetables and cheese.
- Use frozen broccoli, cauliflower and carrot blend vegetables in a stir-fry. Serve with cooked brown rice.
- Top hot baked potatoes with cooked broccoli and 1 Tbsp melted cheese.
- Buy pre-cut packages of broccoli and cauliflower when on sale.

Selecting and Storing Produce

Broccoli

- Firm, light green stalks.
- Bluish-green florets, tightly closed.

Brussels Sprouts

- Firm, green heads.
- Tightly closed leaves, no yellow color.

Cabbage

- Great buy in cooler months.
- Evenly colored, firm heads with tightly packed leaves.

Cauliflower

- Creamy-white heads with bright green leaves.
- Compact florets without dark spots.

Storing Vegetables

- Store these vegetables in the refrigerator crisper bin and use within a few days for better quality.
- Keep pre-cut, pre-washed bagged vegetables and salads in original bag once opened.
- Remember, frozen vegetables are available year round, are just as nutritious, and easy to prepare for a quick side dish.

Steamed Vegetables
Quick and Easy 5 A Day the Color Way

Vegetables (2 Servings)	**Steaming Time**	**Microwave Time (High)**
Fresh Vegetables Broccoli ½ head (¾ lb) in spears or florets	10 – 11 minutes	(½ cup water) 9 – 11 minutes
Brussels sprouts ½ lb	20 – 25 minutes	(¼ cup water) 8 – 11 minutes
Cabbage ½ head (2 wedges)	18 – 24 minutes	(¼ cup water) 10 – 14 minutes
Cabbage ½ head, shredded	5 – 7 minutes	(¼ cup water) 8 – 10 minutes
Cauliflower ½ head (1 lb) in florets	6 – 8 minutes	(¼ cup water) 12 – 14 minutes
Frozen Vegetables 2 cups	Reduce steaming times by half	Per package directions

Steaming directions

1. Use a pot with a lid and a steamer basket or metal colander.
2. Fill pot with ½ inch of water and place steamer basket inside. Make sure water does not touch bottom of steamer. Add herbs, red pepper flakes, or lemon or orange slices to season water, if desired. Can also use broth instead of plain water.
3. Place vegetables in steamer basket. Cover with lid and cook at high heat until boiling. Reduce heat to low and cook for time listed in chart, until crisp tender.
4. Removed steamed vegetables from pot (be careful with steam) and place in serving bowl.
5. Season as desired and serve hot.

Microwave directions

1. Place vegetables in microwave-safe dish with a lid.
2. Add the amount of water listed in chart and cover.
3. Microwave for amount of time listed in chart, rotating dish if oven does not have turntable.
4. Season as desired and serve hot.

Suggested seasonings

1. Combine 1 Tbsp lemon juice with 2 tsp olive oil (or butter or margarine). Drizzle over hot vegetables. Add ½ tsp dried herbs or 2 tsp fresh herbs, if desired.
2. Top vegetables with 1 Tbsp melted cheese or 1 Tbsp of shredded cheese.
3. Toss with prepared Italian salad dressing or other vinaigrette.

Adapted from *Betty Crocker's Cookbook: Everything You Need to Know to Cook Today*.

APPENDIX LL. LESSON 7: CRUCIFEROUS VEGETABLES – RECIPES

Cabbage Casserole

1 pound lean ground beef	½ cup uncooked rice
1 medium onion, chopped	1 (8 oz) can tomato sauce
3 cups shredded cabbage	1 cup water

1. Heat oven to 350 degrees. Meanwhile, brown ground beef and onion in skillet over medium-high heat until done. Drain the beef mixture to remove as much grease as possible and place in medium baking dish.

2. Spread the shredded cabbage evenly over beef mixture. Sprinkle rice over cabbage and then add the tomato sauce and water.

3. Bake in oven until most of the liquid is absorbed and rice is tender, about 50 minutes. Let sit about 5 minutes before serving.

Nutrition Facts per serving (serving size = 1 cup)	
Calories	193
Total fat	8 grams
Total carbohydrate	18 grams

Adapted from *The New Soul Food Cookbook for People with Diabetes*, by F. D. Gaines & R. Weaver.

APPENDIX MM. LESSON 8: SUMMER SQUASHES, WINTER SQUASHES AND PUMPKINS – LESSON PLAN

Fruits and Vegetables
Lesson 8: Summer Squashes, Winter Squashes and Pumpkins

Getting Started

1. Review lesson plan before each session.
2. Copy handouts:
   a. *Staying Healthy & Fit with Squashes and Pumpkins*
   b. *Choose 5 A Day the Color Way with Squashes and Pumpkins*
   c. Recipes (4)
3. Gather supplies needed for lesson and activities

Supplies Needed

1. Handouts.
2. Ingredients for recipe demonstration (choose from one of the recipes in this packet)
3. Plates, forks or spoons and napkins or other supplies needed to taste recipe.
4. Fresh summer or winter squash and pumpkins, depending on season, to display during lesson. Use canned or frozen items if fresh not available.

