The Effects of a Plant-based Diet on Self-reported Prediabetes

in Davidson, Hamilton, and Rutherford Counties in Tennessee

By

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I dedicate my dissertation to God for His Supreme Power that helped me through my Ph.D. journey because of His plan for my life. I never would have made it without leaning on Jesus, my Lord.

I also dedicate my dissertation to my sons and families: James Allen Jr & Shatika Simmons, DeAndre', Lauryn; Chris Simmons, Christopher Jacob, James Andrew; and Ben Simmons for their understanding, love and support through my Ph.D. journey!

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ABSTRACT

Diabetes mellitus, commonly referred to as "diabetes," is characterized as elevated blood glucose levels resulting from the body's inability to produce insulin or cells' compromised sensitivity to insulin. Type 2 diabetes is a compromised sensitivity to insulin or insulin resistance that causes high blood glucose levels. There are several risks and contributing factors for the development of type 2 diabetes, such as lifestyles (diet and lack of limited physical activity), family history of diabetes, being overweight or obese, and gestational diabetes. Prediabetes is a state of insulin resistance that results in blood glucose levels being in the above-normal range but not high enough for diabetes diagnosis. Of these risk factors for diabetes, obesity is indicated as a leading factor for developing type 2 diabetes. A plant-based diet has been shown to be beneficial for glycemic control and weight management. The purpose of this study was to examine the effects of consuming a plant-based diet on self-reported prediabetes in Davidson, Hamilton, and Rutherford Counties, Tennessee. The sample size of 247 included, 169 females and 77males. The age eligibility was 21 years and older. There was no existing research which examine the relationship of plant-based food consumption and prediabetes in the three aforementioned counties in Tennessee.

Binomial logistic regression analysis was conducted using the totals from each food group to examine the relationship of consuming plant-based foods such as: grains, vegetables, fruits, other proteins, legumes, nuts and seeds and the likelihood of reporting prediabetes when adjusting for all control variables: age, sex, race, BMI, moderate physical activity, family history of diabetes and prediabetes. The results

showed that only age and BMI were statistically significant for an increased likelihood of self-reporting prediabetes.

Logistic regression analysis was also conducted using the totals servings from each food group to examine the relationship of consuming plant-based foods such as: grains, grains and bread, vegetables, fruits, other proteins, legumes, nuts and seeds and the likelihood of reporting prediabetes. The results showed that age and BMI significantly predicted an increased likelihood of reporting prediabetes, when controlling for the Meats and Fish group.

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List of Abbreviations and Terms

Abbreviation	Term	Description
FFQ	food frequency questionnaire	FFQ is a dietary assessment of usual food Intake over a specific time-span, usually one year (Willett, 1998).
FHD	family history of diabetes	The fact of having a relative who also has diabetes ex. a parent, sister, or brother (Wagner et al., 2013).
FPG	fasting plasma glucose	The blood glucose level after 8 hours or more without food (Armstrong & King, 2004).
FPG test	fasting plasma glucose	A test to measure the blood glucose levels after fasting or not eating for 8 hours or more (ADA, 2020).
GDM	gestational diabetes mellitus	Elevated glucose levels resulting in diabetes during pregnancy (Brown-Riggs, 2013; ADA, 2020).

GI	glycemic index	A system to rank carbohydrates based on how quickly these foods raise blood glucose levels (Brand Miller, 2003).
HbA1c	hemoglobin A1c	"A test that measures a person's average glucose level for the past 2-3 month and hemoglobin is the part of a red blood cell that carries oxygen to the cells and some-times joins with the glucose in the blood-stream" (ADA, 2020, p. 1).
HEI	healthy eating index	An index that measures of diet quality for determining how close diets meets USDA's recommendations (USDA, 2019).
uPDI	healthful plant-based diet index	The ranking of positive scores for plant-based foods that are whole foods and no animal foods (Satija et al., 2016; Satija et al., 2019).
IFG	impaired fasting glucose	A blood glucose reading of 100 mg/dL or more after at least 8 hours of fasting (ADA, 2020).

IGT	impaired glucose tolerance	A blood glucose level of 140 mg/dL or higher (ADA, 2020).
OGTT	oral glucose tolerance test	A test that measures the blood glucose level before and 2-hours after consuming a 75-gram glucose solution (ADA, 2020).
uPDI	unhealthful plant-based diet index	The ranking of negative scores for unhealthy plant-based foods and animal foods (Satija et al.,2016).

Terms	**Definition**
Antioxidants	Food substances that prevent the production of free radicals that could damage body cells.
Diabesity	The condition of diabetes and obesity occur-ring simultaneously (Kumar et al., 2017).
Flavonoids	Plant nutrients found in most vegetables and fruits that add its color and promote health such as these classes: flavones, flavanols and Isoflavones (Babu, 2013).

Functional foods	Foods that serve as a health benefit for certain conditions in addition to general nutrition (Riccardi et al., 2005).
Insulin	A hormone produced by the pancreas to regulate blood glucose levels (ADA, 2020; Armstrong & King, 2004).
Minimally processed foods	Foods that have been processed very little, to remain close to the natural form (Rodgers, 2017; USDA, 2018).
Normal weight	BMI from 18.5 -24.9 CDC,2017b).
Obese	BMI of 30.0 & up (CDC, 2017b).
Overweight	BMI from 25-29.9 (CDC, 2017b).
Phytochemical index	The ranking of plant foods based on the plant chemicals content that protects health (Abshirini et al., 2018).
Postprandial	1-2 hours after meal (ADA, 2020).

Whole foods	Foods that are close to the natural state with no processing (USDA, 2018; Rodgers, 2017).

CHAPTER I: INTRODUCTION

Diabetes mellitus, commonly referred to as “diabetes,” is characterized as elevated blood glucose levels resulting from the body’s inability to produce insulin or cells’ compromised sensitivity to insulin. (American Diabetes Association [ADA], 2018; Armstrong & King, 2004). Diabetes prevalence among adults in the United States is projected to increase to 21% by 2050 compared to 14% in 2010 (Boyle et. al, 2010). The two main types of diabetes are type 1 and type 2 (ADA, 2018). Type 1 diabetes, historically known as juvenile diabetes, is diagnosed when the pancreas does not produce any insulin (Armstrong & King, 2004). Type 2 diabetes is a compromised sensitivity to insulin or insulin resistance that causes high blood glucose levels. There are several risks and contributing factors for the development of type 2 diabetes, including lifestyle (e.g., diet and limited physical activity), family history of diabetes, being overweight or obese, and gestational diabetes (CDC, 2019b). Of these risk factors for diabetes, obesity is indicated as the leading factor for developing type 2 diabetes (Canning et al., 2014; NIDDK, 2018). Many people who are overweight or obese have also been diagnosed with type 2 diabetes. The term “diabesity” is used to represent the obesity-related health condition of type 2 diabetes (Astrup & Finer, 2000; Kumar et al., 2017). Diabesity was first used by Sims et al in 1973 (as cited in Kumar et al., 2017) to describe the association between obesity and diabetes. Obesity is a risk factor for type 2 diabetes (Astrup & Finer, 2000; Canning et. al., 2013; Kumar et al., 2017) and is prevalent in Tennessee at the rate of 32.8% in adults (Robert Wood Johnson Foundation & Trust for America’s Health, 2019).

Type 2 diabetes accounts for the greatest percentage of diabetes, which is about 90% of all cases (Armstrong & King, 2004). The diabetes prevalence rate in Tennessee of 14.9 % (ADA, 2018) is higher than the national diabetes prevalence rate of 9.4% (CDC, 2017). A challenge for the prevention of type 2 diabetes is that many people do not know their blood glucose levels are above-normal, especially at the prediabetes state (CDC, 2019).

According to the American Diabetes Association (ADA, 2018), prediabetes is a state of insulin resistance that results in the blood glucose levels being in the above normal range but not high enough for diabetes diagnosis; prediabetes is the intermediate blood glucose level between normal and diabetes (ADA, 2018). Prediabetes was once called “borderline diabetes.” In the 1980s, insulin resistance was termed as “prediabetes” (Gale, 2014). Prediabetes or insulin resistance can be due to impaired fasting glucose (IFG) or impaired glucose tolerance (IGT). Impaired fasting glucose is a blood glucose reading of 100-125 mg/dL after at least 8 hours of fasting (ADA, 2018; Armstrong & King, 2004). Impaired glucose tolerance is a blood glucose reading of 140-199 mg/dL at least two (2) hours after eating (ADA, 2018; Armstrong & King, 2004). If a person has both IFG and IGT, the chance of developing type 2 diabetes may also increase (ADA, 2018; Brand-Miller, 2004). Insulin resistance can cause glucose levels to be uncontrolled. Glycemic control is the healthy blood glucose levels in people with diabetes based on individual target ranges, usually less than 7.0% (ADA, 2020). Because people with prediabetes have a higher probability of developing type 2 diabetes than those without prediabetes (Tabak et al., 2012), the focus of prevention for lowering the rates of type 2 diabetes should be initiatives designed to prevent prediabetes, including weight management. Various strategies have been studied in an effort to prevent type 2 diabetes and prediabetes, including fruits and vegetables consumption and plant-based diets (Hart, 2015; Ley et al., 2014; Li et al., 2016; Marsh et al., 2012; Martin; 2013; Trapp and Levin, 2012). A plant-based diet has been shown to be beneficial in glycemic control (Huo et al., 2015; Trepanowski & Varady, 2015; Zhang et al., 2015). A quality plant-based diet is a food plan that consists of whole foods or minimally processed foods and derived exclusively from plants or plant sources (Rodgers, 2017; USDA, 2018).

Purpose of Study

The purpose of this study was to examine the relationship of consuming a plant-based diet and self-reported prediabetes in adults living in Davidson, Hamilton, and Rutherford Counties, Tennessee. The researcher found no existing research that examines the relationship of plant-based food consumption and prediabetes in the three aforementioned counties in Tennessee.

Statement of the Problem

With the increased cost of insulin in America and some people unable to afford insulin due to the cost (Hirsch, 2016), a plant-based diet may be a more affordable solution. Plant-based diets may help to address the problem of weight management and weight loss, thus lowering the risk of developing prediabetes and type 2 diabetes (Collins et al., 2011; deSouza et al., 2017; Kahleova et al., 2018) and eliminate the need for prescribing insulin. This investigation of the amounts of healthy plant-based foods consumed by volunteer study participants in the selected Tennessee counties aimed to better understand the relationship between diet quality and obesity for those who self-reported prediabetes.

Existing research revealed that consuming a plant-based diet (Wright et al., 2017) has health benefits and may reduce the risk of diabetes in people who have a high probability of developing type 2 diabetes (Barnard et al., 2009; Satija et al., 2016). This research was motivated by the idea that if prediabetes is present years before diabetes occurs, there is a need to investigate ways to prevent prediabetes. Research showing that a plant-based diet can have positive outcomes for glycemic control and weight management (Barnard et al.,2005; Barnard et al., 2006) inspired this investigation to examine the relationship of a plant-based diet and self-reported prediabetes in Davidson, Hamilton and Rutherford Counties in Tennessee.

The three aforementioned counties are among the 644 counties in the Diabetes Belt that extend across 15 states (Meyers, 2011; Meyers, 2017). The Diabetes Belt is within the southern region of the United States and also has a high rate of obesity (Meyers, 2011; Meyers, 2017). Counties close together, geographically, that have a diabetes prevalence rate of 11% or higher are included in the Diabetes Belt profile (Meyers, 2011; Meyers, 2017). The diabetes prevalence rate of adults, ages 20 years or older in Rutherford County is 11 %, Hamilton County is 13 % (lower than in the 2014 data at 14 %), and Davidson County is 11 %, based on 2015 data (Robert Wood Johnson Foundation, 2019). These three counties were chosen for this study sample for a few reasons: 1) they are all part of the Diabetes Belt; 2) they are all in the state of Tennessee and this allows for identification of characteristics that may be similar or unique for the state; 3) these are three of the largest counties in Tennessee and, therefore, the results may be more generalizable and useful in planning programs for awareness and prevention of prediabetes; 4) geographically these counties provide convenience and accessibility of resources for the researcher. Future expansion to other counties may be possible with increased funding and collaboration.

Overview of the Research

For this research study, people were recruited in Davidson, Hamilton and Rutherford Counties who have a family history of diabetes, are overweight, women who have had gestational diabetes, in addition to the general public. All persons who were 21 years or older in the selected counties who provided informed consent were eligible to participate in this study.

The A1cNow brand self-check A1c test used in this study was approved by Federal Drug Administration (FDA) and is annually certified by the National Glycohemoglobin Standardization Program (NGSP) as a reliable test to use for self-check at home (PTS Diagnostics, 2019). Participants who completed the self-check A1c test were aware of their A1c level after completing the test. A normal A1c reading is less than 5.7 %. A reading of 5.7 to 6.4% is at prediabetes state, 6.5% and higher is at diabetes level (ADA, 2018). Participants were advised to discuss the results of the self-check A1c test with their health care provider.

Food frequency questionnaires (FFQs) are surveys that can include demographic and dietary habit questions which serve as a tool to examine the customary dietary intake of food for a specific period of time such as per week, month, year for evaluation or research related to food consumption (Brantsaeter, 2008; Stark, 2002). FFQs are valid and reliable tools for collecting nutrition research data as related to certain health conditions (National Cancer Institute, n.d.; Dyett, 2014).

The FFQ in this study was useful for evaluating the quantity and quality of plant-based foods consumed by study participants. The evaluation of food consumption in this study was important for determining whether participants had consumed the recommended number of servings of plant-based foods per day.

The plant-based foods of main concern for this study were: whole grains, fruits, vegetables, nuts, and legumes. The total number of servings were calculated from each of the food groups as reported by study participants to determine if they had met the daily recommended number of servings for each food group. The serving sizes along with frequency choices were included in the FFQ for aiding participants in self-reporting their dietary habits. Harvard University's food frequency factor scoring system (Harvard University, 2007) was used to standardize the food frequencies reported by participants for creating variables to calculate the total number of servings consumed from each food group. Various calorie levels were included in this study to show the number of time or servings needed to meet recommendation. For example, food labels are based on a 2,000-calorie level. Most women who are moderately active require 2,000 calories per day. The recommendations for 2,000 calories per day are listed in Table 1.

Table 1

Recommended Daily Servings for 2,000 Calorie Plant-based Pattern

Food group	Serving size	Number of times/servings
Fruits	1/2 cup	4
Vegetables, all colors	1/2 cup	5
Grains (whole grains, 50%)	1/2 to 3/4 cup	6.5
Dairy Alternatives	1 cup	3
Proteins:		3.5
Packaged	Package amount	
Legumes	1/2 cup	
Nuts	1/4 cup	
Seeds	1/4 cup	
Healthy fats	1 teaspoon-1/4 cup (varies per food)	27 g

Note. a. g = gram. b. Adapted from the USDA DietaryGuidelines for Americans, 2020-2025.

The total number of servings of plant-based foods consumed per day by all participants were grouped into percentiles to examine the relationship between the levels at which plant-based foods were consumed and self-reported prediabetes. The participants who consumed more plant-based foods and self-reported no prediabetes were different from those who self-reported prediabetes.

A low-fat vegan (plant-based) diet has been shown to aid weight loss and improved glycemic control (Barnard et al., 2005; Barnard et al., 2009). Barnard et al. (2009) found that a low-fat vegan diet resulted in weight loss and the diet plan showed positive correlation to a change that resulted for lowering the A1c levels at 22 weeks and 74 weeks, along with glycemic control even without weight loss. The A1c blood glucose levels for the vegan group decreased by -0.34% and -0.14 % for the conventional diet group (Barnard et al., 2009.) The blood-glucose response or the effect of certain carbohydrates consumed by the study participants may have accounted for the results. The glycemic index is a system that is used to measure carbohydrate quality--the extent that each food raises the blood-glucose levels (Brand-Miller et al., 2003). Many plant-based foods have a low to moderate glycemic index. The glycemic index can be used for selecting lower glycemic indexed foods that will not raise the glucose levels in the blood as fast as foods with higher glycemic indexes (Brand-Miller et al., 2003). Using the GI can be helpful for gaging the blood glucose-response of a meal which could aid in controlling blood glucose levels (Brand-Miller et al., 2003) and promote weight loss.

Assumptions

People who desire to maintain a healthy weight and lifestyle are likely to embrace the consumption of fruits, vegetables, and other plant-based foods, especially when they are knowledgeable of the health benefits and ease of using this type of diet pattern. If prediabetes, which is the intermediate blood glucose level, can be prevented with a quality plant-based diet, diabetes also may possibly be prevented.

Research Question

The research question that guided this study was:

Are people in Davidson, Hamilton, and Rutherford Counties within Tennessee who consume adequate whole grains, fruits, vegetables, dairy alternatives, legumes and nuts according to the USDA's Dietary Guidelines for servings/times per day less likely to report prediabetes or diabetes than people who do not consume the recommended servings of these foods, when controlling for age, sex, race, BMI, previous history or family history of diabetes, CDC's recommended levels of physical activity, and total servings of meat?

Hypothesis

When controlling for age, sex, race, BMI, previous history or family history of diabetes, levels of physical activity based on the CDC's recommendation, and total servings of meat consumed, study participants who consume whole grains, fruits, vegetables, dairy alternatives, legumes and nuts according to USDA's Dietary Guidelines for Americans (DGA) recommended number of times per day are less likely to self-report having prediabetes than study participants who do not consume these foods based on the DGA's recommended number of times per day.

Theoretical Framework for this Research

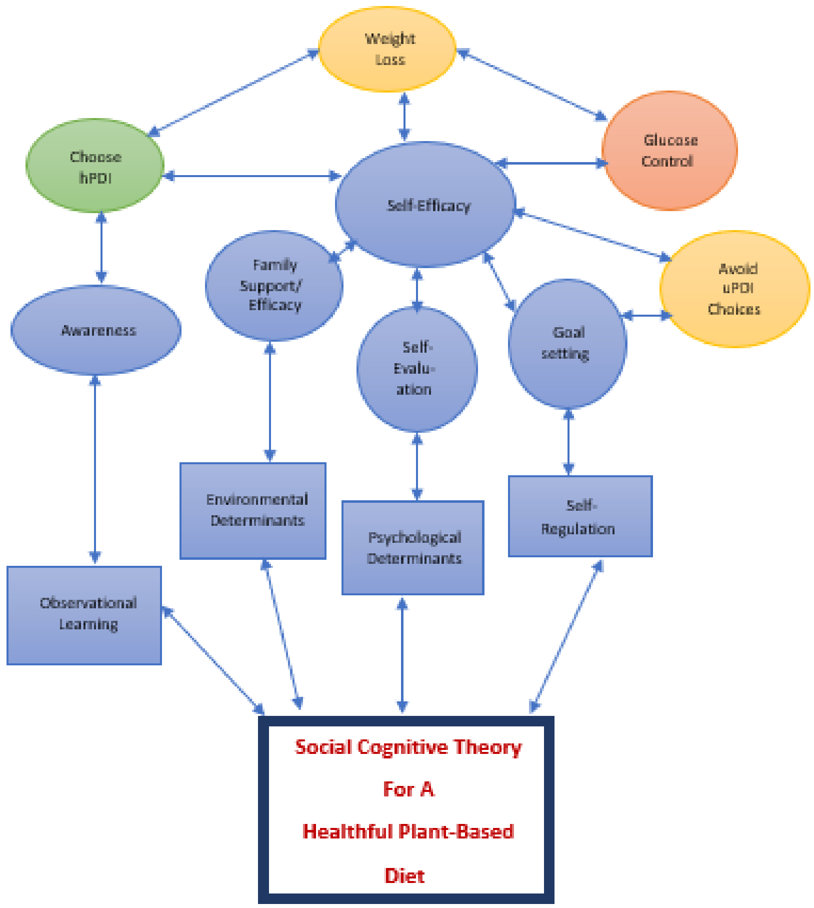
Historically, there has been research on the use of various theories and models for helping to prevent and manage diabetes (Glanz et al., 2008). Theories such as the Social-Cognitive theory (SCT) have been used to inform strategies for diabetes prevention and education programs, and healthy diet consumption focused on eating more fruits and vegetables. These theoretical designs aid in understanding the decision-making process when people are engaged in the practice of incorporating healthful foods in the diet. The SCT described by Bandura (1997) emphasizes self-efficacy as well as collective efficacy to accomplish one's lifestyle goals (Glanz et al., 2008). These SCT constructs, in addition to observational learning, environmental determinants, and psychological determinants (Glanz et al., 2008) served as framework in designing this study.

In one SCT study (Anderson, Winett, & Wojeik, 2007), 712 church attendees of Southwestern Virginia representing 14 different churches participated in a health promotion study. Two-thirds of participants were female, 79% overweight, and 18% African-Africans. Eating habits and shopping practices were evaluated to examine the association of social-cognitive concepts in changing food habits (Anderson, Winett, & Wojeik, 2007). The Food Belief Survey (Anderson et.al., 2000 & Anderson et.al., 2001) was adapted for the study, shopping receipts and a food frequency questionnaire were used as outcome measures (Anderson, Winett, & Wojeik, 2007). The research was particularly focused on social reinforcement regarding nutrition, self-efficacy, expected goal attainment and self-regulatory behavior skills, all of which are aligned with the SCT (Anderson, Winett, & Wojeik, 2007). The results showed a positive association with fat, fiber, fruits and vegetables consumption. Results indicated that the SCT was a good model fit for explaining the observed variance in percent calories of fat (35%), fiber g/1000 kcals (52%), and fruits and vegetables servings/1000 kcals (59%) of foods consumed and on their shopping receipts (Anderson, Winett, & Wojeik, 2007). The findings also showed that the self-regulating skills were enhanced in adults for modifying their diet to make food choices that are healthful (Anderson, Winett, & Wojeik, 2007).

A SCT path design (Figure 1) is shown to visualize the relationships of SCT constructs in explaining the behaviors and actions for consumption of a plant based diet to promote optimum health.

Figure 1

Social Cognitive Theory



Note. Concepts adapted from The Social Cognitive Theory (Bandura, 1997 as cited by Glanz et al., 2008).

Due to the broad scope of SCT, other theoretical models, such as the Health Belief Model (HBM), have been used in conjunction (Glanz et al., 2008, p. 185). HBM focuses more narrowly on investigation of specific behavior changes and reasons that determine the outcome expectation of preventative measures (Glanz et al., 2008).

