The Evaluation of a Pilot Theory-Based Nutrition Intervention Promoting a Mediterranean Diet for the Reduction of Cardiovascular Disease Risk Factors in a High-Risk Population of the Southeastern United States: The Healthy Hearts Program

by

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Abstract

In the United States, Cardiovascular disease (CVD) is responsible for 25% of deaths among adults with morbidity rates highest in the southeastern region of the country. Despite studies showing adherence to a Mediterranean-style Diet (MD) can decrease CVD risk, no clinical MD studies have been conducted in the southeastern United States and few studies worldwide have documented theory-based nutrition education usage in such studies.

The primary aim of the study was to develop a 12-week, theory-based, nutrition education intervention that promotes MD dietary patterns with the supplementation of EVOO and mixed nuts for the reduction of CVD risk in a high-risk population of the southeastern US.

The framework and implementation of the nutrition education component of the intervention was based on the constructs of the social cognitive and the self-determination theory. Thirty participants were randomized into either the American Heart Association group or the MD group. Each group received a 12-week, web-based nutrition education program including 7 nutrition education sessions; weekly access to a registered dietitian; and discussion boards; handouts, recipes, and grocery lists. At baseline and 6 weeks the MD group also received extra-virgin olive oil (EVOO) and mixed nuts.

Blood samples; urine; blood pressure; height; waist, and hip circumference; and body weight and composition were measured at baseline, 6- and 12-weeks. Participants also

completed a Mediterranean diet screener (MDS), and the International Physical Activity Questionnaire.

At 12-weeks both groups had increased nutrition knowledge and MD adherence; however, changes were greater in the MD group. Percent education completion significantly impacted MD adherence scores. Nutrition knowledge and adherence impacted blood glucose, total cholesterol, and non-HDLc. Nutrition knowledge also significantly influenced total cholesterol to HDLc ratio. The AHA group also saw negative shifts for both HDLc (decreased values), LDLc (upward trends) and increased total cholesterol to HDLc ratio. Nut consumption and the interaction of nut and EVOO consumption was correlated with positive changes in HDLc. Percent EVOO consumption was shown to decrease LDLc. Therefore, this pilot study was successful in increasing nutrition knowledge and MD adherence and reducing CVD risk factors in a high-risk population in the Southeastern US.

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References

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List of Abbreviations

CVD	Cardiovascular disease
US	United States
WHO	World Health Organization
MI	Myocardial infarction
TG	Triglycerides
VLDLc	Very-low density lipoprotein cholesterol
LDLc	Low-density lipoprotein cholesterol
IDLc	Intermediate-density lipoprotein cholesterol
Lp (a)	Lipoprotein-a
HDLc	High-density lipoprotein cholesterol
LPL	Lipoprotein lipase
FFA	Free fatty acids
NO	Nitric oxide
ICAM-1	Intercellular adhesion molecule-1
VCAM-1	Vascular cell adhesion molecule-1
ROS	Reactive oxygen species
OxLDLc	Oxidized LDLc
MCP-1	Monocyte chemotactic protein-1

TNF-α	Tumor necrosis factor alpha
IL-1	Interleukin-1
IGF-1	Insulin like growth factor-1
TGFβ	Transforming growth factor beta
FGF	Fibroblast growth factor
ACC	American College of Cardiology
AHA	American Heart Association
HTN	Hypertension
CRP	C-reactive protein
NOS	Nitric oxide synthase
DM	Diabetes mellitus
DM2	Type 2 diabetes mellitus
BMI	Body mass index
DASH	Dietary Approaches to Stop Hypertension
RD	Registered dietitian
MD	Mediterranean Diet
EPIC	European Prospective Investigation into Cancer and Nutrition
PREDIMED	Prevención con Dieta Mediterránea
TMBC	Transtheoretical model of behavior change
SCT	Social cognitive theory
SDT	Self-determination theory
MLT	Mediterranean Lifestyle Trial
HHP	Healthy Hearts Program

IRB	Institutional Review Board
AUPCC	Auburn University Pharmaceutical Care Clinic
MDS	Mediterranean diet screener
MDAS	Mediterranean diet adherence scores
IPAQ	International physical activity questionnaire
KQ	Nutrition knowledge question
AQ	Adherence question
EMR	Electronic medical record
GLM	General linear model

Chapter 1: Introduction

Each year approximately 18 million deaths across the world are a attributed to cardiovascular diseases (CVD), making it, globally, the leading cause of death [1]. The United States (US) is not immune this epidemic, annually CVD is responsible for one in four deaths of Americans [2]. It is estimated that over 92 million Americans have some form of the disease [3]. CVD is defined by the World Health Organization (WHO), as a group of disorders affecting the heart and blood vessels [1]. The manifestation of CVD is most commonly caused by a buildup of fatty deposits, or plaque, on the inner walls of arteries, resulting in a narrowing of these vessels [1, 4]. Myocardial infarctions (MI) and strokes account for the etiology of approximately 80% of deaths from CVD [1]. These complications, as well as others, are typically due to the process of atherosclerosis [1, 4, 5].

1.1 Atherosclerosis

Atherosclerosis is a chronic, multifocal, disease of inflammation that affects medium to large sized arteries fueled by lipids circulating in the plasma [6]. Cholesterol and triglycerides (TG) are lipid substances that are non-polar and therefore must be transported through the plasma in vessels called lipoproteins [7, 8]. Lipoproteins are made up of a hydrophobic core of cholesterol esters and TGs and is surrounded by an

external shell of free cholesterol, phospholipids, and amphipathic apolipoproteins [7-9]. The size, lipid composition, and associated apolipoprotein differentiate these into seven classifications: chylomicrons, chylomicron remnants, very low-density lipoprotein cholesterol (VLDLc), intermediate-density lipoprotein (IDL), low-density lipoprotein cholesterol (LDLc), high-density lipoprotein cholesterol (HDLc), and lipoprotein-a (Lp (a)) (table). Of the seven, five are considered pro-atherogenic (chylomicron remnants, VLDLc, IDL, LDLc, Lp (a)). [7] HDLc is anti-atherogenic due to its role in reverse cholesterol transport [7, 10, 11].

The exogenous and endogenous pathways are main systems for the synthesis and transport of blood lipids. Chylomicrons are primarily formed via the exogenous pathway and are the largest and least dense of the lipoproteins and function to carry dietary TG's, cholesterol, fat soluble vitamins and cholesterol esters to muscle tissues and adipocytes with in the body. Chylomicron is mainly comprised of triglycerides, which account for approximately 90% of its weight [7-9].

The exogenous pathway begins with the consumption, digestion, and absorption of dietary triglycerides and cholesterol. Within the endoplasmic reticulum of intestinal epithelial cells, TG and cholesterol are re-esterified and packaged into chylomicrons. Chylomicrons are then secreted into the intestinal lymph system and enter circulation through the thoracic duct. Once in circulation, chylomicrons bind to muscle and adipose tissue and interact with the enzyme lipoprotein lipase (LPL), which hydrolyzes TG to release free fatty acids (FFA). FFA can then be used in muscle cells for energy and adipocytes for storage [7-9, 12].

After TG hydrolysis and FFA release, the chylomicrons have decreased in size and are now classified as chylomicron remnants which are high in cholesteryl esters. Chylomicron remnants travel to the liver, are transported into hepatic cells by endocytosis, and catabolized by lysosomes, thus freeing previously bound cholesterol. Free cholesterol can then be used in bile acid synthesis, secreted as part of bile acid, or in the formation of VLDLc [7-9, 12].

The endogenous pathway begins in the liver with the synthesis of VLDLc from FFA and cholesterol esters. In VLDLc synthesis, FFA are re-esterified into TG and account for approximately 60% of its mass. Once formed, VLDLc is excreted from hepatocytes and travels to peripheral tissues. LPL hydrolyzes TG and FFA are released for use, thus decreasing the size of the particle which is now classified as IDL. IDL can undergo further catabolism by lipase or return to the liver for hepatic uptake. Catabolism of IDL forms LDLc which can then be taken up by peripheral or hepatic cells [7-9, 12, 13].

LDLc contains mainly cholesterol and cholesterol esters and makes up approximately 70% of plasma cholesterol. LDLc functions to deliver cholesterol to both peripheral tissues as well as hepatocytes. The degradation of LDLc results in the release of free cholesterol, amino acids, FFA, and phospholipids [7-9].

High blood levels of TG, LDLc, VLDLc, and cholesterol tend to promote atherosclerosis development. On the other hand, HDLc has protective properties in atherogenesis by playing main role in reverse cholesterol transport [10, 11]. The reverse cholesterol transport not only slows the progression of plaque accumulation, but also may cause plaque deterioration [14, 15].

The disease process of atherosclerosis is triggered by injury or insults to the arterial endothelial cell wall (Figure 2). Endothelial cells provide a semi-permeable barrier between blood and the arterial wall and regulate the exchange of fluid, nutrients, gases, and waste [16]. Endothelial cells also release molecules to promote vasoconstriction (i.e., nitric oxide (NO) and Prostaglandin I2) or vasodilation (endothelin and angiotensin-II) [16]. Insults to endothelial cells result from direct trauma, hyperlipidemia, hypertension, chronic hyperglycemia, turbulent blood flow, circulation of free radicals, and/or inflammation. As a result, endothelial cells are weakened, and an immune cascade is triggered [6, 11, 17, 18].

Initial atherosclerotic lesions, atheroma, [19] cause endothelial cells start to overproduce cell adhesion molecules, such as intercellular adhesion molecule-1 (ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and P selectin [10]. These molecules along with chemoattractant cytokines (chemokines) recruit circulating monocytes and T-lymphocytes, which then adhere to the endothelium [6, 10, 16]. As the endothelial cells lose integrity, the tight junctions between them begin to loosen, increasing permeability to fluid, lipoprotein particles, and leukocytes. The increased in permeability allows monocytes migrate from the cell wall into the sub-endothelial space and differentiate into macrophages. Lipoprotein particles, especially LDLc, also infiltrate the weakened the arterial cell wall [10, 11, 16]. Once in the sub-endothelial space, the oxidation of LDLc occurs through its interaction with aldehydes, NO, reactive oxygen species (ROS), and lipoxygenase. Scavenger receptors on macrophages uptake oxidized LDLc (OxLDLc), forming foam cells. Foam cells, OxLDLc, and monocyte chemotactic protein-1 (MCP-1) [6] are responsible for the continual recruitment and retention of monocytes and

lymphocytes, and subsequent conversion to macrophages, in the cell wall [6, 10, 11]. Scavenger receptors are not down-regulated by OxLDLc accumulation and therefore uptake is continual until apoptosis or necrosis occurs [10]. Once foam cells die, the lipids they once contained are released and accumulate in the intima under the endothelium [16].

Cytokines and growth factors such as tumor necrosis factor alpha (TNF-α), interleukin-1 (IL-1), insulin like growth factor-1 (IGF-1) transforming growth factor beta (TGFβ), and fibroblast growth factor (FGF) are released by foam cells and activated endothelial cells and are responsible for the recruitment of smooth muscle cells from the media into the intima [20]. Once in the media, the cytokines and growth factors are responsible for the proliferation of smooth muscle cells to foam like cells as well their activation [21]. Upon activation, smooth muscle cells become a source of growth factors platelet-derived growth factor, FGF, IGF-1, monocyte-colony stimulating factor, TGFβ, as well as heparin-binding epidermal growth factor [16, 20]. Over time, the atheroma progresses by the ongoing accumulation of both smooth muscle cells and lipids underneath the damaged endothelium leading to a thickening of the arterial wall. This results in the narrowing of the lumen which reduces the amount of space for blood to flow [22, 23].

Complications arising from atherosclerosis are largely dependent on the arteries affected. It can affect coronary, carotid, peripheral, or renal arteries, and the complications are largely dependent upon which is affected.

1.2 CVD Risk

The probability of developing CVD is dependent upon several risk factors, some of which can be controlled or managed and others that cannot. These risk factors are broken into three general categories: conditions (high blood pressure, high cholesterol, diabetes), behavior (unhealthy diet, physical inactivity, obesity, over consuming alcohol, tobacco use), and family history and other characteristics (family history, age, race or ethnicity) [24, 25].

1.2.1 Conditions: High Blood Pressure

Blood pressure describes the force exerted in arteries from blood each time the heart beats. Systolic pressure, is when the heart contracts and the force is at the highest, while diastolic pressure is the arterial pressure when the heart is relaxing [26, 27]. Blood pressure readings have five classifications, normal, elevated, hypertension (HTN) stage 1, HTN stage 2, and hypertensive crisis (Table 1) [27]. Worldwide, elevated blood pressure affects over 1 billion people and is estimated to be the cause of 7.5 million (12.8%) of deaths each year [28]. According to the American College of Cardiology (ACC) and the American Heart Association's (AHA) guidelines, over 86 million (34%) Americans have high blood pressure and over 103 million adults (45.6) have hypertension [29, 30]. Among adults aged 40-59, the risk from CVD events (MI or ischemic stroke) doubles for every 20/10mmHg increase above 115/75mmHg [28, 31].

The role that high blood pressure plays in CVD risk is multifaceted. Long term high blood pressure puts continual strain on atrial endothelial cell walls and can lead to a weakening in the cell wall. This can predispose the cell wall to injury. Cell injury can result in lesions promoting atherogenesis or in plaque build-up which can result in a

stiffening and narrowing of the arteries [27, 32]. Hypertensive arterial walls also thicken as a result of vascular remodeling in an effort to normalized wall stress [33, 34].

Some data also suggests a possible mechanism in which high blood pressure as a CVD risk factor, is that elevated blood pressure may act as a stimulus for inflammation, which plays a well-documented role in the development of atherosclerotic disease [35, 36]. C-reactive protein (CRP) is considered to have the correlation with HTN compared to other inflammatory makers [37, 38]. Studies have shown significantly higher levels of CRP [39] and the proinflammatory cytokines IL-6 [40-42], IL-1β [43, 44], and TNFα [40, 45, 46] in hypertensive patients compared to normotensive patients. This inflammation can result in endothelial dysfunction by downregulating NO synthase (NOS) protein expression [47], NOS activity [47] and reducing NO bioavailability [36, 48]. Thus, leading to a reduction in inflammatory mediators; increase in endothelial permeability [49]; an upregulation of adhesion molecules [50]; neutrophil aggregation and secretion [51]; increase in pro-inflammatory cytokines by macrophages [52]; and an upregulation in platelet aggregation and adherence [53], all of which can compromise endothelial integrity, promote atherogenic disease, and increase CVD risk.

1.2.2 Conditions: Diabetes

In 2015, approximately 30.3 million adults in the US had diabetes mellitus (DM), 25% of these cases being undiagnosed. Each year over 1.3 million Americans are diagnosed with DM and it is currently the 7th leading cause of death in the US [54].

According to the American Diabetes Association, DM is a metabolic disorder that can result in defective insulin secretion, action, or both. There are two main

classifications, Type 1 and Type 2. Type 1 DM affects approximately 5-10% of those with the disease and is characterized by cell-mediated autoimmune destruction of pancreatic β-cell destruction which leads to insulin deficiency. On the other hand, Type 2 DM (DM2) affects 90-95% of diagnoses with insulin resistance being a hallmark of this form of the disease. Obesity and increased body fat accumulation are major risk factors or the development of DM2 [55].

The pathophysiology of DM results in numerous physiological states which puts those with this disease at high risk for the development of CVD. First, DM puts patients at risk for altered blood lipid profiles. Approximately 97% of diabetics have dyslipidemia, which is highly correlated with the development and progression of atherosclerosis [56]. Hypertriglyceridemia is also common, which can lead to the development of the more atherosclerotic, small, dense LDLc particles. High blood TG can also decrease HDLc levels, leading to a decrease in reverse cholesterol transport [57].

DM can also lead to a disruption in signaling molecules. Often times, there is a decrease in the vasodilator NO coupled with an increase in vasoconstrictor endothelin-1, leaving the body in a hyper-constrictive state [58]. This hyper-constrictive state can result in the release of pro-inflammatory cytokines which can lead to increased endothelial permeability, apoptosis, leukocyte recruitment, and elevated ROS [59, 60]. This chronic, low-level of inflammation seen in diabetics [61] can promote vascular oxidative injury that is associated with ischemic heart disease associated with diabetics [60, 62, 63]. Finally, diabetics tend to have increased coagulability due to increased activation and recruitment of platelets and clotting factors coupled with a decrease in anticoagulant

factors in the blood. The dysfunction in the coagulability of diabetics is responsible for 80% of diabetic deaths [64].

1.2.3 Behavior: Obesity

Since 1975, global obesity rates have almost tripled, it is now estimated that 1.9 billion adults (39%) are overweight and 650 million (13%) obese [65]. Obesity is a chronic, multifactorial disease, characterized is the excessive accumulation and storage of body fat which results in adverse metabolic consequences [66]. Body mass index (BMI), a calculation of weight in kilograms (kg) divided by height in meters squared, is the most common screening tool for obesity. BMI is divided into four general categories: underweight (<18.5 m/kg^2), normal/healthy weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥30.0 kg/m^2) [67]. However, there are three classes of obesity: obesity class I (30.0-34.9 kg/m^2), obesity class II (35.0-39.9 kg/m^2), extreme obesity/obesity class III (≥40.0 kg/m^2) [68] (Table 2).

Not only does obesity increase the CVD risk by 150% and heart failure by 200% [69, 70], but also leads to a 5-times higher risk for hypertension [71, 72]. In the body, white adipose tissue is an endocrine organ that is integrated into both physiological and metabolic control by the secretion numerous protein signals and factors such as cytokines (TNF-α, IL-6) and chemokines (MCP-1) as well as proteins involved in vascular homeostasis (plasminogen activator inhibitor-1, vascular endothelial growth factor), angiogenesis (vascular endothelial growth factor), lipid metabolism (retinol binding protein, cholesteryl ester transfer protein, blood pressure regulation (angiotensinogen), and homeostasis of blood glucose (adiponectin) [73-77]. In

obesity, as the white adipose tissue grows, macrophages infiltrate and it begins to increase the expression and release of inflammatory adipokines (IL-6, TNF-α, haptoglobin, and leptin) [75] and decrease the expression of anti-inflammatory adiponectin [78, 79], thus increasing the state of inflammation in the body and ultimately leads to endothelial cell dysfunction [74, 75]. Obesity is also associated with altered blood lipid profiles such as increased VLDLc, small dense LDLc, TG and decreased HDLc levels as well as insulin resistance [80].

1.2.4 Behavior: Physical Inactivity

According to the WHO, physical inactivity is one of the most important modifiable risk factors in CVD because of its direct relationship with increasing all-cause mortality; doubling CVD, DM, and obesity the risk; as well as increasing blood pressure and blood lipid disorders [81, 82]. There is a direct correlation with sedentary behaviors and increased adverse health outcomes. In fact, increased sedentary behaviors are associated with >100% relative risk of diabetes, 147% increased risk for the development of CVD, and a 49% increase in all-cause mortality risk [83]. According to the Centers for Disease Control, in 2005 over one-third of Americans did not participate in enough physical activity for health benefits and over 14% did not engage in 10 minutes on average per week [84]. Moreover, more than 70% of women and 66% of men in the US fail to meet guidelines set for by the WHO of 30 minutes of moderate physical activity per day [85]. In fact, American adults spend almost 8 hours per day in sedentary behaviors [86, 87].

Manson, et al., conducted a study on the effects of physical activity in CHD prevention in post-menopausal women. Over a 3.2 year follow up, 30 minutes of moderate-intensity physical activity for 5 days per week (2.5 hours/week), resulted in a 30% reduction in cardiovascular events [88]. Another study showed that 170-minutes of moderate-intensity exercise per week, in previously sedentary participants, had an 88% increase in insulin sensitivity that was not associated with weight loss [89]. Furthermore, regular physical activity has been shown to decrease CVD risk factors by: reducing body weight [90]; reducing blood pressure [91, 92]; improving insulin sensitivity [90, 93, 94]; improving glycemic control and metabolic profiles [93].

1.2.5 Behavior: Overconsuming alcohol

Throughout the years, moderate alcohol consumption has been shown to lower the risk for the development of CHD, DM, HTN, heart failure, stroke, and dementia [95]. Studies have shown that men who consume 1-2 drinks per day have a significantly lower risk of CVD than those who drank less or abstained [96, 97] and those drinking 3 to 4 per day had the lowest rates of CHD [96]. Furthermore, after 1-2 weeks, the consumption of ethanol in any form has been associated with increases in HDLc [96].

While moderate alcohol consumption has been proven to have health benefits, the overconsumption of alcohol is detrimental, adverse health effects. Most studies show alcohol consumption and its relationship to CVD, as risk reduction versus a risk factor, as a J-shaped curve with the nadir being 2 drinks per day. After this point, a dose dependent response is seen in increased alcohol consumption and increased CVD mortality [95, 98].

Overconsumption of alcohol has also been associated with increased blood pressure [99], TG, caloric intake and weight gain, and stroke [100].

1.2.6 Behavior: Tobacco

According the US Surgeon General, cigarette smoking the "leading preventable cause of disease and deaths in the US" [101] In fact, the WHO reports that tobacco smoking is responsible for 5.4 million deaths each year across the world [102]. Of these deaths, approximately 35-40% area due to CVD [103]. Tobacco contributes to the etiology and pathogenesis of CVD in many different ways such as contributing to endothelial dysfunction, insulin resistance, inflammation, and altered lipid profiles, as well as promoting a hypercoagulable state.

The inhalation of toxic chemicals during cigarette smoking initiates endothelial cell dysfunction by the oxidizing of LDLc cholesterol to small denser particles and by decreasing the production and bioavailability of NO [104, 105]. Dysfunctional endothelium results in decreased elasticity, stiffening, and trauma to the vascular cell wall [106] as well as reduced coronary blood flow [107]. In addition to endothelial damage, smoking is associated with a chronic state of inflammation which leads to increased 1) leukocyte activation and recruitment [108], 2) markers of inflammation (CRP, IL-6, TNFα) [109], and 3) recruitment of proinflammatory cytokines (VCAM-1, ICAM-1, E-selectin) [110]. This inflammatory environment induces a prothrombotic state within the body leading to higher rates of MI and sudden death among smokers. Smoking can also result in decreased insulin sensitivity and hyperinsulinemia [111] as well as altered blood

lipid profiles (increased levels of total cholesterol, TG, VLDLc, and TG; and lower concentrations of HDLc and apolipoprotein-a) [112].

1.3 Dietary approaches to CVD risk reduction.

1.3.1 The American Heart Association and the Dietary Approaches to Stop Hypertension

The AHA provides dietary guidelines and recommendations for the reduction of CVD risk. Among these recommendations is follow the Dietary Approaches to Stop Hypertension (DASH) eating plan. The AHA recommendations focus on heart healthy food choices while the DASH eating plan provides a flexible structure to create a balanced eating style that promotes heart health by providing daily and weekly goals for each food group [113, 114].

These dietary recommendations include calorie balance, or the concept of using as many calories as one consumes. This, however, does require an individual have an idea of how many calories he/she needs and consumes each day. These calories should come from a variety of foods from all food groups. Current recommendations are as follows: fresh, frozen or canned vegetables (DASH: 4-5 per day); fiber-rich whole grains (DASH: 6-8 daily); low fat or fat-free dairy (DASH: 2-3 servings daily); skinless poultry or fish (DASH $\leq$6 with fish eating at least twice per week); nuts/legumes (DASH 4-5 times per week); and non-tropical oils [113, 114].

While it is important to choose foods from different food groups, it is also important to choose the right foods from within those groups. For example, one should limit saturated fat and trans fats for following the DASH guidelines which means eating less than 5 portions of red meat or sweets per week and limited sugar sweetened

beverages [113]. Alcohol should be limited to 1 drink per day for women and 2 drinks per day for men. Replacing food sources containing trans- and saturated fats with foods high in mono- and poly-unsaturated fat is also recommended. Additionally, if one needs to lower their LDLc cholesterol, no more than 5-6% of total calories should come from saturated fats [113, 114].

Lower sodium foods are also encouraged especially for those who are trying to lower their blood pressure [114]. To accomplish this, combine the DASH diet with no more than 2,300 mg/day of sodium. A 1,500 mg/day sodium limit per day could reduce blood pressure even further [113, 114]. Instead of high sodium foods, one should seek out foods that are rich in potassium, calcium, magnesium, fiber, and protein [113].

Ultimately, as with any dietary guidelines, those following the recommendations should watch portion sizes and ensure that they are being physically active. The DASH and AHA recommendations for exercise are 150 minutes of moderate or 75 minutes of physical activity per week [113, 114].

Multiple studies have evaluated the effectiveness of the DASH diet in comparison to other dietary recommendations and patterns. Conlin et al., reported participants following the DASH diet had greater decreases in both LDLc cholesterol and blood pressure compared to those consuming a typical American diet [115]. A stratified study compared dieters decreasing their sodium at 3600 mg/day, 2300 mg/day and 1500 mg/day. Each group saw a reduction in blood pressure over time; however, the greater the reduction in sodium intakes was directly related to the reduction in blood pressure values [116]. The results of this study are echoed in another research program which showed the

combination of the DASH dietary patterns with an increase in sodium is the most effective method for reducing CVD risk factors [117].

While some studies did show lower total and LDLc concentrations [118], Folsom conducted a study which included over 20,000 women. This study showed that greater compliance with the DASH dietary guidelines did not have an independent long-term association with hypertension or cardiovascular disease mortality. The authors suggested that a higher compliance with the guidelines may be needed to see the trend [119].

To maximize the efficacy of the AHA recommendations and the DASH guidelines for CVD risk reduction, four specific changes in addition to dietary behaviors are recommended. First, become physically active. Participate in at least 150 minutes of moderately vigorous or 75 minutes of vigorous exercise weekly. Second, target a healthy weight. Have realistic expectations and find a reasonable and healthy target. Third, limit alcohol. As previously mentioned, women should only consume one alcoholic drink per day while men can have two. Finally, manage stress in life as it impacts dietary choices, the consumption of alcohol, and measures such as blood pressure which can impact HTN and CVD [113, 114].

1.3.2 Low-carbohydrate and Low-fat diets

Historically, low-carbohydrate dietary recommendations stress limiting complex carbohydrates and simple sugars which can cause the body to oxidize fat to meet its energy requirements. This process induces ketosis for energy needs where ketones are excreted into the urine with fluid. This, coupled with the drastic reduction in calories

from carbohydrates, can result in rapid weight loss; however, it may be hard to maintain due to the diuretic effect [120].

Studies have shown that a low carbohydrate diet can have potential benefits for impacting CVD risk factors. Brehm et al., randomized 53 obese (BMI 30 – 35 kg/m^2) into either a low-carbohydrate or calorie restricted diet. Both groups had access to a registered dietitian (RD) for consultation every other week. After six months, the low-carbohydrate cohort had greater weight loss, increased HDLc, and decreased overall cholesterol when compared to the calorie restricted group [121]. Other studies have reported potential benefits of the low carbohydrate diet including decrease in fasting blood glucose [121-123] and TGs [123].

Low-fat diets recommend consuming, at minimum, less than 30 percent of one's total caloric intake from fat. Numerous studies have evaluated the effectiveness of low-fat diets on CVD risk reduction. Prentice et al, completed an 8.3-year intervention which incorporated 48,835 postmenopausal women between 50 and 79 years in age. This study specifically evaluated the incidence rates for CHD and total CVD over time and did not find any differences between the control group and the low-fat diet groups [124].

Another study introduced what was termed the Pritikin diet. This diet recommended fewer than 10 percent of calories come from fat, 15-20 percent from protein and the remaining calories come from complex carbohydrates. When this diet was combined with statins and vigorous exercise, participants saw a reduction in total and LDLc cholesterol as well as triglycerides. HDLc values were slightly reduced as well [125].

Numerous studies have evaluated the efficacy between low-carbohydrate versus low-fat diets in the reduction of CVD and CVD risk. Foster et al., conducted a one-year

randomized trial with 63 obese men and women that implemented a low-carbohydrate, high-protein, high-fat, or calorie restricted diet to participants. After 6 months, the low-carbohydrate group had greater weight loss; however, after one year, the weight loss between the groups was not significant. Over the 12-months, the low-carbohydrate group did see a greater increase in HDLc and decrease in triglycerides independent of weight loss.

Stern et al., conducted a clinical trial which evaluated the impact differences between a low-fat and low-carbohydrate diet on 132 obese (BMI> 35) individuals over one year. In the first six months, the low-carbohydrate group saw greater weight loss; however, this weight loss was not sustained and by 12 months, there was not significance in total weight loss between groups. The low-carbohydrate group had significant improvements in TGs, HDLc, and hemoglobin A1c (HbA1c), in diabetics, relative to the low-fat group. No differences were seen in total cholesterol, HDLc, blood glucose, plasma insulin, insulin sensitivity, serum creatine, uric acid level, systolic blood pressure and diastolic blood pressure. The low carbohydrate group did see improved insulin sensitivity compared to the low-fat group at 6 months [126].

Other studies have specifically shown increases in HDLc, decreases in LDLc coupled with diastolic blood pressure readings similar to those of people following a low-fat diet [122, 126, 127]. Additionally, those following the low carbohydrate diet saw similar decreases in total cholesterol to HDLc ratios compared to those following a standard low-fat diet [122, 128].

1.3.3 Mediterranean Diet

The Mediterranean Diet (MD) is a model derived from the diet of Crete, most of Greece, and southern Italy in the 1960s which encouraged eating plant-based foods, EVOO as the primary fat source, smaller amounts of fish, poultry, dairy, eggs with little to no red meat, and wine consumption with respect to cultural values and beliefs (Figure 1). The population where this diet was the cultural norm had high life expectancies and low rates of chronic diseases such cancer and heart disease [129].

In recent years, numerous studies have verified nutrition that interventions promoting patterns of a MD effective in reducing CVD incidence, mortality, and risk. The Lyon Diet Heart Study followed 605 participants, with a history of a MI (MI), over the course of 4 years to determine if a MD was effective in reducing cardiac mortality and morbidity. An intermediate analysis reported a significant reduction of risk of MI and death from a MI compared to the control group. A final analysis indicated the MD was protective against subsequent MIs for up 4-years after initial event and significantly reduced the rate of cardiac events and mortality [130, 131].

The Indo-Mediterranean Diet Heart Study randomized 1000 participants into either an Indo-MD intervention group or a low-cholesterol control group and followed them for 2-years. At the end-point, both groups presented with decreased TC, TG, and LDLc levels; however, the Indo-MD group had greater decreases. The Indo-MD group also had increased HDLc levels and was associated with decreased risk of MI, sudden cardiac death, and total cardiac end points [132]. Similarly, The European Prospective Investigation into Cancer and Nutrition (EPIC) study showed an inverse relationship with MD adherence and mortality from CVD in over 70,000 participants from 9 European countries. Results indicated that a 2-unit increase in the MD adherence scoring system was associated with a statistically significant decrease in overall mortality [133]. Moreover, the InterAct

Consortium assessed a subgroup of over 15,000 participants from the EPIC study and found that increases in the MD adherence scoring system was associated with a reduction in DM2 incidence [134].