Beginning the Lesson

1. Introduce yourself
2. Summarize the lesson by reading the objectives.
3. Let the group know the lesson will be informal and they can ask questions any time.

Objectives – The participants will:

1. Understand the nutrition benefits of squash and pumpkin.
2. Identify the different varieties of squash.
3. Learn new ways to prepare and eat squash and pumpkin.
4. Learn how to select and store squash and pumpkin.
5. Understand the protective effects of squash and pumpkin against heart disease and cancer.

Script

Introduction
(*Display fresh summer squash or fresh winter squash or pumpkins – depending on season in which lesson is offered – to refer to during lesson.)*

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day – 5 A Day the Color Way, our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you can reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit** (*hold up handout/show overhead)*.

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and winter squash

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli, spinach and zucchini

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **5 A Day the Color Way**!

Today, we are going to talk about vegetables that come in summer and winter varieties. They also come in different colors – from yellow to orange to green. The summer varieties are tender, while the winter varieties come with a tough skin. Can anyone name these vegetables? *Wait for answers, prompt if necessary.* Right on, we are going to talk about the many types of summer squash and winter squash. We will also talk about why they are so good for us.

(*Display foods as you introduce them; ask participants if they eat these, how often they eat these and if any are favorites.*)

(*Bring in examples of these varieties of squash in season – winter or summer; use pictures in cookbooks or food encyclopedias, especially for the less familiar winter squashes.*)

As you can see, summer squash like yellow squash (or crookneck and straightneck squash), zucchini and pattypan squash are tender vegetables. You can even eat them raw if you like. Pumpkins and winter squashes have a hard outer shell and tough flesh. Pumpkin is actually in the gourd family of squashes. There are many types of winter squashes. Can any of you help name these? Yes, butternut, spaghetti and acorn squash are popular winter squashes. Have you also heard of hubbard, banana, delicata, and turban squashes? You may have seen these colorful squashes in grocery stores in fall or winter. Some of you may have used them as fall decorations.

Nutrition Benefits *(Refer to handout titled Why Fruits and Vegetables are So Good for You.)*
Yellow squash (crookneck and straightneck), pattypan squash and zucchini are summer favorites. How many of you grow these or have grown these in the past? How many of you have neighbors who grow these and share their crop with you (maybe sneaking large zucchini on your doorstep in the middle of the night!). These summer squashes are a good source of vitamin C. Remember vitamin C helps you fight infections and heal wounds. Also, diets rich in vitamin C may help reduce your risk of cancer, heart disease and cataracts. Summer squash is low in calories – about 20 calories in a ½ cup serving.

Summer squashes contain **antioxidant**s that give them their green and yellow colors. These are called lutein (lou-teen) and zeaxanthin (ze-uh-zan-theen). They are carotenoids, like beta-carotene. These two seem to help protect your eyes from a condition called macular degeneration. This is a leading cause of blindness in older adults. Eat summer squashes or other yellow-green fruits and vegetables every day to help protect your eyes (*examples include spinach, greens, corn, kiwi, okra, and broccoli*).

Winter squashes and pumpkins are all rich in vitamin A (*from carotenoids like alpha- and beta-carotene*). You can tell they are a good source of vitamin A from their rich yellow-orange colors. Remember vitamin A is needed for healthy eyes, lungs and skin and to help fight infections. Also, diets rich in vitamin A from fruits and vegetables may help reduce your risk of heart disease and cancer. Winter squashes and pumpkins are also a good source of vitamin C and fiber.

(*Include this part about pumpkins if you are focusing on winter squash and/or if it is fall.*) You may want to use pumpkins for more than jack-o-lanterns. You might say pumpkins are one of the foods that helped our country's early settlers survive. Native Americans were growing pumpkins long before any settlers arrive in America. Pumpkins became a staple for the Pilgrims when they settled in Massachusetts in the 1600s.

Shopping, Storage, and Preparation

Let's talk about how to buy and store fresh summer squash, winter squash and pumpkins. Summer squash (yellow crookneck or straightneck, pattypan and zucchini) should be firm, glossy, and should not have any brown spots or cracks on their skins. Do not buy squash that are shriveled. Store summer squash in the produce drawer of your refrigerator. Use them within 3 to 5 days after you buy them.

Look for smaller summer squash if you want a tender vegetable. Use larger squash in casseroles or in bread, like zucchini bread. Tender summer squash can be cooked in a variety of ways. They can be grilled, sautéed, used in stir-fry, oven roasted or stewed. Summer squashes can be eaten raw. Try them with your favorite lowfat dip or add them to a green salad.

Winter squash and pumpkin should be firm, heavy for their size, with no cracks or bruises. Avoid any with soft spots. Winter squash and pumpkins will keep for several months if they are ripe and the stem is attached. Store them in a cool, dry place, like on an open shelf or countertop. Do not store them in the refrigerator.