Health Belief Model

The HBM was also a helpful complement to the SCT for framing this research. The HBM focuses on susceptibility, severity, perceived benefits and perceived barriers of a phenomena (Glanz et al., 2008). Cue to action and self-efficacy are the end-goals for the HBM.

Researchers used the education of HBM to examine the diet adherence of people with type 2 diabetes (Mardani et al., 2010). The results showed that there was increased adherence to the diet after use of the HBM intervention strategies (Mardani et al., 2010). This educational strategy of the HBM could also benefit those who are at risk for type 2 diabetes. In another study, the Health Belief Model was tested for plans to consume a plant-based diet with an online survey of 514 participants, ages 18 and up in the United States (Urbanovich & Baven, 2020). The survey included perceived benefits and perceived barriers, cue to action, along other HBM concepts. The results revealed that self-efficacy was a predictor for choosing a plant-based diet.

The vital concepts of the SCT and HBM for understanding decision-making about a plant-based diet appear to be knowledge, cue to action, self-efficacy, opportunities for choice, and social support for the decisions individuals make to promote optimum.

Both SCT and HBM were used as the foundational theory and behavioral model for this study with a good foundation in the literature showing support for the application to the target populations and health behavior changes in this study. A literature review of the benefits and barriers of a plant-based diet, the incorporation of the research tools (FFQ and the A1c kits) to investigate the risk factors along with questions on the FFQ related about self-confidence to consume plant-based foods and knowledge of the serving recommendations for fruits and vegetables further informed the study design, particularly with regards to selection and development of instruments and outcome measures. A literature review of relative research information about a plant-based diet and prediabetes is presented in the next chapter.

CHAPTER II: LITERATURE REVIEW

The purpose of this study was to examine the relationship of consuming a plant-based diet and self-reported prediabetes status in adults living in Davidson, Hamilton, and Rutherford Counties of Tennessee. This chapter is a review of the relevant literature describing the pathophysiology of diabetes, types of diabetes, prediabetes definition, screening, an overview of diabetes research markers, risk factors for developing prediabetes, prevention and management of prediabetes, characteristics of a high-quality plant-based diet, the benefits and barriers of adopting a plant-based diet, and strategies for incorporating a healthy plant-based diet and related concepts.

Pathophysiology of Diabetes

The mechanism of diabetes is somewhat complex based on the literature review showing that blood glucose levels can become abnormal and change from normal blood glucose levels to insulin resistance or prediabetes and diabetes levels, if not prevented. The pancreas and liver have physiological functions for the balancing of glucose in the body. The following sections are descriptive of the process of blood glucose control mechanisms.

States of Insulin Resistance

Insulin resistance indicates beta cell dysfunction in the pancreas (Tabak et al., 2012). The beta cells in the pancreas produce the insulin to lower glucose levels and the alpha cells produce glucagon to raise the blood glucose levels when needed (ADA, 2019). Beta cell dysfunction can cause insulin not to be produced, or to be limited, which causes high blood glucose levels and prevents glucose from entering the cells in the body (Armstrong & King, 2004; Tabak et al., 2012). The sub-phenotypes are impaired glucose tolerance and impaired fasting glucose (Wagner et al., 2013).

Impaired fasting glucose. Impaired fasting glucose is a blood glucose reading of 100 mg/dL or more after at least 8 hours of fasting (ADA, 2018; Armstrong & King, 2004).

Impaired glucose tolerance. Impaired glucose tolerance is a blood glucose level of 140 mg/dL or higher. Davidson (2013), stated in his video presentation that in 1926 the oral glucose tolerance test (OGTT) was "first described to testing postprandial glucose levels for diagnosis of diabetes." The OGTT is obtained using a reading taken before consuming 75 g. of glucose and a repeated reading after the glucose consumption to get the result (ADA, 2018). It should be less than 140 mg/dL to be normal (ADA 2018, Armstrong & King, 2004).

Beta cell dysfunction is present in both IFG and IGT (Tabak et al., 2012), but the two states of insulin resistance differ in their pathophysiological characteristics (Wagner et al., 2013; Tabak et al., 2012). Individuals with IFG have a severely impaired early insulin response while undergoing the oral glucose tolerance test but their insulin secretion improved during the second phase of the test versus people with IGT who have impaired early phase and late phase insulin secretion (Tabak et al., 2012). These findings suggest the "distinct pathophysiological mechanism of isolated IFG and isolated IGT although the clinical relevance of these results does need further clarification" (Tabak et al., 2012, p. 2283). The location in the body that relates most to insulin resistance due to IGT is different from that of the IFG. The main site of insulin resistant in people with IGT is in the muscles with only small changes in the liver and liver insulin sensitivity (Tabak et al., 2012). A plant-based diet could serve as a protective factor for healthy beta cell function within the pancreas (Kahleova et al., 2018).

Abdominal fat (visceral or adipose) distribution can be a predictor of IGT. Visceral fat or adipose fat tissues center around the mid-section of the body and covers vital organs such as the heart, which may cause adverse health conditions (Davidson & Hamdy, 2004). A person could be of normal weight, and could have adipose fat that may cause impaired glucose tolerance which increases the chance for type 2 diabetes. Steps should be taken to lose that abdominal fat (Davidson & Hamdy, 2004) and this goal can likely be reached with a low-fat plant-based diet.

Approximately two-thirds of the patients with IFG or IGT will develop diabetes and could have been at prediabetes state 5 years before being diagnosed with diabetes. Diabetes develops sooner in patients who have the after-meal high sugar levels (postprandial) which is associated with a higher risk for heart disease (Davidson and Hamdy, 2004). Tabak et al. (2012) indicated that about 5 to 10% (percentage varies according to population conditions) of people with prediabetes will become diabetic every year based on whether the person has IFG or IGT which was based on ADA's definition (Tabak et al., 2012).

These conditions of insulin resistance may subject a person to other health problems, such as damage to their eyes, kidneys, blood vessels, and cause other complications such as neuropathy (CDC, 2016). It is very important to control glucose levels to prevent complications (ADA, 2018; Armstrong & King, 2004; CDC, 2016).

There are several types of diabetes that are the results of dysfunction within the pancreas (ADA, 2018; Armstrong & King, 2004). The different types of diabetes are discussed in the following section to highlight the distinction between diagnosed diabetes and prediabetes states.

Types of Diabetes

In prediabetes, the blood glucose levels are not high enough to be diagnosed as diabetes but it is higher than normal compared to the following types of diabetes that have chronic high blood levels (ADA, 2018).

Type 1 Diabetes

Type 1 diabetes, historically known as juvenile diabetes, is diagnosed when the pancreas does not produce any insulin (Armstrong & King, 2004). The discovery of insulin as a needed resource brought hope for diabetes treatment and increased survival rate for people with type 1 diabetes. Diabetes was a serious diagnosis due to this lack of insulin that caused people to lose a vast amount of weight, sometimes called “wasting away” (Dean & McEntyre, 2004). This was the case mainly with people who had type I diabetes that usually led to death until the discovery of insulin (Armstrong & King, 2004).

Type 2 Diabetes

The ADA (2018) describes type 2 diabetes as a health condition of the body that causes blood glucose (sugar) levels to rise higher than normal to a glucose level of 6.5 percent and is also referred to as "non-insulin dependent diabetes mellitus (NDDM)." Type 2 is the most prevalent type of diabetes diagnosed in adults (CDC, 2019a). If one has type 2 diabetes the body does not adequately use insulin (ADA, 2018). At first, the pancreas makes extra insulin to ameliorate for this deficiency in type 2 diabetes but over time the pancreas cannot make enough insulin to keep the blood glucose at normal levels (Armstrong & King, 2004; Wilson, 2017). Type 2 diabetes usually occurs in adults but can also occur in children. A distinction in the types of diabetes, namely type 1 and type 2 was made in 1950 but it was not commonly distinguished as two kinds until the 1970's (Gale, 2014). Some people who have been diagnosed with type 2 diabetes may have a condition that is related to type 1 diabetes called latent autoimmune diabetes in adults (LADA). LADA is sometimes referred to as type 1.5 (Stenstrom et al., 2005). LADA is a condition in adults with type 2 in which islet antibodies are present at diabetes diagnosis that progress slowly to beta cell failure (Stenstrom et al., 2005). People with LADA do not require insulin at diagnosis and beta cell failure may not occur until 5 years after diagnosis but with some people it may be within the first 5 years of diabetes diagnosis (Stenstrom et al., 2005). Another type of diabetes affects some women during pregnancy.

Gestational Diabetes

Gestational diabetes is diabetes that occurs during pregnancy when blood glucose reaches high A1c levels of 6.5% or higher (Armstrong & King, 2004; Brown-Riggs, 2013). Upon the birth of the baby, glucose levels usually return to normal for mothers who have had gestational diabetes, which means the mother no longer has gestational diabetes. Gestational diabetes may be managed with diet and exercise; however, some women may need insulin shots or pills to help control blood glucose levels during pregnancy (Armstrong & King, 2004). Glucose levels usually do not get high enough to harm the mother. This can cause problems during delivery because the blood glucose of the mother goes into the baby's blood and the baby releases insulin from its own pancreas to lower the glucose levels. When this happens, the baby can become larger than its gestational age and may cause a difficult delivery due to its size (Armstrong & King, 2004). A risk factor for type 2 diabetes is a baby weighing 9 pounds or more at birth (ADA, 2018; Armstrong & King). Women are usually tested between the 24^{th} and 28^{th} week of pregnancy for gestational diabetes (CDC, 2019). Brown-Riggs (2013) suggested the use of a plant-based diet for glycemic control during pregnancy. Early pregnancy can be a good time to consume a plant-based diet to help maintain normal glucose levels to help prevent gestational diabetes. During gestational diabetes, a plant-based diet can help to control blood glucose levels and weight which in turn may also help prevent too much weight gain in the baby (Armstrong & King, 2004; Brown-Riggs, 2013). Screening is warranted to confirm gestational diabetes. Some pregnant moms may have high glucose levels during pregnancy due a condition known as prediabetes. Prediabetes is described in the next section.

Prediabetes

Prediabetes is the intermediate blood glucose level between normal and diabetes levels (ADA, 2018). Although prediabetes is not a type of diabetes or diabetes diagnosis, this condition increases one's chance of being diagnosed with diabetes (ADA, 2018; CDC, 2019a). Prediabetes blood glucose level is a fasting plasma glucose (FPG) level of with normal levels of 100-125 mg/dl before meals and a hemoglobin A1C (HbA1c) of 5.7% to 6.4% (American Diabetes Association, 201; Davidson & Hamdy, 2004; Levenson, 2017). Prediabetes can develop years before one is diagnosed with type 2 diabetes (Armstrong & King, 2004). Being overweight and obese are high risk factors for developing prediabetes or type 2 diabetes. Weight management may be achieved by using a plant-based diet pattern. A plant-based diet may also help to maintain normal glucose levels and prevent insulin resistance thus decreasing the odds of developing type 2 diabetes (Ochai, 2012; Zhang & Azevedo, 2012). Initiatives to prevent prediabetes by early interventions may also help to prevent diabetes or the many complications of diabetes. Special intervention programs have promoted weight loss and increased physical activity to prevent diabetes in people who already have prediabetes (CDC, 2018; Diabetes Prevention Program Research Group, 2015). Because people with prediabetes have a higher probability of developing diabetes than people who do not have prediabetes (Tabak et al., 2012), this attention is warranted to aid in the prevention of diabetes but should be implemented earlier for the most impact. Prediabetes affects more than 88 million people, 18 years and older, in the United States alone, and 90% of this number are unaware that they are at the prediabetes level (CDC, 2019a). Screening will show whether a person's glucose levels confirm a diabetes diagnosis, prediabetes, or normal levels.

Screening for Diabetes

Diabetes is screened using three different tests: fasting plasma glucose tests, hemoglobin A1c test, and an oral glucose tolerance test (ADA, 2018). The hemoglobin A1c (commonly called A1c) test was standardized by the American Medical Association in 2010 for screening and diagnosing diabetes (ADA, 2018; Armstrong & King, 2004). The A1c test is a blood test that measures the extent of blood glucose binding to red blood cells (ADA, 2018). Since red blood cells survive for about two to three months in the blood, the extent of binding reflects the average of a person's blood glucose levels over the past 2-3 months (ADA, 2018; Armstrong & King, 2004). An A1c result of 5.6 % or less is the normal A1c range, 5.7-6.4% is prediabetes range, and 6.5 % or higher shows the ranges for diabetes (ADA, 2018; Armstrong and King, 2004).

The FPG test is a measure of the blood glucose levels after eight (8) hours or more of not eating or having caloric intake (ADA, 2018). The normal reading for FPG test is 99 mg/dL or less, prediabetes is 100-125 mg/dL, and diabetes is 126 mg/dL or more. The fasting plasma glucose (FPG) test is best for verifying the condition of diabetes status but not the best for screening because FPG test is only 50 % sensitive for diagnosing diabetes (Abdallah et al., 2019). The sensitivity and specificity of FPG tests are lower in people ages 65 years and older (Abdallah et al., 2019). The FPG is usually done more than one time and followed by hemoglobin A1c and/or OGTT (Abdallah et al., 2019).

The oral glucose tolerance test (OGTT) is a test that is done after an overnight fasting to measure the blood glucose levels for prediabetes or diabetes by testing the blood before drinking 75 grams of a high-glucose solution and at various intervals for 2-3 hours after drinking the glucose to obtain a blood glucose reading (ADA, 2019). The body can be more at risk for diabetes complications when glucose levels are between 140 and 180 mg/dL range (Armstrong & King, 2004, p.15). This high-level of blood glucose may not be noticed until it is above 180 mg/dL which increases the chance of complications such as vision problems, kidney problems, and nerve cell damage when glucose is not entering the cells for energy, which may also cause fatigue (Armstrong & King, 2004).

The recommendation for diabetes and prediabetes screening is to begin the screening at age 45 years old unless there are other factor that may increase probability of prediabetes (ADA, 2018; Davidson & Hamdy, 2004). The US Preventive Task Force updated the recommendations for screening in 2015 to begin screening at the age of 40 to 70 those who are overweight or obese and have other risk factors (O'Brien et al., 2016; Watson, 2017). The American Academy of Clinical Endocrinologists recommends screening at age 45 for those with a risk factor regardless of the weight status (Watson, 2017).

Overview of Diabetes Research Markers

The prevalence of diabetes and prediabetes rates are increasing in America as well as globally (Boyle et al., 2010). Diabetes, once called "sugar diabetes" or "sugar," was first diagnosed in 1889 (ADA, 2019). The "sugar or sugar diabetes" terms originated as a result of researchers discovering that urine and blood in people with diabetes was sweet (Ahmed, 2002). The body breaks down the carbohydrates consumed into blood glucose (also called blood sugar) which enters the cells to use for energy but when the glucose does not enter the cells it stays in the blood (Armstrong & King, 2004). In 1910, Sir Edward Albert Sharpey-Schafer found that diabetes results from lack of insulin produced in the body. Insulin is a hormone that the pancreas produces to control blood glucose levels and binds to the receptors on cells, thus prompting cells to absorb blood glucose for energy. In type 1 diabetes, when insulin is not being produced by the body, insulin injections have to be given to compensate for the body’s deficiency of this hormone (Armstrong & King, 2004). Though diabetes incidence and prevalence rates were lower during those early years than it is today, people did not have the medicines (such as insulin) and other resources that are available today to thrive and properly manage diabetes (Armstrong & King, 2004). These historical advances in medicine and diabetes research have made a segue into more current preventive strategies that focus on the prevention of prediabetes for preventing type 2 diabetes (Leal et al., 2014; Levenson, 2017; Meigs et al., 2014; NIDDK, 2018; Wilson, 2017). Nutritional and weight management strategies for preventing prediabetes are the focus of this research. The following section presents leading risk factors that may contribute to developing prediabetes.

Risk Factors Associated with Developing Prediabetes

Poor diet quality and inactivity which can be modified accounts for the greatest percentage of insulin resistance that occurs in prediabetes and type 2 diabetes (Watson, 2017). However, other risk factors that are not modifiable also exists, such as family history of diabetes (FHD), race and ethnic groups, and age (Wilson, 2017). Additional factors include gestational diabetes and delivery of a baby weighing more than 9 pounds (Wilson, 2017).

Obesity

Obesity is one of the risk factors associated with insulin resistance (CDC, 2015). Losing weight may help to prevent diabetes and other health conditions such as cancer, heart disease and dementia. Prediabetes can sometimes go unrecognized, especially in people who are overweight or obese (Eikenberg & Davy, 2013). A person's BMI is associated with increased relative risk of type 2 diabetes in the young and middle aged but attenuated as a person gets older (Canning et. al., 2013). Weight loss of 5% could possibly lower the chance of an obese person getting type 2 diabetes (Astrup & Finer, 2000).

Family History of Diabetes

People who have family members with diabetes have a higher probability of developing prediabetes than those who do not have a family history of diabetes (Davidson & Hamdy, 2004).

The research on the family history of disease by Eikenberg and Davy (2012) identified family factors among African-Americans who are disproportionately burdened by diabetes. In another study by Wagner et al (2013) showed the relationship of family history of type 2 diabetes and the risk for prediabetes was investigated. Family history of diabetes was defined as having at least one first-degree relative with type 2 diabetes. The study was conducted to investigate whether having at least one first-degree relative with diabetes was associated with prediabetes. A questionnaire and a personal interview were used to survey participants about the first-degree relatives: parents, sibling, or child (Wagner et al., 2013). In the study, data was collected from 8,106 non-diabetic individuals of European origin through the German Center for Diabetes Research Centers who had a family history of type 2 diabetes or themselves had type 2 diabetes to determine if they had a greater probability for having type 2 diabetes. Of that number, 5,482 people had normal glucose tolerance and 2,624 had impaired fasting glucose (Wagner et al., 2013).

Wagner et al. (2013) found that a family history of diabetes is associated with a 40% increase risk of having prediabetes when taking additional real risk factors, such as obesity and age, in a multivariable model into account. The association of family history of diabetes with increased risk factor for prediabetes shows that it is feasible to consider family history of diabetes in planning diabetes prevention strategies (Wagner et al., 2013). This consideration of family history can also apply to women who are pregnant and have a family history of gestational diabetes.

Gestational Diabetes

Gestational diabetes is due the beta cell dysfunction, which causes insulin resistance during pregnancy (Armstrong & King, 2004). Gueuvoghlanian-Silva et al. (2015) used lipid fingerprinting to test for the severity of the gestational diabetes mellitus in women. The results showed that there were differences between healthy, mild and severe gestational diabetes. This lipid fingerprinting could help to anticipate complications and aid in health care preparation for the mother and baby. Most gestational diabetes can be controlled with diet and exercise but some women with more severe gestational diabetes may need insulin to help balance the blood glucose levels (Armstrong & King, 2004; Brown-Riggs, 2013; Gueuvoghlanian-Silva et al., 2015). The protocol for treatment is selecting healthy diet choices and using portion control which is one aspect of a healthy lifestyle (Gueuvoghlanian-Silva et al., 2015). Lifestyle factors are important to consider during all stages of life.

Lifestyle (diet & exercise)

Unhealthy food choices and eating habits can cause weight-gain. It is important to practice eating a wholesome well-balanced diet to balance food and energy. Physical activity is recommended at 30 minutes per day for at least five times per week (USDA, n.d./b). The diet aspect of practicing a healthy lifestyle is usually the most challenging to master, especially with the diversity of eating habits and diet pattern options.

The information in this chapter up to this point has reflected various constructs of the SCT such as observational learning in which partial information presented here was also shared with the participants in this study in the form of printed information about prediabetes. Awareness and education are necessary for people to have the information-basis to make decisions about healthful changes and move toward self-efficacy for consuming a plant-based diet for weight management and glucose control to prevent prediabetes. Environmental determinants related to community resources such as screenings and available community resources were included in this study. Risk factors were also presented that related to the HBM for perceive susceptibility of prediabetes. The next sections present information on preventing prediabetes, specifically with the plant-based diet, perceived benefits and barriers for consuming a plant-based diet and strategies for self-efficacy in adopting a plant-based diet.

Prevention and Management of Prediabetes

Intervention and prevention must be ongoing to lower the prevalence of type 2 diabetes and prediabetes. Many interventions and studies have focused on modifying or changing risk behaviors such as sedentary lifestyles, nutrition, alcohol consumption and smoking (Hall & Eifert, 2016). Numerous community health programs and innovations, both short-term and long-term, have dictated the path of intervention and prevention strategies for primary prevention of diabetes, prediabetes and obesity (Thomson & Ravia, 2011). There have been many community strategies that promote glycemic control, weight loss, healthy diet and exercise. Prevention strategies that have shown to have effective outcomes, aside from medication, in the prevention and management of prediabetes has been education about diabetes (Kramer et al., 2011) and lifestyle behavior change of diet and exercise (Kong et al., 2014). The following section focus on the diet and the plant-based diet pattern will especially be highlighted for the prevention of prediabetes.

Plant-based Diet Pattern for Preventing Prediabetes

A plant-based diet consists of only foods derived from plants, which is the definition used in this research. Past research has shown that there have been diet plans through the years designed and promoted for optimal health as well as targeted chronic conditions such as diabetes. However, many of these plans are difficult for people to continue as a consistent healthy eating plan (Wing et al., 1998). The plant-based diet pattern has been shown to be a simple eating plan that can be adopted as a consistent lifelong healthy eating plan (Allen et al., 2018; Bagheri et al., 2016; Trapp & Levin, 2012).

Plant-based diet patterns

Plant-based diet patterns are commonly used by vegan and vegetarians. Vegans eat only plant-based foods and the name "vegan" is often used interchangeably with a plant-based diet. There are different types of vegetarian patterns: lacto-ovo eat dairy and eggs with plant-based foods, ovo vegetarians eat only eggs with plant-based foods and pescatarian eat fish and sometimes eggs with plant-based food. Research has shown that consuming legumes and nuts as substitutes for meat in some meals during the week can be healthier than an all-meat diet for protein (Davidson & Hamdy, 2004).