Rozati et al., assessed EVOO responses on inflammatory and cardiovascular metabolic responses. Participants (n=41) were randomized into either an American diet supplied with corn, soybean oil, and butter or an American diet supplied with EVOO. Provided dietary fats were to replace all other lipids in the diet. After 3 months, the EVOO group had a significant decrease in systolic blood pressure as well as increased HDLc cholesterol values trending toward significance when compared to the control group [135].

The Prevención con Dieta Mediterránea (PREDIMED) study was a multicenter, randomized, controlled trial across Spain, that assessed the impact of a MD supplemented with EVOO or mixed nuts against a low-fat diet on both the reduction of CVD risk [136] and the primary prevention of CVD [137]. A total of 7,447 participants, ages 55-80 years old, who were free but at high risk for cardiovascular events but were followed for a median of 4.8 years at 11 different sites throughout Spain. A major cardiovascular event was the primary endpoint and was defined as MI, stroke, or death due to cardiovascular reasons. Secondary endpoints included: MI, stroke, cardiovascular related death, and all-cause death.

In 2013, results from this study were published in the New England Journal of Medicine and reported significantly lower primary endpoints for both MD groups compared to the control with an approximate 30% relative risk reduction. Multivariable-adjusted hazard ratios were reported as 0.70 (95% confidence interval) and 0.72 (95%

confidence interval) for the MD group with EVOO and with nuts, respectively, compared to the control. Significant decreases in stroke rates as a secondary outcome, were seen in both the MD with EVOO (p=0.03) and the MD with nuts (p=0.003) groups compared to the control [138].

In June 2018, this initial report was retracted due to three main errors in either the process or reporting of the randomization procedures. First, four hundred and twenty-five participants had a member of their household enrolled in the study and assigned to an intervention group. These participants were not randomly assigned to intervention groups but rather assigned to the same intervention group as the household member. Early into the study, the PREDIMED Steering committee approved this methodology to prevent bias if members of the same household were assigned different interventions; however, the protocol was not updated to reflect this change. A second issue was reported with one of the eleven sites where 467 participants were not randomly assigned as individual participants but rather were assigned based on the specific clinic visited. Eleven clinics provided the same intervention for all participants visiting their specific site (2 clinics: MD + EVOO, 5 clinics: MD + nuts, 4 clinics: control). Finally, it was discovered that one site inconsistently used randomization tables. Due to these inconsistencies, all data was reanalyzed using methods that were not dependent on the assumption of random assignment and results were republished [137].

Republished data revealed no significant major changes in overall outcomes from original data. Both analyses reported a 30% risk reduction in cardiac events. Additionally, as compared to the control diet both the MD group with EVOO and with nuts had a hazard ratio 0f 0.71 and 0.68 respectively, as compared to the 0.70 hazard ratio

initially reported for both groups. Moreover, both analyses reported a correlation with improved MD adherence and decreased risk of cardiac events. Reanalyzed data supports the conclusions that a MD with the supplementation of EVOO or nuts is beneficial in the primary prevention of cardiovascular events in a high-risk population [137].

An initial analysis of a subset of 772 participants from the beginning phase of the PREDIMED trial was conducted to determine the effectiveness of a short-term, 12-week, intervention on CVD risk factors. At 12-weeks, both the MD with EVOO and MD with mixed nut groups saw a significant decrease in blood glucose, systolic BP, and total cholesterol to HDLc ratio. The MD with EVOO group also saw a significant decrease in CRP when compared to the control group [136].

1.4 Nutrition interventions for CVD risk reduction in the US

Rates of obesity and heart disease are a primary health concern in the US, particularly in the southeastern portion of the country. The population in this region have higher rates of not only CVD and stroke [139], but also greater risk for the development of CVD due to high rates of physical inactivity [140], obesity [141], and diabetes [139].

As previously discussed, much research has been done to determine the most feasible and effective dietary patterns for CVD risk reduction. The AHA researches and analyzes current research upon which they base their dietary recommendations for heart health [114]. In following these recommendations, CVD risk reduction should ensue. Given the prevalence of CVD in the US, particularly in the southeast region, it is safe to conclude that many Americans are not compliant with the recommendations by the AHA.

Based on data from the National Health and Nutrition Examination Survey from 2007 to 2010 and the 2015-2020 Dietary Guidelines for Americans, the AHA has recently concluded in a scientific statement that Americans are consuming less than recommended for fruits, vegetables, dairy, and oils and above recommended amounts of added sugars, saturated fats, and sodium [114] (Figure 3). Therefore, it is imperative to understand which nutritional interventions are effective in reducing CVD risk factors as well as producing dietary behavior changes.

Recent studies have shown adherence to a MD can result in lower CVD mortality rates [130, 132, 133, 142], reduced blood pressure [135, 136], improved lipid profiles [132, 135, 136], and reductions in CVD risk factors [132, 134, 143]. Trials have also indicated that dietary patterns similar to that of a MD is an effective protective method for the primary [137] and secondary [130] prevention of cardiovascular disease. Moreover, MD nutrition education coupled with the supplementation of nuts or EVOO in those at risk for CVD has proven to be effective in reducing CVD risk [136] as well as reducing risk cardiovascular events [142]. However, it is not known whether an intervention combining MD nutrition education along with both EVOO and nuts is an effective strategy for CVD risk reduction.

While interventions using the MD for CVD risk reduction has been studied extensively in Europe, very limited studies have been done in the US. Studies such as the Lyon Diet Heart Study [131] and the Indo-Mediterranean Heart Study [132], have shown that dietary patterns similar to the MD can be integrated into cultures outside of the Mediterranean. Despite this, to date no Mediterranean diet experimental studies have been conducted in the Southeastern US. A recent study revealed MD adherence is significantly lower in a population located in Eastern Alabama, a region located within

the southeastern US, compared to that observed in countries bordering the Mediterranean [144].

The primary aim of the study was to develop a 12-week, theory-based, nutrition education intervention that promotes MD dietary patterns with the supplementation of EVOO and mixed nuts for the reduction of CVD risk in a high-risk population of the southeastern US.

Objective 1: Conduct a review of current literature to assess the most effective theory for the development of a nutrition education program for CVD risk reduction.

Objective 2: Implement a theory-based nutrition education program and assess its effectiveness on nutrition knowledge and dietary behavior changes.

Primary Outcome: Changes in nutrition knowledge and MD adherence scores between baseline and 6 and 12-weeks.

Objective 3: Assess the effectiveness of the MD nutrition education program and the supplementation of EVOO and nuts on CVD risk factors.

Primary Outcome: Changes in systolic blood pressure (mmHg) from baseline to 6 and 12-weeks.

Secondary Outcomes: Changes in diastolic blood pressure (mmHg); weight (kg); BMI (kg/m^2); fasted total cholesterol (mg/dL), HDLc (mg/dL), LDLc (mg/dL), TG (mg/dL), blood glucose (mg/dL), and total cholesterol to HDLc ratio; waist circumference (inches); hip circumference (inches); waist-to-height ratio; and HOMA-IR from baseline to 6 and 12-weeks.

Chapter 1: Tables

Table 1. Blood pressure values and categories[27.]

Blood pressure category	Systolic (mm Hg)		Diastolic (mm Hg)
Normal	<120	and	<80
Elevated	120-129	and	<80
Hypertension Stage 1	130-139	or	80-89
Hypertension Stage 2	≥ 140	or	>90
Hypertensive Crisis	>180	and/or	>120

Table 2. Classifications of BMI values [67].

Classification	BMI
Underweight	< 18.5
Normal	18.5 – 24.9
Overweight	≥ 25.0
Obese	≥ 30.0
Obesity Class I	30.0 – 34.9
Obesity Class II	35.0 – 39.9
Obesity Class III	≥ 40.0

Table 3. Mediterranean diet adherence scores in Spain and Auburn, Alabama.

Mediterranean Diet Adherence Scores	Spain [136] (% population)	Auburn, Alabama [144] (% population)
Low*	5.9	39.9
Medium‡	59.3	46.8
High†	34.7	11.4

* Low scores: Spain, 1-7; Auburn, AL, 1-4.
‡ Medium MEDAS scores: Spain 8-9; Auburn, AL 5-7
† High MEDAS scores: Spain, 10-14; Auburn, AL 8-14

Chapter 1: Figures

Figure 1.

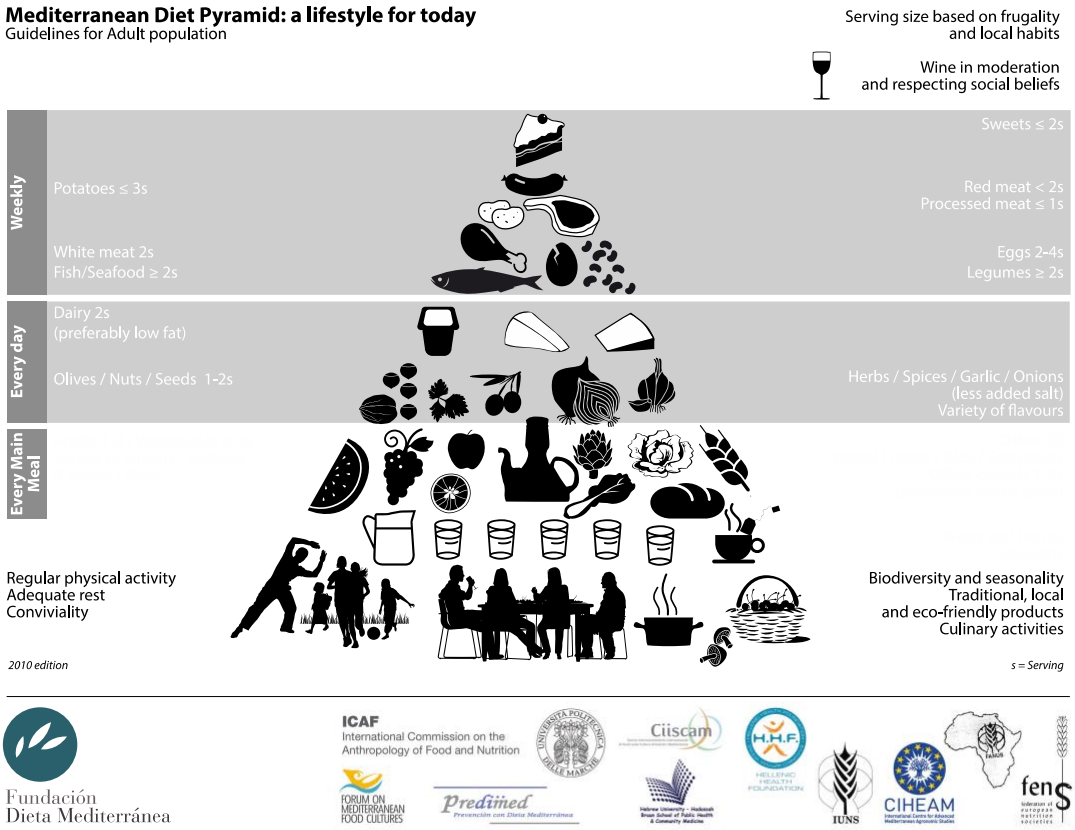


Figure 1: The Mediterranean Diet Pyramid [145]. This pyramid describes the dietary guidelines of a Mediterranean-style diet.

Figure 2.

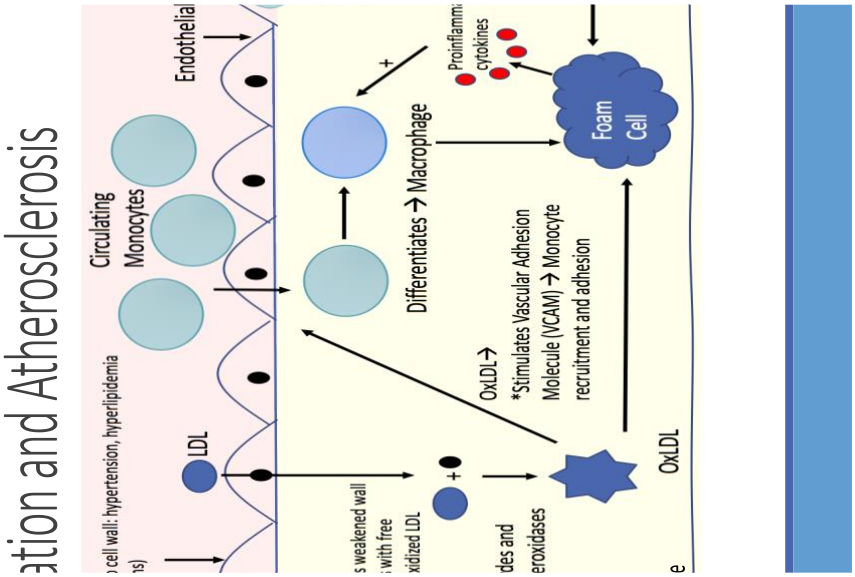


Figure 2: The atherosclerotic process 1) Atherosclerosis begins with an initial insult to artery or vessel walls which weakens cell wall. Insults are typically the result of hypertension and hyperlipidemia. 2) Free radicals along with aldehydes and lipid hydroperoxidases oxidize LDLc 3) Oxidized LDLc leads to inflammation which signals monocytes (WBC) recruitment to the arterial wall. 4) Monocytes enter the arterial wall and differentiate into macrophages. 5) Oxidized LDLc particles stimulate vascular cell adhesion molecule (VCAM) which leads to additional monocyte recruitment and adhesion into endothelial cell wall 6) Oxidized LDLc- apolipoprotein B attaches to macrophage scavenger receptor cells. 7) Macrophages accumulate and are converted into foam cells (fatty acid material + cholesterol). Macrophage necrosis leads to accumulation in endothelial cells. 8) As process continues, more LDLc becomes trapped in the innermost layer of the arterial wall creating a fatty streak. This is held in place by a fibrous cap formed by elastin, collagen, and proliferated smooth muscle cells [6, 11, 16-19].

Figure 3

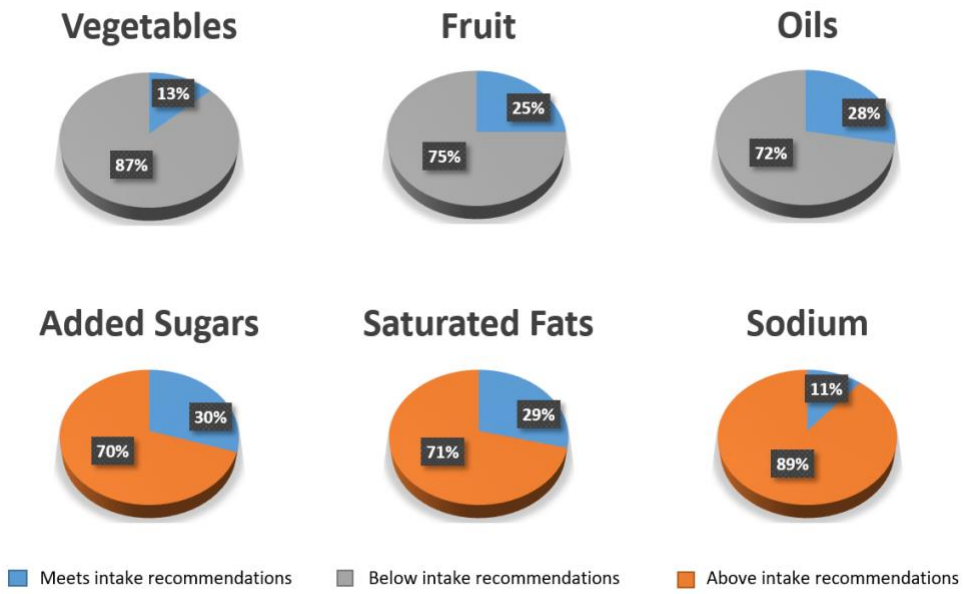


Figure 3. Dietary intakes of Americans versus the dietary recommendations of the American Heart Association [114].

Chapter 2: The use of theory in cardiovascular disease interventions promoting a Mediterranean style diet: a systematic review

2.1 Abstract

Aims: To evaluate the theory or theories that have been effective in promoting behavior change in interventions promoting a MD for the reduction of CVD risk.

Data Synthesis: A systematic review of primary research articles using PRISMA recommendations was conducted. References were retrieved using keyword searches from MEDLINE via PUBMED and included studies targeted participants at high risk for CVD. Two hundred and ninety-one studies were reviewed; however, only six met the inclusionary criteria. Three articles describe the same intervention; therefore, only four were included. Included studies incorporated social cognitive theory, social learning theory, goal-system theory, social ecological theory, self-determination theory, and the transtheoretical model of behavior change. Overall, studies were nutrition interventions in clinical settings with participants at high risk for or with CVD.

Conclusions: Five theories have been used to evaluate interventions for the reduction of CVD risk: transtheoretical model of behavior change, self-determination theory, social cognitive theory, goal-systems theory, and the social ecological theory. To effectively promote dietary behavior change and increase MD adherence in a web-based CVD

intervention, current evidence suggests that constructs from both the self-determination and social cognitive theory should be combined in the theoretical framework.

Key Words: Education Theory; Cardiovascular Disease; Mediterranean Diet

2.2 Introduction

Obesity and heart disease rates are primary public health concerns in the US, and there is a current need to understand which interventions are most effective in reducing risk factors for these nutrition-related conditions. The AHA provides diet and lifestyle recommendations for preventing CVD, including burning as many calories as you consume and eating a variety of foods from all the food groups. In following these recommendations, weight management and CVD risk reduction should ensue. Based on data from the National Health and Nutrition Examination Survey from 2007 to 2010 and the *2015-2020 Dietary Guidelines for Americans*, the AHA has recently concluded that most Americans are eating below the recommended intakes for fruits, vegetables, dairy, and oils while consuming above recommended amounts of added sugars, saturated fats, and sodium all of which are contrary to AHA recommendations [146, 147].

Interventions, including internet-based, are effective in promoting health behavior change [148, 149], and efficacy of behavior change increases by more extensive use of theory [150]. Interventions promoting healthy food consumption – a principle contributor to health and wellbeing – are approaches to decrease obesity and CVD risk. Thus, it is important to evaluate which theories have been implemented in studies designed to reduce CVD incidence and/or risk factors. A nutrition intervention that has proven effective in improving CVD risk factors and reducing CVD-related mortality is

based on the dietary patterns of the Mediterranean region [151-155]. Specifically, nutrition education combined with the supplementation of nuts or EVOO in the diets of individuals at risk for CVD have shown effective in reducing the risk of future cardiovascular events [142, 152]. Moreover, large cohort studies in Europe have demonstrated that adherence to a MD is associated with lower mortality rates, reduced blood pressure, improved lipid profiles, and reductions in CVD risk [152, 153, 156-159]. Researchers are developing protocols for similar studies in the US [160]. Yet, how theory has been applied to interventions promoting the MD has not been systematically reviewed.

The objective of this systematic review was to evaluate theories that have been effective in CVD clinical trials promoting the dietary patterns of a MD.

2.3 Methods

This systematic review followed the recommendations of the 'PRISMA Statement for Reporting Systematic Reviews and Meta-analyses, which sets minimum requirements for reporting and completing systematic reviews and meta-analyses [161].

Eligibility Criteria

This systematic review investigated trials which assessed the effects of education in relation to CVD and MD nutrition interventions. Studies were required to explicitly state the specific theory used in the framework, development and/or implementation of the intervention. Review articles were also excluded.

Information Sources and Searches

A literature search was completed in Medline via PubMed and covered dates from January 1, 1976 until August 1, 2017. Retrieved publications were read to determine appropriateness. Additional studies were identified through a review of references cited by each of the retrieved publications. These studies were identified by evaluating the titles in context of the citation in the reviewed paper.

Study Selection

One researcher was responsible for assessing all titles and abstracts and ensuring that full-text articles met selection criteria. EndNote X8 was used as the reference manager [162]. Selected articles were imported into Endnote [162] and then duplicate articles were removed. Exclusion criteria included the following:

- Children or adolescents as primary participants
- Non-CVD related study
- Not a clinical trial
- Non-MD study
- Non-nutrition focused intervention
- Education, behavioral, or psychological theory not specified

2.4 Results

2.4.1 Study Selection

The literature searches of Medline via PubMed returned 327 articles which were imported into Endnote (Figure 4). Thirty-six of the records were duplicates leaving 291

unique results meeting the search criteria. After title and abstract review, 285 articles were excluded. Reference review of the remaining 8 articles resulted in 0 additional articles with titles that met the inclusion criteria. Thus, a total of 8 articles were available for full-text review. Three of the articles represented the same study; therefore, only the primary article which discussed the theory was included. Four articles described specific theories which had been incorporated in studies involving the diets or lifestyles specifically designed to reduce CVD risk factors using the MD.

The characteristics of the four studies include: participants; theory; intervention; and major findings (Table 4). The major distinction between the studies are the theories used in the interventions. One study focused on using the transtheoretical model of behavior change (TMBC) to implement a MD while a second study used the TMBC in conjunction with the social learning theory [163, 164]. Toobert et al., used the Social Cognitive Theory (SCT) in a MD intervention in conjunction with goals-system theory and social ecological theory; however, the results of this study were not published in the article retrieved by the inclusion search [165]. Social learning theory was the primary individual educational theory incorporated [166]. The final study implemented the self-determination model to assess how the interaction of nutrition education and the self-determination theory (SDT) impacted different genders attempting to implement a MD [167].

The number of participants in the studies ranged from 58 to 279 and included men and women except for one study [165]. One of the articles provided only the protocols and the theory behind the research being conducted, and the reporting of the study

findings were not found in the literature review [165]. Overall, four studies consisted of nutrition interventions using experimental educational trials [163-165, 167].

Risk of bias using the Cochrane Collaboration's tool [168] was not assessed because 3 of the 4 studies did not provide data about retention or blinding in the given articles.

2.4.2 Theories

Table 2 provides a brief overview of included theories.

2.4.2.1 Transtheoretical Model of Behavior Change

While the TMBH is not considered a true education theory, it is a model or framework that has been applied to education development in nutrition interventions. This model focuses on behavior change being a dynamic process which occurs in stages. These stages include pre-contemplation, contemplation, preparation, action, and maintenance [169, 170].

Siero et al., conducted a study in a socio-economically deprived region of the Netherlands using the TMBH to promote behavior change in a population with high risk of CVD [163]. Participants had a mean serum cholesterol between 6 and 8 mmol/l as well as two additional CVD risk factors. Exclusionary criteria were age (greater than 70 years old), diabetes mellitus diagnosis, and use of medications [163].

Participants were divided into three groups. Group A_1, the control group, received a leaflet with the Dutch national nutrition guidelines which is the usual care received in the Netherlands. Group A_2 received nutrition education in a group setting. Group A_3

received the same group education plus the additional stage-matched education. Groups A_2 and A_3 were all from Winschoten County to prevent information on the MD spreading to the control group (Group A_1). Participants from Winschoten Country were divided into ten subgroups of ten before five subgroups were randomly selected to receive the additional tailored education [163].

Groups A_2 and A_3 received three 2-hour group education sessions. The first education session focused on increasing MD knowledge. The second session promoted a positive attitude towards the MD and the final session dealt with improving skills needed to prepare a MD. All 3 groups received margarine to replace butter and cream in the diet [163].

Participants in group A_3 were mailed a tailored letter and received group education. Based on baseline measurements and a psychological questionnaire, the letter contained information that would support the participant based on attitude, self-efficacy, social norm, and stage of change. Stage of change was assessed at both baseline and 16-weeks and was based on the consumption of fish, fruit, and vegetable. The effects of education were statistically evaluated to determine the impact on behavior and attitude [163].

Participants who received nutrition education had a more positive attitude regarding fish consumption ($p < 0.001$). This was evident in evaluations regarding attitude and social norm. Self-efficacy regarding fish consumption, however, was not statistically different. Education also improved the intent of fish consumption ($p<0.001$). Education moved participants from the contemplation stage to the preparation stage where participants were planning how to incorporate this into lifestyle changes [163].

When assessing fruit and vegetable consumption, the interventions did cause a shift in stage of change from preparation to action ($p<0.05$), and education influenced attitudes toward fruit and vegetable consumption. Participants who received tailored nutrition showed consistently higher numerical scores than the group education only; these differences were not statistically significant. Overall, there was no evidence that individually tailored education based on stage of change was more effective in changing behavior towards the MD than group education [163].

2.4.2.2 Self-Determination Theory

The SDT is a motivational theory that rationalizes how human growth tendencies and inherent psychological needs impact self-motivation and integration. Three needs have been identified under this model: the need for competence, relatedness, and autonomy[171].

A Canadian study used constructs of the SDT in a 12-week MD intervention that evaluated eating behaviors, anthropometric, and metabolic variables. All participants, 64 men and 59 premenopausal women, showed signs of CVD risk factors. The primary objective was to assess differences between genders[167].

Participants received three group education sessions which covered MD principles, cooking lessons, and a potluck dinner. Additionally, participants had three individual counseling sessions and four follow-up phone calls. Fasting blood samples, anthropometric and blood pressure measurements, dietary intake assessments (Food Frequency Questionnaire) [167], and the Three-Factor Eating Questionnaire [172] were all conducted at baseline. These assessments as well as perceived MD adherence

assessments were conducted at 12-weeks, 3-months post intervention and 6 months post intervention [167, 172].

At 12-weeks, 3-months post intervention, and 6-months post intervention men had a significant decrease in both baseline energy density ($p=0.02$) and in energy intake from carbohydrates ($p=0.03$) and lipids ($p=0.01$). When comparing MD scores, both men and women achieved significant increase in scores over time ($p<0.0001$); yet, the differences between men and women were not significant. However, food intake changes between genders were observed for red meat ($p=0.03$) and whole fruit ($p=0.04$), where men showed greater changes towards following the MD [167].

When assessing anthropometric measures, men had significantly lower waist circumference at the end of the intervention and maintained it post-intervention. Women had a lower waist circumference at the end of intervention; however, it tended to regress post-intervention. Positive changes in lipid profiles were more pronounced in men than women during and post-intervention. Overall, the authors suggest that the 12-week intervention modeled on the SDT may be more beneficial for men than women [167].

2.4.2.3 Multi-Model Approach

The SCT builds on the concepts of behaviorist learning theories by suggesting that processes also occur between stimulus and response and that behavior can be derived from observational learning. The social learning theory falls under the umbrella of the SCT. The social learning theory requires community involvement in the planning, implementation, evaluation, and management of the system [173, 174].

Toobert et al. began conducting diabetes management research in the northwest US, using just the SCT; however, over time other behavioral models, such as the goal-system theory [175] and social ecological theories [165, 176-178], were incorporated. This combination was developed to address the hindrances and support factors which impact behavior change. It was then applied to a 24-month long nutrition education program that followed 279 postmenopausal women with a diagnosis of type 2 diabetes, putting them at high risk for CVD [165].

The control group contained 123 participants and the Mediterranean Lifestyle Trial (MLT) group 156. At 6 months, the MLT group was further separated into two groups: one group which was engaged in lay person-led peer group support (n = 78) and a second group in computer-based community resources (n= 78) [165]. Participants in the MLT group underwent a three-day retreat where participants were educated by registered dietitians on the MD. Dietitians individualized carbohydrate and fat recommendations to optimize blood glucose and lipid concentrations. Participants were also educated and encouraged to use EVOO instead of butter and cream for cooking. Additionally, physical activity, stress management, and community engagement was encouraged. After 6 months, the lay-led group continued to have weekly meetings for 6 months, bi-weekly for the following 6 months, then finally monthly for the remainder of the study. These meetings included physical activity and support groups.

The computer resource group took the Chronic Illness Resources Survey [179] to determine what resources would be most helpful.[165] Individual support took place four times over 18 months and these sessions included motivational interviewing and computer-based assessments. Most education and interactions focused on both supportive

and interfering factors as these are primary constructs of both the SCT and the social ecological theory. Statistical analyses comparing the impacts of the education model were not presented as a part of this article [165].

The final study, conducted in Belfast, United Kingdom, used a multi-model approach incorporating both the social learning theory and the TMBH. Fifty-eight participants were randomized into three groups: conventional dietetic advice, advice for MD using nutritional counseling, and advice to implement MD with behavioral counselling. The conventional dietetic advice group received conventional dietary advice during admission. The MD nutritional counseling group were given detailed information on how to follow the MD. Home visits from the dietitians occurred in months 1, 2, and 4. The MD behavioral counseling group had a similar visitation pattern with the dietitian; however, behavioral counselling was used to disseminate the MD information. These interventions were tailored to the individual based on the individual's readiness [164].

Adherence to a MD was evaluated using MD score (MDS) assessed through a validated questionnaire. While all three groups showed significant increases in the MDS, there was no statistical difference between the groups at 6- or 12-months. No statistical differences between the groups were seen in vitamin C, oleic acid status, and eicosapentaenoic acid status despite within group statistical improvements in these biochemical markers. These results suggest that neither the nutritional counseling nor the behavioral counseling provided in this study had any significant impact on adherence or biomarkers [164].

2.5 Discussion

There is a lack of published data linking specific theories used in MD nutrition education targeting participants at high risk for CVD. Many of the studies conducted either did not have a formal nutrition education program or the research did not specifically address which theory/theories were incorporated. In addition, few theories have been adequately documented to assess their effectiveness for MD education (Table 6). The current literature search found few published studies that discussed combining specific theories with nutritional interventions for CVD that promote a MD when there is significant evidence to support that the dietary pattern is cardioprotective [152, 153, 156-159, 180]. Nevertheless, it is expected that education strategies successfully implemented in the previously mentioned studies would be effective when educating on the MD to populations at high risk for CVD.

Two studies incorporated individualized and tailored experiences for participants; however, both studies were unable to show statistical benefits of this individualized effort [163]. Similar results were seen through basic MD education or using conventional methods of education. Therefore, the TMBH may not be the most beneficial for MD nutrition interventions as it requires more time and has shown few fruitful results.

The SDT was reported to be more beneficial for MD adherence and anthropomorphic results in males compared to females. While the SDT worked for some individuals, other individuals needed the support of a team. Encouragement and engagement by the community can spur the individual on to success just as much as personal drive [167].

The SCT, which relies on human-to-human interaction, may be a way to reach communities in today's world of social networking and smart phones. Today, technology

allows us to connect with populations more frequently and deeper than researchers were able to do in the past. This would provide not only a support system around those trying to reduce their CVD risk factors, but it would also provide multiple avenues to get the support/education needed to continue a healthy lifestyle.

Based on the evidence presented, the SDT and SCT appear to be the most effective in CVD interventions promoting a MD. In the current review, these theories were not applied in a web-based intervention. However, current research supports the effectiveness of both of these theories in web-based interventions. Utilizing constructs of these theories has been proven effective in promoting behavior changes such as improved dietary intake [181] and meal planning [181, 182]; increased physical activity [183-187]; and weight loss [185, 188, 189] in online intervention platforms. Therefore, we can conclude that these theories could be effective in a web-based intervention, promoting the MD for CVD risk reduction.