Winter squashes and pumpkins are often baked. You can cut them in half and bake in the oven or cook in a microwave. You can even bake them whole in the oven if you poke holes in the skin. Scoop out the cooked flesh and season with a little butter, salt and spices like cinnamon or nutmeg. You can also use the cooked flesh in recipes. Winter squash can also be peeled and cut into chunks and baked, boiled, steamed or pan-fried. You can eat the seeds of winter squash and pumpkin. Remove the seeds from the flesh. Rinse to remove strings. Place on an oiled baking sheet. Sprinkle with garlic powder, a pinch of salt and any other seasonings you desire. Roast in a hot oven (about 400°F oven) until seeds are toasted but not burned.

Don't forget about canned and frozen squash and pumpkin! They are good for you too and can save a lot of preparation time! Packages of frozen, sliced summer squash are great for casseroles and soups. Frozen, mashed winter squash makes a great side dish or recipe ingredient. Canned pumpkin is good to use in many recipes, including pumpkin pie. Canned pumpkin keeps most of its vitamin A and is an excellent way to increase your daily servings of vegetables.

Let's talk about some delicious ways that we can prepare summer squash, winter squash, and pumpkin.

(Refer participants to the handout "Easy ways to Enjoy Squash and Pumpkin")

1. Make a summer squash vegetable medley. Slice one yellow squash, one zucchini and one onion. Cook in a medium saucepan with ½ to 1 of cup water, 1 tablespoon butter, and your favorite seasoning. Try garlic powder, fresh or dried herbs, pepper or salt-free seasoning blends.

2. Pan-fry summer squash for a quick side dish. Slice one summer squash, one zucchini and one onion. Cook in skillet over medium-high heat in 1 to 2 tablespoons canola oil until crisp-tender. Add seasonings as you like.
3. Try raw slices of yellow squash, pattypan squash or zucchini with your favorite Ranch-style dressing or dip. Also add raw squash slices to green salads.
4. Add grated zucchini or yellow squash to quick bread or muffin recipes for moist, sweet bread.
5. Roast summer squash for quick, flavorful side dish. Toss thick slices or chunks of summer squash with olive oil, salt, pepper, garlic powder and fresh or dried herbs. Spread on baking sheet (line with foil for easier cleaning). Place in hot oven (450°F) and roast until edges of squash start to brown, about 15 minutes. Stir halfway through cooking.
6. Microwave winter squash for quick side dish. Cut a butternut or other winter squash in half. Scoop out seeds and strings. Place halves face down in a microwave-safe baking dish. Cook on high for 3 minutes. Remove, turn face up and season with cinnamon, sugar and butter. Return to microwave and cook on high until tender, about 7 to 10 minutes.
7. Keep canned pumpkin on hand for quick side dishes (mashed pumpkin), pumpkin bread or pumpkin pie.

Activity

Okay, let's review before we try a tasty squash recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating colorful summer or winter squashes or pumpkins do for you? *Help you stay healthy and fit – reduce risk of heart disease and cancers and help protect eyes.*

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APPENDIX NN. LESSON 8: SUMMER SQUASHES, WINTER SQUASHES AND PUMPKINS – HANDOUTS

Choose 5 A Day the Color Way with Squashes and Pumpkins

- Make a summer squash medley. Slice one yellow squash, zucchini and onion. Cook in medium saucepan with ½ cup water, 1-tablespoon butter or oil, and your favorite seasonings.

- Pan-fry summer squash for a quick side dish. Slice one yellow squash, zucchini and onion. Cook in skillet over medium-high heat in 1 to 2 tablespoons oil until crisp-tender, and then season.

- Try raw slices of yellow squash, pattypan squash or zucchini with your favorite dip or salad dressing. Add raw squash slices to green salads or pasta salads.

- Add grated zucchini or yellow squash (about 1 cup) to quick bread or muffin recipes for moist, sweet bread.

- Roast summer squash for a quick flavorful side dish. Toss cut squash with oil and seasonings. Spread on baking sheet. Place in 450°F oven and roast until edges start to brown, about 15 minutes. Stir once halfway through cooking.

- Microwave winter squash or pumpkins for a quick side dish. Cut squash in half, scoop out seeds and place in microwave-safe baking dish. Cook on high for 3 minutes. Season with cinnamon, sugar and butter. Microwave on high until tender, about 7 to 10 minutes.

- Keep canned pumpkin on hand for quick side dishes, bread or pie.

Staying Healthy & Fit with Squashes and Pumpkins

- Summer squashes (yellow squash, pattypan squash and zucchini) are good sources of vitamin C. Winter squashes (acorn, butternut, spaghetti, hubbard and turban) and pumpkins are also good sources of vitamin C.
    - Choose 1 to 2 servings of vitamin C-foods every day to have healthy gums, help fight infections and heal wounds, and reduce your risk of heart disease, cancer and cataracts.
- Winter squashes and pumpkins are rich in vitamin A.
    - Choose 1 to 2 servings of vitamin A-rich foods every day to have healthy eyes, lungs and skin, to fight infections, and reduce your risk of heart disease and cancer.
- Yellow squash and zucchini contain lutein and zeaxanthin, which give them their yellow and green colors.
    - Eat fruits and vegetables that supply lutein and zeaxanthin every day to help protect your eyes from macular degeneration (a condition that leads to blindness).
- Summer squashes and winter squashes are a good source of fiber.
    - Eat five or more servings of fruits and vegetables for the fiber and other nutrients you need to stay healthy and fit.