Examples of healthful plant-based diet patterns

The American Diabetes Association (ADA) reported four basic diet patterns that are predominantly plant-based. Examples of the ADA illustrated diet patterns from their 2019 consensus report based on the potential health benefits are as follows:

Vegetarian and vegan diet. The vegetarian and vegan diet pattern were listed to reduce the risk of diabetes, A1c reduction, and weight loss.

Mediterranean diet. The Mediterranean was listed for reducing the risk of diabetes, A1c reduction and cardiovascular disease.

DASH. The DASH diet was listed to for reduced risk of diabetes, weight loss, as well as the lowering of blood pressure.

The Low-fat Diet. The low-fat diet was listed for reducing the risk of diabetes and to aid in weight loss and management.

Characteristics of a High-quality Plant-Based Diet

A high-quality plant-based diet consists of whole foods or minimally processed foods derived from whole grains, fruits, vegetables, legumes, and nuts (USDA, 2018; Rodgers, 2017). A whole-food diet, sometimes referred to as "clean eating," has increased in preference among people in recent years because of available foods with less additives to the natural foods (Allen et al., 2018). The natural state of vegetables and fruits helps to minimize added sugars, fats and sodium in the diet. Herbs and spices can make foods more palatable and could also increase the health benefits of a plant-based diet (Beidokhti & Jager, 2017). Decision for healthy choices can result in the best return of investment for a new lifestyle when unprocessed foods are more plentiful in the diet. Bagheri et al. (2016) examined healthy and unhealthy diet patterns and their relationships with prediabetes. Bagheri et al. (2016) identified a healthy diet plan that consisted of vegetables, fruits and legumes (VFL) and the unhealthy diet plan that consisted of sweets, solid fats, meat and mayonnaise (SSMM) to see if there is any relationship to prediabetes. The SSMM plan was associated with a greater chance for prediabetes (Bagheri et al., 2016). All types and colors of vegetables should be included in a quality plant-based diet including root vegetables, tuber vegetables, leafy vegetables, seed pod vegetables, and all types of fruits and less fruit juices.

Benefits of a Plant-Based Diet for Preventing Prediabetes

A plant-based diet may help the body in many ways, such as providing nutrients, weight loss, and support to the pancreas by lightening the load on the pancreas through a well-planned whole-food diet. Based on the literature review, diets with lower sugar content can minimize the pancreas release of insulin for stabilizing blood glucose and in helping maintain glucose control.

A plant-based diet may be appropriate especially for women with gestational diabetes (Brown-Riggs, 2013) and people who are overweight or obese (Barnard et al., 2009) because they have a higher chance of developing type 2 diabetes or prediabetes. The plant-based diet pattern may be more beneficial to people who have impaired glucose tolerance than those with impaired fasting glucose (Barnard, et al, 2006). People may have a normal fasting glucose level but may not be able to metabolize glucose levels properly at 2 hours after eating, which is the postprandial period (Armstrong & King, 2004). The monitoring of postprandial glucose levels should be done while making changes. When people reach the maintenance or termination stage as in the transtheoretical model, they are more likely to continue with the new behavior (Glanz, 2008). Researchers have shown that a plant-based diet can help control glucose levels for people with IGT (Barnard, et al, 2006). There are other benefits of a plant-based diet that are noted in the subsequent subsections.

Functional Foods

A plant-based diet can also include functional foods in the eating plan (Riccardi et al.,2005). Functional foods are foods that have been proven to positively affect one or more target bodily functions or health conditions (Riccardi et al.,2005). When the body is deficient in certain functions, it may need mediating steps to aid in the successfully carrying out of the necessary functions that keeps the body healthy. Some plant-based foods such as: certain fruits, vegetables, beverages, oils, and spices serve as functional foods that may help the body function properly (Beidokhti & Jager, 2017). Examples of functional foods for weight loss include foods with fiber, green tea, low fat dairy foods and nuts. Functional foods also include foods such as cinnamon that may help with glycemic control and colorful fruits and vegetables containing high antioxidant levels that may help to prevent some forms of cancer. These foods and spices should be discussed with a physician before consumption or incorporating into a plant-based diet plan. Another benefit of a plant-based diet is the provision of essential nutrients from the many types of plant foods that are available.

Essential Nutrient Intake

Including adequate amounts of plant-based foods can help to ensure that a person is getting the vitamins, phytochemicals, antioxidants and other necessary nutrients for good health. A plant-based diet can be as adequate in providing the necessary nutrients for a healthy diet as an omnivorous or conventional diet. Alternative plant-foods can provide iron, protein, and calcium, which are the main concerns for many people when choosing a plant-based diet. Vitamin B_{12} is also a concern because vitamin B_{12} is naturally found in meats or meat products however, it can be obtained from fortified cereal or may be supplemented (Trapp & Levin, 2012). Examples of other important nutrients that are found in fruits, vegetables, legumes, and nuts are: vitamins A, B, C, E, & K, potassium, and magnesium can also be obtained from plant-based foods.

Plant-based foods, such as fruits vegetables, legumes, nuts, and seeds, are good sources of phytochemicals. An existing study by Abshirini et al. (2018) revealed that phytochemicals can have a protective factor for reducing diabetes. This study was conducted with 300 participants (150 healthy and 150 people with prediabetes) using a phytochemical index. They found that fruits were the best source of phytochemicals along with legumes, vegetables, nuts, seeds, olive, olive oil, and whole grains respectively (Abshirini et al., 2018). Polyphenols in berries, cherries, and apples are the most effective phytochemicals to help lower glucose levels (Abshirini et al., 2018).

Babu et al. (2013) described flavonoids as the color pigmented compounds in fruits and vegetables. Flavonoids are substances found in the colors of fruits and vegetables that have been shown to be beneficial in the prevention of certain diseases. The consumption of flavonoids can have an anti-diabetic effect by helping send signals to the pancreas for beta cell function thus promoting glucose control (Babu et al.,2013).

Researchers have shown that plant-based foods provide antioxidants that may help to prevent prediabetes (Sostoudeh et al., 2018). Sostoudeh et al. (2018) conducted a study to evaluate the association between antioxidants and prediabetes, and found that people who eat high amounts of antioxidants were less likely to have prediabetes. The sources of antioxidants that correlated with an unlikely prediabetes state are fruits, vegetable, legumes, nuts, teas and olive oil when consumed in plentiful amounts (Sostoudeh et al., 2018). In addition to the nutrients previously mentioned, plant-based foods supply fiber that is needed for helping to metabolize blood glucose.

Fiber

Fiber has been shown to aid lowering of the post-prandial glucose levels in people with type 2 diabetes and insulin resistance (Barnard et al., 2006; Wheeler et al., 2012). Wheeler et al. (2012) conducted a review that examined seven randomized controlled trial (RCT) about fiber intake and diabetes. The results indicated that glucose tolerance improved in six of the trials examined and the A1c showed a decrease according to the study by Ziai et al. (2005) as reported by (Wheeler et al., 2012). Fiber can also help with weight loss and help to satisfy hunger due to the soluble fiber in plant-based foods (Zhang et al., 2018).

Weight Loss

A low-fat plant-based diet may help a person lose weight even without calorie limits and portioned amounts (Barnard et al., 2009; Bennett & Appel, 2016). Two of the Healthy People 2020 objectives for persons with prediabetes are: (1) D-16.2 which is to increase the proportion who report trying to lose weight and (2) D-16.3 which is to increase the proportion from 48.5 to 53.4 percent of persons who report reducing the amount of fat calories consumed (Healthy People 2020 Team, 2015). Healthy People 2020 is a goal planning system for the improvement of health in America which contains over 1,200 objectives with 42 topic areas for assessment, planning and conducting public health initiatives (Healthy People 2020 Team, 2015). Weight loss can help to balance blood glucose levels for glycemic control.

Glycemic Control

Existing studies indicate that plant-based diets are effective for glucose control (Barnard, Cohen, & Jenkins, 2006; NIDDK, 2018; Wright et al., 2017; Yokoyama et al. 2014). A study using a low-fat vegan diet showed an improvement in glycemic control for people with type 2 diabetes compared to the American Diabetes Association guidelines that includes meat and all food groups (Bernard, Cohen, & Jenkins, 2006). Both groups showed improvement but the low-fat vegan group had the greatest improvement in their A1c and lipids levels.

Diet for Glycemic Control During Gestational Diabetes in Pregnancy

A plant-based diet has been shown to help control glucose levels in gestational diabetes (Brown-Riggs, 2013). A plant-based diet of high carbohydrate intake can be a difficult task to manage when the mother has diabetes during pregnancy. A vegan diet may be more challenging than other types of vegetarianism because animal products are not consumed, even as the recommendation is 175 grams of carbohydrates per day until the last trimester when more carbohydrates are needed for the health of the baby (Browns-Riggs, 2013). The diet would include whole grains, vegetables, fruits, legumes and nuts (Browns-Riggs, 2013).

There are barriers to consuming a plant-based diet for women at times other than pregnancy and with men as well. Examples of the barriers to consuming a plant-based diet are explained in the next section.

Barriers to Adopting a Plant-Based Diet

Research has shown that not everyone is accepting of the plant-based diet pattern (Pohjolianen, 2015). Pohjolianen (2015) highlighted barriers to adopting a plant-based diet, which were: meat enjoyment, eating routine, health perception, and difficulty preparing vegetarian foods. People have expressed various reasons for not adopting the plant-based diet as presented in subsequent sections.

Diet Change, Personal choice, Preferences and Food Preparation Skills

People may desire to make changes but may not have the self-efficacy to take action due to the “cost of change” (Glanz et al., 2008, pp. 99 & 102). The “cost of change” is a concept related to a factor(s) one might have to consider in the decision-making or re-structuring process for initiating a new plan of action (Glanz et al., 2008). An example of sustained results of eating fruits and vegetable was the MENU program (Thomson & Ravia, 2011). The MENU program is a web-based program that promotes the consumption fruits and vegetables (Thomson & Ravia, 2011).

Lee, McKay and Ardern (2015) conducted a study with 98 patients and 25 healthcare providers in a diabetes education center in Ontario, Canada to assess the awareness, perception and barriers of adopting a plant-based diets for managing type 2 diabetes. The results showed that 66 % of the patients would use a plant-based diet for 3 weeks to help manage their diabetes and nine percent of the participants were already using a plant-based diet. The results for the health care providers showed that 72% had knowledge of a plant-based diet for helping to manage type 2 diabetes but only 32 % were recommending the plant-based diet to patients. Barriers that surfaced in that study with one-half of the participants were: family eating habits, a lack of meal planning, and preference to eat meat as the primary reasons to not use a plant-based diet. Additional factors for not choosing a plant-based diet were: food cost, ease of cooking, time constraints, and other factors not shown. The percentage of participants who were not confident enough to try a plant-based diet in the study was 17-28% (Lee, MacKay & Ardern, 2015).

Minorities and Low-Income Family Status

Minorities and low-income populations have disproportionately differing levels of fruits and vegetables consumption today, a status which is very different from past-times (Gary et al., 2004). Gary et ai., 2004 showed that African Americans, on a whole, consumed less than the recommended amounts of 2 or more servings of fruits and 3 or more servings of vegetables. Study participants in this study with more education and higher income consumed higher levels of fruit intake. Kurmanyika reported that in 1965 (as cited by Gary et al., 2004), African American and low socioeconomic Whites showed a better diet than Whites of higher socioeconomic Whites and as time progressed, African Americans and people of lower income had less improvement than Whites and people of higher incomes (Gary et al., 2004).

Lack of Food Access

There are resources today that can help families supplement their food to ensure adequate nutrition for the family such as the Women, Infant and Children (WIC) program that allows fresh produce purchases. However, for various reasons, the WIC program is not always utilized by people who need it. The Supplemental Nutrition Assistance Program (SNAP) for limited resources families and individuals will also allow plant-based food purchases (USDA, n.d.). Research has been done on food insecurity and food access through food pantries (Noerper, 2018), which showed that all nutrition may not be met from food pantries but that food pantries can help to supplement the nutritional resources of families in times of need. The environment and food dessert residential areas with limited places to purchase produce and other quality plant-based whole foods can be a barrier for many families. The price of plant-based foods can be too high for limited resource families to purchase on a regular basis. According to a Washington, D.C. study by Frankenfeld, Leslie, and Makara (2015), the environment has a statistically significant association with diabetes, obesity and the consumption of 5 or more fruits and vegetables.

A concern for consuming adequate nutrition is a barrier for many people because animal-based foods are thought to supply nutrients that cannot be obtained from plant-based foods.

Concerns for Obtaining Certain Necessary Nutrients

Research has shown that micronutrient inadequacies do exist in the U.S. population (Oregon State University, n.d.). Therefore, some nutrients may need special consideration to prevent deficiency, such as iron, vitamin B_{12} and protein (Trapp & Levin, 2012). Accommodations can be made to ensure adequate nutrient intake when using a plant-based diet as shown in Table 2. According to Trapp and Levin (2012), “a macronutrient profile of 75-80% of energy from carbohydrates, 10-15% from protein, and 10% from fat is recommended” (p. 41). Table 2 shows that iron can be obtained from leafy greens and legumes, vitamin B_{12} can come from fortified cereal and plant beverages, while protein can be supplied by legumes, nuts, tofu (Trapp & Levin, 2012).

Table 2

Plant-based nutrient accommodation

Nutrient concern	Nutrient accommodation
Protein	Beans, seitan, tofu, tempeh, lentils, grains
Vitamin B 12	Fortified cereal or non-dairy milk,
Iron	Green leafy vegetables and legumes
Omega 3 fatty acids	Flaxseeds, walnuts, cauliflower, soybeans, tofu, brussel sprouts
Calcium	Bok choy, broccoli, collard greens, fortified juices & breakfast cereals
Vitamin D	Ergocalciferol supplements are made from non-animal sources.

Note: Table adapted from Trapp & Levin (2012).

A well-balanced plant-based diet can supply the necessary nutrients for a healthful diet plan.

Strategies for Adopting a Quality Plant-Based Diet Pattern

The literature review showed that a plant-based diet can be effective in weight loss (Barnard et al., 2005) and controlling glucose levels (Barnard et al., 2006) in people who have high probability of being diagnosed with diabetes (Collins et al., 2011; deSouza et al., 2017; Kahleova et al., 2018). Many people may only need strategies to initiate the process of dietary change for a healthy diet. The following subsections gives ways to adopt a plant-based diet.

Dietary Indexes

Quality selection tools are available in the form of various indexes that have been created for evaluating healthful food choices, such as Healthy Eating Index, healthful plant-based diet Index (hPDI), glycemic index, and others. These measurement tools can be used especially by health educators to help clientele balance glucose levels and food choices. In 1995, a Healthy Eating Index system was designed with 13 components to evaluate foods based on how well the foods reflect the dietary guidelines for Americans (USDA, 2019). The best HEI score is 100.

The healthful plant-based diet index could be a good tool to help quickly gauge diet quality. The healthful plant-based diet index (hPDI) is also a tool that nutrition educators can use to help clients with diet assessment and promotion of healthy plant-based food choices (Satija et al., 2016). Satija et al. (2016) suggested that a plant-based diet could reduce the risk or the probability of having type 2 diabetes. The results of their study indicated that there were healthful and unhealthful versions of the plant-based diet associated with type 2 diabetes incidence in 3 prospective cohort studies in the U.S. (Satija et al., 2016, 2019). The study included 69,949 women from the Nurses' Health Study conducted between 1984 and 2012. The study also included 90,239 women from the Nurses' health study 2 for the years of 1991 to 2011, and 40,539 men from the Health Professional's Follow-up study from 1986 to 2010. Satija et al. created an overall plant-based diet index where plant-based foods receive positive scores while animal foods receive reverse scores. The healthful plant-based diet index included foods such as whole grains, fruits, vegetables, nuts, legumes, healthy vegetable oils, teas, and coffees which received positive score. Examples of less healthful plant foods were fruit juices, sweetened beverage, refined grains, potatoes, sweets and desserts and animal foods that received a reverse score as these foods were on the unhealthful plant-based diet index ([uPDI] Satija et al., 2016; Satija et al., 2019).

Complementing the healthful plant-based diet index (Satija et al., 2016; Satija et al., 2019) with the glycemic index for helping to maintain glycemic control and to manage weight (Brand-Miller et al., 2003) could possibly aid in the prevention of prediabetes and type 2 diabetes. The glycemic index classifies carbohydrate foods into low (GI of 0-55), intermediate (GI of 56-69) and High (70 & higher) as standardized index values (Brand-Miller et al., 2003). The glycemic index was developed by Dr. David Jenkins and team at the University of Toronto, Canada in 1981.

In this study, the GI was a highlighted index of focus because the strategy is specific to controlling blood glucose levels. The GI classifies foods on a value scale of 0-100 and the higher the GI value number, the faster it is expected the glucose levels will rise in the body when consuming certain food items which may signal hyperglycemia (Brand-Miller et al., 2003). Hyperglycemia is elevated blood glucose (Brand-Miller et al., 2003; ADA, 2018). The use of the glycemic index (GI) to select low glycemic foods when shopping can also be helpful for choosing a quality diet plant-based diet (Brand-Miller et al., 2003). Numerous research studies have shown positive relationships of a low glycemic diet as reported in the meta-analysis by Zafar et al. (2019) that included analysis of 54 studies. The results showed lowered FPG, A1c, lipids, and BMIs for people with impaired glucose tolerance and diabetes of those who consumed the low glycemic diet (Zafar et al., 2019)

The various foods shown in Table 3 includes glycemic index values for each food listed. The cereals in Table 3, bran flakes (74) and corn flakes (92) have a GI value that is high. When these food items are consumed, it will make the glucose level go up faster than if Frosted Flakes (55) had been chosen bearing a low GI value. Another example is kidney beans, canned versus boiled for the same amount of 2/3 cup is different and both are in the low GI range. The boiled kidney beans have a much lower value of 23 versus GI of 52 for the canned kidney beans as listed in Table 3.

Table 3

Glycemic Index (GI) Food Examples

Food example	Amount	GI value
Almonds	1.75 oz.	0
Apple	1 medium	38
Avocado	1/2 cup	0
Banana	1 medium	52
Beets, canned	1/2 cup	64
Blueberry muffin	small	59
Bran flakes	1/2 cup	74
Cherries, raw	18 single cherries	22
Corn Flakes	1 cup	92
Cucumber	3/4 cup	0
Frosted flakes	1 cup	55
Kidney beans, canned	2/3 cup	52
Kidney beans, boiled	2/3 cup	23
Kiwi	1/2 cup	58
Oatmeal	1 cup	42
Pear, raw	1/2 cup	38
Popcorn, plain, microwaved	1 1/2 cup	72
Pumpkin	3 ozs.	75
Yam, peeled, boiled	5 ozs.	37

Note: Adapted from Brand-Miller et al., 2003. Low (GI of 0-55), intermediate (GI of 56-69) and High (70 & higher) as standardized index values.

It should be noted that low GI foods can be eaten alongside high GI foods for balance and glycemic control (Brand-Miller et al., 2003). Fruits and vegetables are naturally low in fats and this diet is carbohydrate-based, even as most fruits and vegetables have a low to intermediate GI (Brand-Miller et al., 2003). Th glycemic index can be a very helpful tool to use when choosing and shopping for lower GI foods. The GI tool can complement various diet patterns for selecting foods that are best for glycemic control. The subsequent section describes examples of plant-based diet patterns that are well-recognized for use in certain chronic conditions.

Choose My Plate APP

The new Choose My Plate App is available for planning healthy meals and tracking dietary activities (USDA, 2020). This App is also a tool that can be utilized for tracking physical activities. Additionally, wearable fitness watches are available for tracking calories along with physical activities.

Foods to Include in a Plant-Based Diet

Foods to include in a plant-based diet are whole foods that are minimally processed. A plant-based diet pattern consists of foods from these categories: whole grains, fruits, vegetables, nuts, legumes, and healthy vegetable oils. Trapp and Levin (2012) suggested using the Power Plate that was developed by the Physicians Committee for Responsible Medicine in 2009 (pg. 40). The “Power Plate” is divided into four sections which include the following food categories: grains, fruits, vegetables, and legumes. Trapp and Levin (2012) found that the patients who did not consume animal products showed improved glycemic control using the “Power Plate.” The “Power Plate” strategies also helped with portion control which is important for balancing the number of recommended daily servings and caloric intake.

The plant-based diet pattern for ages 21 years old and up includes 6.5-10.5 servings from the Grain group, 5-7 servings of all colors of vegetables from the Vegetable group, and 3-5 servings from the Fruit group, 3-3 servings from Dairy Alternatives, 3-6 servings from Protein group for adults, and 3-5 servings of vegetable protein per day.

Servings represented the number of times a food is consumed for this study (USDA, 2020).

The "Dietary Guideline for Americans 2020-2025 shows recommended daily or weekly amounts as cups and ounce-equivalent. The daily food consumption frequencies on the food frequency questionnaire were calculated using the Harvard's frequency factor scoring system (Harvard, 2007).

According to USDA (2015) the Dietary Guidelines for Americans' statement concerning a vegetarian food pattern:

"Healthy Vegetarian Pattern is adapted from the Healthy U.S. Style Pattern, modifying amounts recommended from some food groups to more closely reflect eating patterns reported by self-identified vegetarians in the National Health and Nutrition Examination Survey (NHANES). Meats, poultry and seafoods were not included in the plan. (p.86)." This vegetarian food pattern included more grains, soy, legumes, nuts, and seeds in the recommendations (USDA, 2015).

Chapter 2 Summary

Based on literature review, diet and exercise are the leading protective factors for maintaining good health. Research has shown that even among people who exercise and consume unhealthful diets, this can be counterintuitive for maintaining healthy weights. Past research is indicative of diet inadequacy for obtaining the necessary micro- and macronutrients to maintain good health and for weight management.

Investigating diet and prediabetes status through this research study provided a better understanding of the diet and self-reported prediabetes. A low-glycemic low-fat plant-based diet may be the answer to weight loss, weight management, and glycemic control for preventing prediabetes. A diet plan different from that of a conventional diet is warranted for people who have a high chance of having insulin resistance in order to prevent type 2 diabetes. A kaleidoscope of fruits and vegetables should be included in planning the diet. Colorful plant-based foods are sources of flavonoids, phytochemicals, and antioxidants that help to prevent diabetes (Brand-Miller et al., 2003; Burani & Foster-Powell, 2001). It must be stated that this research study was aligned with USDA's recommendations to consume foods with adequate nutrients and amounts for good health and included the examination of the amounts of foods consumed by study participants to ascertain whether adequate amounts of plant-based foods are being consumed to affect the prevalence of diabetes. Fortunately, data are available concerning fruits and vegetables consumption but research regarding the relationship of plant-based food intake to chronic disease prevention is limited for Tennessee. This study is the first to investigate a plant-based diet pattern and if there was relationship to self-reported prediabetes, according to the researcher’s knowledge.