2.6 Conclusions

Based on the given systematic literature review, a combination of 5 different theories have been used to evaluate education designed to reduce CVD risk factors in conjunction with a MD nutrition intervention: TMBH, SCT in conjunction with goal-system theory and social ecological theory, the SDT, and social learning theory with the TMBH. Utilization of the majority of behavioral/education models revealed no statistical advantages. The SDT was more successful for men than women. Even though the results of the study combining the SCT, goal-system theory and social ecological theory combination were not published with the project methodologies [165], other have

reported that the SCT was successful when implemented in community and clinical trials in non-MD studies [190-193]. Importantly, behavioral change techniques which have been shown to increase dietary intervention effectiveness align with both the SCT and the SDT [194]. Recent studies have also reported that the SCT and SDT were affective in promoting health behavior change [181-189]. To conduct a theory-based study using today's technology, the current evidence suggests that an ideal web-based CVD intervention would combine constructs from both the SDT and SCT in order to effectively promote dietary behavior change and increase MD adherence.

Chapter 2: Tables

Table 4. Characteristics of Included Studies

Study	**Setting**	**Baseline Participants**	**Theory**	**Study Details**	**Outcomes**
Siero et al., 2000 [163]	Netherlands	Mean Serum Cholesterol 6-8 m/mol Two additional CVD risk factors 55% female Low income $n_0 = 262$	Transtheoretical Model of Behavior Change	Length: 16 weeks Three groups: control, meetings with MD education, and meetings plus tailored education MD Education consisted of three meetings Assessed food intake and attitudes	Fish intake increased in non-control groups Education improved attitude Tailor-based education showed no additional benefits

Logan et al, 2010 [164]	Belfast, UK	$n_0 = 58$ $n_{12} = 36$ CVD diagnosis	Social Learning Theory Transtheoretical model of behavior change	Length: 12 months Randomized trial Control group v MD education using nutrition counseling v MD education using behavioral counseling MD compliance assessed using MDS Biochemical variables assessed	Increase in MDS and biochemical markers in all groups MD education using nutrition counseling and behavioral counseling had no statistical impact
Toobert et al., 2002 [165]	Oregon	279 postmenopausal women Type 2 diabetes diagnosis for at least 6 months Under age of 70	Social Cognitive Theory Goal-systems Theory Social Ecological Theory	24 months MD and lifestyle management program At 6 months, divided into program with lay leaders or personalized social support Behavior and physiological endpoints	Outcomes not reported

Leblanc et al., 2014 [167]	Quebec, Canada	n = 123 (52% men) Premenopausal women Slightly elevated LDLc-C or total-C to HDLc-C ratio>5 At least one other symptom of metabolic syndrome	Self-Determination Theory	Length: 12 weeks + 6 months follow-up Group education (3 sessions) and individual counselling (3 sessions)	Both men and women showed physiological and adherence improvements, but men showed greater improvements Men maintained eating behaviors and physiological improvements longer than women

Table 5. Theory overview.

Theory	Theory Overview	Theory Strengths	Theory Weaknesses
Transtheoretical Model of Behavior Change [163, 164, 169, 170]	Behavior change theory 5 stages of change individuals go through in the process of developing new behaviors Model used to develop stage-based education, supporting each stage of change	Individualized education/ intervention Education/ intervention changes as participants progresses through stages of change	Time consuming for study investigators
Self-Determination Theory [167, 171]	Motivational theory Rationalizes human growth with inherent psychological needs: competence, relatedness, autonomy When psychological needs are met, self-motivation increases	Links growth to needs Needs impact integration Practical implications	Does not account for personal extrinsic motivators Some individuals need team support
Social Cognitive/Learning Theory [164, 165, 173, 174]	A learning theory Learning occurs between stimulus and response Behavior can be derived from observational learning Social learning falls under SCT umbrella and the community involvement in planning, implementation, evaluation, and management is crucial	Encourages people in community to become involved Multiple avenues for education Increases reach of health professionals	Requires willing volunteers to lead Individuals who are non-social may feel overwhelmed

Theory	Theory Overview	Theory Strengths	Theory Weaknesses
Goal-Systems [165, 175]	A cognitive and motivational theory Links higher level goals to lower sub-goals which are needed to achieve higher level goals	Encourages the use of smaller, achievable goals to reach larger, more difficult goals Provides connections between cognition and physical manifestation of goals and achievements	Cognitive properties partially determine motivational properties
Social Ecological Theory [165, 175-178]	Theory-based framework Frames community interventions to examine the relationship between the individual and the broader community	Links environmental factors to behaviors and decisions Assessing interrelations of both personal and environmental factors	Model is most effective when all five levels are incorporated into the intervention

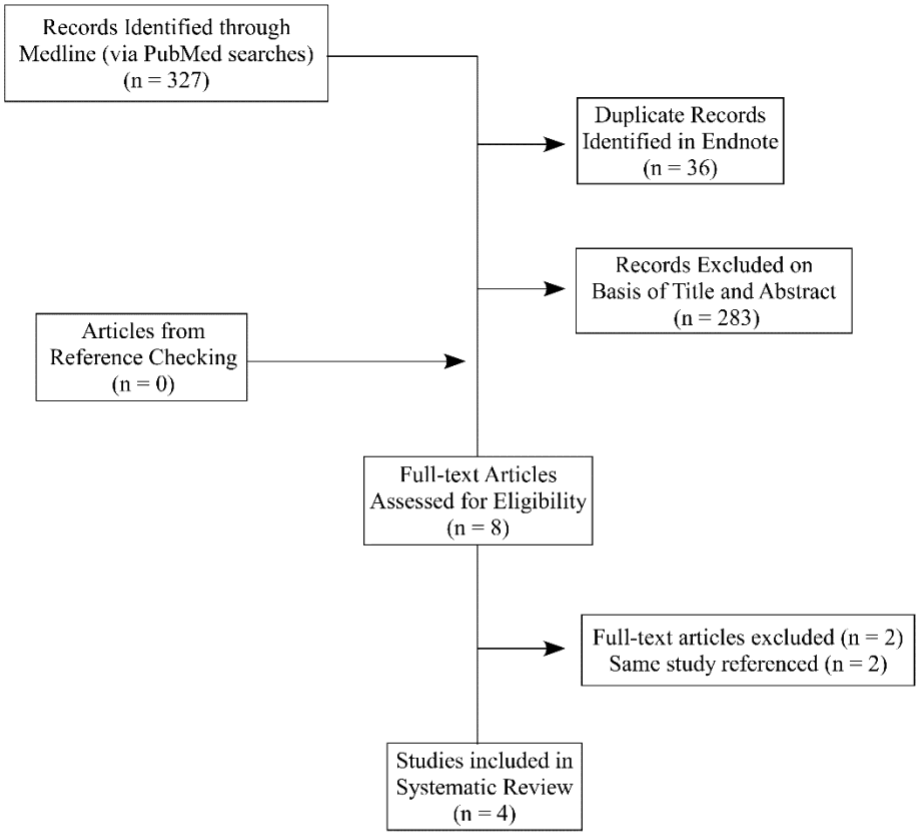
Table 6. Theory Evaluation in Studies Reviewed

Study	**Theory**	**Strengths of Theory**	**Weaknesses of Theory**
Siero et al., 2000 [163]	Transtheoretical Model of Behavior Change	The method showed improved adherence to MD	Individualized education was not more effective than less demanding techniques
Logan et al., 2010 [164]	Social Learning Theory/ Transtheoretical Model of Behavior Change	Improvements in adherence and biological variables	Results were not statistically different than control group showing additional efforts may not have been more effective than traditional efforts
Toobert et al., 2002 [165]	Social Cognitive/Goal-Systems/Social Ecological Theory	No results were provided in the study	Study results were not provided
Leblanc et al., 2014 [167]	Self-Determination Theory	Adherence to MD and biological markers improved	Males showed greater improvements than females using this theory

Chapter 2: Figures

Figure 4

A



B

Search Strategy

1	("education" OR "theory" AND "dietary intervention" AND "Mediterranean diet" AND "Cardiovascular disease")
2	("nutrition education" OR "theory" AND "Cardiovascular disease" AND "Mediterranean diet")
3	("nutrition education" OR "theory" AND "Mediterranean diet")
4	("Mediterranean diet" + "Education" + "Nutrition" + "Intervention" + "Disease")

Figure 4. Study flow diagram and search strategy. (A) The study flow diagram detailing inclusion and exclusion of articles from the systematic review and (B) the search strategy terminology.

Chapter 3: A theory-based nutrition education program improves Mediterranean diet adherence in a population at high risk for cardiovascular disease in the southeastern United States

3.1 Abstract

Objective: Develop and implement a theory-based nutrition education program to increase Mediterranean diet (MD) adherence in a high risk population for cardiovascular disease

Design: Randomized, controlled trial assessing the effectiveness of a 12-week web-based nutrition education program

Setting: Auburn University, Auburn AL

Participants: Adults (n=39) with a BMI of >24.9 (m/kg^2) and at least two additional cardiovascular disease risk factors were randomized into either the control or intervention group

Intervention(s): Web-based nutrition education program promoting either American Heart Association recommendations (control group) or MD patterns (intervention group). The MD group also received EVOO and mixed nuts

Main Outcome Measure(s): Nutrition knowledge and MD adherence scores

Analysis: Fisher's exact test analyzed demographic characteristics. Paired t-tests, F-tests, t-tests, trend analyses, and a general linear model were all used to assess changes in nutrition knowledge and adherence scores.

Results: Both groups saw increased scores in nutrition knowledge and adherence; however, changes were greater in the MD group. Percent education completed significantly impacted MD adherence scores

Conclusions and Implications: The increased nutrition knowledge and behavior in both groups coupled with the significant impact percent education completion had on adherence scores, suggest that this theory-based education program is successful in promoting behavior change

Key Words: Theory, Nutrition Education, Mediterranean Diet

3.2 Introduction

CVD is currently the leading cause of death in the US and affects over 90 million Americans [3]. Healthful changes in dietary habits, such as increasing fruit, vegetable, and whole grain consumption, has been shown to decrease CVD risk factors.[113, 195, 196] Nutrition education is a key component in promoting these dietary behavior changes. Current research shows that the use of web-based nutrition education is a more

effective approach than non-web based programs in both increasing nutrition knowledge and promoting behavior change [148, 197]. Furthermore, the use of theoretical constructs within web-based interventions have substantial positive effects on health behavior change [150].

In recent years, studies have shown that adherence to dietary patterns similar to that of a MD is a healthful dietary approach[198] in part due to the primary[138, 199] and secondary[200] prevention of CVD. The MD is a plant-based diet that encourages EVOO as the primary source of dietary fat, and the consumption of fruits, vegetables, and whole grains at each meal. Olives, nuts, seeds and low-fat dairy are consumed daily while small amounts of fish, poultry, and eggs only on a weekly basis. Wine is to be consumed in moderation and in respect of social beliefs and local traditions [145]. This pattern of dietary consumption is vastly different than that seen in the high-risk CVD population in the southeastern US. In fact, a recent study assessing MD adherence in this population showed 40% of participants having a low MD adherence and less than 12% with high MD adherence [144].

Theory-based nutrition interventions have been successful in promoting long-term dietary behavior change [201-206]. However, only a limited number of studies in the US [165], Europe [163, 164], and Canada [167, 207] have been conducted using a theory-based approach to a nutrition intervention for CVD prevention or risk reduction using the MD. [163-165, 167, 207] Importantly, there is a lack of such studies in the southeastern US where MD adherence rates are low and the CVD morbidity and mortality rates are high [3]. Therefore, there is a need for a theory-based approach to a nutrition intervention to promote MD adherence in the Southeastern US. Thus, the objective of this study was

to develop and implement a theory-based nutrition education program to increase MD adherence in a population in the southeastern US at high-risk for CVD.

3.3 Methods

Study Design

This prospective randomized controlled trial was designed to assess the effectiveness of a 12-week, web-based nutrition education program, the Healthy Hearts Program (HHP), on nutrition knowledge and adherence to a MD in the Southeastern US. After consent, all eligible participants were randomly assigned into two groups, control or intervention, using the random number generator from Microsoft Excel 2010 for Windows®. This trial received an expedited review and obtained approval from Auburn University's Institutional Review Board (IRB) and is registered with ClinicalTrials.gov (NCT03683134).

Participants

Participants were recruited from the Auburn University Pharmaceutical Care Clinic (AUPCC) in Auburn, Alabama. The AUPCC coordinated the recruitment of employees and dependents who were enrolled in the university's health insurance plan. Recruitment methods included emails containing news and informational letters, flyers, and advertisements. Additionally, those participating in the AUPCC's health and wellness initiative, "Healthy Tigers," received handouts in the clinic as well as additional emails inviting them to join the HHP.

Eligible participants were adults, ≥18 years of age, members of the university's health insurance plan with a BMI ≥25 and 2 or more of the following risk factors for CVD: high blood pressure (BP) *(systolic BP >140mmHg and/or diastolic BP >90mmHg)*; men ≥55 years of age; women ≥60 years of age; high cholesterol *(total cholesterol >200mg/dL, LDLc cholesterol ≥160mg/dL, HDLc: men ≤40mg/dL or women ≤50mg/dL)*; elevated fasting blood sugar *(≥130mg/dL)*; current smoker *(≥1 cigarette per day)*; or a family history of premature coronary heart disease. Exclusion criteria included: previous cardiovascular event(s) (i.e.: MI or stroke); any change in medication for the treatment of high blood pressure, cholesterol, or blood sugar in the 12-weeks prior to the start of the trial; peanut, tree nut, or olive food allergy or intolerance; pregnancy or breastfeeding; and no access to a computer and/or internet.

Data Collection

At baseline, 6-weeks, and 12-weeks, participants completed a validated Mediterranean Diet Screener (MDS) [144]. The MDS is a 29-question screener which contains 14 questions addressing adherence to dietary intakes similar to those found in the MD and 15 assessing general nutrition knowledge that parallels with the dietary patterns of a MD. Five questions regarding demographics are also included in the MDS. Both adherence and nutrition knowledge questions are paralleled to address 6 food categories relating to the food patterns of a MD: lipids; fruits and vegetables; protein; dairy; wine; and sweets. Knowledge questions were scored as +1 for correct responses, -1 for incorrect responses, and 0 points were given if a participant answered, 'not sure' [144]. As Schröder et al. previously described, points were awarded to MD adherence

scores (MDAS) as +1 for responses that show adherence to patterns of a MD or 0 as for responses not showing MD adherence [208] MDAS. were divided into 3 categories reflecting MD adherence, low adherence (MDAS 1-4), medium adherence (MDAS 5-7), and high adherence (MDAS 8-14) [144].

Intervention

Eligible participants were assigned into either the control group, which promoted dietary recommendations from the AHA, or the intervention group, which promoted the dietary patterns of a MD. Participants in this study completed a 12-week web-based nutrition education program using the Alfresco Community®[209] as the on-line learning platform. Within this learning platform, participants in each group were given a unique username and were granted access to a site within the Alfresco Community® [209] for their assigned group where all components of the education program were delivered. Components included: education lessons/modules, discussion boards, links to external resources, and printable handouts.

Education modules were developed and delivered by a RD and pre-recorded using "GoToTraining" [210]. Each session lasted 10-15 minutes and links to the videos were made available to participants electronically via Alfresco Community® and GoToTraining [209]. Sessions for each group were paralleled in topic, time, and were structured similarly; however, the specific recommendations from each dietary pattern were emphasized accordingly.

Education topics were developed based on the 6 categories in the MDS [144]. The nutrition knowledge portion of the MDS was used as a pre- and post-test for the

education portion of the HHP. While questions from the nutrition knowledge portion of the screener are general nutrition questions based on correlation with parameters in the MD. Since the MDS was used as the pre- and post- test for the education program, all new educational material about each dietary pattern was provided in weeks one through six to assess nutrition knowledge changes at 6-weeks and retention at 12-weeks. Participants were asked to complete 7 education sessions throughout the program. Education modules were completed 1 per week for the first 6 weeks and the final at week 9. The final module at week 9 provided an overview of the assigned dietary pattern and no new information was presented at this time. Each presentation was structured using the same format to address and explain the what, why, where, and how for each topic (Table 7).

A discussion board was available throughout the study for participants within each group to interact with one another at any time. Weekly, a RD would be "live" on the discussion board for "Dietitian Discussion Day". During this time, a RD would initiate discussions, answer questions, provide feedback, and encourage interaction among group members. Handouts, flyers, external resources, and recipes were provided on group pages that supported and complimented each education topic.

The MD group received 3L of EVOO, 1.5 pounds raw almonds, and 1.5 pounds walnuts at baseline and 6-weeks. Participants in the MD group were instructed to replace all current fats used in their diets with EVOO. The MD group was encouraged to incorporate ¼ cup EVOO into their diets each day. The amount provided allowed for usage in family meal preparations. Two tablespoons of each nut, for a total of ¼ cup per

day was to be consumed solely by the participant. The adherence portion of the MDS was used to assess behavior change towards dietary patterns of the MD.

Theoretical applications

The theoretical framework of this study integrated concepts from the SCT and the SDT. The SCT provides a context to help understand behavior change in individuals. It suggests that learning occurs in a social context that requires continual interaction between the person, environment, and behavior. One unique aspect of the SCT is that it emphasizes both external and internal social reinforcement. It explains how people regulate their behavior through control and reinforcement to achieve goal-directed behavior that can be maintained over time. This theory consists of 6 main constructs: reciprocal determinism, behavioral capability, observational learning, reinforcements, expectations, and self-efficacy [174, 211, 212]. Table 8 briefly describes these concepts and how they were applied in this intervention.

The SDT is a theory of motivation and personality. It focuses on the motivation of choices and the degree in which those choices are self-motivated and self-determined and explain the interaction between the tendencies of human growth and inherent psychological needs. According to this theory, the psychological needs of competence, and autonomy must be satisfied in order for an individual to learn to self-regulate and sustain desired behaviors through the process of internalization and integration. The third inherent psychological need is relatedness, meeting this need is also crucial for internalization. Relatedness describes the need of an individual to feel close to part of a group or community. The SDT postulates that once these inherent needs are met, self-

motivation, integration, and growth will follow [171, 213-215]. A brief overview of each construct and how it was applied to the HHP is provided in Table 9.

Statistical Analyses

Fisher's exact test was used to assess the demographic characteristics between groups. Paired *t*-tests were used to evaluate the changes of each participant over time as a part of global and group analyses for all adherence and nutrition knowledge questions as well as total scores. F-tests were used to assess differences in variances within the total population and by group for all adherence and nutrition knowledge questions and total scores. *t*-tests, assuming equal or unequal variances, were used as a follow-up test to assess differences in means. Analysis of trends on total MDAS and total nutrition knowledge scores were performed to determine if changes in scores occurred over time. A general linear model was used to assess the impact of education, time completed in study, and group on all adherence and nutrition knowledge questions and total scores. All previously described analyses were conducted in Minitab (Minitab 18, 2017). Analysis percentiles and score rankings were conducted using the N-1 chi-squared test. All statistics were completed at a 95 percent confidence interval (alpha = 0.05).

3.4 Results

3.4.1 Participants

One hundred and eleven people responded to recruitment efforts and expressed interest in the program. Forty-two were excluded from the study for the following

reasons; did not meet stated minimum CVD risk factors (n=34); nut allergy or intolerance (n=3); pregnancy or currently breastfeeding (n=2); or experienced a recent change in medication (n=3). The 69 who met eligibility requirements were enrolled into the HHP and randomized into groups; however, 21 did not attend the baseline visit and were therefore excluded from the study. A total of 23 and 26 participants in the MD and AHA groups, respectively, completed baseline assessments. Over the course of the 12-week program, 21 participants, 7 from the MD group and 12 from the AHA group, were excluded from the study due to failure to attend follow-up appointments at 6-weeks (MD: n=4; AHA: n=10) and 12-weeks (MD: n=3; AHA: n=2) (Figure 5). No significant differences between the MD or AHA groups were seen in gender, age, BMI, ethnicity, level of education, or self-reported health qualifications between participants completing the study and those participants who completed <12-weeks. (Table 10)

3.4.2 Nutrition Knowledge

All participants showed significant improvement in total nutrition knowledge scores from baseline to 12-weeks (p=0.011). Significant improvement in one nutrition knowledge question (KQ15 [fruits & vegetables], p=0.043 and p=0.010) from baseline to 6- and 12-weeks respectively, was observed. No statistical improvements were noted when the scores between 6 and 12-weeks were compared (Table 11). The AHA group showed no significant improvements within individual nutrition knowledge questions or in total nutrition knowledge scores over time. The MD group had statistically significant improvements for KQ15 [fruits & vegetables] and the total KS from baseline to 12-weeks (p=0.006; p=0.034). A trend analysis exhibited continual upward trend for nutrition

knowledge scores over the 12-weeks. While no significance was observed, both groups showed increases in total nutrition knowledge over time. The MD group had a 2.67-point increase in average nutrition knowledge scores and the AHA group improved by 1.79 points.

A further assessment of nutrition knowledge examined the relationship that group assignment, percent of education completed, and time point of the study (i.e.: baseline vs 6-weeks vs 12-weeks) had on nutrition knowledge scores (Table 12). Group assignment was a statistically significant factor for two nutrition knowledge questions (KQ2 [lipids, fruits & vegetables], p=0.034; KQ13 [lipids], p=0.021). The percent of education participants completed was a significant factor in the improvement of KQ3 [fruits & vegetables] (p=0.001), KQ5 [protein] (p=0.011), KQ8 [sweets] (p=0.019), and KQ15 [fruits & vegetables] (p=0.002). Significance related to education completion was also seen in KQ11 [lipids] (p=0.015); however, the lack of fit to the regression line was also significant (p=0.001) for this question showing a significant amount of scatter in the data which could not be explained by the three variables. The time point in the study (i.e.: baseline, 6-weeks, or 12-weeks) was not a significant factor in relation to change nutrition knowledge scores. The amount of education completed was a statistically significant factor in total nutrition knowledge scores (p=0.001).

3.4.3 Adherence

Similarly, to nutrition knowledge scores, the impact of group assignment, length of time in study, and percent education completed was evaluated statistically on MD adherence scores (Table 13). Previous analyses determined if individuals improved over

time, this analysis used the entire data set to determine which factors were most influential on adherence scores. Group assignment was a statistically significant factor for four MD adherence questions (AQ): AQ2 [lipids] (p=0.003), AQ5 [protein] (p=0.017), AQ6 [dairy] (p=0.025), and AQ14 [fruits & vegetables] (p=0.022). The percent of education completed played a significant role in AQ1 [lipids] (p=0.013), AQ3 [fruits & vegetables] (p=0.007), AQ5 [protein] (p=0.010), and AQ13 [protein] (p=0.007). Time point of study progression was also a significant factor in four adherence questions: AQ5 [protein] (p=0.007), AQ11 [sweets] (p=0.021), AQ12 [lipids] (p=0.019), and AQ13 [protein] (p=0.003). Group assignment, amount of education completed, and time point were all statistically significant factors in total AQ scores (p=0.001, p=0.011, p=0.0001). Statistical analyses were not able to be run on the question relating to wine adherence (AQ8 [wine]) due to no variance in participant responses. A trend analysis of total MD adherence scores revealed a positive trend in both the AHA (p=0.036) and the MD (p=0.001) groups in adherence over time (Figure 6).

Comparing individual AQ scores between the MD and the AHA group, the MD group had significantly greater adherence scores for AQ5 [protein] (p=0.010) and AQ12 [lipids] (p=0.018) at 6-weeks and for AQ2 [lipids] (p=0.041) and AQ12 [lipids] (p=0.0017) at 12-weeks (Table 14). The entire population exhibited significant increases in adherence at baseline when compared to 6-weeks in AQ5 [protein] (p=0.002), AQ11 [sweets] (p=0.010), and AQ13 [protein] (p=0.032) and when compared to 12-weeks in AQ4 [fruits & vegetables] (p=0.029), AQ11 [sweets] (p=0.024), AQ12 [lipids] (p=0.008), and AQ13 [protein] (p=0.010). When compared to baseline responses, at 6-

weeks, the MD had significant improvements in five questions, AQ2 [lipids] (p-0.041), AQ5 [protein] (p=0.002), AQ7 [sweets] (p=0.034), AQ12 [lipids] (p=0.004) and AQ13 [protein] (p=0.007). The control group showed no significance in any individual questions this time-point. Between baseline and 12-weeks, the MD group had increase in AQ12 [lipids] (p=0.010). No significant changes were seen in individual AQs between weeks 6 and 12.

Assessing the categorical AQ data (i.e., low (1-4), medium (5-7), and high (8-14)) between the groups, significantly (p=0.004) more participants in the MD group had high adherence scores at 6-weeks. No significance was determined between groups in low or medium categories at baseline, 6-weeks, or 12-weeks. When categorical adherence data was assessed in all participants at all data collection points, a statistically significant increase in the percentage of all participants in the high adherence category (p=0.003; p=0.004) and significant decrease (p=0.004; p=0.006) in the number of participants in the low adherence between baseline and 6 weeks and baseline and 12 weeks, respectively, was observed (Table 15). The MD group had a significant decrease in the percentages of participants in the low adherence group at both 6-weeks (p=0.005) and 12-weeks (p=0.005) compared to baseline and a significant increase in the percentage of participants in the high adherence group at 6-weeks (p=0.003) and 12-weeks (p=0.004) compared to baseline percentages. A statistically significant (p=0.027) increase from baseline adherence scores in the percentage of AHA participants achieving high adherence scores was observed at 12-weeks. No significant changes were seen in either group between 6 and 12 weeks.

AQs were then assessed according to the specific adherence category (lipids, fruits & vegetables, protein, dairy, sweets, and wine) (Table 16). Significant improvements towards adherence were seen in the MD group between baseline and 6-weeks for lipids (p=0.003), fruits and vegetables (p=0.041), protein (p=0.003), and sweets (p=0.006). Also, comparing 12-week scores to baseline, significant improvements were seen in adherence for lipids (p=0.001), protein (p=0.027), and sweets (p=0.029). However, even though significant increases toward adherence were seen in protein consumption when baseline adherence was compared to 6-weeks and 12-weeks, a significant decrease (p=0.019) in protein adherence was seen when comparing the mid-point and end-point adherence scores. In the AHA group, no significant improvements were seen towards adherence of lipids, fruits and vegetables, dairy, or sweets. The AHA group did show significant improvements in protein adherence at both 6-weeks (p=0.035) and 12-weeks (p=0.021). It is important to note that no participants, in either group, scored any points towards adherence to wine consumption at any time point.

3.5 Discussion

CVD is the leading cause of death in the US [3], and adults in the southeastern region have some of the highest prevalence rates of both CVD risk factors and morbidity in the nation [139-141]. Adherence to dietary patterns similar to a MD have been shown to be affective in the prevention and reduction in CVD and its risk factors [136, 138, 200, 216]. Theory-based approaches to nutrition interventions can help to promote long-term behavior changes and increased adherence to more healthy dietary patterns [201-206]. This study aimed to evaluate the impact of a theory-based nutrition education program in

the southeastern US on nutrition knowledge and MD adherence in a population at high-risk for CVD.

In the total participant population, the overall total nutrition knowledge scores improved from baseline to six weeks during the intensive education portion of the program. Yet, the AHA group showed no significant increase by question or total nutrition knowledge. In contrast, total nutrition knowledge and nutrition knowledge on a fruit and vegetables question in the MD group increased between baseline and 12 weeks. A trend analysis of total KS showed continual upward trends in both groups over time. Importantly, we observed that the amount of education completed was a statistically significant factor in total nutrition knowledge scores in the total participant population.

While increasing nutrition knowledge regarding the MD was important, ultimately, adherence to the MD is a main outcome for testing the effectiveness of the theory-based HHP. This study showed that 53% of the population had low adherence compared to 42% and 7% having medium and high adherence, respectively. This is similar to the 2017 study on the general population in Lee County, AL which showed low, medium, and high adherence scores to be 40%, 49%, and 11%, respectively [144].

Similar to a MD dietary pattern, the AHA recommends consuming lean-meats and fish, low-fat dairy, a variety of fruits and vegetables, nuts and legumes, and whole grains. However, the AHA recommends using non-tropical vegetable oils and limiting fat intake to no more than 20-35% of your total daily calories [217-219] which is in contrast to the MD emphasizes EVOO [145] as the primary dietary fat with intakes up to 45% of total calories per day [220]. While both diets place higher emphasis on eating lean white meats and fish, MD is more of a plant-based diet that encourages plant-based proteins, fresh

fruits, and vegetables at each eating occasion [145, 217]. Due to these similarities, one would expect to see some increases in both nutrition knowledge and MD adherence scores in each group.

Indeed, nine individual MD AQ scores as well as total MD adherence scores significantly improved at 6-weeks and 12-weeks when compared to baseline. Our results demonstrate that the amount of education completed had a positive impact on MD adherence and that greater MD adherence in the MD group (three MD adherence individual question scores) compared to the AHA group are consistent with the focus of the MD nutrition education in the MD group. Importantly, the MD group showed significant improvements in adherence between baseline and 6-weeks for lipid, fruit and vegetables, protein, and sweet consumption. Significant improvement was seen in adherence to lipids and protein between baseline and 12 weeks. The AHA group only showed improvement in protein adherence at both six and 12 weeks.

The trend analyses of total MD adherence showed a significant positive trend in increased MD adherence in both the AHA ($p=0.036$) as well as the MD group ($p=0.001$). Categorical data analyzed by χ^2 tests verified these results. At baseline, no differences were seen in the distribution of participants in the different adherence categories; however, by six weeks, the MD group had significantly more participants in the high category compared to the AHA group. Between baseline and 6 weeks and baseline and 12 weeks, the MD group had a significant decrease in the participants falling in the low category and a significant increase in the participants having high adherence. A significant increase in participants in the high adherence category was also seen in the control group at both 6-weeks and 12-weeks.

When comparing the changes in categorical scores, the education was successful in increasing MD adherence. At baseline, only 14.29% percent of the MD group had high adherence compared to 71.42% percent at 6-weeks and 50.00% percent at 12 weeks. Similarly, 53.85% of the AHA group had low compliance at baseline while only 23.08% had low adherence at 12 weeks. Thus, the HHP is a successful method for increasing MD adherence.

A limitation to the study was that MD adherence was self-reported and may not reflect actual dietary intake. Another limitation in the current study was that it was a pilot study with a small sample size. However, even given this limitation we were able to observe significant differences in nutrition knowledge and MD adherence scores over time in the total population and in the AHA and MD groups.

In conclusion, our results demonstrate that the AHA and MD nutrition education programs resulted in an increase in nutrition knowledge and MD adherence over time and that the MD nutrition education program was more effective in increasing MD adherence scores over time. Our results demonstrating that percent education completed was a statistically significant factor in MD adherence suggest that our nutrition education has the potential to promote dietary behavior change by increasing MD adherence.