APPENDIX OO. LESSON 8: SUMMER SQUASHES, WINTER SQUASHES AND PUMPKINS – RECIPES

Squash Casserole

Vegetable cooking spray	1 (6 oz) package stuffing mix	1 Tbsp canola oil
1 medium onion, chopped	1 pound yellow squash, sliced	1 large egg
1 cup shredded carrots	1 cup (8 oz) reduced-fat sour cream	
1 cup reduced-sodium chicken broth		

1. Preheat oven to 375°F. Spray a 2-quart casserole dish with vegetable cooking spray, set aside.
2. Heat oil in skillet over medium heat. Add onion and sauté until softened, about 5 minutes. Set aside.
3. Combine squash and remaining ingredients in large bowl. Stir in cooked onion, mixing well.
4. Pour mixture into casserole dish. Bake until mixture is bubbly and lightly browned on top, about 30 – 40 minutes. Makes 8 servings.

Nutrition Facts per serving (serving size = about 1 cup)	
Calories	163
Total fat	6 grams
Total carbohydrate	23 grams

Adapted from Southern-Style Diabetic Cooking by Marti Chitwood, RD, CDE.

APPENDIX PP. LESSON 9: BEANS – LESSON PLAN

Fruits and Vegetables
Lesson 9: Beans

Getting Started

1. Review Lesson plan before each session.
2. Copy handouts:
   a. *How Much Fiber is in Beans?*
   b. *Stay Healthy and Fit with Beans, Beans and More Beans!*
   c. Recipes (3)
3. Gather supplies needed for lesson and activities.

Supplies Needed

1. Collect ingredients for the recipe you prepare.
2. Bring supplies for tasting recipe, such as plates, forks or spoons, and napkins.
3. Bring one can each of baked beans, pinto beans and black-eyed peas.
4. Bring assorted packages of dried beans to demonstrate varieties

Beginning the Lesson

1. Introduce yourself
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Understand the protective effects of beans against heart disease, cancer and other health conditions.
2. Learn the nutrition benefits of beans.
3. Know the amount of fiber recommended for older adults each day.
4. Identify ways to add beans to their diets.

Script

Introduction
(*Display different varieties of dried beans and the three types of canned beans.*)

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day – 5 A Day the Color Way, our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit** (*hold up handout/show overhead).*

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **at least 5 servings of fruits and vegetables**!

Let's begin today by playing a guessing game. Who can name a vegetable, or plant-food, that is: inexpensive; is a staple in many different cultures and has been for many centuries; is small and available in a variety of shapes and colors; is a rich source of protein and fiber; is available canned or dried; and has been considered by some to be magic (*Jack in the Beanstalk*). That's right – BEANS are all this and more!

Today we'll talk about beans, beans and more beans! Beans are also known as **legumes**. Peas, lentils, chickpeas (garbanzo beans) and peanuts are all legumes. ***How many of you have ever heard the word legume, spelled l-e-g-u-m-e, before?*** *(Allow the participants to respond.)* Legumes are not to be confused with a lagoon, spelled l-a-g-o-o-n, a body of water, like the place where the folks on Gilligan's Island were stranded. Legumes are plants that have pods with tiny rows of seeds inside. We will use the word **bean** instead of legume in our lesson today.

(Introduce and display the different kinds of beans. Ask the participants if they regularly eat this type of bean, how often they eat it, if it might be their favorite, or how they like to eat it.)

Health Benefits of Beans

People have been eating beans for thousands of years! Beans supply many of the nutrients thought to be important to help reduce risk of heart disease, cancer and obesity. Beans and peas are a rich source of fiber and protein – in fact they are a cheap source of protein and a good meat replacement or extender. One-half cup of cooked beans supplies about eight grams protein, or about as much as eight ounces of milk or 1½ ounces of meat. We will talk more about fiber in a moment.

Beans are also a good source of potassium, the B-vitamin folate, and special disease fighters called phytochemicals. Diets that include beans often may:

1. Help reduce risk of high blood pressure and stroke because they are a good source of potassium (*FDA approved health claim states: Diets containing foods that are good sources of potassium and low in sodium may reduce the risk of high blood pressure and stroke*).
2. Help reduce risk of heart disease because they are a good source folate**,** which can help lower harmful homocysteine levels.
3. Help reduce risk of some cancers because they are rich in fiber and a good source of folate and phytochemicals.

What is Fiber?

Now let's focus on fiber for a moment. What comes to mind when you think of fiber? What is it? Well, fiber is not just bran and "twigs" and it is not just a "medicine" for constipation. There is more to the story. Fiber gives plant foods their structure while they are growing and gives them the crunch or texture when they are eaten. Fiber is what we call the complex carbohydrates in plant foods, like beans, grains, nuts, fruits and vegetables, that our bodies cannot digest (*this is why it was once called roughage*). Fiber is either soluble or insoluble.