The SCT was used in previous studies to show how observational learning through education and awareness, the environment (family, community and other support organizations), and self-evaluation can help to adopt a new behavior, specifically to consume a plant-based diet for optimal health. The aforesaid constructs can create a cue to action toward self-efficacy and influence decisions for goal attainment in weight management and glucose control (Anderson et al., 2007).

The HBM has also been used to identify beliefs about adopting a plant-based diet (Mardani et al., 2010). After having knowledge about prediabetes, weight management or weight loss benefits, changed behavior may only happen when a person feel confident to take action. Research showed that a person will take action based on their perceived benefits and their perceived barriers can limit or prevent the changed behavior (Glanz et al., 2008).

The following chapter include the methodology and procedures for conducting this research study.

CHAPTER III: METHODS

The purpose of this study was to examine the association between the consumption of a plant-based diet and the status of cases of self-reported prediabetes among the adult population in Davidson, Hamilton, and Rutherford Counties in Tennessee. This chapter provides an overview of the research methods for this study which includes the targeted population, study design, instrumentation and data collection, measures, and statistical analysis. Primary data was utilized for this study which was approved by the Middle Tennessee State University Institutional Review Board (IRB) with approval #19-1278 and #20-2065 (Appendix A).

Target Population

The target population included in this study were adults ages 21 years and older, both male and female. This study was also intended to reach a target population with a family history of diabetes, people who were overweight/obese, and women diagnosed previously with gestational diabetes. Participants who provided informed consent, using the Institutional Review Board approved consent form, were enrolled as participants in the study (Appendix B). Study participants were recruited from among people who were receiving services at scheduled health events, attended churches and public places in Davidson, Hamilton, and Rutherford counties.

This study was conducted in-person and online using Qualtrics with a total of 273 food frequency questionnaires recorded from participants. Of these, 26 questionnaires were not included because the FFQ were not completed or the participants lived in counties other than the survey-counties and were excluded. The remaining 247 study participants were included in this study.

Study Design

The research design was a cross-sectional population-based study, in which convenience sampling was used. G-power (Faul et al., 2007) was used to calculate the sample size, which was deemed at a minimum of 244 participants. The power analysis was calculated using an alpha level of .05 (one tail), and binomial distribution. The sample size was expected to yield 90% power to show a difference between the plant-based food consumption of participants who self-reported prediabetes, and participants who did not self-report prediabetes. Primary data collected from the three (3) aforementioned counties was utilized for this study. The following section shows the research tools and process.

Instruments and Data Collection Process

This section include description of the data collection instruments and data collection process that was used for this research study.

Data Collection Instruments

The Middle Tennessee State University (MTSU) Institutional Review Board (IRB) approved food frequency questionnaire (FFQ) was used to collect data on demographics, diet/eating habits, physical activity, and diabetes status of participants for evaluating the variables in this study. The A1c kit was used by study participants to help participants obtain an A1c reading of their blood glucose levels to self-report on their questionnaire.

FFQ. FFQs are commonly used to assess the dietary intake of individuals in a population to examine the relationship between diet and health (Brantsaeter, 2008). A FFQ termed as “prudent” that included fruits, vegetables, legumes, nuts, whole grains fish and seafood was examined and found to be reliable and reproducible based on a factor analysis of two FFQ’s (Hu et al., 1999). The first FFQ was examined along with a Western diet that included processed meats, red meats, refined grains. The results showed the “reliability correlation for the factor scores between the 2 FFQ’s were .70 for the prudent diet pattern and .67 for the Western diet pattern (Hu et al., 1999). Both were reliable and reproducible and this shows that FFQ’s of varying degrees can be used to obtain the desired information about usual eating habits as related to health behaviors. The Willett FFQ was used for this study was based on the varied food choices of both plant-based and the conventional diet and the foods that people are accustomed to eating in the southeastern region

An FFQ adapted from Harvard’s Willett food frequency questionnaires was used to examine the relationship between plant-based food consumption and prediabetes. The Willett FFQ is a 201-item questionnaire in which food choices are listed as single food items (Harvard, 2007). Research showed validity and reproducibility of the Harvard’s Willett FFQ (Willett, 1998). The validity was examined between the modified Willett and Block (NCI) FFQ’s which resulted in the mean correlation of .60 between the two FFQ’s (Willett, 1998). Both were found to be valid and reproducible because the methods, time of administering the FFQ and the circumstances were different with each FFQ.

The FFQ for this research study included the following sections: demographics, diabetes/prediabetes status, food frequency and physical activity. The FFQ was designed to collect data from the county of residence, Davidson, Hamilton and Rutherford. The FFQ included demographics such as: age, sex, education, marital status, height & weight for BMI, race, income, and number in household. Diabetes status, family history of diabetes, food/diet habits, and physical activity levels data were also collected using the FFQ.

The 35-item dietary-habit section of this food frequency questionnaire was developed by modifying the aforementioned Harvard's Willett FFQ. In this study, many of the food items were grouped together to have a condensed version of the FFQ, in order to minimize the time requirement for completion of the FFQ by participants. The dietary habits section of this questionnaire included portion sizes and pre-determined frequency choices for each food item. The original Willett FFQ was created with 8 to 9 frequency choices for most items, but was modified for this study to have only 7 frequency choices (from 2 times per day to never) for the amount of food usually eaten by participants, as they reflected back over the past year. Approval was granted from Harvard's T.H. Chan School of Public Health Nutrition Department to use the instrument for this study (Appendix C).

The introductory questions related to demographics and awareness of USDA's recommended serving amounts, while the physical activity questions were taken from the Family Life, Activity, Sun, Health, and Eating (FLASHE) parent demographics and parent physical activity surveys (National Cancer Institute, 2017). The FLASHE questionnaire is a survey tool developed by the National Cancer Institute for collecting information about dietary habits of parents with adolescents for cancer prevention programs. Examining the lifestyle of an individual was the major portion of the FLASHE questionnaire which involved the surveying of diet and physical activity behaviors. (National Cancer Institute, 2017).

The diabetes questions in the modified FFQ were adapted from the National Health and Nutrition Examination System (NHANES) 2015-2016 diabetes/prediabetes survey. The NHANES is an annual surveying system designed to assess the health and nutritional status of adults and children in the United States, and is conducted using in-person interviews, physical exams, and clinical lab tests of selected participants in the study. Various datasets compiled from this information are used for health research, and in reports on health status in America (NHANES, 2017).

A1c Kits

To ensure that the A1c results would be available for participants of this study, another step was added to protocol 19-1278 with MTSU's IRB approval under IRB 20-2065. The IRB 20-2065 was approved for study participants to voluntarily perform a self-check A1c test.

The A1cNow self-check A1c kits are Federal Drug Administration (FDA)-approved for home use by individuals, and were provided for each participant who consented to perform the test (PTS Diagnostics, 2019). The A1c kits are annually certified by the National Glycohemoglobin Standardization Program (NGSP) as a reliable test to use for self-check at home (PTS Diagnostics, 2019).

Data Collection

Recruitment and eligibility. The modified FFQ was used in this research study to collect data from participants, ages 21 years and older, both male and female in Davidson, Hamilton, and Rutherford counties who were recruited and enrolled in the study (Appendix D). The recruitment flyer, researcher's and co-researcher's scripts (Appendix E), questionnaire, and consent form were approved by Middle Tennessee State University's Institutional Review Board under IRB protocol 19-1278.

Flyers were created to aid in the recruitment of study participants. The flyer included an overview of the research, the purpose of the study, eligibility for participating in the study, and the risk and benefits of this study (Appendix F). There were no adverse effects expected in the use of the FDA approved self-check A1c kits. However, people were informed that there was a possibility of some temporary redness or tenderness at the finger stick site, for a few participants. Adults were given a flyer for the recruitment and enrollment of study participants. Adults, ages 21 and older, who gave consent were enrolled as participants. Flyers were distributed at health events, churches, and other public places such as laundromats, beauty and barber shops to recruit participants. Contacts were made with faith-based organizations, health event coordinators, churches and other public places to distribute flyers, to schedule recruitment times and for conducting the research.

Data collection steps. At the scheduled time, the researcher set up at the study locations and recruited participants by distributing the flyers, and then those who read it, completed the consent form, and gave consent were enrolled. Upon completion of the consent form, the subject was asked to complete the modified FFQ.

After completion of the FFQ, the study participants were asked to voluntarily use an A1c self-check kit to obtain an A1c reading of their blood glucose levels over the previous 2-3 months. In a situation where an A1c self-check kit use was not feasible such as in some churches, public locations, or online surveys through Qualtrics, only self-reported data without the use of the A1c self-check kit was available and reported on the questionnaire for data analysis. Each participant was given an A1c test, alcohol pad, and band-aid for performing the test, with assistance of the researcher, if needed. The participants were verbally informed that the researcher was available to answer any questions about the FFQ or the A1c instructions. The researcher gave a brief verbal explanation about the testing supplies and provided instructions for the participants to follow. The participant followed the A1c kit instruction sheets for pricking their finger, collecting the blood in the shaker, and applying the blood sample on the test strip in the monitor. The participants were asked to document their A1c results on the FFQ. Participants were also provided an index card to write down their A1c result and were advised to follow-up with their doctor as feasible. The use of the A1c kit was observed by the researcher.

Participants were then given a token gift of appreciation for completing the questionnaire. Participants who completed the questionnaire online received a “thank you” message at the end of the online questionnaire, and were encouraged to send an email to the researcher to receive the appreciation gift packet. All participants who made email requests were sent the token gift through the United States Postal Service.

Security and Confidentiality. Upon completion of the FFQ, the subject returned the questionnaire to the researcher and secured in a locked box alongside the consent forms. For use of the A1c kits, a separate room was provided for the participants or screen petition was used to provide privacy for participants while they completed the A1c test. The tables were covered with plastic covering and wiped down with alcohol and paper towel after each participant. A separate trash can with trash liners was used to dispose of the trash. A biospecimen container was used to dispose of the used testing supplies. All disposed items were removed from the study locations by the researcher and properly disposed.

Online Data Collection

Due to the COVID-19 pandemic and social distancing mandates, the conversion of the study to an online format was approved by MTSU IRB. Qualtrics, an online survey system, was used to collect additional data for this research.

The sub-sections below provide information on the independent, dependent and control variables that were measured.

Independent Variables

The main independent variables measured were the total number of times that grains and whole grains, fruits, vegetables, legumes, and nuts were consumed per day, according to the USDA's Dietary Guidelines for Americans' recommendations. An index was created to categorize these main variables into categories of either "Met" or

“Unmet”. The Harvard food frequency factor scoring list was used to calculate the total number of times plant-based foods were consumed per day by study participants, based on the USDA’s Dietary Guidelines for Americans’ recommendations. A minimum number of servings was set for each food group based on the age category, moderate physical activity, and calorie level to determine if the USDA’s recommendations had been met. The caloric levels for both males and females according to age level categories on the FFQ are presented in Table 4. Some females 60 years old and older may only require 1,600 and some males 60 years old and older may only require 2,000 calories.

Table 4

Recommendations for a calorie level diet pattern by age and calorie level

Food Groups	Men 21-44 Years 2,600 Calories	Women 21-44 Years 2,000 Calories	Men 45-59 Years 2,400 Calories	Women 45-59 Years 2,000 Calories	Men 60 & up Years 2,200 Calories	Women 60 & up Years 1,800 Calories
Whole grains	9.5 oz/eq	6.5 oz/eq	8.5 oz/eq	6.5 oz/eq	7.5 oz/eq	6.5 oz/eq
Vegetables	7	5	6	5	6	5
Fruits	4	4	4	4	4	3
Dairy Alternatives	3	3	3	3	3	3
Protein Sources	4.5 oz/eq.	3.5 oz/eq.	4.0 oz/eq.	3.5 oz/eq.	3.5 oz/eq.	3.0 oz/eq.

Note.

Dependent Variables

The dependent variable was prediabetes which was measured by performing binomial logistics regressions, using self-reported responses from the questionnaire. Participants were asked the following question on the questionnaire for determining prediabetes status: “Have you ever been told by a doctor or other health professional that you have any of the following: prediabetes, impaired fasting glucose, impaired glucose tolerance, or borderline diabetes? If a “Yes” response was given for one or more of the diabetes status items, they were included in the prediabetes count. Results from the A1c self-check home kits that were provided to participants were used to further investigate the diabetes and prediabetes status of participants.

In this study, participants self-reported A1c results from two sources that was included in the analysis. One source was the results of an A1c test performed by a doctor or healthcare professional and the second source was the results from a self-check home kit that was provided to participants. The protocol for using the self-check home kits was discontinued due to COVID-19 pandemic and the social-distancing mandates.

Control variables

The control variables were self-reported age, sex, race, BMI, personal history or family history of diabetes and prediabetes, levels of physical activity based on the CDC’s recommendation, and total servings of meat consumed. Age, sex and race were analyzed using self-reported responses from the FFQ. The reported weight and height for each participant was used to calculate respective Body Mass Index (BMI) as a continuous variable. The formula for calculating BMI is weight (lb.) / [height (in.)]^2 x 703 (CDC, 2017b). Meat consumption was categorized and measured based on the number of times meat was consumed per day, using the food frequency questionnaire choices of responses. Physical activity levels were calculated based on the number of minutes per day or week as self-reported by study participants. Physical activity levels were categorized by minutes as vigorous or moderate and walking in varying time spans (less than 30 minutes per day, 30 to 60 minutes per day, and more than 60 minutes per day).

Statistical Analysis

The statistical analysis required data cleaning after exporting the data file from Qualtrics and data entry with visual re-checking during entry of the in-person hard copy FFQs. The data cleaning involved deletion of some incomplete entries, and recoding necessary variables into continuous or categorical variables and editing variable labels for analysis and hypothesis testing. All in-person FFQ responses were entered in Qualtrics along with the online surveys. The data were pre-coded in Qualtrics for use with the Statistical Package for Social Sciences (SPSS) for analysis. SPSS version 27 was used for analyzing the data, such as running descriptive statistics of the study participants and food intakes along with crosstabs and logistic regressions analysis.

Data Preparation

Even though the initial variables had been pre-coded in Qualtrics, additional coding was necessary for analyzing the data. Upon completion of data collection, whether in-person or through Qualtrics online survey system, the data were cleaned and prepared for analysis. A codebook was produced to provide descriptive information about each variable. (Appendix G). A calculated variable list was also developed to explain how various variables were calculated as part of data analysis. (Appendix H). The food variables were re-coded with the Harvard's food frequency factor for computing the daily amounts consumed of each food. The food frequency factor is used to standardize the frequency to per/day serving amounts. The frequency choices on the FFQ extended to times per month, the per/day amount was needed for analysis. All food items were added together for each food group and recoded into a new variable showing the total servings for each food group.

Height was transformed from feet and inches to total inches for calculating BMI and recoded into a new continuous variable called BMI. BMI was recoded into a categorical variable (BMI_Cat) for showing the BMI categories of underweight, normal, overweight and obese.

Race was also recoded from a single variable name for each race on Qualtrics into a new categorial variable that listed all 6 race choices into one (1) categorical variable for analysis. The new variable included all races that were listed on the questionnaire for participants to designate the race(s) that best describe them. (Appendix H).

Analysis

Descriptive statistics analysis was conducted (means, standard deviations, frequencies) for the plant-based foods consumed by participants along with their demographic characteristics. Descriptive statistics were used to assess consumption knowledge with the following question from the FFQ “how many servings of fruits and vegetables were recommended by USDA’s Choose My Plate?” Assessment of confidence to consume fruits and vegetables from the FFQ was analyzed using descriptive statistics for the statement “I feel confident in my ability to eat fruits and vegetables every day.” Crosstabulations were performed to summarize the association between key categorical variables. Binomial logistic regressions were used to identify the best model for showing the relationship between plant-based food consumption and self-reported prediabetes. Binomial logistic regression is an appropriate statistical method to use for multiple categorical independent variables and one dichotomous dependent variable (Morgan et al., 2011). Percentiles were calculated to observe whether there was a difference in the plant-based food consumption for participants who self-reported prediabetes and those who did not self-report prediabetes.

CHAPTER IV: RESULTS

The purpose of this research study was to examine the association between the consumption of a plant-based diet and self-reported prediabetes among adults in Davidson, Hamilton, and Rutherford counties, Tennessee.

Demographics

Table 5 illustrates the demographic characteristics of the study participants. There were 169 (68.4%) female participants, 77 (31.2%) male participants and 1(0.4%) participant did not provide a response. The age categories for the survey were: 21-34, 35-44, 45-59, and 60 years or older, with the majority of participants being 45 years and older. A total of 239 participants reported their race; the majority of the participants reported their best described race as Black or African American (n = 202 or 81.8%) and White (n = 30 or 12.1%). The calculated BMI based on self-reported weight and height revealed that 101 (40.9%) were obese, 72 (29.1%) were overweight, 45 (18.2%) were normal, and 8 (3.2%) were underweight. The mean average weight was 188 lbs. (*SD* = 55.9).

Diabetes Status

The diabetes status was determined by self-reported responses on the FFQ in response to the following question. The results revealed the diabetes status of 235 participants. Overall, 35 (14%) participants reported diabetes, of which 30 (86%) were females, and 5 (14%) were males. There were 200 (81 %) who self-reported “no diabetes.”

Prediabetes Status

Participants were asked the following question on the questionnaire for determining prediabetes status. Prediabetes was self-reported on the survey. Overall, 50 (20.2%) participant reported prediabetes, of which 37 (74%) were females, and 13 (26%) were males.

A1c Readings

A total of 94 participants self-reported A1c readings, from their doctor or healthcare professional (n = 36) and from the use of the A1c self-check kits that were provided (n = 72). Fourteen (14) participants reported both readings from the doctor or healthcare professional and from the use of the A1c self-check kits as shown in Table 4. The A1c readings were categorized into normal or no diabetes, prediabetes, and diabetes results using levels according to ADA (2020).

Table 5

Descriptive Statistics of the A1c Readings (N=108).

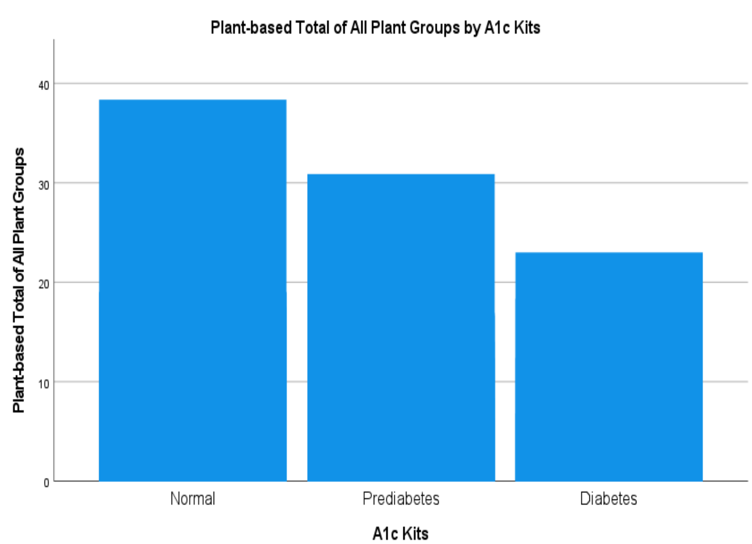
A1c Source	Number	Mean	S. D.	Min.	Max.
A1c Doctor	36	6.4	2.1	3.6	16.0
A1c Self-check Kits	72	5.6	1.2	4.3	12.3
Participants who reported both A1c[a] Doctor + A1c Self-check Kits	14	6.5	1.8	3.6	12.3
All A1c Readings[b]	108	5.85	1.64	3.6	16.0

Note. a = All readings, including 0 for those who did not report.

Participants were asked on the FFQ: “Have you ever had a hemoglobin A1c test (this test shows your averaged glucose level for the last 2-3 months) by a doctor or other health professional?” Response choices were: (a) Yes or No. (b) “If yes, what was your most recent A1c level?” There were 36 participants who self-reported A1c test results from a doctor or health professional. Among the 36 participants, 12 reported no diabetes, 10 reported prediabetes, and 14 reported diabetes. The findings showed that the mean A1c percentage from the doctor as self-reported by study participants was 6.4% (*SD = 2.1).* (Table 4). Of the 72 participants who self-reported A1c results from the use of the A1c self-check kits, 53 reported no diabetes, 10 reported prediabetes, and 9 reported diabetes based on their A1c readings. The mean percentage glucose level from the use of the self-check A1c kits was 5.56% *(SD = 1.2)* as shown in Table 4.

Figure 2

Total Plant-based food consumption of Participants who used the A1c Kits



Family History of Prediabetes and Diabetes

There were 157 (63%) participants who reported a family history of diabetes. There were 55 (26%) who reported a family history of prediabetes.

Physical Activity Levels

The physical activity level categories included minutes of vigorous, moderate and walking activities per day. Answer options for time spent engaged in physical activity included 0-29 minutes, 30-59 minutes, and 60 minutes or more. A total of 232 participants self-reported varying amounts of time spent in physical activity at various intensity levels. Among participants who reported engaging in moderate intensity levels of physical activity, 98 (39.7%) did so for 0-29 minutes, 78 (31.6%) did so for 30-59 minutes, and 50 (20.2%) did so for 60 minutes or more minutes per day, all of which are illustrated in Table 6.

There were also 102 (41.3%) participants who reported engaging in vigorous intensity level of exercise for 0-29 minutes, 73 (29.6%) with 30-59 minutes, and 57 (23.1%) with 60 or more minutes (not shown). Among participants who reported walking as a form of exercise, 114 (14.2 %) walked for 0-29 minutes, 75 (30.4%) walked for 30-59 minutes, and 38 (15.4 %) walked for 60 minutes or more per day (not shown). The U.S.D.A.'s Dietary Guidelines for Americans recommends 30 minutes of physical activity per day or 150 minutes of moderate exercise per week (USDA, 2020). The calculations for this study were based on moderate physical activity.