Table 7. Nutrition education format and explanation

Component	Description
What and Why	What is the topic? Why is it important? - Provides background explaining topic - Identifies the different types of the food (i.e.: different types of dietary fats, carbohydrates, grains) - Describes the importance of the topic related to its specific functions in the body, health benefits, and/or health risks
Where	Where is it found? - Provide lists of food choices - Identify less healthy food options and provide more nutrient rich alternatives
How	How much per day? How can I incorporate this into my diet? - Provide the recommended amounts needed - Identify recommended portion sizes - Provide ways to increase or decrease current intakes - Describe easy ways to incorporate into current eating patterns

Table 8. The Social Cognitive Theory: Construct definitions and applications from the Healthy Heart Program

Concept	Definition	Healthy Hearts Program Application
Reciprocal Determinism	The mutual interaction between the person, environment, and behavior	Provide online community (environment), encourage interaction through dietitian discussion days (person), and promote discussion of strategies for success and overcoming barriers (behavior)
Behavioral Capability	Ability to perform behavior through knowledge and skills	Provide nutrition education modules - Discuss the "what and why", "where", and "how" Address specific barriers of individuals and provide strategies for overcoming during dietitian discussion days
Expectations	Beliefs about the outcomes of specific behavior or action	Each nutrition education module to address the "what and why" - Explains benefits of desired behavior - Educates on consequences of undesired behavior
Self-Efficacy	The confidence in one's own ability to perform action	Dietitian Discussion Days: - Emphasize individual strengths and success - Provide information on overcoming setbacks Education Modules - Provide the "where" and "how" for each topic - Provide a weekly achievable goal for each topic
Observational Learning	Reproduce actions witnessed from others	Online Community - Discussion boards to show others' experiences Dietitian Discussion Days - Encourage participant discussion about behaviors and personal success strategies
Reinforcement	Internal or external responses to an action/behavior that increase or decrease likeliness of reoccurrence of action	Provide praise and encouragement during online interactions, deter and reframe negative responses in online community

Table 9. The Self-Determination Theory constructs and the Healthy Heart Program application

	Self-Determination Theory Constructs		
The Healthy Hearts Program Applications	**Competence** *The ability to interact with the environment proficiently and effectively*	**Autonomy** *The ability to initiate and regulate one's own behavior*	**Relatedness** *The feelings of closeness or belonging to a group*
Nutrition Education Modules	Provide clear and neutral information about assigned dietary pattern "What" portion of education session Provide clear, manageable goals at the end of each session Promote self-efficacy by providing handouts, grocery lists, and other resources	Present options for ways to incorporate components of dietary pattern Allow participant to make decision, no coercion "Where" and "How" portions of education sessions	Provide engagement tasks in the form of weekly goals
Online Community	Promote self-efficacy by helping participants develop action plans for set-backs or barriers Explore barriers and provide tools to help build participants confidence that the change can be made Provide positive feedback to participants	Provide support for autonomy: - Grocery lists - How to eat healthy when eating out - Portion size charts	Non-judgmental space, encourage interaction and comradery within group Express empathy Promote Feelings of closeness and belonging to a social group during discussions

Table 10. Demographic comparison of participants completing 100% vs participants completing <12 weeks

Characteristics	< 12-week completion AHA vs MD			12-week completion AHA vs MD			12-week vs < 12-week completion Combined Groups		
	AHA (n=12)	MD (n=7)	*P* value	AHA (n=14)	MD (n=16)	*P* value	<12 week (n = 19)	12 weeks (n=30)	*P* value
Gender [n (%)]									
Male	1 (8.33)	3 (42.86)	0.117	2 (14.29)	3 (18.75)	1.000	4 (21.05)	5 (1)	0.720
Female	11 (91.67)	4 (57.14)	0.117	12 (85.71)	13 (81.25)	1.000	15 (78.95)	25 (82.14)	0.720
Age [n (%)]									
35-44	3 (25.00)	2 (28.57)	1.000	4 (28.57)	3 (18.75)	0.675	5 (26.32)	7 (23.33)	1.000
45-54	4 (33.33)	3 (42.86)	1.000	5 (35.71)	6 (37.50)	1.000	7 (36.84)	11 (36.67)	1.000
55-64	4 (33.33)	2 (28.57)	1.000	5 (35.71)	7 (43.75)	0.722	6 (31.58)	12 (40.00)	0.762
65-74	1 (8.33)	0 (0)	1.000	0 (0)	0 (0)	1.000	1 (5.26)	0 (0)	0.388
BMI, kg/m^2 [n (%)]									
25 .0–29.9	1 (8.33)	1 (14.29)	1.000	4 (28.57)	3 (18.75)	0.675	2 (10.53)	7 (23.33)	0.451
30.0–34.9	4 (33.33)	2 (28.57)	1.000	7 (50.00)	4 (25.00)	0.257	6 (31.58)	11 (36.67)	0.767
35.0–39.9	2 (16.67)	3 (42.86)	1.000	1 (7.14)	5 (31.25)	0.175	5 (26.32)	6 (20.00)	0.729
≥40.0	5 (41.67)	1 (14.29)	0.333	2 (14.29)	4 (25.00)	0.657	6 (31.58)	6 (20.00)	0.498
Ethnicity [n (%)]									
White	5 (41.67)	5 (71.43)	1.000	12 (85.71)	8 (50.00)	0.058	10 (52.63)	20 (66.67)	0.377
Black African	3 (25.00)	1 (14.29)	1.000	1 (7.14)	5 (31.25)	0.175	4 (21.05)	6 (20.00)	1.000
Black Other	3 (25.00)	0 (0)	0.263	0 (0)	2 (12.50)	0.485	3 (15.79)	2 (6.67)	0.363
Chinese	0 (0)	0 (0)	1.000	1 (7.14)	0 (0)	0.467	0 (0)	1 (3.33)	1.000
Other‡	1 (8.33)	1 (14.29)	1.000	0 (0)	1 (6.25)	1.000	2 (10.52)	1 (3.33)	0.551
Education [n (%)]									
High School Diploma	1 (8.33)	1 (14.29)	1.000	1 (7.14)	1 (6.25)	1.000	2 (10.53)	2 (6.67)	0.636
GED	1 (8.33)	0 (0)	1.000	0 (0)	1 (6.25)	1.000	1 (5.26)	1 (3.33)	1.000
Technical or trade	0 (0)	2 (28.57)	0.123	0 (0)	0 (0)	1.000	2 (10.52)	0 (0)	0.145
Associate degree	1 (8.33)	1 (14.29)	1.000	1 (7.14)	3 (18.75)	0.602	2 (10.52)	4 (13.33)	1.000
Bachelor's degree	4 (33.33)	0 (0)	0.245	4 (28.57)	6 (37.50)	0.709	4 (21.05)	10 (33.33)	0.518
Masters or professional	5 (41.67)	3 (42.86)	1.000	8 (57.14)	5 (31.25)	0.269	8 (42.11)	13 (43.33)	1.000
Health Qualifications [n (%)]									
Yes‡‡	0 (0)	1 (14.29)	0.368	2 (14.29)	0 (0)	0.209	1 (5.26)	2 (6.67)	1.000
No	12 (100.00)	6 (85.71)	0.368	12 (85.71)	16 (100.00)	0.209	18 (94.74)	28 (93.33)	1.000

‡," Other" ethnicities specified were: Black American, Mixed, and Hispanic.
‡‡, Health qualifications listed: MSN in nursing and PhD in pathology.
* indicates significance (α=0.05; p<0.05)
Fisher's exact test was used for analyses.

Table 11. Nutrition knowledge scores for individual questions in the total population, AHA, and MD groups.

			Knowledge scores and between group analysis (MD v AHA) Combined (n=29); MD (n=15); AHA (n=14)						**Within group adherence****		**Trend analysis**
			Baseline		**6-weeks**		**12-weeks**		*P-values*		
KQ	**Category**	**Group**	Mean	SD	Mean	SD	Mean	SD	B v 6	B v 12	*P-value*
		Combined	0.862	0.516	1.000	0.000	1.000	0.000	0.161	0.161	0.137
KQ1	Lipids	MD	0.733	0.704	1.000	0.000	1.000	0.000	0.164	0.164	0.129
		AHA	1.000	0.000	1.000	0.000	1.000	0.000	----	----	----
	Lipids/	Combined	0.379	0.942	0.448	0.910	0.517	0.829	0.712	0.502	0.842
KQ2	Fruits & Vegetables	MD	0.200	1.014	0.200	1.014	0.200	1.014	1.000	1.000	1.000
		AHA	0.538	0.877	0.692	0.538	0.846	0.376	0.584	0.219	0.544
	Fruits &	Combined	0.517	0.785	0.552	0.827	0.655	0.721	0.813	0.403	0.782
KQ3	Vegetables	MD	0.400	0.828	0.467	0.915	0.533	0.834	0.719	0.546	0.914
		AHA	0.615	0.768	0.615	0.768	0.769	0.599	1.000	0.584	0.821
	Lipids/	Combined	0.483	0.634	0.621	0.622	0.586	0.682	0.293	0.477	0.700
KQ4	Fruits & Vegetables	MD	0.333	0.724	0.533	0.640	0.467	0.743	0.334	0.582	0.732
		AHA	0.615	0.506	0.692	0.630	0.769	0.599	0.673	0.337	0.931
		Combined	0.448	0.783	0.690	0.712	0.586	0.825	0.129	0.502	0.495
KQ5	Protein	MD	0.400	0.828	0.600	0.828	0.467	0.915	0.384	0.806	0.810
		AHA	0.462	0.776	0.769	0.599	0.692	0.751	0.219	0.513	0.530
		Combined	0.517	0.738	0.724	0.649	0.690	0.712	0.227	0.202	0.487
KQ6	Dairy	MD	0.533	0.743	0.867	0.352	0.600	0.828	0.173	0.719	0.367
		AHA	0.462	0.776	0.538	0.877	0.769	0.599	0.776	0.165	0.572
	Dairy/ Fruits	Combined	0.724	0.528	0.655	0.721	0.724	0.649	0.573	1.000	0.893
KQ7	& Vegetables	MD	0.667	0.617	0.533	0.834	0.800	0.561	0.433	0.546	0.567
		AHA	0.769	0.769	0.439	0.599	0.615	0.768	1.000	0.549	0.767
		Combined	0.655	0.614	0.552	0.736	0.690	0.660	0.501	0.813	0.719
KQ8	Sweets	MD	0.533	0.743	0.333	0.900	0.600	0.737	0.458	0.806	0.638
		AHA	0.769	0.769	0.439	0.439	0.769	0.599	1.000	1.000	1.000
		Combined	0.414	0.780	0.414	0.825	0.586	0.733	1.000	0.258	0.625
KQ9	Wine	MD	0.200	0.862	0.333	0.816	0.667	0.724	0.610	0.068	0.272
		AHA	0.615	0.650	0.615	0.768	0.538	0.776	1.000	0.584	0.847
		Combined	0.679	0.612	0.862	0.516	0.931	0.371	0.170	0.090	0.160
KQ10	Protein	MD	0.533	0.743	0.733	0.704	0.867	0.516	0.384	0.207	0.390
		AHA	0.846	0.376	1.000	0.000	1.000	0.000	0.165	0.165	0.108
		Combined	0.828	0.539	0.862	0.516	0.956	0.186	0.813	0.103	0.472
KQ11	Lipids	MD	0.867	0.516	0.733	0.704	0.933	0.258	0.582	0.334	0.574
		AHA	0.9231	0.2774	1.000	0.000	1.000	0.000	0.337	0.337	0.160
		Combined	0.828	0.468	0.862	0.441	0.931	0.371	0.745	0.264	0.647
KQ12	Sweets	MD	0.800	0.561	0.800	0.561	1.000	0.000	1.000	0.189	0.393
		AHA	0.846	0.376	0.923	0.277	0.846	0.555	0.584	1.000	0.865
		Combined	0.931	0.371	0.931	0.371	0.862	0.516	----	0.326	0.776
KQ13	Lipids	MD	0.867	0.516	0.867	0.516	0.733	0.704	----	0.334	0.773
		AHA	1.000	0.000	1.000	0.000	1.000	0.000	----	----	----
KQ14	Protein	Combined	0.690	0.604	0.724	0.591	0.759	0.577	0.787	0.646	0.906
		MD	0.600	0.737	0.667	0.617	0.933	0.258	0.670	0.096	0.255

		AHA	0.769	0.439	0.769	0.599	0.769	0.439	1.000	1.000	0.559
KQ15	Fruits & Vegetables	Combined	0.517	0.634	0.793	0.559	0.828	0.539	**0.043***	**0.010***	0.088
		MD	0.333	0.724	0.667	0.724	0.867	0.516	0.173	**0.006***	0.095
		AHA	0.692	0.480	0.923	0.277	0.769	0.599	0.082	0.584	0.457
Total MDK Score		Combined	9.448	4.339	10.69	4.072	11.28	2.975	0.124	**0.011***	0.178
		MD	8.00	4.66	9.33	4.72	10.67	2.87	0.369	**0.034***	0.228
		AHA	10.92	3.62	12.08	2.81	11.85	3.16	0.096	0.202	0.588

* Indicates significance of ($p < 0.05$)

** Paired t-tests were used for statistical analyses; $\alpha=0.05$

Table 12. Assessment of the impact of group, education, and time on nutrition knowledge scores in the total population.

Knowledge Question (KQ)‡‡	Education		Group		Time		Lack-of-Fit	
	F-value‡	*p*-value	F-value‡	*p*-value	F-value‡	*p*-value	F-value‡	*p*-value
KQ1 (LS)	0.37	0.868	2.68	0.106	2.00	0.143	0.460	0.963
KQ2 (LS)	1.95	0.095	4.66	**0.034***	0.20	0.822	0.390	0.985
KQ3 (FV)	8.41	0.001*	0.25	0.621	0.36	0.699	0.630	0.863
KQ4 (FV)	0.34	0.888	2.55	0.114	0.35	0.704	0.61	0.880
KQ5 (P)	3.19	**0.011***	0.25	0.616	0.80	0.451	0.60	0.887
KQ6 (D)	1.10	0.369	1.13	0.290	0.72	0.489	0.51	0.941
KQ7 (D)	0.32	0.898	0.00	0.985	0.11	0.898	0.57	0.907
KQ8 (LS)	2.90	**0.019***	1.29	0.260	0.38	0.683	0.73	0.767
KQ9 (W)	1.46	0.214	0.26	0.613	0.48	0.618	1.72	0.242
KQ10 (P)	1.52	0.194	1.32	0.254	1.94	0.151	0.63	0.851
KQ11 (P)	3.04	0.015*	0.74	0.393	0.85	0.432	4.88	0.001*
KQ12 (LS)	1.16	0.335	0.01	0.931	0.44	0.648	1.79	0.049*
KQ13 (L)	0.78	0.569	5.58	**0.021***	0.26	0.772	0.12	1.000
KQ14 (P)	1.00	0.425	0.73	0.394	0.10	0.907	1.31	0.214
KQ15 (FV)	4.17	**0.002***	0.06	0.809	3.03	0.054	0.94	0.536
Total Score	6.23	**0.001***	2.63	0.109	2.46	0.092	0.69	0.809

* Indicates ($p<0.05$)

‡ Statistical analyses used: General Linear Model, $\alpha=0.05$

‡‡MDS question category: Lipids (L); Sweets (S); Fruits & Vegetables (FV); Protein (P); Dairy (D); Wine (W).

Table 13. Assessment of the impact of group, education, and time on Mediterranean diet adherence scores in the total population.

Adherence Question (AQ)‡‡	Education		Group		Time		Lack-of-Fit	
	F-value‡	*p*-value	F-value‡	*p*-value	F-value‡	*p*-value	F-value‡	*p*-value
AQ1 (L)	3.11	0.013*	0.01	0.916	2.12	0.127	0.93	0.551
AQ2 (L)	0.78	0.570	9.21	0.003*	1.15	0.323	0.24	0.999
AQ3 (FV)	3.44	0.007*	0.27	0.608	2.61	0.080	0.25	0.999
AQ4 (FV)	1.18	0.326	0.03	0.866	2.51	0.088	0.41	0.981
AQ5 (P)	3.28	0.010*	5.92	0.017*	5.33	0.007*	0.82	0.668
AQ6 (D)	0.50	0.773	5.19	0.025*	1.21	0.302	1.22	0.278
AQ7 (S)	0.91	0.478	0.23	0.635	1.26	0.290	0.92	0.562
AQ8 (W)	--	--	--	--	--	--	--	--
AQ9 (P)	0.54	0.744	3.50	0.065	1.10	0.339	0.74	0.752
AQ10 (10)	0.55	0.741	1.06	0.307	2.01	0.141	0.75	0.749
AQ11 (S)	0.99	0.432	2.04	0.157	4.05	0.021*	1.27	0.243
AQ12 (L)	1.18	0.326	3.57	0.063	4.17	0.019*	0.89	0.590
AQ13 (P)	3.46	0.007*	1.47	0.230	6.38	0.003*	1.21	0.279
AQ14 (FV)	2.28	0.054	5.50	0.022*	0.88	0.418	0.55	0.919
Total AQ	3.19	0.011*	0.001	0.001*	13.56	0.001*	0.95	0.526

* Indicates ($p<0.05$)

‡ Statistical analyses used: General Linear Model, $\alpha=0.05$

‡‡ *MDS question category: Lipids (L); Sweets (S); Fruits & Vegetables (FV); Protein (P); Dairy (D); Wine (W).*

Table 14. MD adherence percentages for the individual questions in the AHA and MD groups and the total population.

			Adherence percentages[‡] and between group analysis (MD v AHA) Combined (n=29); MD (n=15); AHA (n=14)					
(AQ)	**Category**	**Group**	Baseline *n (%)*	*P*-value[**]	6-weeks *n (%)*	*P*-value[**]	12-weeks *n (%)*	*P* value[**]
AQ1	Lipids	Combined	18 (62.07)		24 (82.76)		24 (82.76)	
		MD	8 (53.33)	0.324	13 (86.67)	0.571	13 (86.67)	0.570
		AHA	10 (71.43)		11 (78.57)		11 (78.57)	
AQ2	Lipids	Combined	1 (3.45)		2 (6.90)		4 (13.79)	
		MD	1 (6.67)	0.334	2 (13.33)	0.164	4 (26.67)	**0.041**[*]
		AHA	0 (0)		0 (0)		0 (0)	
AQ3	Fruits & Vegetables	Combined	9 (31.03)		16 (55.17)		16 (55.17)	
		MD	5 (33.33)	0.786	9 (60.00)	0.595	8 (53.33)	0.840
		AHA	4 (28.57)		7 (50.00)		8 (57.14)	
AQ4	Fruits & Vegetables	Combined	3 (10.34)		8 (27.59)		10 (34.48)	
		MD	1 (6.67)	0.508	4 (26.67)	0.911	5 (33.33)	0.895
		AHA	2 (14.29)		4 (28.57)		5 (35.71)	
AQ5	Protein	Combined	9 (31.03)		21 (72.41)		16 (55.17)	
		MD	6 (40.00)	0.289	14 (93.33)	**0.010**[*]	8 (53.33)	0.840
		AHA	3 (21.43)		7 (50.00)		8 (57.14)	
AQ6	Dairy	Combined	18 (62.07)		22 (75.86)		23 (79.31)	
		MD	11 (73.33)	0.204	13 (86.67)	0.167	13 (86.67)	0.320
		AHA	7 (50.00)		9 (64.29)		10 (71.43)	
AQ7	Sweets	Combined	20 (68.97)		25 (86.21)		23 (79.31)	
		MD	9 (60.00)	0.289	14 (93.33)	0.256	11 (73.33)	0.420
		AHA	11 (78.57)		11 (78.57)		12 (85.71)	
AQ8	Wine	Combined	0 (0)		0 (0)		0 (0)	
		MD	0 (0)	1.000	0 (0)	1.000	0 (0)	1.000
		AHA	0 (0)		0 (0)		0 (0)	
AQ9	Protein	Combined	2 (6.90)		5 (17.24)		2 (6.90)	
		MD	1 (6.67)	0.961	4 (26.67)	0.172	2 (13.33)	0.164
		AHA	1 (7.14)		1 (7.14)		0 (0)	
AQ10	Protein	Combined	1 (3.45)		6 (20.69)		5 (17.24)	
		MD	1 (6.67)	0.334	4 (26.67)	0.419	3 (20.00)	0.690
		AHA	0 (0)		2 (14.29)		2 (14.29)	
AQ11	Sweets	Combined	16 (55.17)		25 (86.21)		24 (82.76)	
		MD	10 (66.67)	0.206	14 (93.33)	0.258	13 (86.67)	0.571
		AHA	6 (42.86)		11 (78.57)		11 (78.57)	
AQ12	Lipids	Combined	7 (24.14)		15 (51.72)		17 (58.62)	
		MD	3 (20.00)	0.596	11 (73.33)	**0.018**[*]	12 (80.00)	**0.017**[*]
		AHA	4 (28.57)		4 (28.57)		5 (35.71)	

AQ13	Protein	Combined	16 (55.17)		26 (89.66)		25 (86.21)	
		MD	9 (60.00)	0.595	15 (100.00)	0.063	13 (86.67)	0.941
		AHA	7 (50.00)		11 (78.57)		12 (85.71)	
AQ14	Fruits & Vegetables	Combined	8 (27.59)		9 (31.03)		5 (17.24)	
		MD	6 (40.00)	0.128	6 (40.00)	0.289	4 (26.67)	0.172
		AHA	2 (14.29)		3 (21.43)		1 (7.14)	

			Within group adherence**		**Trend analysis**
			B vs 6	B vs 12	*P*-value
AQ	**Category**	**Group**	*P*-value	*P-value*	
AQ1	Lipids	Combined	0.081	0.081	0.155
		MD	0.050	0.050	0.095
		AHA	0.668	0.668	0.885
AQ2	Lipids	Combined	0.557	0.164	0.348
		MD	0.550	0.149	0.321
		AHA	1.000	1.000	1.000
AQ3	Fruits & Vegetables	Combined	0.066	0.066	0.106
		MD	0.150	0.277	0.330
		AHA	0.254	0.134	0.302
AQ4	Fruits & Vegetables	Combined	0.097	**0.029***	0.880
		MD	0.149	0.073	0.198
		AHA	0.366	0.198	0.442
AQ5	Protein	Combined	**0.002***	0.066	**0.013***
		MD	**0.002***	0.471	**0.025***
		AHA	0.121	0.058	0.136
AQ6	Dairy	Combined	0.261	0.153	0.306
		MD	0.369	0.369	0.562
		AHA	0.453	0.254	0.513
AQ7	Sweets	Combined	0.119	0.373	0.285
		MD	**0.034***	0.446	0.108
		AHA	1.000	0.628	0.866
AQ8	Wine	Combined	1.000	1.000	1.000
		MD	1.000	1.000	1.000
		AHA	1.000	1.000	1.000
AQ9	Protein	Combined	0.231	1.000	0.336
		MD	0.149	0.550	0.321
		AHA	1.000	0.317	0.610
AQ10	Protein	Combined	**0.046***	0.087	0.134
		MD	0.149	0.291	0.361
		AHA	0.150	0.150	0.348
AQ11	Sweets	Combined	**0.010***	**0.024***	**0.022***
		MD	0.073	0.203	0.301
		AHA	0.058*	0.058	**0.070***

AQ12	Lipids	Combined	**0.032***	**0.008***	**0.024***
		MD	**0.004***	**0.001***	**0.001***
		AHA	1.000	0.691	0.901
AQ13	Protein	Combined	**0.004***	**0.010***	**0.005***
		MD	**0.007***	0.104	0.054
		AHA	0.121	0.055	0.089
AQ14	Fruits & Vegetables	Combined	0.775	0.349	0.463
		MD	1.000	0.446	0.694
		AHA	0.628	0.548	0.577

* Significance of ($p < 0.05$)
** χ^2 (n-1) statistical analyses was used; α=0.05
‡(n)= the number of MD adherent responses; percentage shows the percent of the group with a positive adherent score.

Table 15. Between group and within group comparisons of adherence categories based on total adherence score.

Adherence Category	Between Group Adherence Rates Combined (n=29); MD (n=15); AHA (n=14)					
	Group	Baseline n (%)	*P* value‡ n (%)	6-weeks n (%)	*P* value‡ n (%)	12-weeks n (%)	*P* value‡ n (%)
Low (1-4)	Combined	15 (53.57)		5 (16.67)		4 (13.33)	
	MD	8 (57.14)	0.866	1 (7.14)	0.121	1 (7.14)	0.253
	AHA	7 (53.85)		4 (30.77)		3 (23.08)	
Medium (5-7)	Combined	11 (42.38)		10 (35.71)		12 (46.67)	
	MD	4 (28.57)	0.354	3 (21.43)	0.087	6 (42.68)	0.866
	AHA	6 (46.15)		7 (53.85)		6 (46.15)	
High (8-14)	Combined	2 (6.90)		12 (42.86)		11 (39.29)	
	MD	2 (14.29)	0.165	10 (71.42)	0.004*	7 (50.00)	0.319
	AHA	0 (0)		2 (15.38)		4 (30.77)	

Adherence Category		Within group adherence‡		
	Group	B vs 6 *p-value*	B vs 12 *p-value*	6 vs 12 *p-value*
Low (1-4)	Combined	0.004*	0.006*	0.753
	MD	0.005*	0.005*	1.000
	AHA	0.242	0.113	0.664
Medium (5-7)	Combined	0.612	0.772	0.250
	MD	0.668	0.444	0.438
	AHA	0.700	1.000	0.700
High (8-14)	Combined	0.003*	0.004*	0.787
	MD	0.008*	0.047*	0.254
	AHA	0.1338	0.027*	0.361

‡ Statistical analyses of N-1 chi-squared test of proportions was used, $\alpha=0.05$

* Indicates significance of ($p < 0.05$)

Table 16. Within group assessment of Mediterranean diet adherence based on food category

		Adherence Category					
Mediterranean Diet		**Lipids**	**FV[#]**	**Protein**	**Dairy**	**Sweets**	**Wine**
Baseline	*Mean*	0.800	0.733	1.133	0.733	1.267	0
	SD	0.775	0.799	1.125	0.458	0.704	0
6-week	*Mean*	1.600	1.267	2.333	0.867	1.800	0
	SD	0.828	0.704	0.816	0.352	0.414	0
12-week	*Mean*	1.933	1.133	1.667	0.867	1.625	0
	SD	0.884	0.990	0.816	0.352	0.500	0
***p-value*[‡]**							
Baseline v 6-weeks		0.003*	0.041*	0.003*	0.433	0.006*	----
Baseline vs 12-weeks		0.001*	0.096	0.027*	0.334	0.029*	----
6-weeks vs 12-weeks		0.136	0.634	0.019*	1.000	0.189	----
American Heart Association		**Lipids**	**FV**	**Protein**	**Dairy**	**Sweets**	**Wine**
Baseline	*Mean*	1.000	0.571	0.786	0.500	1.214	0
	SD	0.679	0.852	0.802	0.519	0.802	0
6-week	*Mean*	1.071	1.000	1.500	0.643	1.571	0
	SD	0.616	1.038	0.941	0.497	0.646	0
12-week	*Mean*	1.143	1.000	1.571	0.714	1.643	0
	SD	0.663	0.784	0.938	0.469	0.497	0
***p-value*[‡]**							
Baseline v 6-weeks		0.671	0.082	0.035*	0.336	0.096	----
Baseline vs 12-weeks		0.435	0.111	0.021*	0.082	0.054	----
6-weeks vs 12-weeks		0.671	1.000	0.836	0.583	0.720	----

FV= Fruits and Vegetables

‡ Statistical analyses: paired t-tests; $\alpha=0.05$

* Indicates significance of ($p < 0.05$)

Chapter 3: Figures

Figure 5

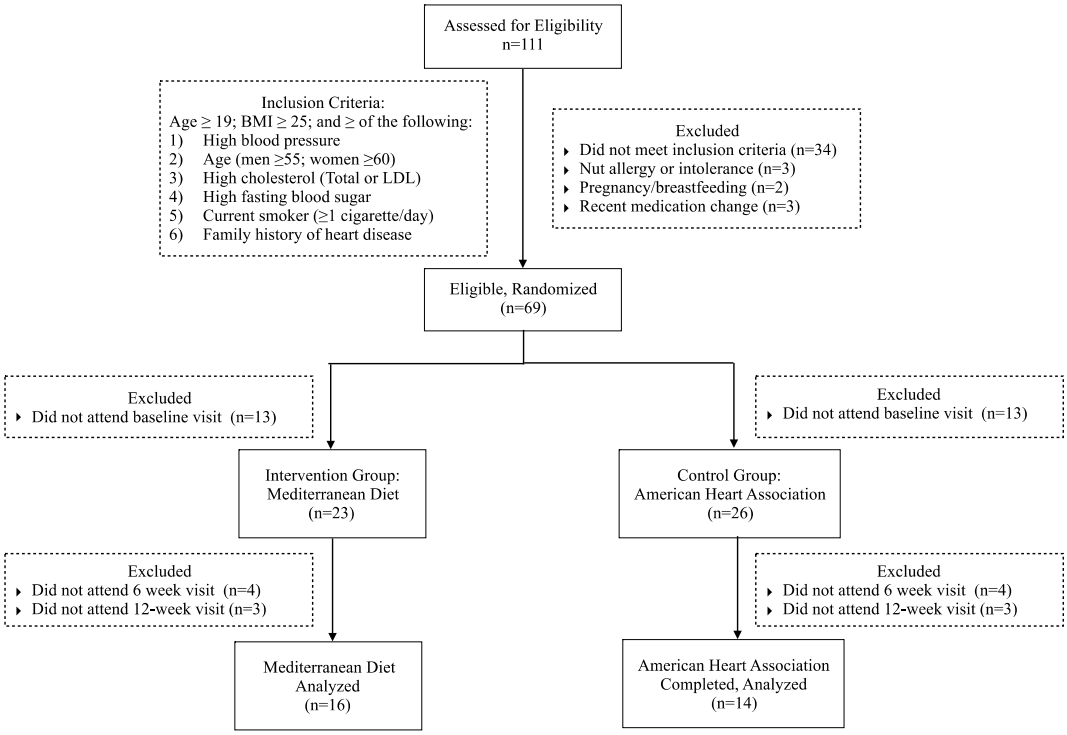


Figure 5: Flow chart of participants from recruitment to study completion.

Figure 6.