Insoluble fiber helps keep you regular and helps prevent constipation. **Soluble fiber** helps you digest foods more slowly and may help lower cholesterol and blood sugar levels. However, it may take large amounts of fiber to help lower blood sugar levels.
A variety of high fiber foods supplies both types of fiber.

Fiber-rich diets can help you avoid constipation, hemorrhoids and diverticulosis. That's not all. Fiber rich diets (that include beans, grains, nuts, fruits and vegetables):

1. May help reduce risk of heart disease, stroke, high blood pressure, certain cancers and type 2 diabetes.
2. May help with weight control by helping you feel full longer with fewer calories.
3. May help with diabetes management through better blood glucose control, though you have to consume large amounts of fiber to do this.

How much fiber do you need each day?
(Begin passing around the three cans of beans so the participants can read the amount of fiber each contains.)
I know you want to find out how much fiber you need daily to have all these benefits. Most healthy adults age 51 and older should consume between 21 grams and 30 grams of fiber daily (*21 grams/day for women age 51 and older; 30 grams/day for men age 51 and older; NAS 2002*). If you eat beans at least 3 to 5 times a week, and eat at least 5 servings of fruits and vegetables daily and choose whole grain foods, you'll get enough fiber and won't have to count exactly how many grams you are eating each day.

Let's look at these bean labels and find out how much fiber is supplied in a serving. First, look at the **Nutrition Facts** panel for the serving size (at the top). Then look for the words, **Dietary Fiber**, which is listed under **Total Carbohydrates**. What is the serving size and how much fiber is supplied (*probably 5 to 8 g, depending on variety*)? One serving of beans (1/2 cup) can supply about ¼ to 1/3 of your fiber needs.

Yes, but not too quickly!
Ready to jump on the fiber bandwagon? Hold on – don't jump too quickly. Increase your fiber intake slowly to give your stomach time to adjust if your diet is low in fiber now. You'll also need to drink plenty of water or other fluids (8 cups daily) to help avoid gas and stomach discomfort from a high fiber diet.

Let's look at the amount of fiber found in different kinds of beans and ways you can prepare high fiber foods.

How much fiber is in beans? *(Refer participants to How Much Fiber is in Beans handout.)*

Beans pack fiber in a small package!

Cooked beans:	Serving	Fiber (grams)
baked beans, plain or vegetarian	1/2 cup	5
kidney beans	1/2 cup	5
lima	1/2 cup	5
lentils	1/2 cup	4
peas (canned)	1/2 cup	4
pork and beans	1/2 cup	8
refried beans	1/2 cup	6
pinto	1/2 cup	9

Now let's look at some ways you can add beans to your daily menu!

Beans, beans and more beans!
(Refer participants to "Beans, Beans and More Beans" handout)
Take advantage of beans' health benefits by eating bean dishes at least 3 to 5 times a week. Eat beans more often if you do not eat much or any meat or other good sources of protein.

1. Substitute mashed beans for part of the ground meat in recipes like meatloaf or tacos. Replace ¼ pound of ground meat with ½ - 2/3 cup mashed beans.
2. Add beans to soups, stews or chili to replace some or all the meat.
3. Top your salads with drained beans. Try different varieties of beans - black, kidney, red, soybeans, chickpeas or garbanzos, lima, navy, great northern, or pinto beans.
4. Mash leftover cooked beans (or canned beans) and spread on a tortilla, top with salsa, sour cream and cheese. Roll up tortilla and enjoy a quick meal or snack.
5. Keep different varieties of canned beans on hand for a quick meal or to add to recipes.
6. Choose bean-based soups/stews for a filling, protein packed meal. Try split pea soup, lentil soup, chili, navy bean soup, ham and bean soup or black bean soup.
7. Toss together a bean salad with drained, canned beans and other vegetables (such as Three-Bean salad).
8. Keep dry beans on hand for making a steaming pot of beans in the winter.
9. Top pasta with steamed vegetables, beans and tomato/pasta sauce.
10. Make beans one of your choices when you have a vegetable plate at restaurants.

Activity

Okay, let's review before we try a tasty bean recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating beans do for you? *Help you stay healthy and fit – reduce risk of high blood pressure, stroke, heart disease, cancer, diabetes, etc.*
3. Beans are a rich source of what? *Protein and fiber.*

Now lets try one of our great bean recipes. The following recipes may be familiar to you or they may have a new twist to them! Whatever the case may be, try these and dare to expand your taste bud's horizons! *Prepare one recipe in advance for participants to taste test or choose one recipe to demonstrate in front of the participants for taste testing.*

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Coffman, K., & Wright, M.O., The Big Bean, 2003.

Stay Healthy and Fit with Beans, Beans and More Beans!