Table 6

Descriptive *Statistics of Study Participants*

	Frequency	Percent
Sex		
Male	77	31.2
Female	169	68.4
Age		
21-34 years	46	18.6
35-44 years	47	19
45-59 years	77	31.2
60 years and up	76	30.8
Race		
American Indian or Alaska Native	1	0.4
Asian	2	0.8
Black or African American	202	81.8
White	30	12.1
Hispanic	3	1.2
Other	4	1.6
Education		
Less than a H.S. degree	4	1.6
H.S. degree or GED	31	12.6
Some college but not college degree	81	32.8
B.S. degree or higher	127	51.4
Diabetes Status		
Type 1	2	0.8
Type 2	29	11.7
Gestational Diabetes	4	1.6
Prediabetes Status	50	20.2
Family History of Diabetes	55	0.0
Family History of Prediabetes	0	0.0
Physical Activity Level (30-59 mins.)		
Vigorous	73	29.6
Moderate	78	31.6
Walking	75	30.4
BMI		
Normal	45	18.2
Underweight	8	3.2
Overweight	72	29.1
Obese	101	40.9

Table 6 ***(cont'd.)***

Descriptive Statistics of Study Participants

	M	*SD*
BMI	29.9	7.9
Weight (lbs.)	188.9	55.9
Height (inches)	67	3.8

Note. a. M = mean, SD = standard deviation, BMI = body mass index.

b. α = .05.

Descriptive Statistics of Food Consumption

A descriptive statistical analysis of participants and food consumption is shown in Table 7. The mean consumption in all food groups were below the recommended number of servings for many of the participants based on their caloric requirement. However, the fruits *M = 3.55 (2.36)* and vegetables *M = 3.53 (2.58)* groups were the highest in consumption.

Table 7

Descriptive Statistics of All Food Consumption (N=247)

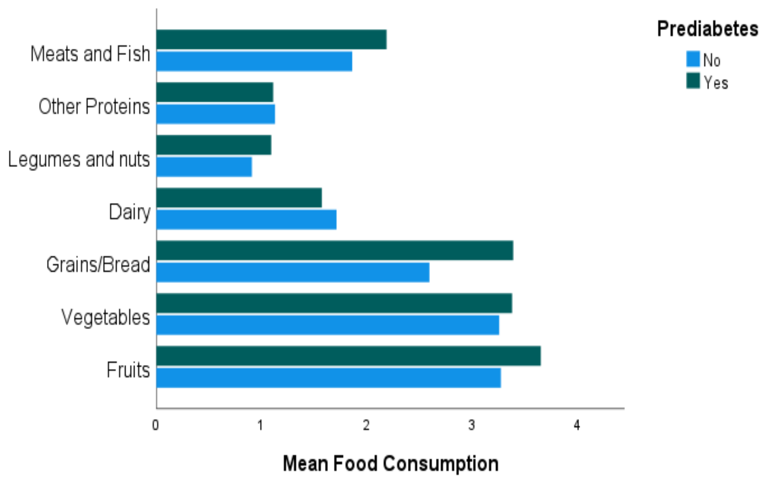
	N	*M*	*SD*
Fruits	203	3.55	2.36
Vegetables	208	3.53	2.58
Grains/Bread	194	3.18	2.90
Dairy/Dairy Alternatives	212	1.75	1.56
Legumes and Nuts	227	1.06	1.00
Meats & fish	218	2.02	1.75
Other protein	226	1.24	1.08

Note. N = number, M = mean, SD = standard deviation.

Participants who reported prediabetes consumed more servings of fruits and vegetables than those who reported “No prediabetes” as illustrated Figure 3.

Figure 3

Food Consumption by All Participants with and without Prediabetes



Note. a. CI = confidence Intervals. b. 95% Cis [1.70, 2.20], [.98, 1.27], [.81, 1.11], [1.46, 1.88], [2.44, 3.68], [2.91, 3.68] and [3.03, 3.72], respectively as shown.

Multiple Binomial Logistic Regression Analysis

Binomial Logistic regression was performed for this research to examine the independent variables, control variables, and dependent variables to investigate the relationship between a plant-based diet and self-reported prediabetes. Each sub-section will show the related table based on the analysis.

Binomial Logistic Regression of Total Servings of All Food Groups and Prediabetes

A binomial logistic regression analysis was conducted using the totals from each food group to examine the relationship between the consumption of various plant-based foods such as: whole grains and bread, vegetables, fruits, other proteins, legumes, nuts and seeds and the likelihood of reporting prediabetes (Table 8). The results showed that the Grains and Bread group, $p = .01$, OR = 1.3; 95% CI [1.04, 1.62] and the Dairy/Dairy Alternative group, $p = .04$, OR = .6; 95% CI [.443, .998] were statistically significant in predicting the likelihood of reporting prediabetes, when controlling for the Meat and Fish group. More specifically, increases in Grains and Bread consumption by 1 ounce-equivalent increased the likelihood of reporting prediabetes by a factor of 1.3, whereas increases in Dairy or Dairy Alternatives consumption by 1 cup or 1 ounce of cheese decreased the likelihood of reporting prediabetes by a factor of .6.

Table 8

Logistic Regression of Total Servings of All Food Groups and Prediabetes

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Fruits	.086	.115	.559	1	.455	1.090	.870	1.366
Vegetables	-.180	.115	2.439	1	.118	.835	.666	1.047
Grains/Bread *	.266	.113	5.530	1	.019	1.305	1.045	1.629
Dairy/Dairy Alternatives *	-.409	.207	3.884	1	.049	.664	.443	.998
Legumes and Nuts	.459	.256	3.220	1	.073	1.583	.958	2.614
Meats and fish	.252	.148	2.910	1	.088	1.287	.963	1.720
Other Proteins	-.355	.285	1.549	1	.213	.701	.401	1.226
Constant	-1.350	.409	10.885	1	.001	.259		

Note. a. α = .05. b. * denotes statistically significant.

Binomial Logistic Regression Participants' Characteristics and All Food Group Total Servings

Binomial Logistic regression was conducted to examine the relationship between the control variables and independent variables (total servings of food groups), and the likelihood of self-reporting prediabetes, which is illustrated in Table 9. Age showed statistical significance for predicting self-reported prediabetes, $p = .009$, OR = 1.9; 95% CI [1.19, 3.36], and BMI, $p = .003$, OR = 1.1; 95% CI [1.04, 1.19] was also found to be statistically significant in predicting the likelihood of self-reporting prediabetes. This indicated that for every 1-year increase in age, the likelihood of self-reporting prediabetes increased by a factor of 1.9. The results also indicated that as BMI increased by 1.0 kg/m2, the likelihood of reporting prediabetes increased by 1.1.

Table 9

Logistic Regression for Participant Characteristics and Total Servings of All Food Groups

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Age *	.692	.266	6.758	1	.009	1.997	1.186	3.365
Sex	.862	.650	1.755	1	.185	2.367	.662	8.470
Race	-.625	.457	1.869	1	.172	.536	.219	1.311
BMI *	.105	.036	8.607	1	.003	1.111	1.036	1.192
Moderate P.A.	-.096	.354	.074	1	.786	.908	.454	1.817
FHD	.926	.604	2.351	1	.125	2.525	.773	8.252
FHP	.981	.576	2.903	1	.088	2.668	.863	8.251
Fruits	.054	.162	.109	1	.741	1.055	.768	1.449
Vegetables	-.348	.185	3.518	1	.061	.706	.491	1.016
Grains/Bread	.275	.181	2.311	1	.128	1.316	.924	1.875
Dairy/Dairy Alternatives	-.035	.301	.014	1	.907	.965	.535	1.742
Legumes and Nuts	.464	.346	1.796	1	.180	1.591	.807	3.137
Meats and fish	.174	.219	.627	1	.429	1.190	.774	1.828
Other Protein	-.537	.388	1.917	1	.166	.585	.273	1.250
Constant	-5.186	2.184	5.640	1	.018	.006		

Note. a. Total foods consumed with all independent and control variables. b. Moderate P.A.= Moderate physical activity. c. Moderate P.A = 30-59 minutes. c. α = .05. d. * denotes statistically significant.

Binomial Logistic Regression of Prediabetes by All Food Group Servings with Meats and Fish

Binomial Logistic regression analysis was conducted in the next model to control for the consumption of meats and fish in the analysis using the USDA's DGA recommendations. As shown in Table 10, age, $p = .01$, OR = 1.7; 95% CI [1.13, 2.68] and BMI, $p = .004$, OR = 1.0; CI [1.03, 1.15] each showed statistical significance in predicting an increased likelihood of self-reporting prediabetes. This indicated that for every 1-year increase in age, the likelihood of self-reporting prediabetes increased by a factor of 1.7. The results also indicated that as BMI increased by 1.0 kg/m2, the likelihood of reporting prediabetes increased by 1.0.

Table 10

Logistic Regression of Prediabetes by Total Food Group Servings with Meats and Fish

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Fruits	.071	.132	.289	1	.591	1.073	.829	1.390
Vegetables	-.196	.140	1.959	1	.162	.822	.624	1.082
Grains/Bread	.243	.143	2.870	1	.090	1.275	.963	1.688
Dairy/Dairy Alternatives	-.325	.240	1.834	1	.176	.722	.451	1.157
Legume and Nuts	.580	.296	3.844	1	.050	1.786	1.000	3.188
Other Protein	-.411	.316	1.695	1	.193	.663	.357	1.231
Meats and fish	.143	.166	.736	1	.391	1.153	.833	1.598
Age *	.553	.221	6.244	1	.012	1.738	1.127	2.681
BMI *	.085	.029	8.525	1	.004	1.089	1.028	1.153
Constant	-4.903	1.116	19.308	1	.000	.007		

Note. a. This model includes Meats and Fish group in the analysis. b.* denotes statistically significant.

Binomial Logistic Regression of Prediabetes by Food Group Servings with Age and BMI

Binomial Logistic regression analysis was conducted to assess the relationship between USDA's DGA and the likelihood of reporting prediabetes, when adjusting for Age and BMI. Table 11 shows the results for those who consumed a plant-based diet, which excludes items from the Meats and Fish group. As shown in Table 11, both age and BMI were statistically significant in predicting the likelihood of reporting prediabetes (p = .007, p = .002, respectively). Age was OR = 1.8; 95% CI [1.17, 2.77] and

BMI was OR = 1.0; 95% CI [1.04, 1.16]. These results indicated that an increase in age by 1-year increased the likelihood of self-reporting prediabetes increased by a factor of 1.8. As BMI increase by 1.0 kg/m2, the likelihood of reporting prediabetes increased by 1.

Table 11

Logistic Regression of Prediabetes and Total Food Group Servings without Meats and Fish

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Fruits	.049	.127	.149	1	.700	1.050	.818	1.348
Vegetables	-.159	.130	1.495	1	.221	.853	.662	1.100
Grains/Bread	.257	.143	3.221	1	.073	1.293	.977	1.711
Dairy/Dairy Alternatives	-.318	.237	1.793	1	.181	.728	.457	1.159
Legumes and Nuts	.550	.293	3.533	1	.060	1.734	.977	3.078
Other Protein	-.355	.311	1.300	1	.254	.701	.381	1.290
Age *	.592	.218	7.386	1	.007	1.808	1.179	2.770
BMI *	.092	.029	9.957	1	.002	1.097	1.036	1.161
Constant	-5.065	1.132	20.019	1	.000	.006		

Note. a. Meats and Fish Group is excluded in the analysis. b. α = .05. c. * denotes statistically significant.

There is a difference in the calorie requirements of males and females within the same age group and activity level. In this study, calculations were performed using the lower calorie levels for each age group range listed for moderate physical activity. Table 12 shows the females who met the recommendation of plant-based foods based on 1,800 to 2,000 calories which are the levels for most females ages 21-59 years (USDA, 2020).

Table 12

Number of Females Who Met the Recommended Servings by Age and Calorie Levels

	21-34 years[a]		35-44 years[a]		45-59 years[a]		60 years & up[b]		
Food Groups	Not Met	Met	Not Met	Met	Not Met	Met	Not Met	Met	Total
Grains/Bread	18	8	26	6	38	15	37	20	168
Vegetables	11	15	24	8	35	18	37	20	168
Fruits	12	14	22	10	26	27	17	40	168
Dairy/Dairy Alternatives	19	7	25	7	45	8	38	19	168
Protein Sources	20	6	24	8	41	12	36	21	168

Note. a. Based on 2,000 calories. b. Based on 1,800 calories. c. *N = 168.*

Male participants who met the recommendation of plant-based foods based on calorie levels from 2,400 to 2,800 are shown in Table 14. A minimum number of servings was set for each food group based on the age category, moderate physical, and calorie level to determine if the USDA’s recommendations had been met.

Table 13

Number of Males who Met the Recommended Servings by Age and Calorie Levels

	21-34 years[a]		35-44 years[a]		45-59 years[a]		60 years & up [b]		
Food Groups	Not Met	Met	Not Met	Met	Not Met	Met	Not Met	Met	Total
Grains/bread	18	2	13	2	14	9	14	5	77
Vegetables	16	4	14	1	17	6	12	7	77
Fruits	12	8	9	6	13	10	9	10	77
Dairy/Dairy Alternatives	14	6	12	3	14	9	13	6	77
Protein Sources	16	4	14	1	18	5	15	4	77

Note. a. Based on 2,600 calories. b. Based on 2,400 calories. c. *N = 77.*

To assess consumption knowledge, participants were asked in the FFQ if they knew "how many servings of fruits and vegetables were recommended by USDA's Choose My Plate". The results showed that many did not know how many total servings of fruits and vegetables were recommended per day by the USDA's Choose My Plate. Assessment of confidence in consuming fruits and vegetables was gauged by responses to the statement, "I feel confident in my ability to eat fruits and vegetables every day." Results show that 142 (57.5%) and 59 (23.9 %) participants strongly agreed and somewhat agreed, respectively, with the statement.

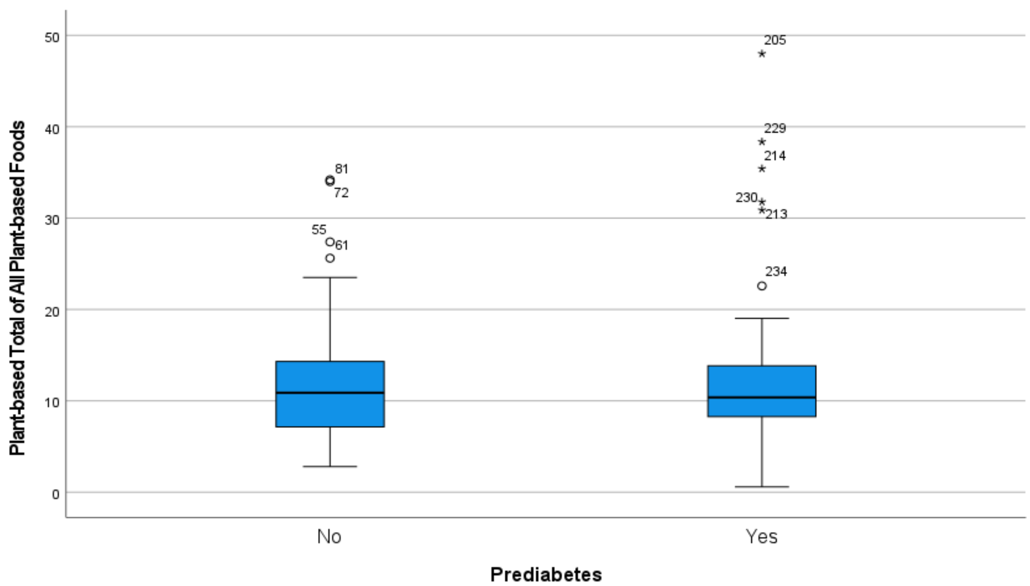
Figure 4 shows the percentile range of participants who met the daily recommended number of plant-based food servings and self-reported prediabetes or diabetes. The mean intake of the total plant-based foods without dairy, meat and fish was 11.84 (SD = 7.13) servings for participants who self-reported "no prediabetes" (*N =162).* Several people did consume high amounts of plant foods as shown in Figure 4.

There were participants who were vegetarian or vegan which may account for the outliers; therefore, the outliers were included in the analysis. Higher servings of plant foods are expected for those who are consuming a plant-based diet.

Percentile Ranking for Plant-Based Foods and Self-Reported Prediabetes

Figure 4

Percentiles of Participant's Plant-Based Food Consumption and Prediabetes Status



Note. a. CI = confidence Intervals. b. 95% CI [10.73, 12.95], b. α= .05.

Results Summary

The results of this study showed that the Grains and Bread group, $p = .02$, OR = 1.3, 95% CI [1.05, 1.63] and the Dairy group, $p = .05$, OR = .66, 95% CI [.443, 998] significantly predicted the likelihood of reporting prediabetes, when controlling for the Meats and Fish group. The results indicated that an increase in the consumption of Grains and Bread by 1 ounce-equivalent increased the likelihood of reporting prediabetes by a factor of 1.3. It also indicates that increases in the consumption of Dairy by 1 cup decreased the likelihood of self-reporting prediabetes. Additionally, based on a logistic regression analysis of all food groups and prediabetes when adjusting for all control variables, age and BMI showed statistical significance for increased likelihood of self-reported prediabetes. When investigating the relationship between plant-based foods and the likelihood of self-reporting prediabetes and adjusting for age and BMI. The results showed that age and BMI, significantly predicted an increased likelihood of self-reporting prediabetes ($p = .007$, $p = .002$, respectively).

CHAPTER V: DISCUSSION

The purpose of this research study was to examine the relationship between the consumption of a plant-based diet and the self-reported prediabetes status of adults in Davidson, Hamilton, and Rutherford counties in Tennessee. Specifically, we tested the hypothesis that, when controlling for demographic and lifestyle factors, those who consume whole grains, fruits, vegetables, dairy alternatives, legumes and nuts according to USDA's Dietary Guidelines for Americans (DGA) recommended number of times per day are less likely to self-report having prediabetes than those who do not consume the recommended amount. The results generally supported this hypothesis with some caveats. The results showed that the BMI of 173 participants out of 247 were in overweight or obese categories.

Diabesity is having obesity and diabetes concurrently (Astrup & Finer, 2000). The three-county locations of this research are in the Diabetes Belt. Counties in the Southeastern region of the United States that have a diabetes prevalence rate of 11% or higher with the aforesaid region are documented to be in the Diabetes Belt (Myers, 2017). The results of this study also found BMI as being positively associated with likelihood of self-reporting prediabetes, and therefore support the construct of diabesity and of making weight management a target of intervention concurrently with, or as a proxy for, intervention for prediabetes. BMI is a modifiable factor for preventing prediabetes and diet has been shown to be effective for lowering body weight (Wilson, 2017).

This study revealed that most of the participants did not consume adequate number of servings from the various food groups to meet the recommended Dietary Guidelines for Americans (DGA) for a plant-based diet. Calorie requirements are different according to the age and activity level of the study participants. Many of the participants in the two older age groups of 45-59 and 60 years and up consumed the same number of servings and calories as these two younger age groups of 21-44 and 35-44 years old. Physiologically, consuming the same high level of calories as one ages and reduced physical activity will lead to weight gain. Excessive weight gain will lead to BMI in overweight and obesity categories, and BMI was significantly associated with participants' likelihood of self-reporting prediabetes in this study. Therefore, a dietary intervention that focuses on reduced caloric intake adjusted for age and physical activity level appears supported by this study's findings. As reviewed earlier in this manuscript, the plant-based diet can offer a lower caloric intake with simultaneously providing other nutritious benefits.

Many individuals are not consuming adequate amounts of fruits and vegetables. According to DGA 2020-2025, adults ages 31-59 years consume more than the recommended number of servings from the Grain/bread group but not enough whole grains (USDA, 2020). This age group is also consuming more than the recommended number of servings from the meat and fish group (USDA, 2020). Adults in this age range are also not consuming the recommended number of servings from the fruits, vegetables, dairy, legumes and nuts groups according to the DGA recommendations. One interesting finding in this study was the discrepancy between participants' self-report of feeling knowledgeable about the USDA recommendations and their self-reported food intake. This underscores that perceived knowledge does not inherently lead to behavior change. The HBM focuses on individual behaviors and complements SCT while helping to understand individual reasons or desires for behavior change (Glanz et al., 2008). It has to start with the individual and their desire for change. Perceived benefits and barriers guide a person in the decision-making processes for changing unhealthy to healthy behaviors. Perceived susceptibility and severity can also be cues to action for prevention (Glanz et al., 2008). SCT deals with the interpersonal resources connecting the individual with the community and community resources after the cue to action so that they may reach their desired goals for self-efficacy in healthy behaviors (Glanz et al., 2008).

The SCT can aid in understanding the decision-making process for adopting a healthful plant-based diet versus an unhealthful plant-based diet pattern as well as designing prevention program. Individual and community health initiatives that encourage the intake of more plant-based foods would be a preventative approach to lower the rates of obesity and prediabetes, especially age groups of 21-34 and 35-44 years old. Environmental determinants of family and community efficacy based on community resources along with food choices are vitally necessary for weight management and prediabetes prevention.

Support from others to help in goal-attainment can be helpful, especially of those who share the same goals. Factors such as transportation and accessibility to food resources (Noerper, 2019) can sometimes be a barrier for families and individuals which limits their food supply. They reach out to each other in many other ways. For example, in this study, the in-person participants seem to be comfortable within the casual and relaxed setting for the completing the FFQ and using the A1c kits. They were in environments that they were accustomed to and people that they knew which provided social support for them.

Another pertinent finding in this study revealed that consumption of food from the Grains and Bread group increased the chances for self-reported prediabetes. Caution may be warranted to avoid overconsumption of unhealthful foods from the Grains and Bread food group. Although, whole grains and fiber are beneficial for preventing adverse health conditions such as obesity and Type 2 diabetes (Zhang et.al., 2018). Many of the foods from the Grains and Bread group are enriched or more processed rather than containing whole grains and foods in the natural form. It is recommended that 50% of the foods from the Grains and bread group be whole grains (USDA, 2020). When performing a logistic regression with all the food groups and prediabetes, those who consumed more grains and bread were more likely to self-report prediabetes. This study showed that in general, participants consumed more servings of white bread and other refined grain foods and dairy.