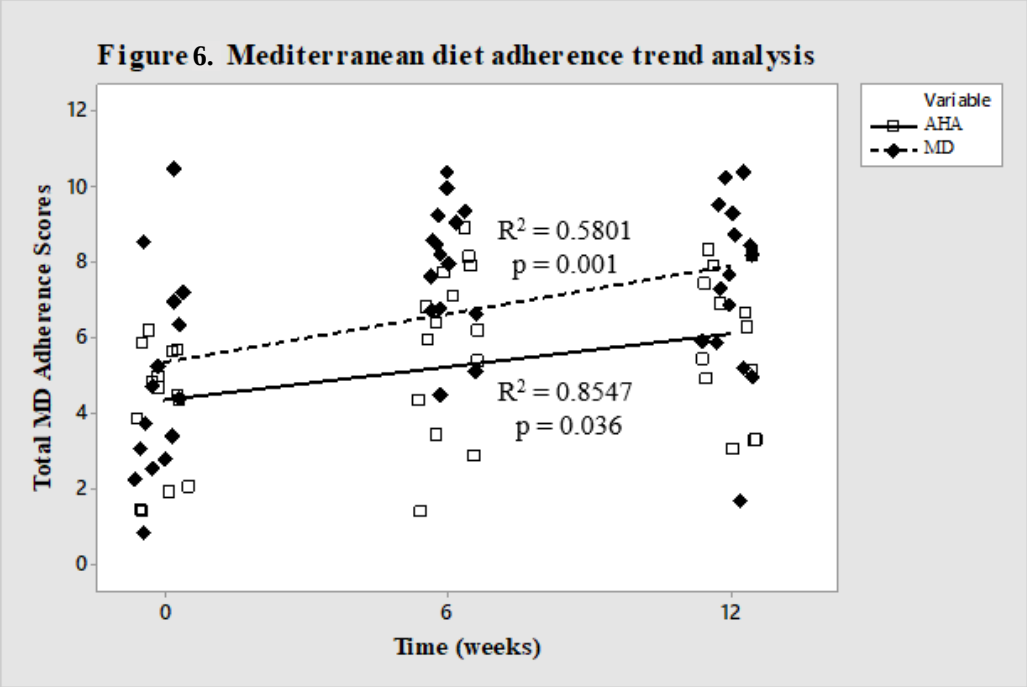


Figure 6: Trend analysis of total MD adherence scores in both the MD and AHA groups.

Chapter 4: An experimental study of a Mediterranean-style diet supplemented with nuts and extra-virgin olive oil for cardiovascular disease risk reduction in a high-risk population in the Southeastern United States: the Healthy Hearts Program

4.1 Abstract

Objective: Assess the efficacy of a MD intervention in reducing CVD risk factors in a high-risk population in the southeastern United States

Design: Randomized, controlled trial assessing the effectiveness of a 12-week nutrition intervention in reducing CVD risk factors in Auburn University, Auburn AL

Methods: Adults (n=30) with a BMI of >24.9 (m/kg^2) and at least two additional cardiovascular disease risk factors were randomized into one of two groups. The control group (n=14) received nutrition education on the recommendations of the AHA. The intervention group (n=16) received education promoting the patterns of and supplementation of EVOO and mixed nuts.

Main Outcome Measure(s): The primary outcome measure was change in systolic blood pressure (mmHg) from baseline to 6 and 12-weeks. Secondary outcome measures include changes from baseline to 6 and 12-weeks in diastolic blood pressure (mmHg); weight (kg); BMI (kg/m^2); fasted total cholesterol (mg/dL), HDLc (mg/dL), LDLc (mg/dL), TG (mg/dL), total cholesterol to HDLc ratio, blood glucose, and HOMA-IR; waist circumference (inches); hip circumference (inches); and waist-to-height ratio.

Analysis: A 95% level of significance (α=0.05) was used for all analyses. Paired t-tests and one-sided, two-sample t-tests were used to analyze actual measures and changes in measure from baseline to 6- and 12-weeks. A one-way analysis of variance (ANOVA) was used to assess trends. The GLM was used to assess the impact of specific variables on measured outcomes.

Results: The AHA group had decreases in actual outcome measures in HDLc, total cholesterol/HDLc ratio, and TG at baseline to 6-weeks, while the MD group had decreases in fat mass and BMR. The population as a whole, experienced a decrease in weight, BMI, and TG from baseline to 6-weeks. At 12-weeks, decreases in weight, BMI, and percent body fat were seen in the entire population compared to baseline. The MD group experienced trends towards significance in the differences in measures from baseline to 12-weeks in systolic blood pressure, TG, and total cholesterol to HDLc ratio. Group assignment played a significant role from baseline to 6-weeks in systolic blood pressure, HDLc, and LDLc levels. Nutrition knowledge influenced blood glucose and total cholesterol levels while adherence impacted total cholesterol and non-HDLc levels. Finally, percent nut consumption had a significant impact on HDLc levels, percent EVOO consumption significantly influenced LDLc values, and the nut/EVOO interaction was significant in both systolic pressure and HDLc levels.

Conclusions and Implications: While some significance and trends towards significance were observed in outcome measures, increases in nutrition knowledge (blood glucose, total cholesterol), MD adherence (total cholesterol, non-HDLc), percent nut consumption

(HDLc), percent EVOO consumption (LDLc), and the interaction of nut and EVOO consumption (systolic blood pressure and HDLc) proved to be the most significant influences on measurement outcomes. Due to the small population of the current study, these measures are encouraging in that a MD can be implemented on a larger scale with potential positive impacts on CVD risk in a population with low MD adherence.

Key Words: Mediterranean diet; extra-virgin LDLc; mixed nut; nutrition education; cardiovascular disease

4.2 Introduction

CVD is a clinical condition which causes approximately 18 million deaths in the US annually [3, 30]. Risk factors for CVD development fall into 2 categories: modifiable and non-modifiable. Modifiable risk factors which are the focus of CVD interventions include physical inactivity, obesity, unhealthy diet, tobacco use, excess alcohol consumption, high blood pressure, diabetes, and dyslipidemia [25, 221]. Nearly half of all American adults have at least one of the three key risk factors (high blood pressure, high cholesterol, and smoking) for heart disease [24]. However, adults in the southeastern US have higher prevalence rates of physical inactivity [140] and obesity [141], in addition to higher prevalence rates of stroke, diabetes, and heart disease [139], which puts this population at high-risk for CVD morbidity and mortality.

Nutrition interventions promoting healthy food habits and choices can manage and reduce many of the risk factors associated with cardiovascular disease. Recently, studies have shown that following dietary patterns similar to those of a MD is a beneficial

way of reducing CVD risk. Adhering to dietary patterns of a MD can reduce the risk [143, 222, 223] and incidence [224] of DM2 , decrease blood pressure [223, 225], improve blood lipid profile [223, 226], and play in role in both the primary [142] and secondary prevention [130] of CVD. In fact, studies have shown that nutritional interventions promoting the patterns of a MD, coupled with the supplementation of EVOO or mixed nuts, can be effective in reducing CVD risk in as little as 12-weeks [223].

Despite published evidence of the efficacy of the MD in reducing CVD risk [130, 142, 143, 222-226] few studies have been conducted assessing its effectiveness in the US. To date, no clinical MD studies have been conducted in the Southeastern US aiming to improve risk factor status for CVD. The primary objective of this pilot study was to assess the efficacy of a MD intervention in reducing CVD risk factors in a high-risk population in the Southeastern US.

4.3 Methods

Study Design

The current study was a prospective randomized controlled trial in Lee County, AL to assess the effectiveness of a 12-week intervention, The HHP, in reducing CVD risk factors in a population in the southeastern US. The protocol for this trial was reviewed and was granted approval by the Auburn University institutional review board. Funding was provided by the Malone-Zallen Graduate Research Fellowship, Auburn University. The funding source has no involvement in any aspect of the study.

Participant Selection and Randomization

Recruitment was coordinated through the AUPCC in Auburn, AL. Employees and dependents of Auburn University who were enrolled in the university's health insurance received emails containing flyers, informational letters, and advertisements. Flyers, handouts, and emails promoting the study were also distributed to those who participated in the AUPCC's health and wellness initiative, "Healthy Tigers". After recruitment, 111 people were assessed for eligibility.

Eligible participants were adults, ≥18 years of age, members of the university's health insurance plan with a BMI ≥25 and 2 or more of the following risk factors for CVD: high blood pressure BP*)*; men ≥55 years of age; women ≥60 years of age; high total cholesterol*;* elevated fasting blood glucose; current smoker; or a family history of premature coronary heart disease. Once eligibility was determined, those meeting study criteria (n=69) received written informed consent. A random number generator was used to randomize participants into one of two intervention groups: a control group following the AHA recommendations (n=26) or MD group supplemented with EVOO and mixed nuts (n=23). Throughout the 12-week intervention, a total of 19 participants (MD, n=7; AHA, n=12) were excluded from the study due to failure to attend 6-week (MD, n=4; AHA, n=9) or 12-week visits (MD, n=3; AHA, n=3).

Intervention and measurements

A theory-based approach was used in the development and implementation of the HHP. The theoretical framework utilized constructs from both the social cognitive theory as well as the self-determination theory. The nutrition education portion of the HHP was

a web-based program that used the online learning platform Alfresco Community® [209]. Participants were assigned a unique study ID for anonymity in the all online interactions.

Each intervention group had a specific Alfresco Community site that included seven intervention specific nutrition education sessions, which were recorded via "GoToTraining" [210]. Sessions were developed and delivered by a registered dietitian (RD). Participants were asked to complete one education session per week for the first six weeks and the final session at week 9. Participants also had access to handouts, links to external resources, and discussion boards. Within the discussion board, participants were able to interact with one another at any time throughout the study. Also, once per week for the entire 12-week duration, participants had the opportunity to join in "Dietitian Discussion Day" with a RD. During this one-hour open forum, participants could address any questions, concerns, or successes with a RD or other members of the intervention group. No education was provided on weight loss, calorie reduction, or increasing physical activity.

Participants were seen at the AUPCC at baseline, 6-weeks, and 12-weeks. At each visit, participants were asked to complete a validated MD screener [144], the International IPAQ [227], provide a urine sample, and provide blood samples by both capillary and venipuncture blood draws. The MD screener and IPAQ were used to assess changes in MD adherence and nutrition knowledge and physical activity, respectively. Capillary and venipuncture blood draw were collected by pharmacists, pharmacy residents, a RD, or dietetic students who were trained and certified in phlebotomy. Collection procedures followed guidelines set by the WHO's best practices in

phlebotomy [228]. Capillary blood draws were used to measure fasted blood glucose (mg/dL), total cholesterol (mg/dL), LDLc-cholesterol (mg/dL), HDLc-cholesterol (mg/dL), triglycerides (mg/dL), non-HDLc, and the total cholesterol to HDLc ratio. Serum was isolated from venipuncture blood samples, aliquoted, and stored at -80^0F.

At each of these visits, weight (pounds), BMI (kg/m^2), fat percent (%), basal metabolic rate (kilojoules and kilocalories), impedance (Ω), fat mass (pounds), fat free mass (pounds), total body water (pounds), and desirable fat percent range was measured using a TANITA TBF-300A body composition analyzer. Using procedures outlined in the National Health and Nutrition Examination Survey (NHANES) Anthropometry Procedures Manual, pharmacists or pharmacy residents obtained height (inches), waist circumference (inches), hip circumference (inches) [229]. These measures were used to calculate both waist-to-hip and waist-to-height ratios. The NHANES procedures were also used for measuring systolic blood pressure (mmHg), diastolic blood pressure (mmHg) and resting pulse (bpm). All weight measurements were converted to kilograms (kg) for analysis and reporting purposes.

Participants also received medication therapy management assessment by a pharmacist in order to identify any potential or actual drug-related problem, and to monitor for efficacy and safety of all medications, make recommendations for vitamins, minerals, and supplements, and provide preventative care recommendations (such as immunizations, osteoporosis screenings, colonoscopy, mammograms, and other recommended medical screenings that are recommended for the patient's age, gender, and concomitant disease states and medications).

All subjective and objective medical information collected was recorded in the electronic medical record (EMR) that is used in the AUPCC and the "Healthy Tigers" programs. This EMR is a secure medical record that meets all HIPAA requirements and has been reviewed by the Harrison School of Pharmacy, HIPAA officer, the Auburn University HIPAA officer, and the AU HIPAA consultant, and meets all legal and security requirements. These data will be perpetually stored in this EMR as required of medical data. Access to this EMR is restricted to authorized personnel only.

At each visit, all participants met with a RD or dietetic student to discuss any questions or concerns regarding their assigned dietary patterns. At baseline and 6-weeks, participants in the MD intervention group also received 3 liters of EVOO *Partanaa, Sicilian Extra Virgin Olive Oil* (purchased from Tal Depot, Farmingdale, NY) and 3 pounds of mixed nuts (1.5 pounds raw almonds and 1.5 pounds raw walnuts, purchased from nuts.com, Cranford, NJ) to supplement their diet. Consuming ¼ cup mixed nuts and ¼ cup EVOO each day was instructed. Participants were asked to return unused portions of both EVOO and mixed nuts at both 6-weeks and 12-weeks as a measure of compliance.

Statistical Analyses

A 95% level of significance ($\alpha = 0.05$) was used in all analyses. Paired *t*-tests were run to assess individual changes in the anthropometric and blood measures between baseline and 6-weeks and between baseline and 12-weeks. The null hypothesis for the paired *t*-tests assumed that there would be no differences for a single individual's measures between any two timepoints. These analyses were completed for the total

population and for each group. One-sided, two-sample *t*-tests were run to determine the differences between the measures at baseline compared to 6-weeks, and baseline compared to 12-weeks. These analyses were completed on both the raw data as well as the changes from baseline measurements. One-sided, two-sample *t*-tests were also conducted using the *f*-test as a pre-test to compare the measurement changes between baseline and 6-weeks and baseline and 12-weeks between the AHA and MD groups. This analysis was an attempt to assess change in time through a normalized manner and reduce the variability that was seen in the actual measurement data. It also provided insight as to which group may have had more physical changes in measurements during each six-week interval. Once variances were assessed for equality, differences between the mean changes were analyzed using the *t-tests.*

One-way analysis of variance (ANOVA) was used to conduct a trend analysis using the dataset for the entire population as well as each group's dataset. This set of analyses was conducted to determine if any changes in means occurred over time where time was the only influencing factor. The trends (slopes of the regression lines) were also statistically analyzed for differences between the AHA and MD groups using a regression analysis where time, group, and the interaction of time and group were used as predictors. If the group*time interactions were significantly different, then the null hypothesis of no difference between the slopes of the AHA and MD trends was rejected.

The General Linear Model (GLM) was used to examine the impact specific variables have on changes in the measured outcomes between baseline and 6-weeks and baseline and 12-weeks.

4.4 Results

At baseline, demographic characteristics were similar between groups (Table 17). No significant differences were seen between groups in gender, age, BMI, ethnicity, education level, or nutrition knowledge score. Females in the MD group did have significantly higher MD adherence (p=0.0001) then females in the AHA group. In assessing the total population, there was a significantly higher number of female participants (p=0.0001) than males. There are also significantly more black (Caribbean/African/Other) (p=0.024) and white females (p=0.001) than males. Gender differences in amount of education were significant. Significantly more of males did not receive a bachelor's degree (p=0.005) than females. Also, significantly more females (p=0.006) than males received a bachelor's degree. Using scores reported in previous literature [230], nutrition knowledge and MD adherence, were similar between males and females. Baseline demographic characteristics of participants completing the study versus those who did not were also similar (Table 18). No significant difference was observed between groups in gender, age, BMI, ethnicity, or education. However, females who did not complete the study did have significantly lower baseline KS (p=0.020) and MD adherence (p=0.0001) than females who completed the study.

An assessment of within group outcome measurements (actual) showed significant decreases within the AHA group from baseline to 6-weeks in weight (AHA, p=0.025), HDLc (AHA, p=0.004), and triglycerides (AHA, p=0.010) (Table 19). At this time point, no significant changes were seen in the MD group. When assessing changes in actual measures from baseline to 12-weeks, both the MD and AHA groups revealed significant within group reductions in weight (MD, p=0.050; AHA, p=0.030) and BMI

(MD, p=0.0.015; AHA, p=0.055). The MD group had significant decreases in, BMR (MD, p=0.030) and fat mass (MD, p=0.030) while the AHA group presented significant decreases in HDLc (AHA, p=0.017) and total cholesterol/HDLc (AHA, p=0.032). From baseline to 6-weeks, the total population of participants displayed statistically significant decreases in weight (p=0.041), BMI (p=0.039) and TG (p=0.010). When compared to baseline, all participants combined, presented significant decreases in weight (p=0.007), BMI (p=0.002), and percent body fat ($p=0.026$).

Between group analyses at each time point to determine differences in variable measurements between the AHA and MD groups (Table 19). No significant differences were observed between groups at baseline, 6-weeks, or 12-weeks. However, trends towards significance were observed at systolic blood pressure at 6-weeks (p=0.07) and with triglyceride values (p=0.09) and total cholesterol/HDLc (p=0.09) at 12-weeks.

Changes from baseline in measured values were assessed between the AHA and MD groups at 6- and 12-weeks (Table 20). At 6-weeks, statistically significant changes in and HDLc (p=0.009) were observed. At 12-weeks, significant changes were seen in HDLc (p=0.006), and total cholesterol (p=0.009).

Relationships between AHA and MD measured outcomes were assessed to determine if any trends were present in the total participant population as well as within the individual groups. Despite having statistical differences over time, no statistical trends were determined using this analysis.

The impact of group, nutrition knowledge, and MD adherence on measured variables were assessed between baseline and six-weeks and baseline and 12-weeks (Table 21). Between baseline and six-weeks, the group was shown to significantly impact

systolic pressure (p=0.012), HDLc (p=0.038), LDLc (p=0.047). At 6-weeks, nutrition knowledge and adherence scores impacted blood glucose (p=0.022; p=0.009, respectively). The baseline to 12-week comparison showed the group was significant in explaining changes in HDLc (p=0.01). Total cholesterol (p=0.023) was impacted by nutrition knowledge scores, and adherence had a significant impact on changes to total cholesterol (p=0.003), and non-HDLc (p=0.020).

The impact of EVOO consumption, nut consumption, and their combined interaction on the changes in measured variables between were evaluated between baseline and six-weeks and baseline and twelve-weeks are reported in Table 22. Percent nut consumption played a significant role in HDLc levels at both 6-weeks (p=0.001). EVOO consumption played a significant role on LDLc levels (p=0.034) at 12-weeks. The combined consumption of nuts and EVOO had a significant role in both systolic blood pressure (p=0.035) and HDLc levels (p=0.001) at 6 weeks.

4.5 Discussion

Heart disease is the leading cause of death in the US and is responsible for one in four deaths each year [3, 30] Adults in the Southeastern US have greater prevalence rates of physical inactivity [140], obesity [141], stroke, diabetes, and heart disease [139], putting this population at increased CVD risk. In recent years, nutrition interventions promoting the dietary patterns of the MD have shown to reduce CVD risk by reducing the risk [142, 143, 222] and incidence [231] of type 2 DM, decreasing blood pressure [223, 225], and improving blood lipid profiles [223, 232]. Moreover, interventions coupling patterns of a MD with the supplementation of EVOO or mixed nuts have been

effective in reducing CVD risk in as few as 12-weeks [223]. Therefore, the aim of this study was to assess the effectiveness of a nutrition intervention promoting a MD with the supplementation of EVOO and mixed nuts, on the reduction of CVD risk in a high-risk population in the Southeastern US.

Impacts of Group, Knowledge, and Adherence

As previously published, the theory-based education program of the HHP was successful in increased nutrition knowledge and MD adherence in the overall population of the program. A GLM analysis was used to ascertain which measurements group, nutrition knowledge scores, and MD adherence statistically impacted. Group assignment (AHA vs MD) was statistically significant in explaining changes in systolic pressure, HDLc, and LDLc between baseline and 6-weeks. The MD group saw a slight increase in SP between baseline and six-weeks and then saw a slight decrease in the SP at 12-weeks which caused a statistically significant difference ($p = 0.012$) between the changes in SP between baseline and 6-weeks using the one-sided two-sample t-test comparing the changes in the AHA and MD groups.

The group also statistically impacted the changes in HDLc between baseline and 12-weeks. The paired *t*-test analysis also showed a significant decrease ($p = 0.017$) in HDLc between the baseline and 6-week measurements for the AHA group while this was not seen in the MD group. The group also impacted four different cholesterol statistical analyses. The one-sided two-sample t-test showed, at both baseline to 6-week and baseline to 12-week, statistically significant differences in the change and actual HDLc measurements between groups (6-week *p*-value = 0.07 and 12-week *p*-value = 0.021) and

within groups (AHA baseline vs. 6-week *p*-value = 0.004 and AHA baseline vs. 12-week = 0.017). While numerical increases were seen in HDLc for the MD group, the values were not statistically significant; however, it is important to note that increases in HDLc support improved cardiovascular health. Statistically significant decreases in HDLc over time for the AHA and global populations would not support the idea of improved heart health.

Similarly, to HDLc, the group had a statistical impact on LDLc between baseline and 6-weeks. While there was not a statistical difference between the group changes at this time (p = 0.18, 1-sided, two sample *t*-test), the MD group saw a slight decrease in LDLc while the AHA group saw a slight numerical increase in LDLc. No statistical differences were found within group over time. The final cholesterol measurement impacted by group was the total cholesterol to HDLc ratio. The AHA group saw a slight increase in this value while the MD saw a cardiovascular positive decrease in this score despite no statistical significance (*p*-value = 0.11, 1-sided, two-sample *t*-test) between the changes between baseline and 6-weeks.

The final measurement impacted by group in the GLM was the percent body fat between baseline and 12-weeks. Both the MD and AHA groups saw a decrease in percent body fat; however, the differences between the baseline and 6-week (*p*-value 0.08) and baseline and 12-week (*p*-value = 0.045) measurements were statistically significant between groups.

Using the GLM analysis, both nutrition knowledge and adherence scores were statistically significant for explaining the changes in glucose from baseline to six-weeks. The paired *t*-test analyses compared how each participant's measurements changed over

time (either globally or within groups) between baseline and 6-weeks or baseline and 12-weeks. When comparing the impacts of group using the paired *t*-test (*p*-value = 0.46) and one-sided, two-sample *t*-tests (global *p*-value = 0.350, MD *p*-value = 0.375, and AHA *p*-value = 0.415), no changes or differences were seen which leaves little explanation as to what may have caused these changes.

Similarly, to blood glucose, both nutrition knowledge and adherence were statistically significant in explaining the changes in both total cholesterol and non HDLc between baseline and 12-weeks. While a general increase in the total cholesterol was seen in the AHA population and a slight numerical decrease was witnessed in the MD population, no statistical differences were noted between the MD and AHA groups (one-sided, two-sample *t*-test of differences *p*-value = 0.19).

The final two measurements which were impacted in this GLM were the total cholesterol to HDLc ratio between baseline and 12-weeks (impacted by nutrition knowledge) and BMI between baseline and 12-weeks being impacted by adherence. While statistical differences between groups were not seen in the BMI analyses, the one-sided, two-sample *t*-tests comparing the differences between baseline and 12-weeks between groups did show statistical differences (*p*-value = 0.0096).

These statistics do, indeed, show that the increase in nutrition knowledge and MD adherence can impact blood or anthropometric measures which have an impact on cardiovascular health.

The only analysis that did not group that did not show a statistical loss in weight between either baseline and six-weeks or baseline and 12-weeks was the MD group in the first six weeks of the study. However, comparatively, by the conclusion of the study, the

MD group had lost 0.94 percent of their original weight compared to 0.92 percent and 0.78 percent in the global and AHA populations, respectively. While weight loss was not coached in this program, the mean weights for both groups did go down over time. The results were more consistent with the MD group (0.45% and 0.94% weight loss at 6 and 12 weeks, respectively) than compared to the AHA group whose weight loss was more front heavy in the study (0.74% and 0.78% at 6 and 12 weeks, respectively).

Similar to weight, anthropometric measures such as hip circumference, waist circumference, and waist-to-hip ratio all had a high probability of finding statistical significance in all analyses. Of the 9 one-sided, two-sample *t*-tests which compared the measured values comparing the baseline measurements to the 6-week measurements, 8 were statistically significant within group. The paired *t*-analyses which assessed individual changes within group between baseline and 6-weeks or baseline and 12-weeks found 10 of the 12 analyses statistically significant. No real trends were noticed as most groups had a slight size reduction between baseline and 6-weeks and then a slight increase between 6- and 12-weeks within all three populations.

When considering lipid and lipoprotein measurements, paired *t*-tests showed differences in the, HDLc for the AHA group between baseline and 6-weeks (p-value = 0.004) and baseline and 12-weeks (*p*-value = 0.017), triglycerides for the global population between baseline and 6-weeks (*p*-value = 0.010) and baseline and 12-weeks (p-value = 0.095) as well as the AHA group between baseline and 6-weeks (*p*-value = 0.010). The AHA group also saw an increase in the total cholesterol to AHA ratio between baseline and 12-weeks (*p*-value = 0.032). The AHA group saw its cholesterol move in negative directions for both AHA and LDLc over time. While the LDLc results

were not statistically significant, the group did see a numerical 11.64-point increase in LDLc over 12-weeks.

One concern regarding this study was the feasibility of implementing a program that modeled EVOO and nut consumption which were not staples of the southeastern US diet. While one group did not measure the use of EVOO and nut consumption, the MD group was supplemented with both foods and were asked to return unused oil and nuts to ensure oil and nut consumption could be quantified. This methodology of quantifying consumption is not perfect as family members may have consumed some of the supplements; however, it does provide a practical estimate of EVOO and nut consumption.

A second GLM analysis assessed the impact of EVOO consumption, nut consumption, and the interaction of EVOO and nut consumption of the measured anthropometric and blood measurements. While there were not many instances when the change in measurements could be explained in the GLM by these three covariates, nut consumption positively impacted HDLc values between baseline and 6-weeks (p-value = 0.0001). The interaction of nut and EVOO consumption was also statistically significant in the HDLc change between baseline and 6 weeks (p-value = 0.004). While the MD group (those who were supplemented with EVOO and nuts) did not see a statistical decrease in HDLc over time, the nut and EVOO consumption seems to statistically have had an influence in preventing the increase in HDLc which was witnessed in the AHA group. The supplementation of EVOO had a positive impact in LDLc measurements (p-value = 0.034). As mentioned earlier, the AHA group saw an increase in LDLc while the

MD group saw a numerical decrease in LDLc over time; thus, the consumption of EVOO positively impacted a risk factor of CVD.

Overall, the study also showed that this type of diet could also be implemented. In the MD group, an average of 44% of the 3L of EVOO was consumed during the first six-weeks and overall, 40% of the provided EVOO was consumed. While these values may seem low, 25% of the MD group members did not consume any EVOO between baseline and 6-weeks, and three consumed no EVOO in the second six-weeks. The forth member of the MD group who did not consume any EVOO in the first six weeks only consumed 3% of the provided EVOO in the second six-weeks. When these members were removed from the analysis, 59% of the provided oil was consumed in the first six-weeks, and approximately 50% of the provided EVOO was consumed overall.

Four members of the MD group did not consume any nuts in the first six week with two beginning to consume nuts during the second six weeks. Using the entire group, 68% of the provided nuts were consumed in the first six weeks and overall. However, when removing those who did not consume any nuts, 91% of the nuts were consumed during the first six weeks and a 73% consumption rate was seen overall.

In conclusion, the increased nutrition knowledge and MD adherence did translate into improved anthropometric and blood measures within both groups. This was specifically noticed in lipid and lipoprotein measures. Additionally, the GLM was able to determine when group education and practices may have statistically impacted the overall test results when actual differences between groups may not have been statistically significant. Increases in nutrition knowledge (blood glucose, total cholesterol), MD adherence (total cholesterol, non-HDLc), percent nut consumption (HDLc), percent

EVOO consumption (LDLc), and the interaction of nut and EVOO consumption (systolic blood pressure and HDLc) proved to be the most significant influences on measurement outcomes. Due to the small population of the current study, these measures are encouraging in that a MD can be implemented on a larger scale with potential positive impacts on CVD risk in a population with low MD adherence.

Chapter 4: Tables

Table 17. Between group and within group comparison of baseline demographic characteristics

Characteristics	Baseline Demographic Characteristics				
	AHA (n=14)	MD (n=16)	*P* value*	Combined (n=30)	*P* value*
Gender [n (%)]					
Male	2.00 (14.29)	3.00 (18.75)	0.745	5.00 (16.67)	**<0.0001***
Female	12.00 (85.71)	13.00 (81.25)		25.00 (83.33)	
Age [mean (SD)] †					
Male	48.00 (7.00)	49.33 (8.73)	0.868	48.67 (8.11)	0.460
Female	50.33 (9.85)	53.38 (6.25)	0.372	51.86 (8.32)	
BMI, kg/m^2 [mean (SD)] †					
Male	30.90 (1.10)	31.97 (6.43)	0.804	31.43 (5.05)	0.196
Female	33.82 (5.44)	36.35 (5.33)	0.253	35.08 (5.44)	
Ethnicity [n (%)]					
Black/Caribbean/African/Other					
Male	0.00 (0.00)	1.00 (6.25)	0.350	1.00 (3.33)	**0.024***
Female	1.00 (7.14)	6.00 (37.50)		7.00 (23.33)	
White					
Male	2.00 (14.29)	2.00 (12.50)	0.888	4.00 (13.33)	**0.001***
Female	10.00 (71.43)	6.00 (37.50)		16.00 (53.33)	
Other					
Male	0.00 (0.00)	1.00 (6.25)	0.350	1.00 (3.33)	0.556
Female	1.00 (7.14)	1.00 (6.25)		2.00 (6.67)	
Education [n (%)]					
<4-year higher education degree					
Male	0.00 (0.00)	0.00 (0.00)	0.281	0.00 (0.00)	**0.005***
Female	2.00 (14.29)	5.00 (31.25)		7.00 (23.33)	
Bachelor's degree					
Male	0.00 (0.00)	1.00 (6.25)	0.875	1.00 (3.33)	**0.006***
Female	4.00 (28.57)	5.00 (31.25)		9.00 (30.00)	
>4-year higher education degree					
Male	2.00 (14.29)	2.00 (12.50)	0.888	4.00 (13.33)	0.120
Female	6.00 (42.86)	3.00 (18.75)		9.00 (30.00)	
Knowledge Score[230] [mean (SD)]†^					
Male	10.00 (5.00)	10.67 (1.63)	0.514	10.33 (3.71)	0.593
Female	11.17 (2.967)	7.38 (4.11)	0.190	9.28 (4.21)	
MD Adherence Score [230] [mean (SD)]†^					
Male	5.50 (0.50)	6.00 (3.86)	0.279	5.75 (3.03)	0.540
Female	3.83 (1.82)	9.54 (1.83)	**0.0001***	6.69 (1.88)	

* α=0.05

One-way, two-sample t-test was used for all analyses except (†). N-1 chi-squared test was used for these analyses

^ data from unpublished research

Table 18. Baseline demographic comparisons between participants completing 12-weeks versus participants completing <12-weeks

	Baseline Demographic Characteristics		
	12-week completion (n=30)	<12-week completion (n=19)	*P*-values
Gender [n (%)]			
Male	5 (16.67)	4 (21.05)	0.703
Female	25 (83.33)	15 (78.95)	0.703
Age [mean (SD)]†			
Male	48.67 (8.11)	46.00 (8.76)	0.655
Female	51.86 (8.32)	53.53 (9.72)	0.584
BMI, kg/m^2 [mean (SD)]†			
Male	31.43 (5.05)	34.98 (5.85)	0.374
Female	35.08 (5.44)	38.43 (8.12)	0.171
Ethnicity [n (%)]			
Black/Caribbean/African/Other			
Male	1 (3.33)	0 (0.00)	0.427
Female	7 (23.33)	7 (36.84)	0.309
White			
Male	4 (13.33)	1 (10.00)	0.730
Female	16 (53.33)	7 (36.84)	0.265
Other			
Male	1 (3.33)	1(15.79)	0.125
Female	2 (6.67)	0 (0.00)	0.255
Education [n (%)]			
≤4 year higher-education degree			
Male	0 (0.00)	2 (10.53)	0.426
Female	7 (23.33)	5 (26.32)	0.814
Bachelor's degree			
Male	1 (3.33)	0 (0.00)	0.427
Female	9 (30.00)	4 (21.05)	0.494
> Bachelor's degree			
Male	4 (13.33)	2 (10.53)	0.773
Female	9 (30.00)	6 (31.58)	0.908
Knowledge Score [mean (SD)]†^			
Male	10.33 (3.71)	10.25 (2.99)	0.973
Female	9.28 (4.21)	5.13 (5.55)	0.020*
MD Adherence Score [mean (SD)]†^			
Male	5.75 (3.03)	1.75 (0.50)	0.044*
Female	6.69 (1.88)	3.46 (1.98)	0.0001*

* α=0.05

†One-way, two-sample t-test was used for analyses. N-1 chi-squared test was used for all other analyses

^ data from unpublished research [230]

Table 19. Within and between group assessment of actual measurement outcome values over time.