- Eat bean dishes at least 3 to 5 times a week. Eat beans more often if you do not eat many other good sources of protein.
- Substitute mashed beans for part of the ground meat in recipes like meatloaf or tacos. Replace ¼ pound of ground meat with ½ to 2/3 cup mashed beans.
- Add beans to soups, stews or chili.
- Top green salads with drained beans.
- Mash leftover cooked beans (or canned beans) and spread on a tortilla with salsa, sour cream and cheese for a quick meal.
- Keep different varieties of canned beans on hand for a quick meal or to add to recipes.
- Choose bean-based soups/stews for a filling, protein packed meal. Try split pea soup, lentil soup, chili, navy bean soup, ham and bean soup or black bean soup and more.
- Toss together a bean salad with drained canned beans and other vegetables (for example, a Three Bean Salad).
- Keep dry beans on hand for making a steaming pot of beans.
- Make beans one of your choices when you have a vegetable plate in restaurants.

How Much Fiber is in Beans?

Beans pack fiber in a small package!

Cooked beans:	Serving	Fiber (grams)
Baked beans	1/2 cup	5
Kidney beans	1/2 cup	5
Lima	1/2 cup	5
Lentils	1/2 cup	4
Peas (canned)	1/2 cup	4
Pork and beans	1/2 cup	8
Refried beans	1/2 cup	6
Pinto	1/2 cup	9

APPENDIX RR. LESSON 9: BEANS – RECIPES

Black Bean Dip

1 can (15 oz) black beans, drained
½ cup creamy salad dressing (such as Miracle Whip)
½ cup reduced fat sour cream
¼ cup salsa
2 Tbsp chopped fresh cilantro or parsley (or use 2 tsp dried)
½ tsp garlic powder
1 dash hot pepper sauce, or to taste
salt and pepper to taste, optional
1 can (4 oz) chopped green chili peppers
1 tsp chili powder
tortilla chips or cut vegetables

1. Mash beans with a fork in a medium-mixing bowl.
2. Add salad dressing, sour cream, green chilies, cilantro or parsley, chili powder, garlic powder, hot pepper sauce, salt and pepper if using, and salsa to mashed beans. Mix well and chill.
3. Serve as a dip with baked or regular tortilla chips and cut vegetables. Makes at least 8 appetizer servings.

Nutrition Facts per serving (serving size = about 1/3 cup)	
Calories	104
Total fat	4 grams
Total carbohydrate	13 grams

Vegetarian Bean Stew

1 Tbsp canola oil
2 cups chopped tomato
1 tsp dried oregano
½ cup shredded cheese, cheddar
¼ tsp ground pepper, optional
2 cloves garlic, minced
1/8 tsp salt, optional
1 cup green bell pepper, chopped
1 medium onion, chopped
2 cups zucchini, sliced
2 cups cooked brown rice
1 can kidney beans, rinsed and drained

1. Heat oil in a large soup or stockpot. Sauté onion and garlic in heated oil until tender, careful not to burn garlic. Add zucchini, green pepper, oregano, salt and pepper. Cook for 5 minutes.

2. Add tomato and beans to vegetable mixture. Cover and cook until thoroughly heated, about 15 minutes. Serve with hot cooked rice and sprinkle with shredded cheese. Makes 6 servings.

Nutrition Facts per serving (serving size = 1 cup stew)	
Calories	219
Total fat	5 grams
Total carbohydrate	34 grams

Adapted from *The New Soul Food Cookbook for People with Diabetes* by F.D. Gaines and R. Weaver.

APPENDIX SS. LESSON 10: GARLIC AND ONIONS – LESSON PLAN

Fruits and Vegetables
Lesson 10: Garlic and Onions

Getting Started

1. Review lesson plan before each session.
2. Gather supplies needed for lesson and activities.
3. Copy handouts:
    a. *Meals + Garlic and Onions = A Happy Heart and Tummy*
    b. *Be Smart about Garlic and Medicines*
    c. *Take Care To Prepare*
    d. Recipes (3)

Supplies Needed

1. Handouts
2. Ingredients for recipe you choose to prepare.
3. Supplies for tasting recipe, such as plates, forks or spoons, and napkins
4. Minced garlic and/or onions to set out before lesson to allow odor to spread.
5. Fresh garlic bulbs, garlic powder, bottled minced garlic and/or varieties of onions to display and refer to during lesson).

Beginning the Lesson

1. Introduce yourself
2. Summarize the lesson by giving the objectives.
3. Let the group know the lesson will be informal and they can ask questions anytime.

Objectives – The participants will:

1. Understand the health benefits of garlic and onions against heart disease and cancer.
2. Learn the risk of eating too much garlic while taking blood thinners and/or eating foods and herbs that act like blood thinners.
3. Learn how to select and store garlic and onions.
4. Identify new ways to prepare garlic and onions.

Script

Introduction
(*Set out an open container of chopped garlic and/or chopped onion before you begin lesson to allow odor to spread to audience. Display other examples of garlic and onions to refer to during lesson.*)

What may be the secret to staying healthy and fit as we age? **Eating 5 to 9 servings of colorful fruits and vegetables every day is our age-defying formula for health that may help:**

1. **Fight cancer.**
2. **Fight heart disease.**
3. **Fight effects of aging** (on eyesight, memory, immune function and painful inflammation).