Results of this study showed that Dairy and Dairy alternative foods decrease the likelihood of self-reporting prediabetes. Dairy alternatives are readily available for those who wish to replace dairy in their diets. Wolf et al., (2020) revealed that about 62% of the households in America consume dairy products and approximately 38% consume dairy alternatives. But when dairy alternatives are not available, some of the dairy alternative households will substitute dairy (Wolf et al., 2020). Research shows that calcium, vitamin D, protein and other nutrients found in dairy are also available in plant sources (Trapp & Levin, 2012).

This study showed that many of the participants were not consuming the recommended servings of fruits and vegetables which is consistent with a previous study that showed inadequate consumption of fruits and vegetables (Simmons & Weatherby, 2018). The latter study used data from the 2011-2012 National Health and Nutrition Examination (NHANES). The study included 3,432 total participants, of which 25% of the total participants had prediabetes, and 10% had diabetes. Analysis of the data indicates that 25% of participants who did not eat fruits or vegetables had prediabetes (Simmons & Weatherby, 2018).

Fruits and vegetables are essential components of a plant-based diet. A plant-based diet promotes glycemic control and weight management in people who are likely to report prediabetes (Li et al., 2016). The natural sugars in a plant-based diet can better be metabolized than high-sugared processed foods. Fruits can serve as an alternative to eating high sugar beverages, candies and desserts because fruits do contain natural sugars that the body is better able to process. Fruits and vegetables can provide more volume for feeling full and for satiety.

However, overeating fruits, especially dried fruits should be avoided in order to maintain healthy glucose levels. The glycemic index can be a very useful strategy for selecting lower GI foods that will keep the glucose at a lower level (Brand-Miller, Foster-Powell & Sandall (2005). Based on the research literature, people who have impaired glucose tolerance are more at risk of having complications such as vision problems, nephropathy, and neuropathy than those who have impaired fasting glucose (Wagner et al., 2013; Tabak et al., 2012). The postprandial time after meals is so important and an opportune time for controlling glucose levels; especially for those with IGT. Postprandial is the time immediately after meals. Avoiding a quick elevation of the glucose level, especially during 1–2-hour postprandial times, can be helpful to people with insulin resistance for managing blood glucose levels. This can be accomplished for many people by adopting a plant-based eating pattern, using the GI, and having the support of others. Observational learning through awareness and education of how to use the GI to select healthful and lower GI foods may aid in preventing glucose spikes, especially during snack time or during stressful times.

The eating habits observed in this study suggest the need for greater knowledge about plant-based diets coupled with an increase in self-efficacy concerning the selection, preparation, and consumption of more healthy plant-based foods. Participants were asked on the FFQ about their confidence to consume fruits and vegetables. The results showed that most of the participants strongly agreed or somewhat agreed that they were confident in their ability to eat fruits and vegetables every day. However, many did not know how many total servings of fruits and vegetables were recommended per day by the USDA. Observational learning through awareness and education on the recommended number of servings of fruits and vegetables for a plant-based diet may encourage increased consumption fruits and vegetables along with other plant-based food choices. Psychological determinants such as self-evaluation and rewarding goal-attainment, even gradual changes, can lead to glucose control and weight loss. In this study, it showed that people with prediabetes consumed more fruits and vegetables. It is possible that participants who consumed more fruits and vegetables already have prediabetes status or overweight and have been told by doctor that they are at-risk of diabetes according to the FFQ responses in this study. There were 94 (38%) of the participants in the study who self-reported that they had been told by their doctor that they have risk factors for diabetes. This results also related to perceived susceptibility and perceived severity as a cue to action.

The HBM include perceived susceptibility of an event occurring and perceived severity (Glanz et al., 2008). The risk for diabetes may have been motivation for them to eat more fruits and vegetables based on perceived susceptibility of diabetes, especially for those with a family history of prediabetes or diabetes. The perceived susceptibility and perceived severity may also be reflected in the participants' results of A1c test and fasting plasma glucose. The cue to action may be initiated by the awareness of above-normal blood glucose levels along with self-regulation and self-evaluation toward changed behavior for preventing prediabetes.

In general, this research showed that participants were not consuming enough plant-based foods. Self-regulation can be evident in the food choices based on self-control and will power to choose healthful eating such as consumption of a plant-based diet. Self-evaluation of the expected outcomes for change is important for progressive steps to change. For example, in this study self-evaluation with A1c kits and reflection of food habits could have motivated participants to set goals for the process of changes they wish to make for optimum health.

Implications of Research Findings

With the present statistics from the CDC (2019a) indicating obesity is a primary risk factor for type 2 diabetes, there is a need for preventive strategies to lower the percentage of persons who are overweight or have obesity. The CDC (2019a) reported that 72% of the adult population in America are overweight or obese, a number which has almost doubled since the year 2000. Many already have a condition called "diabesity" which is obesity and diabetes occurring simultaneously (Astrup & Finer, 2000). Thibault et al., (2016) included being overweight among the personal health risk factors that increased the chances of developing type 2 diabetes. Individuals with a family history of diabetes and those who wish to manage their weight for preventing prediabetes or diabetes should receive nutritional information and strategies to help them have healthy lifestyles. Trapp and Levin (2012) suggested that doctors should be aware of the plant-based diet benefits, explain it to patients, and encourage change.

Additionally, other key strategies for awareness and social support to change are to utilize:

1. Handheld technology (Eunseok et al., 2014) and applications (APPs) such as the Choose My Plate APP (USDA, n.d./c) for adults to remind them of the recommended number of servings to meet USDA's recommendations according to their ages and calories levels.
2. Local community engagement programs (Brunton et al., 2017) that promote consumption of fruits and vegetables (Carter, 2008) or community initiatives to sustain optimal health (Kennedy et al., 2014).

3. Online support groups so that others with like-concerns may share their thoughts and problem-solving techniques, and even applaud each other for accomplishing their healthy lifestyle goals to prevent prediabetes.
4. Increased prediabetes awareness events and media coverage in local communities.
5. Partnerships for collaborating with physicians and healthcare professionals to connect with their e-health programs and patient portals to provide personal prediabetes awareness/prevention messages or flyers their patients.

Limitations

There were a few limitations in this research study. Firstly, this was a cross-sectional study with self-reported data that was reliant on recall responses from the study participants. Future research could examine prospective logs for more accurate data.

Secondly, specification for whole grain options were limited in the FFQ. The researcher was unable to address the hypothesis of whole grains due to these limitations of the data. Future research might provide a selection option on the FFQ to designate whether all the grains and cereal food items are whole grains or not for improved accuracy. Also, in most of analysis of this study, dairy and dairy alternatives were combined together as a group. Future research could include dairy alternatives only in the analysis.

Thirdly, causality could not be inferred in this study. While a correlation may lead to important information about developing prevention and interventions, the results from this study cannot support a causal relationship.

Fourthly, the results of the self-check A1c showed the levels at the time of the test and may not be definitive for a diabetes diagnosis. Health conditions such as iron deficiency anemia or other conditions may affect the results and therefore must be followed up with other tests to confirm diabetes status or diagnosis (Sacks, 2013). In addition, due to the COVID-19 pandemic and the social-distancing mandates, face-to-face contact for using the A1c self-check kits was discontinued. Therefore, data was limited for use of the A1c Kits. Lastly, most of the participants who reported having received a fasting plasma glucose or A1c Test by a doctor or health care professional, did not give the requested value on the survey.

Future research in this area, with additional funding, could utilize more definitive testing or medical confirmation of diagnoses. This study population includes participants from 3 counties in Tennessee, and therefore the results cannot be generalized to all people in the Diabetes Belt nor the entire population. Future research could replicate this study in additional counties, states, and regions.

Future Research

Future research might include more survey questions to investigate whether study participants identify their diet pattern as plant-based (vegan, vegetarian, etc.), omnivore (consume both meats and fish and plant-foods), or other-write-in. Future research could include more questions on the FFQ or complement the FFQ with other investigative tools for gathering information about their decisions for choosing a plant-based diet that are specific to the study participants, especially the perceived benefits and barriers to consuming plant-based foods (ex. an attitudinal scale). Additional questions may have revealed more reasoning about the unmet recommendations of certain food groups. FFQs are appropriate for screening dietary habits (Stark, 2002; Willett, 1998), but adding a food diary would help participants better recall food intake and the frequencies, especially if it is a lengthy period to recall (De Keyzer et al., 2011). Also, the aid of an Interviewer to assist participants in providing more accurate information would be helpful.

Conclusion

In conclusion, this research entailed an investigation of diet habits and prediabetes status to examine if there was a relationship between a plant-based diet and self-reported prediabetes. Based on the results of this study which showed that BMI is a statistically significant predictor of prediabetes, focus should be on this modifiable factor through promotion of a healthy weight. There is a need to promote the eating of healthful plant-based foods, especially fruits and vegetables for the functional health benefits. A plant-based diet has been shown to be a beneficial nutritional strategy for losing weight and maintaining healthy body weights (Satija et al., 2019) as well as being a part of healthy best practices for glycemic control (Esposito & Guigliano, 2014). Healthy best practices that promote glycemic control may also help lower the risk for prediabetes and Type 2 diabetes (Esposito & Guigliano, 2014). The goal should be best practices for a healthy diet and lifestyle throughout life before disease occurs.

The results of this study could aid in initiating progressive goals for planning and implementing prediabetes prevention programs that complement other healthy community programs to help lower the diabetes prevalence rate in the Diabetes Belt. Beginning with Davidson, Hamilton, and Rutherford Counties in Tennessee, this research can serve as dissemination of needs assessment for addressing prediabetes prevention.

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APPENDICES

Appendix A: IRB Approval Letters

Appendix B: Informed Consent

Appendix C: Email granting permission to use the Harvard Willett's FFQ

Appendix D: Food Frequency Questionnaire

Appendix E: Researcher's script

Appendix F: Flyers

Appendix G: Codebook

Appendix H: Calculated Variables

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APPENDIX A: IRB APPROVAL LETTERS

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN007 – EXEMPTION DETERMINATION NOTICE

Friday, July 26, 2019

Principal Investigator	**Dorothy E. Simmons** (Student)
Faculty Advisor	Andrew Owusu
Co-Investigators	Chris Simmons*
Investigator Email(s)	*des3a@mtmail.mtsu.edu; andew.owusu@mtsu.edu; chris.simmons@lipscomb.edu*
Department	Human Performance and *Lipscomb University
Protocol Title	***The effects of a plant-based on prediabetes***
Protocol ID	**19-1278**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category *(2) Educational Tests* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	**EXEMPT from furhter IRB review*** **	Date	**7/26/19**
Date of Expiration	NOT APPLICABLE		
Sample Size	300 (THREE HUNDRED)		
Participant Pool	**Healthy adults (18 or older)**		
Exceptions	NONE		
Mandatory Restrictions	1. Participants must be 18 years or older 2. Informed consent must be obtained from the participants 3. Identifying information must not be collected		
Restrictions	**1. All restrictions for exemption apply. 2. Mandatory informed consent with age-verification. 3. Direct in person interaction; NOT approved for online data collection**		
Approved IRB Templates	1. In person Informed consent; 2. Recruitment Flyer.		
Funding	NONE		
Comments	NONE		

***This exemption determination only allows above defined protocol from further IRB review such as continuing review. However, the following post-approval requirements still apply:

- Addition/removal of subject population should not be implemented without IRB approval
- Change in investigators must be notified and approved
- Modifications to procedures must be clearly articulated in an addendum request and the proposed changes must not be incorporated without an approval
- Be advised that the proposed change must comply within the requirements for exemption
- Changes to the research location must be approved – appropriate permission letter(s) from external institutions must accompany the addendum request form

- Changes to funding source must be notified via email (irb_submissions@mtsu.edu)
- The exemption does not expire as long as the protocol is in good standing
- Project completion must be reported via email (irb_submissions@mtsu.edu)
- Research-related injuries to the participants and other events must be reported within 48 hours of such events to compliance@mtsu.edu

Post-approval Protocol Amendments:

The current MTSU IRB policies allow the investigators to make the following types of changes to this protocol without the need to report to the Office of Compliance, as long as the proposed changes do not result in the cancellation of the protocols eligibility for exemption:

- Editorial and minor administrative revisions to the consent form or other study documents
- Increasing/decreasing the participant size

Only THREE procedural amendment requests will be entertained per year. This amendment restriction does not apply to minor changes such as language usage and addition/removal of research personnel.

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

The investigator(s) indicated in this notification should read and abide by all applicable post-approval conditions imposed with this approval. Refer to the post-approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident.

All of the research-related records, which include signed consent forms, current & past investigator information, training certificates, survey instruments and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the sacure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

Click here for a detailed list of the post-approval responsibilities.
More information on exmpt procedures can be found here.

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Wednesday, November 27, 2019

Principal Investigator	**Dorothy E. Simmons** (Student)
Faculty Advisor	Andrew Owusu
Co-Investigators	Chris Simmons*
Investigator Email(s)	*des3a@mtmail.mtsu.edu; andrew.owusu@mtsu.edu; chris.simmons@lipscomb.edu*
Department	Health and Human Performance and *Lipscomb University
Protocol Title	***The effects of a plant-based on prediabetes***
Protocol ID	**20-2065**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(2) Collection of blood samples*. A summary of the IRB action and other particulars in regard to this protocol application is tabulated below:

IRB Action	**APPROVED for ONE YEAR**		
Date of Expiration	**12/31/2020**	Date of Approval	11/27/19
Sample Size	300 (THREE HUNDRED)		
Participant Pool	Target Population 1: Primary Classification: **General Adults (18 or older)** Specific Classification: **NONE** Target Population 2: Primary Classification: **NONE** Specific Classification: **NONE**		
Exceptions	1. Survey conducted in accordance to IRB19-1278. 2. Angela Bowman is permitted to access research data. 3. Signature requirement is waived for the informed consent. 4. Participant compensation packet with no cash value is permitted.		
Restrictions	**1. Mandatory ACTIVE adult informed consent.** **2. Direct interaction only; NOT approved for online data collection.** **3. Not approved to collect identifiable information, such as, audio/video data, photographs, handwriting samples, financial information, personal address, driving records, social security number, and etc.** **4. Mandatory final report (refer last page).**		
Approved Templates	MTSU templates: signature informed consent (signature waiver) and recruitment flyer. Non-MTSU template: Recruitment scriptl		
Comments	NONE		

Post-approval Actions

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions (https://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php) imposed with this approval. Any unanticipated harms to participants, adverse events or compliance breach must be reported to the Office of Compliance by calling 615-494-8918 within 48 hours of the incident. All amendments to this protocol, including adding/removing researchers, must be approved by the IRB before they can be implemented.

Continuing Review **(The PI has requested early termination)**

Although this protocol can be continued for up to THREE years, **The PI has opted to end the study by 12/31/2020 The PI must close-out this protocol by submitting a final report before 12/31/2020 Failure to close-out may result in penalties including cancellation of the data collected using this protocol.**

Post-approval Protocol Amendments:

Only two procedural amendment requests will be entertained per year. *In addition, the researchers can request amendments during continuing review. This amendment restriction does not apply to minor changes such as language usage and addition/removal of research personnel. .*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Other Post-approval Actions:

Date	IRB Action(s)	IRB Comments
NONE	NONE.	NONE

Mandatory Data Storage Requirement: All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. TN State data retention requirement may apply. The PI must consult with MTSU Office of Data Management. Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects.

The MTSU IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Expedited Procedures: https://mtsu.edu/irb/ExpeditedProcedures.php

APPENDIX B: INFORMED CONSENT FORM

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance, 010A
Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBF016: INFORMED CONSENT

(Use this consent template when recruiting adult participants not considered as "vulnerable")

A. INFORMATION AND DISCLOSURE SECTION
(Participant Copy)

Primary Investigator(s)	Dorothy E. Simmons		**Student** ☒
Contact information	MTSU Office (If applicable), Telephone and Email ID		
Department Institution	Human Performance		
Faculty Advisor Study	Dr. Andrew Owusu	Department	Human Performance
Title	The Effects of a plant-based diet on prediabetes		
IRB ID	**20-2065**	**Expiration: 12/31/2020**	**Approval: 11/22/2019**

The following information is provided to inform you about the research project and your participation in it. Please read this disclosure carefully and feel free to ask any questions you may have about this study and the information given below. You must be given an opportunity to ask questions, and your questions must be answered. Also, you must receive a signed copy of this disclosure.

Your participation in this research study is voluntary. You are also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the Middle Tennessee State University (MTSU) Office of Compliance (Tel 615-494-8918 or send your emails to irb_information@mtsu.edu. Please visit www.mtsu.edu/irb for general information on MTSU's research participant protection policies.

Please read this section and sign Section B if you wish to enroll in this study. The researcher will provide you with a copy of this disclosure form for you to keep for your future reference.

1. **Purpose of the study:** You are being asked to participate in this research study because this study will aid in investigating the effects of a plant-based diet on prediabetes.

2. **Classification of procedures to be followed and approximate duration of the study:**
   - ☒ 2.1 ***Educational Tests*** – Study involves either standard or novel education practices which consists educational testing and such studies expose the participants to lower than minimal risk
   - ☐ 2.2 ***Behavioral Evaluation***
   - ☐ 2.3 ***Psychological intervention or procedures***
   - ☐ 2.4 ***Physical Evaluation or Procedures***
   - ☐ 2.5 ***Medical Evaluation or Clinical Research***
   - ☐ ***2.6 OTHER***

3. **What are procedures we intend on doing in this study?**
   1. Volunteer study participants will be recruited with a flyer.
   2. Volunteer study participants will read and complete informed consent form.
   3. Research participants will be asked to complete a pen/paper questionnaire.
   4. Once the questionnaire is completed, participants will be offered an A1c self-check test to voluntarily check their blood glucose levels to observe their averaged blood glucose levels for the last 2-3 months.The A1cNow self-check A1c test that is FDA approved for home testing by individuals will be used for this study.

4. **What will you be asked to do in this study?**
A volunteer will help to recruit study participants with the flyer by greeting potential participants giving them the flyer, consent form to read and initial, and collecting the initialed consent form. After completing the consent form, you will be asked to complete a one-time questionnaire with non-identifiable information related to demographics, frequency of foods eaten over the past year, diabetes status, and their physical activity for the last week. You will also be provided a FDA approved A1cNow self-check A1c test on-site at the research locations to check your A1c levels.The risks are expected to be minimal for the use of your time to complete the questionnaire and the usual discomfort of a finger stick for the A1c test.

5. **What are we planning to do with the data collected using your participation?**
The data will be analyzed to see the relationship of a plant-based diet and prediabetes. There will be no identifiable information collected from participants in this study. The information collected will be kept in a locked box onsite and transferred to the faculty advisor's office at MTSU, Murphy Center, room 125. The information will later be transferred onto a secure computer for analysis.

6. **What are the expected results of this study and how will they be disseminated?**
The expected results of this study is a model that shows the best fit for the relationship between consumption of plant-based foods and self-reported prediabetes when controlling for age, sex, race, BMI, family history of diabetes, told "no diabetes" by health care professional, minutes of exercise, and number of times meat is consumed. The results will be disseminated through the publication and distribution of my dissertation.

7. **What are your expected costs to you, your effort and your time commitment?**
There is no cost to the study participants for this study. The questionnaire will take about 10-15 minutes to complete. Each participant who give consent will be offered an A1c kit to obtain their averaged blood glucose reading for the last 2-3 months.The A1c test will take about 8-10 minutes to get results.

8. **What are the potential discomforts, inconveniences, and/or possible risks that can be reasonably expected as a result of participation in this study?**
Some people may experience redness or tenderness at the location of the finger stick. You will be given alcohol to help relieve the tenderness and any redness that may occur.The inconvenience of time used to complete the questionnaire and use the A1c self-check test are also expected.

9. **How will you be compensated for your participation?**
Each person who completes the questionnaire will be given a gift packet that includes information on prediabetes, a pedometer, a refrigerator thermometer, and a food thermometer in appreciation for completing the questionnaire.

10. **What are the anticipated benefits from this study?**
    a. **The benefits to science and humankind that may result from this research:**
    This research will aid in assessment for planning community health initiatives in nutrition education related to weight management and glycemic control especially for people who are overweight and people who have insulin resistance.
    b. **The direct benefits to you which you may not receive outside the context of this research:** DEFAULT - There are no direct benefits to the partipants. The direct benefit for me (the researcher) is the gratification of contributing to the field of community health by disseminating research findings about the effects of a plant-based diet on prediabetes in three of the largest counties in Tennessee.

D. Signature Section
(Researchers' Copy)

Primary Investigator(s)	Dorothy E. Simmons		**Student** ☒
Contact information	MTSU Office (If applicable), Telephone and Email ID		
Department Institution	Human Performance		
Faculty Advisor	Dr. Andrew Owusu	Department	Human Performance
Study Title	The Effects of a plant-based diet on prediabetes		
IRB ID	**20-2065**	**Expiration: 12/31/2020**	**Approval: 11/22/2019**

PARTICIPANT SECTION
(To be filled by the participant and return to the researcher)

	Participants give consent
I have read this informed consent document	☐No ☐Yes
The research procedures to be conducted have been explained to me verbally	☐No ☐Yes
I understand all of the interventions and all my questions have been answered	☐No ☐Yes
I am aware of the potential risks of the study	☐No ☐Yes
I agree to allow my information to be retained by the investigator for use in future research studies	☐No ☐Yes

By entering my initial and my age, I affirm ANONYMOUSLY that I freely and voluntarily choose to participate in this study. I understand I can withdraw from this study at any time without facing any consequences.

Participant's Initial Date Participant's Age

RESEARCHER SECTION
(To be filled by the researchers)

Informed Consent obtained by:

12/7/19 Dorothy E. Simmons Dorothy E. Simmons, Doctoral Student

Date Signature Print Name & Title

Faculty Verification if the PI is a student:

12/7/2019 [signature] ANDREW OWUSU (Associate Prof.)