2-sample, 1-sided t-test (α=0.05)
Total (n=30); MD (n=16); AHA (n=14)

		Baseline			**6-weeks**			**12-weeks**			*P-values*		
Measure	**Group**	Mean	SD	*p*-value	Mean	SD	*p*-value	Mean	SD	*p*-value	B v 6	B v 12	Trend Analysis
Systolic Pressure (mmHg)	Total	123.3	10.02		124.33	11.15		124.36	11.04		0.315	0.335	0.915
	MD	123.88	11.28	0.739	128.0	12.21	0.077*	126.75	11.24	0.211	0.060*	0.225	0.590
	AHA	122.6	8.75		120.14	11.19		121.64	10.57		0.235	0.380	0.810
Diastolic Pressure (mmHg)	Total	81.13	5.48		82.4	10.87		82.87	10.49		0.260	0.155	0.719
	MD	82.25	5.16	0.243	84.12	12.30	0.352	83.75	10.01	0.557	0.265	0.300	0.844
	AHA	78.86	5,74		80.42	9.02		81.86	6.35		0.415	0.140	0.751
Weight (kg)	Total	94.11	16.48		93.76	35.27		93.45	35.63		**0.041**‡	**0.007**‡	0.978
	MD	97.14	17.87	0.286	96.90	35.99	0.258	96.43	36.61	0.287	0.200	0.050	0.988
	AHA	90.66	15.23		90.18	33.98		90.04	34.53		**0.025**‡	**0.030**‡	0.989
BMI (kg/m²)	Total	35.35	5.62		34.1	5.35		33.92	5.40		**0.039**‡	**0.002**‡	0.953
	MD	35.19	5.95	0.390	34.86	5.49	0.416	34.65	5.49	0.436	0.085	**0.015**‡	0.964
	AHA	33.4	5,26		33.24	5.25		33.08	5.38		0.130	0.055*	0.987
Percent Body Fat (%)	Total	43.88	7.59		42.89	7.39		42.39	7.65		0.110	**0.026**‡	0.740
	MD	43.21	8.23	0.610	43.29	8.20	0.755	42.89	8.31	0.702	0.415	0.155	0.990
	AHA	44.64	7.01		42.44	6.62		41.81	7.10		0.130	**0.040**‡	0.528
Basal Metabolic Rate (Kcal)	Total	1659.8	214.11		1665.3	131.38		1663	234.19		0.335	0.410	0.996
	MD	1700.8	241.74		1696.1	235.12		1691.8	238.6		0.185	0.065*	0.994
	AHA	1612.9	174.34	0.259	1639.4	230.54	0.446	1630.0	233.38	0.480	0.270	0.275	0.970
Fat Mass (kg)	Total	40.43	13.16		40.58	11.71		39.94	11.50		0.440	0.320	0.978
	MD	42.55	12.77	0.356	42.41	12.71	0.364	40.84	12.34	0.367	0.360	**0.030**‡	0.982
	AHA	38.10	13.65		38.49	10.51		37.87	10.76		0.410	0.480	0.989
Fat Free Mass (kg)	Total	52.63	8.30		53.02	9.04		53.56	9.72		0.285	0.180	0.924
	MD	54.61	9.43	0.158	54.28	8.75	0.428	54.46	9.68	0.592	0.275	0.335	0.995
	AHA	50.82	6.40		52.02	9.71		52.46	9.95		0.205	0.145	0.952
Total Body Water (kg)	Total	38.73	4.93		38.76	6.63		39.02	7.06		0.475	0.275	0.983
	MD	39.98	6.90	0.221	39.68	6.40	0.430	39.86	7.08	0.495	0.220	0.310	0.992
	AHA	37.30	4.75		37.71	6.98		38.06	7.18		0.330	0.225	0.952
Total Cholesterol (mg/dL)	Total	189.7	42.39		185.4	39.50		188.23	46.16		0.120	0.395	0.925
	MD	190.75	48.20	0.886	188.25	42.20	0.678	184.75	41.19	0.672	0.285	0.070*	0.928
	AHA	188.5	36.38		182.14	37.49		192.21	52.57		0.165	0.370	0.821
HDLc (mg/dL)	Total	53.9	17.56		53.5	18.81		51.3	13.96		0.415	0.055	0.819
	MD	54.12	15.80	0.943	57.81	19.04	0.183	54.5	13.89	0.187	0.105	0.410	0.783
	AHA	53.64	19.99		48.57	17.93		47.71	13.53		**0.004**‡	**0.017**‡	0.624
TG (mg/dL)	Total	126.2	61.62		107.47	40.04		109.4	63.18		**0.010**‡	0.095*	0.366
	MD	111.13	60.24	0.156	102.44	37.08	0.477	91.38	57.83	0.098*	0.205	0.140	0.573
	AHA	143.43	60.70		113.21	43.85		130.07	64.70		**0.010**‡	0.205	0.383
LDLc (mg/dL)	Total	104.28	48.23		106.97	49.92		100.25	57.14		0.255	0.340	0.915
	MD	109.13	50.55	0.538	110.6	38.98	0.664	90.47	52.26	0.422	0.380	0.090	0.516
	AHA	99.07	46.92		103.07	51.75		110.71	61.17		0.285	0.205	0.846

non-HDLc (mg/dL)	Total	131.28	49.54		127.97	48.78		137.05	48.78		0.180	0.210	0.775
	MD	136.56	44.92	0.521	133.25	38.58	0.548	130.19	38.51	0.436	0.240	0.090	0.907
	AHA	124.77	55.88		121.46	60.07		145.46	50.43		0.295	0.080	0.524
Total cholesterol / HDLc	Total	3.58	1.41		3.58	1.46		3.97	1.51		0.480	0.305	0.493
	MD	3.84	1.39	0.289	3.61	1.03	0.893	3.54	0.96	0.092*	0.150	0.105	0.734
	AHA	3.29	1.42		3.54	1.88		4.46	1.88		0.100	**0.032**‡	0.181
Blood Glucose (mg/dL)	Total	102.97	19.72		103.67	21.98		103.83	18.77		0.345	0.305	0.985
	MD	103.81	22.89	0.802	104.69	22.84	0.790	105.19	18.72	0.681	0.375	0.295	0.983
	AHA	102.0	16.15		102.5	21.73		102.29	19.41		0.415	0.400	0.998

‡ and **bold** indicates significance of ($p < 0.05$)
* indicates value that may be trending towards significance

Table 20. Between group assessment of the changes measurement outcomes assessed from baseline to 6 and 12 weeks.

		One-sided, two-sample t-test (α=0.05)					
		Baseline to 6-weeks			Baseline to 12-weeks		
Tested Variable	**Group**	**Mean**	**SD**	***p*-value**	**Mean**	**SD**	***p*-value**
Systolic Pressure (mmHg)	AHA	-2.500	12.62	0.061*	-1.000	12.28	0.222
	MD	4.130	10.10		2.880	14.67	
Diastolic Pressure (mmHg)	AHA	0.570	9.58	0.372	2.000	6.66	0.145
	MD	1.880	11.71		1.500	11.26	
Weight (kg)	AHA	-0.67	1.12	0.709	-0.81	1.45	0.866
	MD	-0.45	2.00		-0.92	2.07	
BMI (kg/m^2)	AHA	-0.16	0.50	0.522	-0.32	0.67	0.442
	MD	-0.33	0.90		-0.54	0.87	
Percent Body Fat (%)	AHA	-2.21	5.92	0.080*	2.84	5.55	0.057*
	MD	0.08	1.21		-0.31	1.14	
Basal Metabolic Rate (BMR)	AHA	17.29	102.12	0.202	17.14	105.46	0.170
	MD	-4.75	22.58		-9.06	22.58	
Fat Mass (kg)	AHA	0.50	7.89	0.767	-0.12	7.87	0.752
	MD	-0.15	1.58		-0.81	1.54	
Fat Free Mass (kg)	AHA	1.21	4.79	0.268	-1.58	4.97	0.314
	MD	-0.33	1.58		-0.15	1.33	
Total Body Water (kg)	AHA	0.41	3.27	0.460	0.76	3.49	0.389
	MD	-0.31	1.51		-0.13	1.51	
Total Cholesterol (mg/dL)	AHA	-6.360	23.36	0.303	3.710	40.28	0.189
	MD	-2.500	17.03		-6.000	15.51	
HDLc (mg/dL)	AHA	-5.46	5.89	**0.009**‡	-7.00	6.88	**0.006**‡
	MD	3.690	11.16		0.380	6.67	
Triglycerides (mg/dL)	AHA	-30.210	40.62	0.193	-10.14	53.71	0.586
	MD	-11.50	35.46		-22.56	64.83	
LDLc (mg/dL)	AHA	4.31	25.47	0.484	-14.50	39.62	0.345
	MD	-1.43	14.35		*-2.54*	15.77	
non-HDLc (mg/dL)	AHA	-3.58	21.23	0.972	*-12.00*	38.67	0.636
	MD	-3.31	18.32		-6.38	18.32	
Total cholesterol/ HDLc	AHA	0.27	0.69	0.889	0.60	0.85	**0.009**‡
	MD	-0.23	0.84		*-0.31*	0.91	
Blood Glucose (mg/dL)	AHA	0.500	8.733	0.459	0.290	8.44	0.751
	MD	0.880	10.862		1.380	9.95	

‡ and **bold** indicates significance ($p<0.05$)
* indicates a potential trend towards significance

Table 21. General Linear Model: Influence of Group assignment, MDK score, MDA score on measurement changes from baseline to 6 and 12 weeks (α=0.05)

Outcome Measure	Changes from Baseline to 6-weeks						Changes from Baseline to 12-weeks					
	Group		*Knowledge Score (6-week)*		*Adherence Score (6-week)*		*Group*		*Knowledge Score (12-week)*		*Adherence Score (12-week)*	
	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value
Systolic Pressure (mm/Hg)	9.31	**0.012‡**	2.17	0.119	1.44	0.289	2.60	0.133	2.60	0.063*	1.21	0.368
Diastolic Pressure (mm/Hg)	0.69	0.425	1.30	0.343	0.68	0.701	0.17	0.689	1.59	0.223	0.55	0.780
Weight (pounds)	0.71	0.420	0.45	0.886	1.04	0.469	0.01	0.931	0.49	0.853	0.62	0.733
BMI (kg/m^2)	0.21	0.658	0.57	0.808	0.73	0.666	0.07	0.799	2.18	0.104	2.60	0.070*
Percent Body Fat (%)	1.71	0.220	0.72	0.692	1.08	0.446	4.30	0.060*	0.46	0.875	1.03	0.459
Basal Metabolic Rate (BMR)	0.01	0.908	0.46	0.880	0.54	0.804	1.39	0.262	1.01	0.479	1.48	0.263
Fat Mass (pounds)	0.34	0.573	0.91	0.556	1.22	0.378	0.35	0.563	0.88	0.565	1.61	0.224
Fat Free Mass (pounds)	0.01	0.942	0.95	0.529	0.82	0.602	0.12	0.732	1.96	0.138	0.63	0.727
Total Body Water (pounds)	0.02	0.887	0.56	0.816	1.05	0.463	1.39	0.262	0.69	0.705	1.63	0.219
Total Cholesterol (mg/dL)	0.09	0.770	1.09	0.449	0.65	0.724	0.34	0.572	3.50	**0.023‡**	6.22	**0.003‡**
HDLc (mg/dL)	5.69	**0.038‡**	0.92	0.550	2.60	0.079*	9.32	**0.010***	1.60	0.221	1.10	0.420
Triglycerides (mg/dL)	0.05	0.832	0.93	0.543	1.06	0.458	0.17	0.687	0.95	0.517	0.15	0.991
LDLc (mg/dL)	5.13	**0.047‡**	1.58	0.241	0.59	0.768	0.80	0.390	0.32	0.951	1.09	0.425
non-HDLc (mg/dL)	0.36	0.563	1.04	0.476	1.10	0.436	2.56	0.136	2.31	0.089*	3.84	**0.020‡**
Total cholesterol/ HDLc	3.59	0.087*	2.36	0.096*	2.09	0.136	3.58	0.083*	1.89	0.151	1.08	0.429
Blood Glucose (mg/dL)	0.03	0.865	3.88	**0.022‡**	5.18	**0.009‡**	1.39	0.261	1.35	0.307	1.19	0.376

‡ and **bold** indicates significance (*p*=0.05)

* indicates values potentially trending towards significance

Table 22. General linear model assessing the impact of the consumption of EVOO, nuts, and EVOO + nuts on outcome measures

	Change in % consumption from baseline to 6-weeks						**Change in % consumption from baseline to 12-weeks**					
	EVOO		*Nuts*		*EVOO+ Nut*		*EVOO*		*Nuts*		*EVOO+ Nut*	
	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value	F-value	*p*-value
Systolic Pressure (mm Hg)	1.12	0.300	3.66	0.067*	4.98	**0.035‡**	1.45	0.239	0.71	0.409	2.67	0.209
Diastolic Pressure (mm Hg)	0.07	0.792	0.01	0.928	0.11	0.742	0.05	0.833	0.00	0.982	0.07	0.797
Weight (kg)	0.02	0.899	0.82	0.373	0.02	0.900	0.09	0.770	0.08	0.780	0.01	0.906
BMI (kg/m^2)	0.04	0.318	0.04	0.835	2.15	0.155	0.04	0.850	0.05	0.827	0.00	0.955
Percent Body Fat (%)	0.35	0.558	0.33	0.568	0.22	0.640	0.46	0.502	0.44	0.514	0.21	0.648
Basal Metabolic Rate (BMR)	0.15	0.706	0.08	0.777	0.08	0.778	0.08	0.786	0.35	0.561	0.13	0.719
Fat Mass (kg)	0.07	0.796	0.06	0.801	0.05	0.829	0.00	0.957	0.13	0.724	0.00	0.945
Fat Free Mass (kg)	0.16	0.693	0.03	0.870	0.09	0.766	0.01	0.933	0.09	0.768	0.01	0.939
Total Body Water (kg)	0.06	0.806	0.01	0.923	0.00	0.964	0.17	0.687	0.11	0.739	0.14	0.713
Total Cholesterol (mg/dL)	0.66	0.424	0.11	0.739	0.38	0.546	0.80	0.380	0.03	0.858	0.26	0.612
HDLc (mg/dL)	2.67	0.114	17.62	**0.001‡**	10.27	**0.004‡**	2.26	0.145	3.00	0.095*	2.71	0.112
Triglycerides (mg/dL)	0.12	0.730	0.26	0.613	0.11	0.739	0.68	0.417	0.32	0.574	0.87	0.361
LDLc (mg/dL)	0.55	0.463	0.22	0.645	0.22	0.643	5.03	**0.034‡**	0.15	0.702	2.23	0.148
non-HDLc (mg/dL)	0.32	0.574	0.10	0.749	0.24	0.625	1.68	0.206	0.92	0.347	0.98	0.331
Total cholesterol/ HDLc	1.73	0.200	1.83	0.187	1.64	0.211	1.36	0.254	2.34	0.138	1.18	0.288
Blood Glucose (mg/dL)	0.02	0.890	1.79	0.192	1.53	0.227	0.21	0.654	0.13	0.723	0.31	0.582

‡ and **bold** indicated significance ($p<0.05$)

* indicates values potentially trending towards significance ($p<0.10$)

Chapter 5: Summary and Conclusion

5.1 Summary

CVD is currently the leading cause of death worldwide, and the same trend extends to the United States. Risk factors such as high blood pressure, high cholesterol, diabetes, physical inactivity, obesity, unhealthy diet, excessive use of alcohol and tobacco, family history, age, race, and ethnicity can all impact one's probability of developing CVD. While some of these risk factors cannot be controlled, many are directly impacted by lifestyle decisions of the individuals. Past research had shown that following a Mediterranean-style Diet or lifestyle could significantly reduce one's propensity to develop of CVD risk factors as well as reduce the occurrence of major CVD incidents.

The Southeastern United States as a region has one of the highest obesity and diabetes rates in the country which puts this population at a higher risk of developing CVD. The goals of the current research were to:

1) Determine the most effective education/psychological theories which could be implemented in a nutrition education program promoting the use of the MD for the reduction of CVD risk factors.
2) Assess the effectiveness of a theory-based education program in terms of increased nutrition knowledge and dietary behavior change.

3) Determine if an education program focused on implementing a MD combined with the supplementation of EVOO and nuts could impact CVD risk factors.

A systematic review of theories implemented as a part of CVD nutrition education was conducted. Five theories were found to have been used in interventions to promote CVD risk factor reduction using a MD: 1) transtheoretical model of behavior change; 2) self-determination theory; 3) social cognitive theory; 4) goals-systems theory; and 5) multi-model approaches. The level of success garnered from theory implementation varied from study to study. Studies which tailored and individualized education programs did not show any advantages over traditional education methods. Overall, the systematic review suggested that implementing the social cognitive theory, which relies on human-to-human interaction, and social determination theory, which encourages personal empowerment in decision-making, would be the most effective. Therefore, the HHP's web-based CVD intervention was developed using constructs of both theories.

The HHP, a prospective randomized controlled trial, was designed to assess the effectiveness of a 12-week, web-based nutrition education program on nutrition knowledge, adherence to a MD, and changes in CVD risk factors for a population living in the Southeastern United States. Nutrition knowledge, adherence, and CVD risk factors were quantified at baseline, 6-weeks, and 12-weeks to assess the effectiveness of the program. Participants in the program were randomly selected to either be in the AHA group which received education based on the AHA recommendations or the MD group which received education tailored to the MD and received supplementary EVOO and mixed nuts.

Using a validated survey instrument, nutrition knowledge for entire population improved from baseline to 12-weeks. Trend analyses showed an upward trend in both groups; however, the total nutrition knowledge scores were only statistically different from the MD group between baseline and 12-weeks. The amount of education completed was shown to statistically contribute to the total nutrition knowledge scores for the entire population.

As there are similarities between the AHA and MD recommendations, it was expected that improved MD adherence in the entire population would be observed, as was seen when comparing MD adherence at both 6- and 12-weeks to baseline. Like nutrition knowledge, the amount of education completed had a positive impact on MD adherence. Additionally, there was greater MD adherence in the MD group (three MD adherence individual question scores) compared to the AHA group which was consistent with the education focus.

At baseline, no differences were observed in the distribution of participants in three different adherence categories (low, medium or high); however, by six weeks, the MD group had significantly more participants in the high category compared to the AHA group which was consistent with a decrease in MD participants falling into the low categories. A significant increase in participants in the high adherence category was also observed in the control group at both 6-weeks and 12-weeks. Overall, the results demonstrate the AHA and MD nutrition education programs resulted in an increase in nutrition knowledge and MD adherence over time and that the MD nutrition education program was more effective in increasing MD adherence scores over time.

Thirty participants completed the HHP. The primary outcome measure for reduction in CVD risk factors was change in systolic blood pressure over time; however, secondary outcomes such as change in weight, diastolic blood pressure, blood glucose, BMI, and fasting glucose and lipid profiles were also assessed. We observed a significant decrease in HDLc between baseline and 6-weeks in AHA group, indicating a worsening in a CVD risk factor. In contrast, the MD group saw a numerical increase in HDLc over time. While statistically significant differences in LDLc between groups did not change over time, the LDLc of the MD group trended down while the LDLc of the AHA group trended up which resulted in the treatment arm assignment to be a significant factor in the GLM analysis. Both groups saw a reduction in body fat over time.

Nutrition knowledge and adherence to the MD impacted change in blood glucose between baseline and six-weeks, total cholesterol between baseline and 12-weeks, and non-HDLc and total cholesterol to HDLc ratio between baseline and 12-weeks. In each case, no differences were seen between groups; however, the nutrition knowledge and adherence scores impacted blood lipid profiles as well as blood glucose. Nutrition knowledge was seen to significantly influence the total cholesterol to HDLc ratio between baseline and 12-weeks while adherence impacted BMI between baseline and 12-weeks. These results do, indeed, show that an increase in nutrition knowledge and MD adherence can impact clinical parameters and anthropometric measures which impact cardiovascular health.

While weight reduction strategies were not part of the education program, the MD group saw a more consistent trend in weight loss than the AHA group. The participants in

AHA group lost most of their weight in the first six weeks while the participants in the MD group saw similar weight loss during each six-week interval.

In the assessment of lipids over time, the participants in the AHA group saw their cholesterol move in negative directions for both HDLc and LDLc; the participants in this group also saw an increase in their total cholesterol to HDLc ratio between baseline and 12-weeks.

It was observed that nut consumption was correlated with positive changes in HDLc between baseline and 6-weeks, and the interaction of nut and EVOO consumption had a positive impact on the change in HDLc between baseline and 6-weeks. Olive oil consumption was correlated with a decrease in LDLc. Therefore, the consumption of EVOO and mixed nuts did reduce secondary outcomes in the study that are associated with CVD risk.

A question on the feasibility of this study is whether a MD could be implemented in the Southeast where EVOO and mixed nuts were not commonly consumed products. Three-fourths of the MD group actively participated in EVOO and nut consumption. Over the twelve weeks, those who used the supplements consumed 50% of the EVOO and 73% of the nuts and MD adherence rates increased in both the AHA and MD groups.

Conclusion

The HHP was a successful pilot study for implementing and educating on the MD in the Southeastern United States. The amount of education sessions completed directly impacted nutrition knowledge and MD adherence. And, increased nutrition knowledge and MD adherence translated into a reduction in CVD risk factors (blood glucose, total

cholesterol, and non-HDLc cholesterol). Those participating in the AHA program saw cholesterol values change, but not for the better while the MD group saw improvements over time. Additionally, increased adherence, specifically nut and EVOO consumption, played a significant role in improvements in HDLc, LDLc, and systolic blood pressure readings. Additional clinical trials need to be conducted to corroborate the results of this study on a larger scale; however, the results of the HHP provide promising results in terms of reducing CVD risk factors in a high-risk population in the Southeastern US.

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Appendix 1

The Healthy Hearts Program Protocol

A Pilot Nutrition Intervention to Reduce Cardiovascular Disease Risk Using a Mediterranean Diet in the Southeastern U.S. (HHP)

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7. **References**

1. Project Overview

1.1. Summary of relevant research findings leading to this research proposal

Obesity and high blood pressure are contributing factors to cardiovascular disease (CVD), a clinical condition which causes approximately 18 million deaths in the United States. The Southeastern United States contains four of the top five states with the highest adult obesity rates. Nutrition interventions promoting healthy food habits and choices can manage obesity and cardiovascular disease. However, recent studies have shown 12-week nutritional interventions promoting the dietary patterns of those seen in the Mediterranean, coupled with the supplementation of EVOO or mixed nuts, are very effective in reducing the risk of CVD and cardiovascular events [136, 138]

1.2. Brief description of methodology, including design, population, and variables of interest

This will be a prospective randomized controlled trial of Auburn University (AU) employees or an adult sponsored dependent of an active employee (<18 years old) who was insured by the AU Health and Pharmacy Insurance plan during 2015 and enrolled in the Health Insurance plan for 2016 and/or 2017. Eligible patients are 1) those completing their "Healthy Tigers" biometric screening between 01/01/2015-5/31/16, 2) who had a BMI ≥30 and two or more of the following CVD risk factors: male, age 55-80; female, age 60-80; current smoker; family history of premature coronary heart disease; received a red or yellow zone reading for their blood pressure, blood glucose, total cholesterol; those with a

diagnosis of hypertension, pre-diabetes, or 147hypercholesterolemia; a patient of the AU Employee Pharmacy enrolled in the TigerMeds program with an existing diagnosis of hypertension, pre-diabetes, or hypercholesterolemia. Patients will be randomized into two groups: the AHA vs MD. The study will consist of a 12-week nutrition education program that includes dietary nutrition education sessions (both groups) and EVOO and mixed nut supplementation (MD group). We will assess program impact by comparing baseline characteristics including body mass index, blood pressure, blood glucose, and total cholesterol, etc., and reassessing the same measures at week 6 and week 12 of the study.

2. Purpose

2.1. Purpose of this project including research questions and/or aims

The primary objective of this pilot study is to assess the efficacy of a MD intervention (education + EVOO and mixed nut supplementation) versus that of an AHA nutrition intervention (education) on serum blood lipid levels as markers for cardiovascular disease risk. As secondary outcomes we will assess insulin resistance, serum metabolic factors, blood pressure, body mass index, and waist circumference.

Research Question: In the Southeastern United States, is the dietary pattern of the American Heart Association or a Mediterranean style diet more effective in the reduction of CVD risk factors.

Aim 1: To assess whether or not patients have improvements in their CVD risk factors by the end of the 12-week program.

Aim 2: To assess which dietary intervention is most effective in the reduction of CVD risk factors at the end of the 12-week program.

2.2. How results of this project will be used (e.g., Presentation? Publication? Thesis? Dissertation?)

It is currently expected that this work will form the base of Ms. Amy Willis' dissertation. The results from this project will be submitted for publication and an abstract will be submitted for acceptance to a professional conference; however, no specific patient information will be disclosed.

3. Participants

3.1. Inclusion and exclusion criteria

a) Inclusion Criteria:

Auburn University employees or an adult sponsored dependent of an active employee who was insured by the Auburn University Health and Pharmacy Insurance Plan during 2015 and/or 2016 and who are enrolled in the Auburn University Health Plan for the 2017 plan year, who meet the following criteria:

1.) Have completed their "Healthy Tigers" screening for the 2015, 2016, or 2017 plan year (completed by the "Healthy Tigers" staff or through submission of a "Healthy Tigers" healthcare provider form OR is a patient of the AU Employee Pharmacy and is enrolled in the TigerMeds program OR is a participant in the Pharmacy Practice Experience (PPE) who is seen within the AUPCC **AND** has a BMI (kg/m2) screening value >24.9 AND has two or more of the following CVD risk factors:

a) screening values classified in the "yellow" or "red" zone for:
   - Systolic blood pressure (mmHg): Yellow zone: ≥140, Red zone: ≥160;
   - Diastolic Blood pressure (mmHg): Yellow zone: ≥90, Red zone: ≥ 100;
   - Fasting blood glucose (mm/dL): Yellow zone: ≥100, Red zone: ≥ 126
   - Blood glucose(random) (mg/dL): Yellow zone: 140-200, Red zone > 200
   - Total Cholesterol (mg/dL): Yellow zone: ≥200, red zone: ≥250

b) Have a pre-existing diagnosis of hypertension, pre-diabetes, or hypercholesterolemia

c) Current smoker (≥1 cigarette/day)

d) Are: male (age: 55-80) or female (age: 60-80)

e) A family history of premature coronary heart disease

f) High risk ethnicity: Black, African American, American Indians/Alaska Natives, Non-Hispanic blacks, Mexican-Americans, Asian, Hispanic/Latino

b) Exclusion Criteria:

1. Minors that are less than 19 years of age
2. Individuals who are not enrolled in the Auburn University health insurance program for the 2016 plan year at baseline and have not yet completed initial visit
3. Individuals who have not completed their 2015 "Healthy Tigers" biometric screening between January 1st and December 31st, 2015 (these can be completed by the "Healthy Tigers" staff or by submitting a healthcare provider form from the individuals' physician to the "Healthy Tigers" office), unless enrolled in TigerMeds.
4. Individuals who are pregnant or who intend to become pregnant during the 12-week health and wellness challenge.
5. Individuals who anticipate absence or travel throughout the study that would interfere with their ability to complete the analysis at the mid-point and end of challenge.
6. Patients with a peanut, tree nut, or EVOO food allergy or intolerance.
7. Patients who are unable or unwilling to travel to Auburn University main campus for live health and wellness challenge events, individual assessments, personal appointments, and pre- and post- data collection

8. Individuals who have NOT been stabilized on medication to treat or manage high blood pressure, high cholesterol, dyslipidemia, or pre-diabetes for at least 12 weeks prior to the study.
9. Patients who do not have access to the internet and therefore unable to complete the education portion of the study
10. Individuals who have a pacemaker
11. Patients who decline participation during informed consent

3.2. Recruitment methods

1. Recruitment will be expanded to include participants enrolled in the Pharmacy Practice Experience who are seen within the AUPCC
2. Recruitment will take place from November 2016-February 2017 until the project is filled
3. A letter describing the research study including the name of the project, the investigators, the inclusion and exclusion criteria, study description, will be e-mailed to all 2015, 2016, and 2017 "Healthy Tigers" and "TigerMeds" participants.
4. Patients that are screened in the "Healthy Tigers" program OR patients who are a part of the PPE program and seen within the AUPCC during the months of November 2016- February 2017 (until the study is filled) and meet criteria on the "Healthy Hearts Program Eligibility Screener" will receive a promotional flier (see Appendix A) during their screening process. If the

patients have questions about the study, they will be directed to Amy Willis or a member of the "Healthy Tigers" staff.

5. Messages about the Healthy Hearts Program will be sent to AU employees via the AU Daily
6. Participants of ScaleBack Alabama who weigh in at the AUPCC during the months of January-February 2017 will receive a promotional flyer
7. Social media announcements on Facebook, Twitter, and Instagram.