Remember, if there is one thing certain about diet, it is that you may reduce your risk of cancer, heart disease and other conditions associated with aging if you eat at least 5 servings of colorful fruits and vegetables daily, as part of an overall diet low in saturated fat and cholesterol.

So, how are all of you going to help yourself fight cancer, heart disease and other diseases of aging? **By eating 5 to 9 servings of colorful fruits and vegetables every day to stay healthy and fit** (*hold up handout/show overhead*).

Let's review. What is the rainbow of colors for staying healthy and fit?

Blue-purple – like blueberries, blackberries, raisins and eggplant

Yellow-orange – like oranges, grapefruit, peaches, summer squash and sweet potatoes

Red – like strawberries, cherries, tomatoes and red cabbage

White – like bananas, onions, garlic and cauliflower

Green – like grapes, kiwi, broccoli and spinach

Just like the different colors of *Lifesavers ™ Candy* represent different flavors, different colors of fruits and vegetables represent different flavors and different disease-fighting nutrients that help you stay healthy and fit. That is why we need **at least 5 servings of fruits and vegetables daily!**

Today we are going to talk about vegetables that are such strong disease fighters you can smell their strength. I think I can smell them now. Can anyone else? What is it? *Wait for answers.* That's right, garlic and onions (*pick up containers of chopped garlic/onions and pass around*).

(Introduce and display these foods. Ask the participants if they regularly eat garlic and onions, how often they eat them, or how they like to eat them.)

Garlic and onions have been around a long time. People in ancient times linked onions with eternal life because of their seemingly endless layers. They also thought onions had various healing powers. Garlic has been used in medical treatments for centuries. Healers long ago used garlic to thin blood and to kill bacteria. Today, scientists are finding these ancient doctors may have been on to something.

Nutrition Benefits
When you think of garlic and onions you probably think of their distinct odors and the delicious flavors they add to foods. Did you know that the substances in garlic and onions that make them smell so strongly are also what make them strong disease fighters? It is true. In part, the garlic and onion odors are due to phytochemicals called allicin and organosulfur compounds, the same compounds that scientists think show disease fighting actions. *If necessary, review phytochemicals – special disease fighters, or "phyters," in fruits and vegetables that are also responsible for the bright colors and distinct odors of produce.*

People who study garlic and onions think people who eat garlic and onions have less heart disease and cancer. In fact, garlic and onions may have many disease fighting activities:

1. May help thin blood and reduce risk of heart attack and stroke.
2. May help lower total blood cholesterol and help increase HDL cholesterol (good or healthy cholesterol) and thus reduce risk of heart disease.
3. May help reduce inflammation, a common problem in many diseases, including asthma, heart disease and arthritis.
4. Can kill cancer cells in test tubes and may help reduce risk of cancer in humans who eat garlic and onions.
5. May help reduce risk of stomach ulcers caused by certain bacteria due to antibacterial properties.

Garlic and onions may do all this and add great flavor to food. Does this make you want to eat more garlic and onions? The evidence seems to suggest you'll reduce your risk of heart disease and cancer if you do. (*Show handout, **Meals + Garlic and Onions = A Happy Heart and Tummy**, as a reminder to include garlic and onions in meals.)*

Alert! Avoid too much of a good thing
Even though garlic and onions are power-packed veggies, it is possible to eat too much of these good foods in some cases. You have to know when to say **Enough**. Garlic can help fight heart disease because it works like a blood thinner. This helps prevent blood clots from forming and causing a heart attack or stroke. However, eating too much garlic may make your blood *too* thin if you also take certain medicines.

If you take medicine to prevent blood clots, then eating lots of garlic and onions may cause your blood to become too thin. If you are taking blood thinners (like Coumadin®, warfarin or aspirin), it is very important to **NOT** eat large amounts of garlic.

REMEMBER – A good rule of thumb about eating garlic:

1. If you ***ARE NOT TAKING*** blood thinners, then eat up to five cloves of garlic per day.
2. If you ***ARE TAKING*** blood thinners (e.g., Coumadin®, warfarin or aspirin) or eating foods or herbs that act like blood thinners, then eat no more than one garlic clove per day.
3. If you are scheduled to have surgery, stop eating garlic two to three weeks before surgery and wait to begin eating garlic until two to three weeks after surgery (or as directed by your doctor).
4. If you are eating large amounts of garlic, do **NOT** eat these foods or take these supplements: high intakes of vitamin E, fish oil and fish oil supplements, ginkgo biloba, feverfew, ginger and ginseng. **Always** tell your doctor if you take these items.

REMEMBER: These are general tips. Discuss the possible problems of any medicines you are taking with your doctor. (*Show handout, **Be Smart About Garlic and Medicines,** to reinforce the message.)*

Shopping and Storage Tips
Fresh garlic and onions add more power to the punch. When shopping, use these tips to find the freshest.

Garlic: Good quality garlic has firm, plump bulbs with tightly closed cloves. The outside skin should be tight and unbroken. Do not buy shriveled, soft, sprouting, or moldy bulbs. Store garlic in a cool dry place that is well ventilated. Do not store fresh garlic in the refrigerator and do not store near potatoes or onions.