Date Faculty Signature Print Name & Title

APPENDIX C: EMAIL GRANTING PERMISSION TO USE THE HARVARD WILLETT'S FFQ

-------- Original message --------
From: Laura Sampson <nhlas@channing.harvard.edu>
Date: 6/20/19 4:06 PM (GMT-06:00)
To: Dorothy E Simmons <des3a@mtmail.mtsu.edu>
Cc: Andrew Owusu <Andrew.Owusu@mtsu.edu>, "Angie S. Bowman" <Angie.Bowman@mtsu.edu>
Subject: Re: Harvard's Willett Food Frequency Questionnaire

Dorothy,
Please see https://regepi.bwh.harvard.edu/health for our ffqs.

Our policy,
The questionnaires on this website are protected by copyright. All rights are reserved. The content and design of these questionnaires may not be used in any way for commercial purposes without permission. In general, use of the questions for scientific research is allowed. Please cite the webpage with the questionnaire in the published research.

If you intend to use the food frequency questionnaire to collect dietary data that will be processed by our group, please do not use copies from this website; you must obtain forms that can be scanned. For more information, please visit the Harvard T.H. Chan School of Public Health's Nutrition Department's download site.

Good luck with your dissertation.

Laura

On Thu, Jun 20, 2019 at 3:16 PM Dorothy E Simmons <des3a@mtmail.mtsu.edu> wrote:
Hello Ms. Sampson,

My name is Dorothy Simmons. I am a doctoral student majoring in Human Performance with a specialization in Health. I am at the beginning stage of my dissertation research on the topic of a plant-based diet and diabetes/prediabetes.

During my search for a food survey tool, I saw Harvard's Willett food frequency questionnaire that was closely aligned with what I really needed because it had the portion sizes along with the frequencies. I think that is good because it gives the participant a guideline for recalling the amounts of each food item that they consumed.

Please, could you grant me permission or give me the contact person for permission to use the Willett food frequency questionnaire and modify it (combine food items to shorten) for the framework of the nutrition section in my survey? I will give proper credit and reference citation in my dissertation.

I would greatly appreciate your assistance for permission to use the Willett food frequency questionnaire.

Thank you in advance for your time and assistance!

Dorothy

Dorothy E. Simmons, Doctoral Student
Human Performance-Health specialization
des3a@mtmail.mtsu.edu
615 496-5835

APPENDIX D: SURVEY

Plant-based diet foods questionnaire

DEMOGRAPHICS

Instructions: We would like to know some general information about you. Your answers to the following questions will aid in better understanding your answers on other sections of this survey.

In what county do you live?_________________

1. **What is your age?**

   - ☐ Ages 21-34
   - ☐ Ages 35-44
   - ☐ Ages 45-59
   - ☐ Ages 60 and up

2. **What is your sex?**

   - ☐ Male
   - ☐ Female

3. **What is the highest grade or level of education you completed?**

   - ☐ Less than a high school degree
   - ☐ A high school degree or GED
   - ☐ Some college but not a college degree
   - ☐ A bachelor's degree or higher

4. **What is your marital status?**

   - ☐ Married
   - ☐ Divorced
   - ☐ Widowed
   - ☐ Separated
   - ☐ Never married

5. **What is your height and height without shoes?**

   Height: feet_____ and inches ______

   Weight: ____ pounds

6. **Are you Hispanic?** ☐ Yes ☐ No

7. Which one of the following best describe your race? Please select all that apply.

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

8. Thinking about members of your family living in your household, what is your combined annual income, meaning the total pre-tax income from all sources earned in the past year?

- ☐ $0 to $9,999
- ☐ $10,000 to $14,999
- ☐ $15,000 to $19,999
- ☐ $20,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ 75,000 to $99,999
- ☐ $100,000 to $199,999
- ☐ $200,000 or more
- ☐ Prefer not to answer

9. How many people are in your household including you? **Number in household**______________.

10. Have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes?

☐ **Yes, Type I**	☐ **Yes, Type 2**	☐ **Yes, gestational during pregnancy**	☐ **No**

11. Have you ever been told by a doctor or other health professional that you have any of the following?

Prediabetes	☐ Yes	☐ No
Impaired fasting glucose	☐ Yes	☐ No
Impaired glucose tolerance	☐ Yes	☐ No
Borderline diabetes or that your blood sugar is higher than normal but not diabetes or sugar diabetes?	☐ Yes	☐ No

12. Have you ever had a hemoglobin A1c test (this test shows your averaged glucose level for the last 2-3 months) by a doctor or other health professional?

☐ Yes ☐ No

b. **If yes, what was your most recent A1c level?** ________ (leave blank if you don't know).

13. Have you ever had a fasting glucose test by a doctor or other health care professional?

☐ Yes ☐ No

b. **If yes, what was your most recent fasting glucose test results?** ________ (leave blank if you don't know).

14. Have you ever been told by a doctor or other health professional that you have health conditions or a medical or family history that increases your risk for diabetes?

☐ Yes ☐ No

15. Do you have a parent, sibling (sister or brother) or grandparent with diabetes?

☐ Yes ☐ No

16. Do you have a parent, sibling (sister or brother) or grandparent with prediabetes?

☐ Yes ☐ No

FOOD/DIET HABITS. This section is to gain information about the usual foods and amounts you have eaten during the past 12 months.

1. Please select how much you disagree or agree with this statement: "I feel confident in my ability to eat fruits and vegetables every day."

☐ Strongly disagree
☐ Somewhat disagree
☐ Neither disagree or agree
☐ Somewhat agree
☐ Strongly agree

2. How many servings of fruits and vegetables does the government (USDA's Choose My Plate) recommend that adults eat daily? __________servings each day (total fruits and vegetable here)

3. ***Foods checklist*. Directions:** Please check (X) only one (1) box on each line that shows your average amounts of foods you ate at home or away from home during the past year for each food item listed below:

FRUITS:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Fresh fruit, all kind, raw (1)							
Dried fruits, all kind (1/4 cup)							
Melons, all kind, cut (1 cup)							
All Fruits, canned or frozen (1/2 cup)							

FRUITS (continued):	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Fruit Juices, 100 % (small glass)							
Avocado (1/2 or 1/2 cup)							
VEGETABLES:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Cooked vegetables such as: green beans, broccoli, cabbage, carrots, (1/2 cup)							
Cooked roots vegetables such: as turnips, beets, rutabaga (1/2 cup)							
Cooked greens, such as turnip greens, collards, kale and all kind (1/2 cup)							
Raw vegetables, all kind (1 package serving or 1 cup)							
Lettuce, raw (2 cup serving)							
French fries, hash browns, other fried potatoes (6 oz. or 1 serving)							
GRAINS, CEREAL, AND OTHER STARCHES:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Crackers, regular & low fat (6)							
Cold breakfast cereal, all (1 package serving or 1 cup)							
Cooked oatmeal, oat bran, quinoa, brown rice, other whole grains (1 cup)							
Rye, whole wheat, other whole grain bread (1 slice)							
Bagels, muffins, biscuits (1)							
Any pasta or couscous (1 cup)							
White bread, pita bread (1 slice)							
Pancake, waffle, or tortillas (2)							

LEGUMES AND NUTS:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Peanuts, walnuts, almonds, seeds or other nuts (1/4 cup or 1 ounce)							
Cooked dry beans or lentils (1/2 cup) **or bean soup** (1 cup)							
MILK, CHEESE AND OTHER DAIRY	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Cheese, all kind (1 slice or oz.)							
Milk, yogurt, cottage cheese, all kind (1 cup)							
Ice Cream, regular and low fat, all flavors (1/2 cup)							
Almond, soy, other plant milk (1 cup)							
MEATS AND FISH:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Meat: Beef, pork, wild game (4-6 oz. cooked)							
Chicken, turkey (3 oz. cooked)							
Fish (3-5 oz. cooked)							
Processed meats: hot dogs, bologna, other deli meats (1 serving)							
OTHER PROTEIN FOODS:	2 or more times per day	1 time per day	2-6 times per week	1 time per week	1-3 times per month	Less than 1 time per month	Never
Eggs, egg whites, or egg substitutes (1 egg)							
Tofu, soy burgers, bean, or other veggie burger (3-4 oz.)							
Peanut, almond and others nut butter (2 tablespoons)							

PHYSICAL ACTIVITY. Directions: Please fill in the blank to answer the questions **about your usual physical activity during a week.** Physical Activity in this survey means any play, game, sport, exercise or transportation (like walking or biking to work) that gets you moving and breathing harder.

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.**

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

   ___________ **minutes a day.**

3. **During the Last 7 Days, on how many days did you do moderate physical?**
   __________**days per week.**

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

5. **During the Last 7 Days, on how many days did you walk 10 minutes at a time?**
   __________ **days per week.**

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

Thank you for your time and for completing the survey!!

Note. The Food/Diet Habits' section was adapted from the Harvard Willett's Food Frequency Questionnaire (Harvard, 2007). Demographics were adapted from the Family Life, Activity, Sun, Health and Eating (FLASHE) parent surveys (National Cancer Institute, 2017). The diabetes status questions were adapted from the National Health and Nutrition Examination Survey (CDC, 2017)

APPENDIX E: RESEARCHER'S SCRIPT

Hello! My name is Dorothy Simmons. I am a doctoral student at Middle Tennessee State University. I am conducting research on a plant-based diet and prediabetes. Would you be willing to take a few minutes to complete a brief questionnaire? Your response will be anonymous. There will no information collected on the questionnaire that will personally identify you. Also, upon completion of questionnaire, you may use this A1c self-check kit to check your glucose levels to see your averaged blood glucose levels for the last 2-3 months, at no cost to you. The results of this study could aid in developing community health and wellness programs.

This is the informed consent form if you wish to participate in the research. After collecting the consent forms: this is the questionnaire to complete and return to me after the A1c test. If they refuse the A1c test, say: If you can't do the A1c today, please bring the completed questionnaire back to me for your gift.

For A1c test:

This is your A1c test with all the instructions, the lancet, shaker and monitoring device. It tells you to stick your finger with the lancet, fill the vial with enough blood, when to put it in the shaker and drop it in the glucose monitor. It will only take 5 minutes for the results after put the blood in the monitor. Please let me know if you need help with the steps.

Thank you for completing the questionnaire! This is a gift of appreciation for completing the questionnaire. The packet includes information about prediabetes, a pedometer, a refrigerator thermometer, and a food thermometer to use at home.

Enjoy your day!

Volunteer Researcher's script:

Hello! My name is___________. I am assisting Dorothy Simmons who is a doctoral student at Middle Tennessee State University. She is conducting research on a plant-based diet and prediabetes. Would you be willing to take a few minutes to complete a brief questionnaire? Your response will be anonymous. There will no information collected on the questionnaire that will personally identify you. Also, upon completion of questionnaire, you may use this A1c self-check kit to check your glucose levels to see your averaged blood glucose levels for the last 2-3 months, at no cost to you.

This is the informed consent form if you wish to participate. The results of this study could aid in developing community health and wellness programs. After collecting the consent forms: this is the questionnaire to complete and return to me after the A1c test. If they refuse the A1c test, say: If you can't do the A1c test today, please bring the completed questionnaire back to me for your gift. Dorothy can explain more about the A1c test.

Thank you for completing the questionnaire! This is a gift of appreciation for completing the questionnaire. The packet includes information about prediabetes, a pedometer, a refrigerator thermometer, and a food thermometer to use at home. Enjoy your day!

APPENDIX F: FLYERS

Research Participants Needed

Study Title: The Effects of a plant-based diet on prediabetes
Protocol ID 19-1278 Approval 07-19-2019 Expiration N/A

Study Description & Purpose

This is a dissertation study to learn more about prediabetes. The purpose is to investigate the effects of a plant-based diet on prediabetes.

Target Population

All persons who are 21 years or older may participate in this study. This study is also designed to reach people with a family history of diabetes, people who are overweight, and women who have had gestational diabetes.

Risk & Benefits

Participants will be asked to complete a one-time questionnaire with non-identifiable information related to demographics, frequency of foods eaten over the past year, diabetes status, and their physical activity for the last week. The risks are expected to be no more than what you would encounter in ordinary daily activity and the use of your time to complete the questionnaire. The questionnaire will take about 10-15 minutes to complete.

This questionnaire may serve to bring awareness of prediabetes and ways to promote wellness.

Additional Information

Participants will be given a gift packet that includes information about prediabetes, a pedometer, a refrigerator thermometer, and food thermometer to use at home.

Contact Information

Dorothy Simmons, Doctoral Student, Human Performance, 615 496-5835, des3a@mtmail.mtsu.edu
Faculty Advisor: Andrew Owusu, Human Performance, 615 898-5878, andrew.owusu@mtsu.edu

Institutional Review Board, Middle Tennessee State University
2269 Middle Tennessee Blvd, Room 010A, Murfreesboro, TN 37132
Tel 615 494 8918 | Email: irb_information@mtsu.edu | www.mtsu.edu/irb

Research Participants Needed

Study Title: The Effects of a plant-based diet on prediabetes
Protocol ID 20-2065 **Approval** 11-27-2019 **Expiration** 12-31-2020

Study Description & Purpose

This is a dissertation study to learn more about prediabetes. The purpose is to investigate the effects of a plant-based diet on prediabetes.

Target Population

All persons who are 21 years or older may participate in this study. This study is also designed to reach people with a family history of diabetes, people who are overweight, and women who have had gestational diabetes.

Risk & Benefits

Participants will be asked to complete a one-time questionnaire with non-identifiable information related to demographics, frequency of foods eaten over the past year, diabetes status, and their physical activity for the last week. Participants will also be provided a self-check A1c test on-site at the research location. The risks are expected to be minimal for the use of your time to complete the questionnaire and the usual discomfort of the finger stick for the A1c test. The questionnaire will take about 10-15 minutes to complete and the A1c test will take approximately 8-10 minutes to get the results.

This questionnaire may serve to bring awareness of prediabetes and ways to promote wellness.

Additional Information

Participants will be given a gift packet in appreciation for completing the questionnaire that includes information about prediabetes, a pedometer, a refrigerator thermometer, and food thermometer to use at home.

Contact Information

Dorothy Simmons, Doctoral Student, Human Performance, 615 496-5835, des3a@mtmail.mtsu.edu
Faculty Advisor: Andrew Owusu, Human Performance, 615 898-5878, andrew.owusu@mtsu.edu

Institutional Review Board, Middle Tennessee State University
2269 Middle Tennessee Blvd, Room 010A, Murfreesboro, TN 37132
Tel 615 494 8918 | Email: irb_information@mtsu.edu | www.mtsu.edu/irb

APPENDIX G: EMAIL ONLINE RECRUITMENT LETTER

Primary Investigator:	Dorothy E. Simmons
PI Department & College:	Human Performance**,** College of Behavioral and Health Sciences**,** Middle Tennessee State University
Faculty Advisor (if PI is a student):	Andrew Owusu, Human Performance
Protocol Title:	The Effects of a Plant-based Diet on Prediabetes
Protocol ID:	19-1278
Approval Date:	06/02/2020
Expiration Date:	N/A

Dear XXXX

My name is Dorothy Simmons, a PhD candidate at Middle Tennessee State University in the Department of Health and Human Performance. I am conducting research on a plant-based diet and prediabetes. Would you be willing to share this research opportunity by emailing this announcement to your members/clientele? Results from this study could aid in developing community health and wellness programs to aid prevention and management of diabetes. Participants who give informed consent may participate in the study. The link to the online survey is located at the bottom of this email.

Study Description & Purpose:

– Participants will be asked to complete a one-time online questionnaire with information related to demographics, frequency of foods eaten over the past year, diabetes status, and their physical activity for the last week. The responses will be anonymous and no identifying data will be collected from the participants. The information will be stored on a secure computer for analysis. The purpose of this study is to examine the effects of consuming plant-based foods on prediabetes.

Target Participant Pool

– Persons who are 21 years and older, both male and female, may participate in the study.

Risks & Discomforts

– The risks are no greater than what you would encounter in ordinary daily activities and the inconvenience of time to complete the questionnaire.

Benefits

– Participants will gain increased awareness of nutritional habits and prediabetes. The first 100 participants who complete the form and send an email request to receive a packet will receive a gift packet that includes a refrigerator thermometer, cooking thermometer, and a pedometer to use at home.

Additional Information

– All persons, ages 20 years old or younger will be excluded from the study.

Compensation

– A refrigerator thermometer, cooking thermometer, pedometer, and information about prediabetes.

Contact Information

– If you should have any questions about this research study or possibly injury, please feel free to contact Dorothy E. Simmons by telephone 615 496-5835 or by email des3a@mtmail.mtsu.edu OR my faculty advisor, Andrew Owusu, at Andrew.owusu@mtsu.edu, 615 898-5878. You can also contact the MTSU Office of compliance via telephone (615 494 8918) or by email (compliance@mtsu.edu). This contact information will be presented again at the end of the experiment.

Please enter the survey by clicking the link at the bottom of the email. You will be given a chance to read the entire informed consent to assist you to make a final determination.

Thank you so much for sharing the research questionnaire link!

Yours Sincerely,

Dorothy E. Simmons

Link to Survey on Plant-based Diet and Prediabetes –
https://mtsu.ca1.qualtrics.com/jfe/form/SV_d11XYozkQBkMTc1

APPENDIX H: CALCULATED VARIABLE STEPS

1. All food variables were reversed coded from 1 = 2 or more per day to 1 = Never down for frequency into a food code ending with new (ex. Freshfruits into Freshfruits_new).

2. All food variables ending with "new" were recoded with the frequency factor(ff) score from the Harvard food factor scale with a recoded name ending in "ff" to obtain the amount of each food item per day (such as Freshfruits_newff).

3. All "ff" food items were added together to obtain the total amount consumed from each food group. This created new variables for the food groups, namely: FruitsTotal, VegTotal, Gr_BreadTotal, DairyTotal, LegumesNutsTotal, MeatfishTotal, and

Other ProteinTotal. These variables were the first grouping of the individual food item variables into food group totals for how much was consumed from each group.

4. FV_ amt = Write-in number of fruits and vegetables daily servings that USDA Choose My Plate recommend for adults.

5.Food totals were used for creating Met and Unmet recommendation variables.

6. Recoded Hgt Ft to inches = Hgt_1

*Hgt_1 + Hgt_2 was recoded into HGT_1_new & HGT_2_new to correct the value labels.

7. Recoded Hgt_1 *12 into Hattin

8. BMI recoded into BMI _ CAT = underweight, normal, overweight & obese

9. Hgt In+ weight was computed to get BMI. BMI= wgt * 703/(xx2).

10. Prediabetes + Impaired false Glu+ ImpairGluTolerance +Borderline Diab were added together to create the Prediabetes _ combined variable.

11. Prediabetes_ combined was recoded into Prediabetes_ new = for “yes or no” prediabetes.

12. Recoded LegumesNutsTotal + OtherProteinTotal to create the ProteinVegSource variable.

13. Recoded Protein_VegSources into Protein_VegSourcesCutoff.

14 Recoded FruitsTotal, VegTotal, Gr_BreadTotal, DairyTotal, LegumesNutsTotal, MeatfishTotal, and Other ProteinTotal into PlantBasedTotal

15 PlantBasedTotal was read coded into PlantBasedTotalCutoff for the cut-off number of servings to equal 19.5.

16. FruitsTotal, VegTotal, Gr_BreadTotal, DairyTotal and Protein_VegSources were recorded into food groups ending in 1,800, 2,000, 2,400 and 2,600 to calculate Met and Unmet for both females and males’ calorie requirement. (Appendix I).