4. Project Design and Methods

4.1. Methods for consenting participants

Participants will be seen at the Auburn University Pharmaceutical Care Clinic (AUPCC) for their initial "Healthy Tigers" Healthy Hearts Program consenting visit. During this visit, individuals will be screened for eligibility. Once eligibility is determined, a printed copy of the Informed Consent will be given to and discussed with the eligible individual. If the participant chooses to participate, their signature will be obtained on the consent form. Participants will make an appointment for their Baseline visit.

4.2. Research design and methods

1) Participants will be seen at the Auburn University Pharmaceutical Care Clinic (AUPCC) for their initial "Healthy Tigers" Healthy Hearts Program consenting visit. The assessment will include a health and wellness interview, International Physical Activity Questionnaire, Diet History Questionnaire II, a

Mediterranean diet knowledge/adherence survey, and the completion of the eligibility form. During this visit, the letter of consent will be given to and discussed with the participant. If the participant chooses to participate, their signature will be obtained on the consent form.

2) a) Participants will then return to the Auburn University Pharmaceutical Care Clinic (AUPCC) for their baseline "Healthy Tigers" Healthy Hearts Program visit. Pharmacists and pharmacy residents, employed by the AUPCC will obtain the following: height measurement (inches), weight measurement (pounds), Calculated BMI (kg/m2) measurement of body composition (using bioelectrical impedance analysis) (% body fat, pounds of fat, pounds of lean mass, pounds of total body water), waist measurement (inches), hip measurement (inches), Waist to Hip Ratio, Waist to Height Ratio, Systolic blood pressure (mmHg), Diastolic blood pressure (mmHg), resting pulse (bpm), fasting blood glucose (mg/dL), fasting total cholesterol (mg/dL), fasting LDLc-cholesterol (mg/dL), fasting HDLc-cholesterol (mg/dL), fasting Triglycerides (mg/dL), total Cholesterol to HDLc ratio, Atherosclerotic cardiovascular disease risk (ASCVD) Score (%), fasting insulin mI/L, fasting leptin ng/mL, IL-6 (pg/mL), tumor necrosis factor-α (pg/mL), urinary tyrosol and hydroxytyrosol. These measurements will be repeated at week 6 and week 12 of the trial.

   b) At this baseline appointment, the patient will also receive a baseline medication therapy management (MTM) assessment by a pharmacist in

order to identify any potential or actual drug-related problem (DRPs), and to monitor for efficacy and safety of all medications, make recommendations for vitamins, minerals, and supplements, and provide preventative care recommendations (such as immunizations, osteoporosis screenings, colonoscopy, mammograms, and other recommended medical screenings that are recommended for the patient's age, gender, and concomitant disease states and medications).

c) All subjective and objective medical information collected during this appointment will be recorded in the CompuGroup Medical (CGM) electronic medical record (EMR) that is used in the Auburn University Pharmaceutical Care Center (AUPCC) and the "Healthy Tigers" programs. This EMR is a secure medical record that meets all HIPAA requirements and has been reviewed by the Harrison School of Pharmacy (HSOP) HIPAA officer, the Auburn University HIPAA officer, and the AU HIPAA consultant, and meets all legal and security requirements. These data will be perpetually stored in this EMR as required of medical data. Access to this EMR is restricted to authorized personnel only.

3) Baseline, 6-week and 12-week Appointments

a) Participants will then return to the Auburn University Pharmaceutical Care Clinic (AUPCC) for their baseline "Healthy Tigers" Healthy Hearts Program visit. Pharmacists and pharmacy residents, employed by the AUPCC will obtain the following: height measurement (inches), weight

measurement (pounds), Calculated BMI (kg/m2) measurement of body composition (using bioelectrical impedance analysis) (% body fat, pounds of fat, pounds of lean mass, pounds of total body water), waist measurement (inches), hip measurement (inches), Waist to Hip Ratio, Waist to Height Ratio, Systolic blood pressure (mmHg), Diastolic blood pressure (mmHg), resting pulse (bpm), fasting blood glucose (mg/dL), fasting total cholesterol (mg/dL), fasting LDLc-cholesterol (mg/dL), fasting HDLc-cholesterol (mg/dL), fasting Triglycerides (mg/dL). These measurements will be repeated at week 6 and week 12 of the trial.

All data will be collected at:

Auburn University Main Campus

Auburn University Pharmaceutical Care Clinic (AUPCC)

Harrison School of Pharmacy

2155 Walker Building, War Eagle Way

Auburn University, AL 36849-5506

b) At the baseline appointment, the patient will also receive a baseline medication therapy management (MTM) assessment by a pharmacist in order to identify any potential or actual drug-related problem (DRPs), and to monitor for efficacy and safety of all medications, make recommendations for vitamins, minerals, and supplements, and provide preventative care recommendations (such as immunizations, osteoporosis screenings, colonoscopy, mammograms, and other recommended medical

screenings that are recommended for the patient's age, gender, and concomitant disease states and medications).

c) All subjective and objective information collected during this appointment will be recorded in the CompuGroup Medical (CGM) electronic medical record (EMR) that is used in the Auburn University Pharmaceutical Care Center (AUPCC) and the "Healthy Tigers" programs. The EMR is a secure medical record that meets all HIPAA requirements and has been reviewed by the Harrison School of Pharmacy (HSOP) HIPAA officer, the Auburn University HIPAA officer, and the AU HIPAA consultant, and meets all legal and security requirements. These data will be perpetually stored in this EMR as required of medical data. Access to this EMR is restricted to authorized personnel only. Participants will also have a paper research chart. No identifying data identifying information will be kept in the research chart. Participants will be assigned a personal, unique, and confidential study code at this visit. This study code will be placed at the top of all data sheets that are placed in the research chart. Identifying information will be stored electronically as part of the electronic medical records of the AUPCC for the individual patients. The code list linking the study code to the EMR will be stored in the medical records room the AUPCC (2155C) which has controlled access. The specific cabinet in which it will be stored has a key lock and the key is stored in a password-protected lockbox.

d) At the end of the baseline and 6-week appointments, participants in The Mediterranean Diet (MD) group will receive 3L of EVOO and 3 pounds of mixed nuts. Participants in the MD group will be educated by oral and written means, on consumption goals. Participants will be asked to return any unused supplements at the midpoint (week 6) and 12-week appointment. Information will be provided to the participant on how to access nutritional information used within this study and how to access the educational programming. Written instructions will also be provided.

e) Participants will complete 3 surveys/questionnaires at their baseline visit, 6 week, and 12 week appointments. The Mediterranean diet screener and the International Physical Activity questionnaire will be completed in person. Participants will complete the web-based version of the Diet History Questionnaire II.

4) Participant Involvement Time

Participant Task		**Total Involvement Time**
In-Person Visits to the AUPCC	**Estimated Time**	
Consenting visit	45 minutes	

Baseline visit	45 minutes	
6 week visit	45 minutes	
12 week visit	45 minutes	
Total In-Person Involvement Time		**180 Minutes**
Web-Based Tasks		
Diet History Questionnaire (x3)	30 minutes each	90 minutes
Nutrition Education Modules (x7)	10 minutes each	70 minutes
Total Web-Based Involvement Time		**160 minutes**
Total Participant Involvement Time		**340 minutes**

5) STUDY REQUIREMENTS

   a) The participants will be asked to follow a dietary pattern that is associated with their assigned intervention group. The Mediterranean Diet (MD) group will be given supplements of extra virgin olive oil (EVOO) and mixed nuts. Participants in this group will be asked use these supplements as a part of their daily intake. A total of 6 L of EVOO and 6 pounds of mixed nuts (3 pounds raw walnuts and 3 pounds raw almonds) will be administered throughout the study. Participants in the MD group will be given 3 L of EVOO and 3 pounds of mixed nuts at the baseline

appointment asked to return unused portions of at their 6-week appointment. At that time they will be given a new supplementation of 3 L or EVOO and 3 pounds of mixed nuts. Participants will be given the same instructions for use and asked to return unused portions at the end of the study (week 12).

b) The participants might have follow-up appointments scheduled with the pharmacist within the AUPCC depending on the patient's personal care plan that is developed at baseline. For instance, if a patient has potential or actual drug-related problems that are identified on their baseline MTM appointment, then the pharmacist will schedule follow-up appointments that are appropriate for the problem and the plan of care that is developed to address these problems. This will be done consistently between all patients in the study, regardless of the randomization (the pharmacist and the will be blinded concerning which group the patient is randomized to concerning dietary intervention).

c) Narrated nutrition education presentations will be developed by a registered dietitians, dietetic interns, graduate students, and faculty. These presentations will be loaded on the "Healthy Hearts Program" website. The participants will be asked one presentation weekly for the first 6 weeks of the study and then one additional education module at week 9.

d) The participant will complete the following at baseline, week-6 and week 12 of the study: Diet History Questionnaire II, International Physical Activity Questionnaire, and a Mediterranean diet screener.

e) For patients with a diagnosis of Hypertension or an elevated blood pressure reading during a "Healthy Tigers" screening that is in the yellow or red zone, home blood pressure monitoring might be integrated into the medication therapy management plan of care.

f) For patients with a diagnosis of pre-diabetes, or who have an elevated blood glucose reading during a "Healthy Tigers" screening that is in the yellow or red zones, home blood glucose monitoring might be integrated into the medication therapy management plan of care.

g) All participants will be asked to return to the AUPCC at weeks 6 and 12 for a repeat "Healthy Tigers" analysis and MTM consultation.

4.3. Measurement Procedures

Questionnaires

1) A registered dietitian or trained nutrition student will administer the following:

a) International Physical Activity Questionnaire

b) Mediterranean Diet Knowledge and Adherence Questionnaire

2) Participants will be instructed on how to complete the following questionnaire from home computer

a) Food Frequency Questionnaire- Diet History Questionnaire II (DHQII)

Blood pressure (BP)

1) Blood Pressure[233]: Blood pressure will be taken with a mercury sphygmomanometer with the Korotkoff's sound technique

a) Patient will be seating comfortably, with back supported, legs uncrossed, and upper arm bare.

b) Patient's arm should be supported at approximately heart level

c) Cuff bladder should encircle 80% or more of the patient's arm circumference

d) Mercury column should be deflated at 2-3 mm per second

e) The first and last audible sounds should be recorded as systolic and diastolic pressure, respectively. Measurements should be given to the nearest 2 mm Hg.

f) Neither the participant nor the person taking the measurement should talk during the procedure

Anthropometric measurements: *Anthropometric measurement procedures taken from the National Health and Nutrition Survey (NHANES) Anthropometry Procedures Manual [229].*

1) Height: Participant's height will be measured via standing height.
    a) Height will be measured using a wall-mounted calibrated stadiometer
    b) Prior to measurement, participant will be asked to remove hair ornaments, jewelry, buns.
    c) Participant is to stand up straight against the backboard with the body weight evenly distributed with both feet flat with heels together and toes apart
        i) Depending on the overall body configuration of the participant, the following four points must make contact with the stadiometer backboard– head, shoulders, buttocks, and heels, examples of possible exceptions:
            1. Some overweight individuals cannot stand straight while all four points touch the backboard
            2. Participants with kyphosis – a forward curvature of the spine that appears as a hump at the upper back may make contact not possible
    d) Align the head in the Frankfort horizontal plane (See Figure 1)
        i) In the Frankfort horizontal plane the horizontal line from the ear canal to the lower border of the orbit of the eye is parallel to the floor and perpendicular to the vertical backboard

e) Lower the stadiometer head piece so that it rests firmly on the top of the participant's head

f) Instruct participant to stand as tall as possible and take a deep breath, and hold this position.

g) Record result in inches.

2) Weight: Participants will be weighed on a calibrated scale at the AUPCC

a) Ask participants to remove shoes, purses/bags, jackets or bulky outerwear prior to stepping on the scale

b) Record weight in pounds provide weight to patient.

3) Waist Circumference:

a) Ask participant to remove any jackets or bulky outerwear. If participant feels comfortable, ask to gather his/her shirt above the waist.

b) Ask participant to place hands on opposite shoulders.

c) Stand on participant's right side. Palpate the hip area to locate the right ilium of the pelvis. With a cosmetic pencil draw a horizontal line just above the uppermost lateral border of the right ilium. Cross this mark at the midaxillary line, which extends down from the armpit down the side of the torso.

d) Extend the measuring tape around the waist. Position the tape in a horizontal plane at the level of the measurement mark. Check that the tape is parallel to the floor and lies snug but does not compress the skin.

e) Always position the zero end of the tape below the section containing the measurement value.

f) Take and record the measurement to the nearest 0.1 cm.

Venipuncture blood draw- *Phlebotomy procedures will follow the World Health Organization's Guidelines on drawing blood: Best practices [228].*

1) **Overview**: Participant will be instructed not to eat or drink anything, other than water, after midnight the day of their baseline, 6-week, and 12-week visits. Phlebotomy of a peripheral arm vein will be performed by AUPCC clinicians (pharmacists and pharmacy residents) who have been phlebotomy trained, using sterile procedures and seated position. A sterile bandage will cover the phlebotomy site after the procedure and arm will be elevated to ensure that bleeding has stopped. The participant will be observed for any lightheadedness, bruising or bleeding during and after the procedure.

   a) If the participant is lightheaded, he/she will be reclined until symptoms resolve

   b) If the participant is asymptomatic after the phlebotomy procedure, he/she will be released

   c) A maximum of 3 attempts to access a vein will be allowed at each visit, for each participant. If 3 unsuccessful attempts to access a vein are made, the participant will be excused from this portion of the study.

2) **Materials**

   a) Safety Needles, 22g or less; Butterfly needles, 21g or less

   b) Vacuum tube

   c) Tourniquets

   d) Antiseptic. Individually packaged 70% isopropyl alcohol wipes

   e) 2x2 gauze or cotton balls

   f) Sharps disposal container. An OSHA acceptable, puncture proof container marked “Biohazardous”

   g) Bandages or tape

3) **Safety**

   a) Observe universal (standard) safety precautions.

   b) Wash hands in warm, running water with approved handwashing product. Hands are to be washed before and after each phlebotomy is performed.

   c) Gloves are to be worn during all phlebotomies, and changed between patient collections. Palpation of phlebotomy site may be performed without gloves providing the skin is not broken.

4) **Procedure**

   a) Identify participant.

   b) Select the site (preferably at the bend of the elbow). Palpate the area; locate a vein of good size that is visible, straight, and clear. The vein should be visible without applying the tourniquet.

   c) Apply a tourniquet, 4-5 finger widths above the selected site.

d) Ask the patient to forma fist so that the veins are more prominent

e) Put on well-fitting, gloves.

f) Disinfect the site using 70% isopropyl alcohol and allow to dry. DO NOT touch the site once disinfected.

g) Anchor the vein by hold the patient's arm and placing a thumb BELOW the venipuncture site. **DO NOT touch the cleaned site; in particular, DO NOT place a finger over the vein to guide the needle.**

h) Perform venipuncture. Enter the vein swiftly at a 30 degree angle.

i) Once sufficient blood has been collected, release the tourniquet BEFORE withdrawing the needle

j) Withdraw the needle gently and give the patient a clean gauze or dry cotton-wool ball to press gently on the site. Ask the patient NOT to bend the arm.

k) Discard the used needle and syringe or blood sampling device immediately into the sharps container

l) Check the label and forms on vacuum tube for accuracy

m) Place items that can drip blood or body fluids into the "Biohazardous" waste container

n) Remove gloves and place them in the general waste.

o) Perform hand hygiene

Urine collection *A clean catch urine sample will be obtained from the participant. Procedures are derived from the U.S. National Library of Medicine. (7)*

1) Participant will be instructed not to void immediately prior to baseline, 6-week, and 12- week appointments.
2) Participants will be given verbal and written instructions on how to provide a clean catch urine sample. Instructions will include:
    a) You will use a special kit to collect the urine, it will include a cup and two wipes.
    b) Wash your hand with soap and warm water
    c) *Females*
        i) Sit on the toilet with legs spread apart. Use two fingers to spread open the labia.
        ii) Use a wipe to clean the inner folds of the labia. Wipe front to back.
        iii) Use a second wipe to clean over the opening where urine comes out (urethra), just above the opening of the vagina.
        iv) Keeping your labia open, urinate a small amount into the toilet bowl, then stop the flow of urine
        v) Hold the urine cup a few inches from the urethra and urinate until the cup is about half full.
        vi) You may finish urinating in the toilet bowl.
    d) *Males*

i) Clean the head of the penis with a sterile wipe. If you are not circumcised, you will need to pull back (retract) the foreskin first.

ii) Urinate a small amount into the toilet bowl, and then stop the flow of urine.

iii) Then collect a sample of urine into the clean or sterile cup, until it is half full.

iv) You may finish urinating in the toilet bowl.

4.4. Data collection instruments

1) Clinical Data Recording Form (height measurement (inches), change in baseline body weight (%), change in total body weight (kg), Calculated BMI (kg/m2) measurement of body composition (using bioelectrical impedance analysis) (% body fat, pounds of fat, pounds of lean mass, pounds of total body water), waist measurement (inches), hip measurement (inches), Waist to Hip Ratio, Systolic blood pressure (mmHg), Diastolic blood pressure (mmHg), resting pulse (bpm), fasting blood glucose (mg/dL), fasting total cholesterol (mg/dL), fasting LDLc-cholesterol (mg/dL), fasting HDLc-cholesterol (mg/dL), fasting Triglycerides (mg/dL), total Cholesterol to HDLc ratio.
2) International Physical Activity Questionnaire
3) Mediterranean Diet Nutrition Adherence and Knowledge Questionnaire
4) Diet History Questionnaire II (DHQ II)

4.5. Data analysis

Descriptive statistics will be conducted and presented for the population. Baseline demographics will be compared between the 2 groups and compared using the appropriate test for each data point. Continuous variables will be compared using student t-tests, categorical variables will be compared using chi-square tests, etc. Age will be collected as a continuous variable (years). Ethnicity will be collected as a categorical variable (Caucasian, Asian, African-American, Hispanic, Other, Not Reported). Level of education will be collected as a categorical variable (high school, some college, college degree, graduate degree, professional degree, etc.), smoking status will be collected as a categorical variable (never smoked, past smoker, current smoker), obesity (dichotomous), HTN (dichotomous), hypercholesterolemia (dichotomous), Number of patients with 1 disease state (continuous), number of patients with 2 disease states (continuous), number of patients with 3 disease states (continuous), number of patients with 4 disease states (continuous), number of yellow values (continuous), number of red zone values (continuous).

Baseline data on change in baseline body weight (%), change in total body weight (kg), calculated BMI (kg/m2) measurement of body composition (using bioelectrical impedance analysis) (% body fat, pounds of fat, pounds of lean mass, pounds of total body water), waist measurement (inches), hip measurement (inches), Waist to Hip Ratio, Waist to Height Ratio, Systolic blood pressure (mmHg), Diastolic blood pressure (mmHg), resting pulse (bpm), fasting blood

glucose (mg/dL), fasting total cholesterol (mg/dL), fasting LDLc-cholesterol (mg/dL), fasting HDLc-cholesterol (mg/dL), fasting Triglycerides (mg/dL), total Cholesterol to HDLc ratio, will be compared to data at week-6 and the end of the 12 weeks

• Student's T test will be used to compare the continuous data collected in the study

• Chi Square test will be used to compare the categorical data collected in the study

The Diet History Questionnaire II, International Physical Activity Questionnaire, and the Mediterranean Knowledge/Adherence questionnaire will be collected at the beginning, mid-point and the end of the study. The number of drug-related problems identified through Medication therapy management will be collected at the beginning and end of the study

5. Risks and Discomforts

5.1. Description of potential risks that participants may encounter

Physical Risk: Blood draw (venipuncture phlebotomy)- Patients will have approximately 10 mL of blood taken a total of three times (total 30 mL or 2 tablespoons over 12 weeks) throughout this study (baseline, week 6, and week 12). The blood will be taken via venipuncture phlebotomy of the arm. Risks

include: pain or discomfort at the site of puncture; bruising at point of blood draw; redness and swelling for the vein; rarely an infection; and, uncommonly, faintness from the procedure. See Appendix G "Measurement Procedures."

Breach of confidentiality: Investigators will be accessing confidential or identifiable data of participants. Precautions described below.

5.2. Description of precautions taken to eliminate or reduce potential risks

Venipuncture phlebotomy precautions: Verbal and written consent will be received from each patient. Patient will receive verbal and written risks of procedure. All venipuncture guidelines will be followed as outlined in protocol.

Patient data is stored securely in the electronic medical record (EMR). Access to the EMR is restricted to individual account holders assigned by the clinic in a password-protected program. When recorded into the clinical data recording form, data will be recorded confidentially with a numbered linkage back to the patient. No personally identifiable information will be recorded with the associated patient data. All information linking patients and data will be stored in a locked cabinet in a controlled access medical records room.

All surveys and questionnaires will remain anonymous and have no identifiable patient information. Patients' data from survey collection will remain confidential through the use of Qualtrics for delivery of the surveys.

6. Benefits

6.1. Description of direct benefits to participants by participating in this study

This study should have benefits on participants' CVD risk. They should see decreases in their blood pressure, blood glucose, total cholesterol, and blood pressure after completion.

All participants will receive free nutrition education and access to a registered dietitian throughout the study. Both groups will receive nutrition education on dietary interventions that studies have shown decrease the risk of CVD. Therefore, benefits include, obtaining the nutritional knowledge to change dietary patterns for the reduction of CVD risk factors.

6.2. Description of benefits for the general population that may be generated from this study

This study should have benefits on participants' CVD risk. They should see decreases in their blood pressure, blood glucose, total cholesterol, and blood pressure after completion. Participants will also gain insight into proper dietary patterns for the reduction of CVD risk factors.

Appendix 2. Clinical Trial Registration

Clinical Trial Registration by ClinicalTrials.gov

ClinicalTrials.gov PRS
Protocol Registration and Results System

ClinicalTrials.gov Protocol Registration and Results System (PRS) Receipt
Release Date: September 26, 2018

ClinicalTrials.gov ID: NCT03683134

Study Identification

Unique Protocol ID:	The Healthy Hearts Program
Brief Title:	A Mediterranean Diet Nutrition Education Program for the Reduction of Cardiovascular Disease Risk in the Southeastern U.S. (HHP)
Official Title:	A Pilot, Theory-Based, Nutrition Intervention Promoting a Mediterranean Diet for the Reduction of Cardiovascular Disease Risk Factors in a High-Risk Population of the Southeastern United States: The Healthy Hearts Program (HHP)
Secondary IDs:	

Study Status

Record Verification:	September 2018
Overall Status:	Completed
Study Start:	January 23, 2017 [Actual]
Primary Completion:	September 7, 2017 [Actual]
Study Completion:	September 7, 2017 [Actual]

Sponsor/Collaborators

Sponsor:	Auburn University
Responsible Party:	Principal Investigator Investigator: Michael W. Greene [mgreene] Official Title: Director, Auburn University Metabolic Phenotyping Laboratory Affiliation: Auburn University
Collaborators:	

Oversight

U.S. FDA-regulated Drug:	No
U.S. FDA-regulated Device:	No
U.S. FDA IND/IDE:	No
Human Subjects Review:	Board Status: Approved Approval Number: 16-183 EP 1608 Board Name: Institutional Review Board Board Affiliation: Auburn University Phone: 334-844-5966 Email: IRBAdmin@auburn.edu

Address:

The Office of Research Compliance (ORC)
115 Ramsay Hall, Auburn University
Auburn, AL 36849

Data Monitoring: No

FDA Regulated Intervention: No

Study Description

Brief Summary: A 12-week, randomized nutrition intervention for the reduction of cardiovascular disease risk factors in a high-risk population in the southeastern United States. The primary objective of this pilot study was to assess the efficacy of a Mediterranean diet intervention (education + extra-virgin olive oil (EVOO) and mixed nut supplementation) versus that of an American Heart Association (AHA) nutrition intervention (education) on serum blood lipid levels as markers for cardiovascular disease risk. Researchers conducting this trial hypothesize that a greater reduction will be seen in cardiovascular disease risk factors in the Mediterranean diet intervention.

Detailed Description:

Conditions

Conditions: Cardiovascular Diseases
Cardiovascular Risk Factor
Obesity

Keywords: Cardiovascular Disease
Mediterranean Diet
Nutrition education

Study Design

Study Type: Interventional

Primary Purpose: Treatment

Study Phase: N/A

Interventional Study Model: Parallel Assignment

Number of Arms: 2

Masking: Double (Care Provider, Investigator)

Allocation: Randomized

Enrollment: 58 [Actual]

Arms and Interventions

Arms	Assigned Interventions
Experimental: Mediterranean diet group Participants will receive both nutrition education on patterns of a Mediterranean style diet as well as olive oil and mixed nuts.	Behavioral: Mediterranean diet Participants will receive nutrition education and educational materials from a registered dietitian on patients on the patterns of a Mediterranean style diet. Seven education sessions will be delivered through an online platform. Participants will be asked to complete

Arms	Assigned Interventions
	one education session per week for the first six weeks and the final session at week 9. Dietary Supplement: Olive oil and mixed nuts Participants in the Mediterranean diet group will receive 3 liters of extra-virgin olive oil and 3 pounds of mixed nuts (1.5 pounds raw almonds and 1.5 pounds raw walnuts) at baseline and at 6 weeks. Participants will be educated by oral and written means, on consumption goals of the nuts and olive oil.
Active Comparator: American Heart Association group Participants will receive nutrition education on the dietary recommendations for heart health from the American Heart Association.	Behavioral: American Heart Association Participants will receive nutrition education and educational materials from a registered dietitian on patients on the dietary recommendations from the American Heart Association for heart health. Seven education sessions will be delivered through an online platform. Participants will be asked to complete one education session per week for the first six weeks and the final session at week 9.

Outcome Measures

Primary Outcome Measure:

1. Systolic Blood Pressure Measurement
   Measured in mmHg

   [Time Frame: Change from at baseline blood pressure to 6-weeks]
2. Systolic Blood Pressure Measurement
   Measured in mmHg

   [Time Frame: Change from at baseline blood pressure to 12-weeks]

Secondary Outcome Measure:

3. Diastolic Blood Pressure Measurement
   Measured in mmHg

   [Time Frame: Change from at baseline weight to 6-weeks]
4. Diastolic Blood Pressure Measurement
   Measured in mmHg

   [Time Frame: Change from at baseline weight to 6-weeks]
5. Change in Weight
   Measured in kilograms (kg)

   [Time Frame: Change from at baseline weight to 12-weeks]
6. Change in Weight
   Measured in kilograms (kg)

   [Time Frame: Change from at baseline weight to 12-weeks]
7. Calculation of Body Mass Index (BMI) (kg/m∧2)
   Height in meters will be combined with weight in kilograms will be combined to report BMI in kg/m∧2)

   [Time Frame: Change from baseline weight to 6-weeks]
8. Calculation of BMI (kg/m∧2)
   Height in meters will be combined with weight in kilograms will be combined to report BMI in kg/m∧2)

   [Time Frame: Change from baseline weight to 12-weeks]
9. Concentration of fasted total cholesterol

Measured in mg/dL

[Time Frame: Change from baseline weight to 6-weeks]

10. Concentration of fasted total cholesterol
Measured in mg/dL

[Time Frame: Change from baseline weight to 12-weeks]

11. Concentration of fasted high-density lipoprotein (HDL) cholesterol
Measured in mg/dL

[Time Frame: Change from baseline weight to 6-weeks]

12. Concentration of fasted high-density lipoprotein (HDL) cholesterol
Measured in mg/dL

[Time Frame: Change from baseline weight to 12-weeks]

13. Concentration of fasted low-density lipoprotein (LDL) cholesterol
Measured in mg/dL

[Time Frame: Change from baseline weight to 12-weeks]

14. Concentration of fasted low-density lipoprotein (LDL) cholesterol
Measured in mg/dL

[Time Frame: Change from baseline weight to 6-weeks]

15. Concentration of fasted triglycerides
Measured in mg/dL

[Time Frame: Change from baseline weight to 6-weeks]

16. Concentration of fasted triglycerides
Measured in mg/dL

[Time Frame: Change from baseline weight to 12-weeks]

17. A calculation of total cholesterol (mg/dL) to HDL (mg/dL) ratio
Total cholesterol (mg/dL) will be used with HDL (mg/dL) to calculate total cholesterol to HDL ratio

[Time Frame: Change from baseline weight to 12-weeks]

18. A calculation of total cholesterol (mg/dL) to HDL (mg/dL) ratio
Total cholesterol (mg/dL) will be used with HDL (mg/dL) to calculate total cholesterol to HDL ratio

[Time Frame: Change from baseline weight to 6-weeks]

19. Concentration of fasted blood glucose
Measured in mg/dL

[Time Frame: Change from baseline weight to 6-weeks]

20. Concentration of fasted blood glucose
Measured in mg/dL

[Time Frame: Change from baseline weight to 12-weeks]

21. A calculation of waist (inches) to height (inches) ratio
Waist circumference in inches will be calculated with height measurement in inches to report the waist-to-height ratio

[Time Frame: Change from baseline weight to 12-weeks]

22. A calculation of waist (inches) to height (inches) ratio
Waist circumference in inches will be calculated with height measurement in inches to report the waist-to-height ratio

[Time Frame: Change from baseline weight to 6-weeks]

23. Calculation of homeostatic model assessment (HOMA)-insulin resistance (IR) from fasted blood concentrations of fasted blood glucose and fasted insulin
Fasting plasma glucose in mg/dL and fasting serum insulin in milliUnits (mU)/l will be used to calculate HOMA-IR as an indicator for insulin resistance.

[Time Frame: Change from baseline weight to 6-weeks]

24. Calculation of homeostatic model assessment (HOMA)-insulin resistance (IR) from fasted blood concentrations of fasted blood glucose and fasted insulin

Fasting plasma glucose in mg/dL and fasting serum insulin in mU/l will be used to calculate HOMA-IR as an indicator for insulin resistance.