Onions: Good quality onions do not have sprouts or show decay. They should be dry and firm. Some varieties are flatter in shape and have fewer, lighter colored, paper skins than storage onions. Store onions in a cool, dry place that is well ventilated. Do not store whole onions in plastic and do not store in the refrigerator. Also avoid storing onions near garlic or potatoes. Cut or chopped onions can be stored in the refrigerator in sealed containers or ziptop bags for 2 to 3 days.

You may want to try other vegetables and herbs that contain the same disease fighting compounds as onions and garlic. These include scallions or young green onions; red onions, which have a sweeter flavor than yellow onions and additional disease-fighting phytochemicals; shallots (shah – lots or shal – lets), which look like small onions with more concentrated flavor; leeks, which look live overgrown scallions with a milder, sweeter taste; and chives, a herb that gives foods a mild onion flavor (often served with baked potatoes).

Cooking Tips
The way garlic is cooked affects its power to fight disease. Heat from cooking stops the release of the disease fighting parts of garlic. As little time as 30 seconds of microwave cooking, or 20 minutes of oven cooking has a big effect. But, there is something you can do.

Crush or chop garlic cloves and let them sit for about 10 minutes at room temperature before cooking. This allows time for the disease-fighting compounds to be released before they are heated. Also, try to cook garlic and onions for only short amounts of time.

For best results when cooking or sautéing garlic and onions (and/or with other vegetables) for recipes, add the garlic after the onions (or other vegetables) have begun to soften. This allows the garlic to cook for less time and helps prevent it from burning and developing an off-flavor. (*Show handout, **"Take Care to Prepare"** as a reminder for pre-preparation of garlic and give handouts of recipes using garlic and onions.)*

Staying healthy and fit with garlic and onions
Be sure to add onions and garlic to your meals each day. Try some of these suggestions:

1. Include chopped onions and garlic in veggie stir-fry.
2. Simmer peeled garlic cloves (cut in half) in soups and stews.
3. Add peeled garlic cloves to simmering potatoes when making mashed potatoes. Mash garlic with potatoes to make garlic mashed potatoes.
4. Include a mixture of garlic and onions in soup, stew and casserole dishes.
5. Add quartered onions to roasted vegetable recipes.
6. Sprinkle garlic powder over cooked vegetables or on green salads.
7. Add onion slices to sandwiches or salads.
8. Try French onion soup for a warm meal.
9. Add mashed garlic to your favorite salad vinaigrette and let steep to add flavor.

Activity
Okay, let's review before we try a tasty recipe.

1. How many servings of fruits and vegetables do you need to eat daily? *At least 5 a day.*
2. What can eating garlic and onions do for you? *Help you stay healthy and fit – reduce risk of heart attack, stroke, lower cholesterol, reduce inflammation, reduce risk of cancer, etc.*

Prepare one recipe in advance for participants to taste test or choose one recipe to demonstrate in front of the participants for taste testing.

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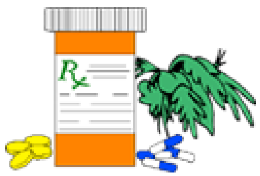
Be Smart About Garlic and Medicines



If you are taking blood-thinners, aspirin, or other blood-thinning drugs or herbs …

+

… and eating garlic …

=

…limit garlic to 1 clove per day.

If you are NOT taking blood-thinners, aspirin, or other blood-thinning drugs or herbs …

+

… and eating garlic …

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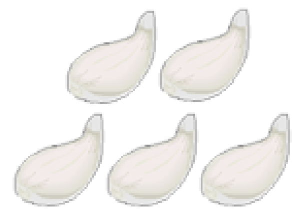

… eat 2 to 5 garlic cloves per day for good health.

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APPENDIX UU. LESSON 10: GARLIC AND ONIONS – RECIPES

Salsa

14.5 oz. diced tomatoes, canned
11.5 oz. tomato juice
2 oz. green pepper, chopped
2 oz. onion, chopped
dash garlic powder
2 oz. green chilies, canned
2.5 oz. jalapenos, canned, diced

4 Tbsp cider vinegar
½ tsp salt
½ tsp Tabasco sauce
½ tsp granulated sugar
1/8 tsp cayenne pepper
1/8 tsp cumin, ground

1. Combine all ingredients in a bowl.

2. Mix well and serve.

Avocado Salsa

1 medium avocado	1 large, ripe tomato	¼ cup finely chopped red onion
2 tsp dried cilantro*	2 cloves garlic, minced	½ tsp ground cumin
½ tsp black pepper	½ tsp salt, optional	juice of 1 large lime (~2-3 Tbsp)

1. Combine all ingredients in medium-mixing bowl. Stir well, but careful not to break up vegetable chunks.

2. Chill well before serving to allow flavors to blend. Serve with tortilla chips, cut vegetables or as a topping for salad or other vegetables. Makes 12 servings.

*May substitute 2 Tbsp fresh chopped cilantro

Nutrition Facts per serving (serving size = about 2 Tbsp)

Calories	30
Total fat	2 grams
Total carbohydrate	2 grams