[Time Frame: Change from baseline weight to 12-weeks]

Eligibility

Minimum Age:	19 Years
Maximum Age:	
Sex:	All
Gender Based:	No
Accepts Healthy Volunteers:	No
Criteria:	Inclusion Criteria:

- Enrolled in Auburn University's health insurance program during the course of the study or a dependent of the enrollee during the course of the study
- BMI >24.9 (kg/m2)
- AND Meets two or more of the following
- Screening values classified in the "yellow" or "red" zone for:
- Systolic blood pressure (mmHg): Yellow zone: ≥140, Red zone: ≥160;
- Diastolic Blood pressure (mmHg): Yellow zone: ≥90, Red zone: ≥ 100;
- Fasting blood glucose (mm/dL): Yellow zone: ≥100, Red zone: ≥ 126
- Blood glucose (random) (mg/dL): Yellow zone: 140-200, Red zone > 200
- Total Cholesterol (mg/dL): Yellow zone: ≥200, red zone: ≥250
- Have a pre-existing diagnosis of hypertension, pre-diabetes, or hypercholesterolemia
- Current smoker (≥1 cigarette/day)
- Are: male (age: 55-80) or female (age: 60-80)
- A family history of premature coronary heart disease
- High risk ethnicity: Black, African American, American Indians/Alaska Natives, Non-Hispanic blacks, Mexican-Americans, Asian, Hispanic/Latino

Exclusion Criteria:

- Minors that are less than 19 years of age
- Individuals who are not enrolled in the Auburn University health insurance program for the 2016 plan year at baseline and have not yet completed initial visit
- Individuals who have not completed their 2015 “Healthy Tigers” biometric screening between January 1st and December 31st, 2015 (these can be completed by the “Healthy Tigers” staff or by submitting a healthcare provider form from the individuals’ physician to the “Healthy Tigers” office), unless enrolled in "TigerMeds".
- Individuals who are pregnant or who intend to become pregnant during the 12-week health and wellness challenge.
- Individuals who anticipate absence or travel throughout the study that would interfere with their ability to complete the analysis at the mid-point and end of challenge.
- Patients with a peanut, tree nut, or olive oil food allergy or intolerance.
- Patients who are unable or unwilling to travel to Auburn University main campus for live health and wellness challenge events, individual assessments, personal appointments, and pre- and post- data collection

- Individuals who have NOT been stabilized on medication to treat or manage high blood pressure, high cholesterol, dyslipidemia, or pre diabetes for at least 12 weeks prior to the study.
- Patients who do not have access to the internet and therefore unable to complete the education portion of the study
- Individuals who have a pacemaker
- Patients who decline participation during informed consent

Contacts/Locations

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Auburn University

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Principal Investigator: Amy W Willis, MS

IPDSharing

Plan to Share IPD: No

References

Citations:

Links:

Available IPD/Information:

Documents

Study Protocol and Statistical Analysis Plan
Document Date: June 9, 2017
Uploaded: 09/21/2018 13:56

Informed Consent Form
Document Date: June 9, 2017

Appendix 3. Informed Consent

AUBURN UNIVERSITY

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College of Human Sciences

Department of Nutrition, Dietetics, and Hospitality Management

INFORMED CONSENT

For a Research Study entitled:

"The Healthy Hearts Program: a pilot nutritional intervention to reduce cardiovascular disease risk factors"

You are invited to participate in a research study to help determine the impact of nutrition interventions on cardiovascular disease risk factors. The study is being conducted by Amy Willis, MS, RD, LD, under the direction of Michael Greene, PhD, from the Department of Nutrition, Dietetics, and Hospitality Management, and Kimberly Braxton Llyod, PharmD, in the Auburn University Pharmaceutical Care Center (AUPCC). You were selected as a possible participant because you are 19 years or older and meet one of following:

- A previous diagnosis of high blood pressure, total cholesterol, or pre-diabetes OR
- Lab results for your blood pressure, cholesterol, blood glucose or BMI were elevated in the past

Your involvement in this study will not in any way affect Healthy Tigers participation or any insurance deduction benefit derived as a result of Healthy Tigers participation.

What will be involved if you participate? If you decide to participate in this research study, you will be asked to participate in a 12-week nutrition education program that includes:

Education: Throughout the study, you will have access to the following:

- Seven on-line nutrition education modules
- Recipes, shopping lists, and menu planning tips and techniques
- An individual session with a registered dietitian
- Contact information to a registered dietitian to answer questions

Assessments: At three different points throughout this study, you will be asked to visit the AUPCC and participate in the following assessments:

- Questionnaires for diet analysis and knowledge and energy expenditure assessment. 2 questionnaires will be completed during your visits at the AUPCC and one will be web-based and will be completed from your personal computer. Instructions for the web-based questionnaire will be given during your first visit.
- Blood work to assess:
  - Blood sugar
  - Blood lipids/cholesterol
  - Inflammation
  - Diet analysis
- Urine analysis for diet analysis

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DEPARTMENT OF NUTRITION, DIETETICS,
AND HOSPITALITY MANAGEMENT

- Height, weight, blood pressure, waist circumference, body composition

How much time will I need to invest throughout the study? Throughout the 12-week study, your total time commitment will be approximately 5 ½ hours (not including travel to and from the AUPCC). You will be asked to come the the AUPCC for 4 visits (approximately 45 minutes each). You will also be asked to complete web-based tasks (education modules and questionnaires) that will range from 10-30 minutes each.

Are there risks or discomforts?

Confidentiality: A risk associated with participating in this study is a breach of confidentiality. To minimize these risks, we will securely store all of your personal information and remove all identifying information during data collection.

Blood Draws: There are also risks associated with a venipuncture blood draw. You will have approximately 10 mL of blood taken 3 times over the course of 12 weeks from your arm. The total amount of blood taken for the whole study will be approximately 2 tablespoons (30 ML). Risks include: pain or discomfort at the site of puncture; bruising at point of blood draw; redness and swelling for the vein; rarely an infection; and, uncommonly, faintness from the procedure. To minimize risks, all blood will be drawn by phlebotomy trained clinicians who will inform and monitor you before, during, and after the procedure.

Participation: Participation in this study result in a perceived social risk due to participation. Participation in the Healthy Hearts Program will not affect Healthy Tigers participation or any insurance deduction benefit derived as a result of Healthy Tigers participation.

Are there any benefits to yourself or others? If you choose to participate, you will receive free enrollment in a 12-week nutrition program and receive free health assessments, diet plans, recipes, nutrition education, and medication check-ups throughout the 12-week challenge. You will learn important information on dietary ways to reduce cardiovascular disease risk factors.

Will you receive compensation for participating? All participants who complete all nutrition education components will be entered into a lottery for a chance to win a $50.00 gift card, participants have a 1 in 30 chance of being selected to win. You may also be randomized into a group that receives free olive oil and nuts as a part of your dietary plan. Participants have a 1 in 2 chance of being randomized into this group.

If you change your mind about participating, you can withdraw at any time during the study. Your participation in every aspect of this study is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or stop participating will not jeopardize your future relations

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AND HOSPITALITY MANAGEMENT

with Auburn University, the AU Pharmaceutical Care Clinic, or the Department of Nutrition, Dietetics, and Hospitality Management.

Your privacy will be protected. Any information obtained in connection with this study will remain anonymous (*or confidential*). Information obtained through your participation may be presented at a professional meeting or published in a journal.

If you have questions about this study, *please ask them now* OR contact Amy Willis at awillis@auburn.edu. A copy of this document will be given to you to keep.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

_____	_____
Participant's signature Date	Investigator obtaining consent Date
_____	_____
Printed Name	Printed Name
	_____
	Co-Investigator Date
	_____
	Printed Name

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Appendix 4. Mediterranean Diet Screener

Mediterranean Diet Screener [144]

Mediterranean Diet Knowledge/Adherence Questionnaire

We would like to ask you a few questions about your diet	**Check the box that applies**		
1. Do you use olive oil as main culinary fat?	Yes ☐	No ☐	
2. How many tablespoons of olive oil do you consume in a given day (including oil used for frying, salads, out-of-house meals, etc.)?	<1 ☐	1-4 ☐	>4 ☐
3. How many vegetable servings do you consume per day? (1 serving: ½ cup cooked, 1 cup raw [consider side dishes as half a serving])	<1 ☐	1-2 ☐	>2 ☐
4. How many fruit units (including natural fruit juices) do you consume per day? (1 serving: 1 cup)	<1 ☐	1-3 ☐	>3 ☐
5. How many servings of red meat, hamburger, or meat products (ham, sausage, etc.) do you consume per day? (1 serving: 2-3 ounces)	<1 ☐	1-3 ☐	>3 ☐
6. How many servings of butter, margarine, or cream do you consume per day? (1 serving: 1 tablespoon)	<1 ☐	1-3 ☐	>3 ☐
7. How many sweet or carbonated beverages do you drink per day?	<1 ☐	1-3 ☐	>3 ☐
8. How many glasses of wine do you drink per week? ☐Red ☐White ☐Both	<2 ☐	2-7 ☐	>7 ☐
9. How many servings of legumes (beans, black eyed peas) do you consume per week? (1 serving: 1 cup)	<1 ☐	1-3 ☐	>3 ☐
10. How many servings of fish or shellfish do you consume per week? (1 serving: 2-3 ounces of fish or 3 ounces of shellfish)	<1 ☐	1-3 ☐	>3 ☐
11. How many times per week do you consume commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard?	<3 ☐	3-5 ☐	>5 ☐
12. How many servings of nuts (including peanuts) do you consume per week? (1 serving: ¼ cup)	<1 ☐	1-3 ☐	>3 ☐
13. Do you preferentially consume chicken, turkey, or rabbit meat instead of veal, pork, hamburger, or sausage? Are you a vegetarian or vegan? ☐Yes ☐No	Yes ☐	No ☐	
14. How many times per week do you consume boiled vegetables, pasta, rice, or other dishes with a sauce of tomato, garlic, onion, or leeks without meat sautéed in olive oil?	<1 ☐	1-2 ☐	>2 ☐

1

Mediterranean Diet Knowledge/Adherence Questionnaire

This next set of questions is about your understanding of nutrition	**Check the box that applies**		
	True	False	Not Sure
1. A salad dressing made with mayonnaise is as healthy as the same dressing made with olive oil.	☐	☐	☐
2. To eat healthily, you should eat less fat. Whether you also eat more fruit and vegetables does not matter.	☐	☐	☐
3. The health benefit of fruits and vegetables lies alone in the supply of vitamins and minerals.	☐	☐	☐
4. If you have eaten high-fat foods, you can reverse the effects by eating apples.	☐	☐	☐
5. A healthy meal should consist of half meat, a quarter vegetables and a quarter side dishes.	☐	☐	☐
6. Skim milk contains fewer vitamins and minerals than whole milk.	☐	☐	☐
7. For healthy nutrition, dairy products should be consumed in the same amounts as fruit and vegetables.	☐	☐	☐
8. The same amount of sugar and fat contains an equal amount of calories.	☐	☐	☐
9. Wine can reduce the risk of certain diseases.	☐	☐	☐
10. Lentils contain only few useful nutrients, therefore their health benefit is not great.	☐	☐	☐
11. Oily fish (salmon, mackerel) contain healthier fats than red meat.	☐	☐	☐
12. To eat healthily, you should eat less. It does not matter what foods you reduce.	☐	☐	☐
13. Fat is always bad for your health; you should therefore avoid it as much as possible.	☐	☐	☐
14. The same amount of beef steak and chicken breast contains an equal amount of calories.	☐	☐	☐
15. Pasta with tomato sauce is healthier than pasta with mushroom and cream sauce	☐	☐	☐

Mediterranean Diet Knowledge/Adherence Questionnaire

Finally, we would like to ask you a few questions about yourself

1. Are you male or female?
   a) Male □
   b) Female □

2. How old are you?
   a) less than 18 □
   b) 18-24 □
   c) 25-34 □
   d) 35-44 □
   e) 45-54 □
   f) 55-64 □
   g) 65-74 □
   h) more than 75 □

3. What is your ethnic origin?
   a) White □
   b) Black Caribbean □
   c) Black African □
   d) Black other □
   e) Indian □
   f) Pakistani □
   g) Bangladeshi □
   h) Chinese □
   i) Asian- other □
   Please specify:

   ……
   j) Any other ethnic group □
   Please specify:

   ……

4. What is the highest level of education you have completed?
   a) Elementary school □
   b) Middle school □
   c) High school diploma □
   d) GED □
   e) Technical or trade certificate □
   f) Associate degree □
   g) Bachelor's degree □
   h) Master's or professional degree □

5. Do you have any health or nutrition related qualifications?

   a) Yes □
   Please specify:

   ……
   b) No □

Appendix 5. International Physical Activity Questionnaire

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

SHORT LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised August 2002.

Appendix 6. The Healthy Hearts Program Data Collection Sheet

Healthy Hearts Program Data Sheet

Patient STUDY CODE:

Patient VISIT: Baseline 6 week 12 week

----------To be answered during Healthy Tigers Screening----------

1. Blood Pressure: _____/_____

2. Tanita

Age	
Height (inches)	
Weight (pounds)	
BMI	
Fat %	
BMR	
Impedance	
Fat Mass	
FFM	
TBW	

3. Lipid Panel-GLU **(ONLY USE CASSETTES LABELED "AMYS STUDY")**

TC	
HDLc	
TRG	
LDLc	
Non HDLc	
TC/HDLc	
Glucose	

4. Hip and Waist Circumference

Hip Circumference (inches)	
Waist Circumference (inches)	

5. Medications

Is the patient taking medication to manage:		
Blood Pressure	Yes	No
Diabetes/Blood Sugar	Yes	No
Cholesterol	Yes	No

********SEE OTHER SIDE*********

If "YES" on any of question "5" please answer the following:

Blood Pressure:

a. Was dosage: Increased Decreased Discontinued

b. Was medication changed: Yes No

- Name new Medication: _____

c. Was a new medication added? Yes No

- Name new medication_____

Diabetes/Blood Sugar

a. Was dosage: Increased Decreased Discontinued

b. Was medication changed: Yes No

- Name new Medication: _____

c. Was a new medication added? Yes No

- Name new medication_____

Cholesterol

a. Was dosage: Increased Decreased Discontinued

b. Was medication changed: Yes No

- Name new Medication: _____

c. Was a new medication added? Yes No

- Name new medication_____

----------To be answered by lab clinicians----------

Did the patient leave a urine sample? YES NO

Was blood successfully drawn from the patient? YES NO

Appendix 7. Education Teaching Plans

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet Group
Topic: The Mediterranean Diet: An Overview
Week and Lesson: Week 1, Lesson 1
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify why following patterns of a MD would be beneficial
    b. Identify the patterns of a MD are
    c. Determine appropriate serving sizes

B. Lesson body

Objectives	Notes to support objectives
Identify why following patterns of a MD would be beneficial	- Why would the MD be good for you? - Risk factors for heart disease - Controlling the controllable risk factors - Benefits of following a MD
Identify the patterns of a Mediterranean diet	- Guidelines for food to consume during main meals, each day, weekly and occasionally - Other elements that are part of Mediterranean diet: wine, moderation, rest, cooking, socialization, seasonality - The Mediterranean diet pyramid
Determine appropriate serving sizes	- Portion size versus serving size - What makes up one serving, a visualization guide - What makes up one serving, a food group guide

C. Weekly goals
    a. Replace cooking fat with EVOO
    b. Consume ¼ cup (about 4 Tablespoons) of mixed nuts and EVOO each day
    c. Consume one additional fruit or vegetable serving at each meal

D. Materials
    a. PowerPoint presentation
    b. Serving size visualization guide
    c. Serving size food group guide
    d. Mediterranean diet pyramid, handout
    e. Guide to the Mediterranean diet, handout

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: The American Heart Association: An Overview
Week and Lesson: Week 1, Lesson 1
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify why following patterns of the AHA would be beneficial for health
    b. Identify the recommendations of the AHA
    c. Determine how to appropriately read nutrition labels to determine appropriate serving sizes

B. Lesson body

Objectives	Notes to support objectives
Identify why following the recommendations of the AHA would be beneficial for heart health	- Why would the AHA recommendations be beneficial for your health? - Risk factors for heart disease - Controlling the controllable risk factors - Benefits of following recommendations of the AHA
Identify the recommendations from the AHA	- Daily serving recommendations for each food group: fruits and vegetables; whole grains; dairy; poultry, meat, and eggs; fish and seafood; nuts, seeds, and beans; fats and oils; added sugars; salt; alcohol
Determine how to appropriately read nutrition labels to determine appropriate serving sizes	- Portion size versus serving size - What makes up one serving, a visualization guide - What makes up one serving, a food group guide - Understanding food labels

C. Weekly goals
    a. Identify what types of food from each food group you are eating
    b. Determine correct serving size from the portion sizes given
    c. Read at least 3 nutrition labels per day and identify the 5 different areas of the label

D. Materials
    a. PowerPoint presentation
    b. Serving size visualization guide
    c. Serving size food group guide
    d. How do I follow a healthy diet? Answers by Heart, handout
    e. How to eat healthy, the American Heart Association, handout

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: Dietary Fats: The good, the bad, and the ugly
Week and Lesson: Week 2, Lesson 2
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify what dietary fats are and why they are important to the body
    b. Identify the different types of dietary fats and their impact on health
    c. Identify foods containing the different types of dietary fat
    d. Understand how much dietary fat is needed per day

B. Lesson body

Objectives	Notes to support objectives
Identify what dietary fats are and why they are important to the body	- The Basics of Fat: the good, the bad, and the ugly
Identify the different types of dietary fats and their impact health	- The Good: Monounsaturated Fats and Polyunsaturated Fats - The Bad: Saturated Fats - The Ugly: Trans Fats
Identify foods containing the different types of dietary fat	- Foods rich in monounsaturated fats - Foods rich in polyunsaturated fats - Foods containing saturated fats - Foods containing trans fats
Describe how much dietary fat is needed per day	- How much do I need

C. Weekly goals
    a. Identify the sources of dietary fats in the foods you consume
    b. Replace at least 2 “bad” or “ugly” fats with “good” fats each day
    c. Choose packaged products with lower amounts of saturated fats and higher amounts of unsaturated fats

D. Materials
    a. PowerPoint presentation
    b. Olive oil 101. Handout
    c. Olive oil tasting. Handout
    d. Mediterranean Slower Cooker Chicken and Potatoes. Recipe
    e. Broccoli Rabe with Kalamata Olive. Recipe

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: Dietary Fats: The good, the bad, and the ugly
Week and Lesson: Week 2, Lesson 2
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify what dietary fats are and why they are important to the body
    b. Identify the different types of dietary fats and their impact on health
    c. Identify foods containing the different types of dietary fat
    d. Understand how much dietary fat is needed per day

B. Lesson body

Objectives	Notes to support objectives
Identify what dietary fats are and why they are important to the body	- The Basics of Fat: the good, the bad, and the ugly
Identify the different types of dietary fats and their impact health	- The Good: Monounsaturated Fats and Polyunsaturated Fats - The Bad: Saturated Fats - The Ugly: Trans Fats
Identify foods containing the different types of dietary fat	- Foods rich in monounsaturated fats - Foods rich in polyunsaturated fats - Foods containing saturated fats - Foods containing trans fats
Describe how much dietary fat is needed per day	- How much do I need

C. Weekly goals
    a. Identify the sources of dietary fats in the foods you consume
    b. Replace at least 2 “bad” or “ugly” fats with “good” fats each day
    c. Choose packaged products with lower amounts of saturated fats and higher amounts of unsaturated fats

D. Materials
    a. PowerPoint presentation
    b. The good, the bad, the ugly. Infographic. Handout
    c. Chicken picatta, recipe
    d. Broiled Asparagus spears with lemon, recipe
    e. Classic Greek salad, recipe

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: Grains and Fiber: the whole truth
Week and Lesson: Week 3, Lesson 3
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify the different types of carbohydrates
    b. Identify the different types of grains and where they are found
    c. Identify the different types fiber and sources of each
    d. Understand how many grains should be consumed each day

B. Lesson body

Objectives	Notes to support objectives
Identify the different types of carbohydrates	- Background: Macronutrients and Calories - Carbohydrates: the basics - Simple Carbohydrates - Complex Carbohydrates
Identify the different types of grains and where they are found	- Grains: the WHOLE truth - Refined vs Whole Grains
Identify the different types fiber and sources of each	- Whole grain sources - Whole grain benefits - Soluble and Insoluble Fiber: Benefits - Fiber Sources
Describe how many grains should be consumed each day	- Grains: How much per day - Grains: Serving sizes

C. Weekly goals
    a. Identify the types of grain
    b. Make at least half of your grains whole grain choices
    c. Try at least one new source of whole grains

D. Materials
    a. PowerPoint presentation
    b. Whole Grains 101. Handout
    c. Whole, Refined, and Enriched. Handout
    d. Whole Grain Recipes

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: Grains and fiber: the whole truth
Week and Lesson: Week 3, Lesson 3
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify the different types of carbohydrates
    b. Identify the different types of grains and where they are found
    c. Identify the different types fiber and sources of each
    d. Describe how many grains should be consumed each day
    e. Identify sources of sodium and determine how much is recommended per day

B. Lesson body

Objectives	Notes to support objectives
Identify the different types of carbohydrates	- Background: Macronutrients and Calories - Carbohydrates: the basics - Simple Carbohydrates - Complex Carbohydrates
Identify the different types of grains and where they are found	- Grains: the WHOLE truth - Refined vs Whole Grains
Identify the different types fiber and sources of each	- Whole grain sources - Whole grain benefits - Soluble and Insoluble Fiber: Benefits - Fiber Sources
Describe how many grains should be consumed each day	- Grains: How much per day - Grains: Serving sizes
Identify sources of sodium and determine how much is recommended per day	- Sodium, what is it? - Sodium: daily recommendations

C. Weekly goals
    a. Identify the types of grain
    b. Make at least half of your grains whole grain choices
    c. Try at least one new source of whole grains

D. Materials
    a. PowerPoint presentation
    b. Grains and Fiber. Handout
    c. Carbohydrates 101. Handout
    d. Overnight no-cook banana oatmeal. Recipe
    e. Whole-wheat pasta with broccolini and feta. Recipe
    f. Farro salad with roasted eggplant and pine nuts. Recipe
    g. Grain salad with tomatoes, corn, and basil. Recipe

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: Protein: the main sources
Week and Lesson: Week 4, Lesson 4
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify what protein is and why it is important in the body
    b. Identify sources of protein
    c. Determine how much is needed in the diet

B. Lesson body

Objectives	Notes to support objectives
Identify what protein is	- Protein: the basics - Protein: macronutrient
Identify why protein is important in the body	- Why is protein important - Protein functions
Identify sources of protein	- Where is protein found in our diets? - Protein in foods - Protein sources - Protein: meat, fish, poultry - Protein: dairy and eggs - Protein: nonanimal sources
Determine how much is needed in the diet	- Protein: How much per day - Protein: Serving sizes

C. Weekly goals
    a. Replace at least 2 servings of less lean protein sources with fish, poultry, or lean meat
    b. Consume fish 2 times per week.
    c. Make 2 meals per week meatless

D. Materials
    a. PowerPoint presentation
    b. Make Each Day Mediterranean. Handout
    c. Mediterranean Diet Cheat Sheet. Handout.
    d. Mediterranean Baked Fish. Recipe.
    e. Chopped Mediterranean Salad with Chicken. Recipe.
    f. Mediterranean Tacos. Recipe.
    g. Roasted Carrots with Farro, Chickpeas & Herbed Crème Fraiche. Recipe

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: Protein: the main sources
Week and Lesson: Week 4, Lesson 4
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify what protein is and why it is important in the body
    b. Identify sources of protein
    c. Determine how much is needed in the diet

B. Lesson body

Objectives	Notes to support objectives
Identify what protein is	- Protein: the basics - Protein: macronutrient
Identify why protein is important in the body	- Why is protein important - Protein functions
Identify sources of protein	- Where is protein found in our diets? - Protein in foods - Protein sources - Protein: meat, fish, poultry - Protein: dairy and eggs - Protein: nonanimal sources
Determine how much is needed in the diet	- Protein: How much per day - Protein: Serving sizes

C. Weekly goals
    a. Replace at least 2 servings of less lean protein sources with fish, poultry, or lean meat
    b. Make 2 meals per week meatless

D. Materials
    a. PowerPoint presentation
    b. Protein. Handout
    c. Protein and Heart Health. Handout.
    d. Seared Tilapia with Pineapple and Cucumber Relish. Recipe
    e. Hearty Bean Burrito Bowl. Recipe
    f. Balsamic chicken with apple, lentil, and spinach salad. Recipe

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: Fruits and Vegetables
Week and Lesson: Week 5, Lesson 5
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify the facts about fruits and vegetables
    b. Describe the recommendations for wine consumption
    c. Describe the importance of fruits and vegetables in the body
    d. Determine how many servings are needed each day
    e. Identify ways to increase fruit and vegetable consumption

B. Lesson body

Objectives	Notes to support objectives
Identify the facts about fruits and vegetables	- Common myths and truths - Myth busters: the truth
Describe the recommendations for wine consumption	- Wine and the Mediterranean Diet
Describe the importance of fruits and vegetables in the body	- Why are fruits and vegetables so important? - Fruits and vegetables: their nutrients and the body
Determine how many servings are needed each day	- How much do I need?
Identify ways to increase fruit and vegetable consumption	- How to eat more

C. Weekly goals
    a. Eat at least 1 fruit and 1 vegetable with every meal
    b. Eat at least 2 different colors of the rainbow each day
    c. Try 1 new fruit or vegetable each week

D. Materials
    a. PowerPoint presentation
    b. Heart-Healthy Eating Mediterranean Style. Handout.
    c. Live Well with the Mediterranean Diet. Handout
    d. Roasted Salmon Rice Bowl with Beets and Brussels. Recipe.
    e. Spiralized Mediterranean Cucumber Salad. Recipe.
    f. Brussel Sprouts and Pepperoni Pizza. Recipe.

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: Fruits and Vegetables
Week and Lesson: Week 5, Lesson 5
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify the facts about fruits and vegetables
    b. Describe the importance of fruits and vegetables in the body
    c. Describe the recommendations for alcohol consumption
    d. Determine how many servings are needed each day
    e. Identify ways to increase fruit and vegetable consumption

B. Lesson body

Objectives	Notes to support objectives
Identify the facts about fruits and vegetables	- Common myths and truths - Myth busters: the truth
Understand the importance of fruits and vegetables in the body	- Why are fruits and vegetables so important? - Fruits and vegetables: their nutrients and the body
Describe the recommendations for alcohol consumption	- Alcohol in your diet
Determine how many servings are needed each day	- How much do I need?
Identify ways to increase fruit and vegetable consumption	- How to eat more

C. Weekly goals
    a. Eat at least 1 fruit and 1 vegetable with every meal
    b. Eat at least 2 different colors of the rainbow each day
    c. Try 1 new fruit or vegetable each week

D. Materials
    a. PowerPoint presentation
    b. Storing Fruits and Vegetables. Handout.
    c. Seasons of Eating. Handout.
    d. Apple and Walnut Chicken Salad with Green Salad. Recipe.
    e. Honey and Spice Pears. Recipe.
    f. Waldorf Salad. Recipe.
    g. White Bean and Vegetable Bowls. Recipe.

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: The Mediterranean Diet: A review
Week and Lesson: Week 9, Lesson 7
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify recommendations from previous recommendations
    b. Identify ways to maintain dietary behavior changes

B. Lesson body

Objectives	Notes to support objectives
Identify recommendations from previously discussed recommendations	- Recommendations: fruits and vegetables - How to eat more - Recommendations: Wine - Recommendations: Grain - Whole Grain Sources - Recommendations: Protein - Protein Sources - Recommendations: Fats and Oils - Sources of heart healthy fats and oils
Identify ways to maintain dietary behavior changes	- Nutrition is a journey not a destination - Making best choices when eating out

C. Materials
    a. PowerPoint presentation
    b. Mediterranean Diet Toolkit. Handout.
    c. Eating out and eating well. Handout.
    d. Grocery stores and the Mediterranean diet. Handout
    e. Medjool Date Pecan Chocolate Truffles. Recipe
    f. Fettuccine Aglio e Olio. Recipe
    g. Greek Quinoa Breakfast Bowl. Recipe

Teaching Plan

Audience: The Healthy Hearts Program: The Mediterranean Diet (MD)
Topic: Grocery Shopping and Eating Out
Week and Lesson: Week 6, Lesson 6
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify ways to make healthy choices when eating away from home
    b. Identify healthy food choices in grocery stores
    c. Identify ways to choose healthy foods within a budget

B. Lesson body

Objectives	Notes to support objectives
Identify ways to make healthy food choices when eating away from home	- Eating away from home: basics - Planning ahead - What to order and what to avoid
Identify healthy food choices in grocery stores	- Heart healthy grocery shopping - A grocery store guide
Identify ways to choose healthy foods within a budget	- Grocery shopping and healthy eating on a budget

C. Goals for the week:
    a. Replace one restaurant meal with a meal prepared and packed from home
    b. Order water instead of other beverages when dining out
    c. Make a detailed grocery list and take it with you when you shop
D. Materials
    a. PowerPoint presentation
    b. Lose it and choose it. Handout.
    c. Grocery shopping tips. Handout.
    d. Tips for Eating Out. Handout
    e. Bento Box Basics. Handout
    f. Grocery List. Handout
    g. Quick and Easy Lunch Recipes. Handout.

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: Grocery Shopping and Eating Out
Week and Lesson: Week 6, Lesson 6
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify ways to make healthy choices when eating away from home
    b. Identify healthy food choices in grocery stores
    c. Identify ways to choose healthy foods within a budget

B. Lesson body

Objectives	Notes to support objectives
Identify ways to make healthy food choices when eating away from home	- Eating away from home: basics - Planning ahead - What to order and what to avoid
Identify healthy food choices in grocery stores	- Heart healthy grocery shopping - A grocery store guide
Identify ways to choose healthy foods within a budget	- Grocery shopping and healthy eating on a budget

C. Goals for the week:
    a. Replace one restaurant meal with a meal prepared and packed from home
    b. Order water instead of other beverages when dining out
    c. Make a detailed grocery list and take it with you when you shop
D. Materials
    a. PowerPoint presentation
    b. What About Eating Out? Handout.
    c. Choosing a Restaurant. Handout.
    d. Tips for Eating Out. Handout
    e. Bento Box Basics. Handout
    f. Grocery List. Handout
    g. Quick and Easy Lunch Recipes. Handout.

Teaching Plan

Audience: The Healthy Hearts Program: The American Heart Association (AHA)
Topic: The American Heart Association: A review
Week and Lesson: Week 9, Lesson 7
Duration: 10-15 minutes

A. Objectives: Following the lesson the participant will be able to
    a. Identify recommendations from previous lessons
    b. Identify ways to maintain dietary behavior changes

B. Lesson body

Objectives	Notes to support objectives
Identify recommendations from previously discussed recommendations	- Recommendations: fruits and vegetables - How to eat more - Recommendations: Alcohol Consumption - Recommendations: Grains and Fiber - Whole Grain Sources - Recommendations: Protein - Protein Sources - Recommendations: Fats and Oils - Sources of heart healthy fats and oils - Recommendations: Salt
Identify ways to maintain dietary behavior changes	- Nutrition is a journey not a destination - Making best choices when eating out

C. Materials
    a. PowerPoint presentation
    b. What About Eating Out. American Heart Association. Handout.
    c. Making Healthy Choices. Handout.
    d. Grocery Shopping on a Budget. Handout
    e. Raisin French Toast Bake. Recipe
    f. White Bean and Quinoa Burgers with Avocado. Recipe
    g. Turkey Bacon and Spinach Quiche with Sweet Potato Crust. Recipe