APPENDIX I: SPSS CODEBOOK

County		Value	Count	Percent
Standard Attributes	Label	In what county do you live?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Dav	95	38.5%
	1	Ham	121	49.0%
	2	Ruther	31	12.6%

Age		Value	Count	Percent
Standard Attributes	Label	What is your age?		
	Type	Numeric		
	Measurement	Ordinal		
Valid Values	0	21-34 years	46	18.6%
	1	35-44 years	47	19.0%
	2	45-59 years	77	31.2%
	3	60 years and up	76	30.8%
Missing Values	System		1	0.4%

Sex		Value	Count	Percent
Standard Attributes	Label	What is your sex?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Male	77	31.2%
	1	Female	169	68.4%
Missing Values	System		1	0.4%

Education		Value	Count	Percent
Standard Attributes	Label	What is the highest grade or level of education you completed?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Less than a h. s. degree	4	1.6%
	1	H.S. degree or GED	31	12.6%
	2	Some college but not college degree	81	32.8%
	3	B.S. degree or higher	127	51.4%
Missing Values	System		4	1.6%

Marital_Status		Value	Count	Percent
Standard Attributes	Label	What is your marital status?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Married	118	47.8%
	1	Divorced	45	18.2%
	2	Widowed	17	6.9%
	3	Separated	4	1.6%
	4	Never married	61	24.7%
Missing Values	System		2	0.8%

Hgt_1		Value	Count	Percent
Standard Attributes	Label	What is your height in feet without shoes? - Feet		
	Type	Numeric		
	Measurement	Scale		
N	Valid	245		
	Missing	2		
Central Tendency and Dispersion	Mean	15.38		
	Standard Deviation	4.652		
	Percentile 25	14.00		
	Percentile 50	14.00		
	Percentile 75	14.00		
Labeled Values	1	4	4	1.6%
	14	5	211	85.4%
	27	6	30	12.1%
	40	7	0	0.0%

Wgt		Value
Standard Attributes	Label	What is your weight in pounds?
	Type	Numeric
	Measurement	Scale
N	Valid	229
	Missing	18
Central Tendency and Dispersion	Mean	188.93
	Standard Deviation	55.877
	Percentile 25	159.00
	Percentile 50	184.00
	Percentile 75	218.00

Hgt_2		Value	Count	Percent
Standard Attributes	Label	What is your height in feet inches without shoes? - Inches		
	Type	Numeric		
	Measurement	Scale		
N	Valid	244		
	Missing	3		
Central Tendency and Dispersion	Mean	7.25		
	Standard Deviation	3.030		
	Percentile 25	5.00		
	Percentile 50	7.00		
	Percentile 75	9.00		
Labeled Values	2	0	15	6.1%
	3	1	15	6.1%
	4	2	18	7.3%
	5	3	28	11.3%
	6	4	25	10.1%
	7	5	32	13.0%
	8	6	29	11.7%
	9	7	28	11.3%
	10	8	10	4.0%
	11	9	17	6.9%
	12	10	13	5.3%
	13	11	14	5.7%

Hisp

		Value	Count	Percent
Standard Attributes	Label	Are you Hispanic?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	243	98.4%
	1	Yes	3	1.2%
Missing Values	System		1	0.4%

Diab

		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by a doctor/health professional-diabetes or sugar diabetes?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Type 1	2	0.8%
	1	Type 2	29	11.7%
	2	Gest Diab	4	1.6%
	3	No Diab	200	81.0%
Missing Values	System		12	4.9%

HHnum		Value	Count	Percent
Standard Attributes	Label	How many people are in your household including you?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	225		
	Missing	22		
Central Tendency and Dispersion	Mean	2.68		
	Standard Deviation	1.507		
	Percentile 25	2.00		
	Percentile 50	2.00		
	Percentile 75	4.00		
Labeled Values	1	1	52	21.1%
	2	2	72	29.1%
	3	3	38	15.4%
	4	4	36	14.6%
	5	5	21	8.5%
	6	6	2	0.8%
	7	7	1	0.4%
	8	8	1	0.4%
	9	9	2	0.8%
	10	10	0	0.0%
	11	11	0	0.0%
	12	12	0	0.0%
	13	13	0	0.0%
	14	14	0	0.0%
	15	15	0	0.0%

	16	16	0	0.0%
	17	17	0	0.0%
	18	18	0	0.0%
	19	19	0	0.0%
	20	20	0	0.0%

Prediabetes		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by a doctor/health professional-you have Prediabetes?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	188	76.1%
	1	Yes	44	17.8%
Missing Values	System		15	6.1%

BorderlineDiab		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by a doctor/health professional-you have Borderline diabetes		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	188	76.1%

	1	Yes	42	17.0%
Missing Values	System		17	6.9%

ImpairFastingGlu

		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by a doctor/health professional-you have Impaired fasting glucose?		
	Measurement	Nominal		
Valid Values	0	No	215	87.0%
	1	Yes	7	2.8%
Missing Values	System		25	10.1%

ImpairGluTolerance

		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by doctor/health professional-you have Impaired glucose tolerance		
	Measurement	Nominal		
Valid Values	0	No	216	87.4%
	1	Yes	4	1.6%
Missing Values	System		27	10.9%

DrA1c_

		Value	Count	Percent
Standard Attributes	Label	Have you ever had a hemoglobin A1ctest by doctor....?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	146	59.1%
	1	Yes, If yes, what was your most recent A1c level?	87	35.2%
Missing Values	System		14	5.7%

DrA1c__1_TEXT

		Value
Standard Attributes	Label	Have you ever had a hemoglobin A1ctest? If yes, what was your most recent A1c level?
	Type	Numeric
	Measurement	Scale
N	Valid	36
	Missing	211
Central Tendency and Dispersion	Mean	6.442
	Standard Deviation	2.1916
	Percentile 25	5.200
	Percentile 50	6.100
	Percentile 75	6.700

Risk		Value	Count	Percent
Standard Attributes	Label	Have you ever been told by a doctor/health professional-you have health or medical conditions that increase risk for diabetes?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	244		
	Missing	3		
Central Tendency and Dispersion	Mean	.39		
	Standard Deviation	.488		
	Percentile 25	.00		
	Percentile 50	.00		
	Percentile 75	1.00		
Labeled Values	0	No	150	60.7%
	1	Yes	94	38.1%

FPG

		Value	Count	Percent
Standard Attributes	Label	Have you ever had a fasting glucose test by a doctor or other health care professional ?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	232		
	Missing	15		
Central Tendency and Dispersion	Mean	.41		
	Standard Deviation	.492		
	Percentile 25	.00		
	Percentile 50	.00		
	Percentile 75	1.00		
Labeled Values	0	No	138	55.9%
	1	Yes, most recent fasting glucose test results?	94	38.1%

FPG_1_TEXT		Value	Count	Percent
Standard Attributes	Label	Fasting glucose test by a doctor or other health care professional? If yes, what was your most recent fasting glucose test results?		
	Type	String		
	Measurement	Nominal		
Valid Values			231	93.5%
	105		1	0.4%
	106		1	0.4%
	125		1	0.4%
	139		1	0.4%
	5.6		1	0.4%
	6.5		1	0.4%
	63		1	0.4%
	72		1	0.4%
	78		2	0.8%
	80		1	0.4%
	88		1	0.4%
	90		2	0.8%
	96		1	0.4%
	98		1	0.4%

FamDiab		Value	Count	Percent
Standard Attributes	Label	Do you have a parent, sibling (sister or brother) or grandparent with diabetes?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	87	35.2%
	1	Yes	158	64.0%
Missing Values	System		2	0.8%

FamPredi		Value	Count	Percent
Standard Attributes	Label	Do you have a parent, sibling (sister or brother) or grandparent with prediabetes?		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	No	172	69.6%
	1	Yes	69	27.9%
Missing Values	System		6	2.4%

Conf_FV_1		Value	Count	Percent
Standard Attributes	Label	“I feel confident in my ability to eat fruits and vegetables every day.”		
	Type	Numeric		
	Measurement	Scale		
N	Valid	240		
	Missing	7		
Central Tendency and Dispersion	Mean	3.22		
	Standard Deviation	1.230		
	Percentile 25	3.00		
	Percentile 50	4.00		
	Percentile 75	4.00		
Labeled Values	0	Strongly disagree	21	8.5%
	1	Somewhat disagree	8	3.2%
	2	Neither agree nor disagree	10	4.0%
	3	Somewhat agree	59	23.9%
	4	Strongly agree	142	57.5%

FV_amt		Value	Count	Percent
Standard Attributes	Label	How many servings of fruits and vegetables does USDA’s Choose My Plate recommend that adults eat daily?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	195		
	Missing	52		
Central Tendency and Dispersion	Mean	120.47		
	Standard Deviation	2.386		
	Percentile 25	119.00		
	Percentile 50	120.00		
	Percentile 75	121.00		
Labeled Values	117	1 serving	9	3.6%
	118	2 servings	24	9.7%
	119	3 servings	49	19.8%
	120	4 servings	31	12.6%
	121	5 servings	37	15.0%
	122	6 servings	15	6.1%
	123	7 servings	7	2.8%
	124	8 servings	8	3.2%
	125	9 servings	6	2.4%
	126	10 servings	4	1.6%
	127	11 servings	1	0.4%
	128	12 servings	2	0.8%
	129	13 servings	2	0.8%
	132	14 servings	0	0.0%
	133	15 servings	0	0.0%

HHIn		Value	Count	Percent
Standard Attributes	Label	Combined household pre-tax annual income from all sources in the past year?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	235		
	Missing	12		
Central Tendency and Dispersion	Mean	4.94		
	Standard Deviation	2.258		
	Percentile 25	4.00		
	Percentile 50	5.00		
	Percentile 75	7.00		
Labeled Values	0	HHIn1	13	5.3%
	1	HHIn2	11	4.5%
	2	HHIn3	4	1.6%
	3	HHIn4	30	12.1%
	4	HHIn5	31	12.6%
	5	HHIn6	50	20.2%
	6	HHIn7	30	12.1%
	7	HHIn8	46	18.6%
	8	HHIn9	4	1.6%
	9	HHIn10	16	6.5%

VPAdWk		Value	Count	Percent
Standard Attributes	Label	During the Last 7 Days, on how many days did you do vigorous physical activities?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	238		
	Missing	9		
Central Tendency and Dispersion	Mean	.76		
	Standard Deviation	.721		
	Percentile 25	.00		
	Percentile 50	1.00		
	Percentile 75	1.00		
Labeled Values	0	0-1 day	97	39.3%
	1	2-4 days	101	40.9%
	2	5 or more days	40	16.2%

VPAmD

		Value	Count	Percent
Standard Attributes	Label	How much time did you usually spend doing vigorous physical activities on one of those days?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	232		
	Missing	15		
Central Tendency and Dispersion	Mean	.81		
	Standard Deviation	.807		
	Percentile 25	.00		
	Percentile 50	1.00		
	Percentile 75	1.00		
Labeled Values	0	0-29 minutes per day	102	41.3%
	1	30-59 minutes per day	73	29.6%
	2	60 or more minutes per day	57	23.1%

MPAdWk		Value	Count	Percent
Standard Attributes	Label	During the Last 7 Days, on how many days did you do moderate physical?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	233		
	Missing	14		
Central Tendency and Dispersion	Mean	1.00		
	Standard Deviation	.751		
	Percentile 25	.00		
	Percentile 50	1.00		
	Percentile 75	2.00		
Labeled Values	0	0-1 day	65	26.3%
	1	2-4 days	102	41.3%
	2	5 or more days	66	26.7%

MPAmD		Value	Count	Percent
Standard Attributes	Label	How much time did you usually spend doing moderate physical activities on one of those days?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	226		
	Missing	21		
Central Tendency and Dispersion	Mean	.79		
	Standard Deviation	.783		
	Percentile 25	.00		
	Percentile 50	1.00		
	Percentile 75	1.00		
Labeled Values	0	0-29 minutes	98	39.7%
	1	30-59 minutes per day	78	31.6%
	2	60 or more minutes per day	50	20.2%

WalkdWk		Value	Count	Percent
Standard Attributes	Label	During the Last 7 Days, on how many days did you walk 10 minutes at a time?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	228		
	Missing	19		
Central Tendency and Dispersion	Mean	1.22		
	Standard Deviation	.799		
	Percentile 25	1.00		
	Percentile 50	1.00		
	Percentile 75	2.00		
Labeled Values	0	0-1 day	53	21.5%
	1	2-4 days	72	29.1%
	2	5 or more days	103	41.7%

WalkmD

		Value	Count	Percent
Standard Attributes	Label	How much time did you usually spend walking on one of those days?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	227		
	Missing	20		
Central Tendency and Dispersion	Mean	.67		
	Standard Deviation	.748		
	Percentile 25	.00		
	Percentile 50	.00		
	Percentile 75	1.00		
Labeled Values	0	0-29 minutes	114	46.2%
	1	30-59 minutes	75	30.4%
	2	60 or more minutes	38	15.4%

A1c_kit

		Value
Standard Attributes	Label	What was your A1c reading from the A1c self-check home kit?
	Type	Numeric
	Measurement	Scale
N	Valid	72
	Missing	175
Central Tendency and Dispersion	Mean	5.556
	Standard Deviation	1.1941
	Percentile 25	4.950
	Percentile 50	5.200
	Percentile 75	5.700

Race

		Value	Count	Percent
Standard Attributes	Label	Which one of the following best describe your race? Please select all that apply.		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	American Indian or Alaska Native	1	0.4%
	2	Asian	2	0.8%
	3	Black or African American	202	81.8%
	4	Native HI or Other Pacific Islander	0	0.0%
	5	White	30	12.1%
	6	Other	4	1.6%
Missing Values	System		8	3.2%

Freshfruits_new

		Value	Count	Percent
Standard Attributes	Label	Freshfruits_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	3	1.2%
	2	less than 1 time per month	7	2.8%
	3	1-3 times per month	12	4.9%
	4	1 time per week	16	6.5%
	5	2 - 6 times per week	50	20.2%
	6	1 time per day	53	21.5%
	7	2 or more per day	93	37.7%
Missing Values	System		13	5.3%

Driedfruits_new

		Value	Count	Percent
Standard Attributes	Label	Driedfruits_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	33	13.4%
	2	Less than 1 time per month	39	15.8%
	3	1-3 times per month	29	11.7%
	4	1 time per week	35	14.2%
	5	2-6 times per week	37	15.0%
	6	1 time per day	26	10.5%
	7	2 or more times per day	20	8.1%
Missing Values	System		28	11.3%

Melons_new		Value	Count	Percent
Standard Attributes	Label	Melons_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	24	9.7%
	2	Less than 1 time per month	44	17.8%
	3	1-3 times per month	42	17.0%
	4	1 time per week	31	12.6%
	5	2-6 times per week	42	17.0%
	6	1 time per day	19	7.7%
	7	2 or more times per day	24	9.7%
Missing Values	System		21	8.5%

CanFrozenFruit_New		Value	Count	Percent
Standard Attributes	Label	CanFrozenFruit_New		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	20	8.1%
	2	Less than 1 time per month	25	10.1%
	3	1-3 times per month	43	17.4%
	4	1 time per week	25	10.1%
	5	2-6 times per week	42	17.0%
	6	1 time per day	32	13.0%
	7	2 or more times per day	39	15.8%
Missing Values	System		21	8.5%

Fruitjuices_new		Value	Count	Percent
Standard Attributes	Label	Fruitjuices_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	17	6.9%
	2	Less than 1 time per month	24	9.7%
	3	1-3 times per month	30	12.1%
	4	1 time per week	28	11.3%
	5	2-6 times per week	45	18.2%
	6	1 time per day	34	13.8%
	7	2 or more times per day	46	18.6%
Missing Values	System		23	9.3%

Avacado_new		Value	Count	Percent
Standard Attributes	Label	Avacado_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	81	32.8%
	2	Less than 1 time per month	34	13.8%
	3	1-3 times per month	27	10.9%
	4	1 time per week	19	7.7%
	5	2-6 times per week	30	12.1%
	6	1 time per day	18	7.3%
	7	2 or more times per day	6	2.4%
Missing Values	System		32	13.0%

Cookedvegs_new		Value	Count	Percent
Standard Attributes	Label	Cookedvegs_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	4	1.6%
	2	Less than 1 time per month	4	1.6%
	3	1-3 times per month	11	4.5%
	4	1 time per week	11	4.5%

	5	2-6 times per week	82	33.2%
	6	1 time per day	50	20.2%
	7	2 or more times per day	71	28.7%
Missing Values	System		14	5.7%

Cookedrootvegs_new

		Value	Count	Percent
Standard Attributes	Label	Cookedroot vegs_new		
	Type	Numeric		
	Measureme nt	Nominal		
Valid Values	1	Never	50	20.2%
	2	Less than 1 time per month	34	13.8%
	3	1-3 times per month	36	14.6%
	4	1 time per week	32	13.0%
	5	2-6 times per week	31	12.6%
	6	1 time per day	21	8.5%
	7	2 or more times per day	22	8.9%
Missing Values	System		21	8.5%

Cookedgreens_new		Value	Count	Percent
Standard Attributes	Label	Cookedgreens_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	7	2.8%
	2	Less than 1 time per month	12	4.9%
	3	1-3 times per month	59	23.9%
	4	1 time per week	38	15.4%
	5	2-6 times per week	59	23.9%
	6	1 time per day	28	11.3%
	7	2 or more times per day	28	11.3%
Missing Values	System		16	6.5%

RawVegs_new

		Value	Count	Percent
Standard Attributes	Label	RawVegs_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	18	7.3%
	2	Less than 1 time per month	32	13.0%
	3	1-3 times per month	29	11.7%
	4	1 time per week	30	12.1%
	5	2-6 times per week	53	21.5%
	6	1 time per day	31	12.6%
	7	2 or more times per day	30	12.1%
Missing Values	System		24	9.7%

Lettuce_new

		Value	Count	Percent
Standard Attributes	Label	Lettuce_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	14	5.7%
	2	Less than 1 time per month	18	7.3%
	3	1-3 times per month	36	14.6%

	4	1 time per week	32	13.0%
	5	2-6 times per week	71	28.7%
	6	1 time per day	32	13.0%
	7	2 or more times per day	24	9.7%
Missing Values	System		20	8.1%

FriedPotFF_new		Value	Count	Percent
Standard Attributes	Label	FriedPotFF_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	7	2.8%
	2	Less than 1 time per month	30	12.1%
	3	1-3 times per month	45	18.2%
	4	1 time per week	55	22.3%
	5	2-6 times per week	52	21.1%
	6	1 time per day	18	7.3%
	7	2 or more times per day	20	8.1%
Missing Values	System		20	8.1%

Crackers_new		Value	Count	Percent
Standard Attributes	Label	Crackers_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	14	5.7%
	2	Less than 1 time per month	30	12.1%
	3	1-3 times per month	35	14.2%
	4	1 time per week	33	13.4%
	5	2-6 times per week	55	22.3%
	6	1 time per day	34	13.8%
	7	2 or more times per day	21	8.5%
Missing Values	System		25	10.1%

CookedCereal_new		Value	Count	Percent
Standard Attributes	Label	CookedCereal_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	15	6.1%
	2	Less than 1 time per month	24	9.7%
	3	1-3 times per month	36	14.6%
	4	1 time per week	23	9.3%
	5	2-6 times per week	64	25.9%
	6	1 time per day	43	17.4%
	7	2 or more times per day	25	10.1%
Missing Values	System		17	6.9%

ColdbreakCereal_new		Value	Count	Percent
Standard Attributes	Label	ColdbreakCereal_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	32	13.0%
	2	Less than 1 time per month	35	14.2%
	3	1-3 times per month	35	14.2%
	4	1 time per week	30	12.1%

	5	2-6 times per week	45	18.2%
	6	1 time per day	32	13.0%
	7	2 or more times per day	15	6.1%
Missing Values	System		23	9.3%

WholeGrBread_new		Value	Count	Percent
Standard Attributes	Label	WholeGrBread_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	19	7.7%
	2	Less than 1 time per month	22	8.9%
	3	1-3 times per month	34	13.8%
	4	1 time per week	29	11.7%
	5	2-6 times per week	68	27.5%
	6	1 time per day	36	14.6%
	7	2 or more times per day	22	8.9%
Missing Values	System		17	6.9%

BagelsMufBis_new		Value	Count	Percent
Standard Attributes	Label	BagelsMufBis_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	16	6.5%
	2	Less than 1 time per month	47	19.0%
	3	1-3 times per month	61	24.7%
	4	1 time per week	40	16.2%
	5	2-6 times per week	32	13.0%
	6	1 time per day	16	6.5%
	7	2 or more times per day	10	4.0%
Missing Values	System		25	10.1%

PastaCous_new		Value	Count	Percent
Standard Attributes	Label	PastaCous_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	14	5.7%
	2	Less than 1 time per month	30	12.1%
	3	1-3 times per month	56	22.7%
	4	1 time per week	55	22.3%
	5	2-6 times per week	44	17.8%
	6	1 time per day	14	5.7%
	7	2 or more times per day	7	2.8%
Missing Values	System		27	10.9%

WhiteBreadPita_new		Value	Count	Percent
Standard Attributes	Label	WhiteBreadPita_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	55	22.3%
	2	Less than 1 time per month	51	20.6%
	3	1-3 times per month	35	14.2%
	4	1 time per week	27	10.9%

	5	2-6 times per week	31	12.6%
	6	1 time per day	15	6.1%
	7	2 or more times per day	13	5.3%
Missing Values	System		20	8.1%

PancakesWafTort_new		Value	Count	Percent
Standard Attributes	Label	PancakesWagTort_		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	15	6.1%
	2	Less than 1 time per month	54	21.9%
	3	1-3 times per month	78	31.6%
	4	1 time per week	28	11.3%
	5	2-6 times per week	30	12.1%
	6	1 time per day	13	5.3%
	7	2 or more times per day	11	4.5%
Missing Values	System		18	7.3%

NutsSeeds_new		Value	Count	Percent
Standard Attributes	Label	NutsSeeds_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	11	4.5%
	2	Less than 1 time per month	21	8.5%
	3	1-3 times per month	31	12.6%
	4	1 time per week	23	9.3%
	5	2-6 times per week	70	28.3%
	6	1 time per day	41	16.6%
	7	2 or more times per day	35	14.2%
Missing Values	System		15	6.1%

DryBeansLent_new		Value	Count	Percent
Standard Attributes	Label	DryBeansLent_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	21	8.5%
	2	Less than 1 time per month	36	14.6%
	3	1-3 times per month	55	22.3%
	4	1 time per week	29	11.7%

	5	2-6 times per week	56	22.7%
	6	1 time per day	20	8.1%
	7	2 or more times per day	12	4.9%
Missing Values	System		18	7.3%

CheeseAll_new		Value	Count	Percent
Standard Attributes	Label	CheeseAll_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	13	5.3%
	2	Less than 1 time per month	18	7.3%
	3	1-3 times per month	31	12.6%
	4	1 time per week	28	11.3%
	5	2-6 times per week	76	30.8%
	6	1 time per day	45	18.2%
	7	2 or more times per day	20	8.1%
Missing Values	System		16	6.5%

MlkYogCotCh_new		Value	Count	Percent
Standard Attributes	Label	MlkYogCotCh_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	30	12.1%
	2	Less than 1 time per month	30	12.1%
	3	1-3 times per month	33	13.4%
	4	1 time per week	19	7.7%
	5	2-6 times per week	52	21.1%
	6	1 time per day	41	16.6%
	7	2 or more times per day	22	8.9%
Missing Values	System		20	8.1%

IceCrm_new		Value	Count	Percent
Standard Attributes	Label	IceCrm_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	28	11.3%
	2	Less than 1 time per month	45	18.2%
	3	1-3 times per month	68	27.5%
	4	1 time per week	43	17.4%
	5	2-6 times per week	28	11.3%
	6	1 time per day	14	5.7%
	7	2 or more times per day	6	2.4%
Missing Values	System		15	6.1%

PlantMlk_new		Value	Count	Percent
Standard Attributes	Label	PlantMlk_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	66	26.7%
	2	Less than 1 time per month	30	12.1%
	3	1-3 times per month	29	11.7%
	4	1 time per week	18	7.3%
	5	2-6 times per week	29	11.7%
	6	1 time per day	27	10.9%
	7	2 or more times per day	22	8.9%
Missing Values	System		26	10.5%

BeefPorkWldgame_new		Value	Count	Percent
Standard Attributes	Label	BeefPorkWldgame_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	31	12.6%
	2	Less than 1 time per month	19	7.7%
	3	1-3 times per month	26	10.5%
	4	1 time per week	23	9.3%
	5	2-6 times per week	70	28.3%
	6	1 time per day	38	15.4%
	7	2 or more times per day	25	10.1%
Missing Values	System		15	6.1%

ChickTurkey_new		Value	Count	Percent
Standard Attributes	Label	ChickTurkey_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	24	9.7%
	2	Less than 1 time per month	7	2.8%
	3	1-3 times per month	11	4.5%
	4	1 time per week	13	5.3%

	5	2-6 times per week	101	40.9%
	6	1 time per day	39	15.8%
	7	2 or more times per day	35	14.2%
Missing Values	System		17	6.9%

Fish_new		Value	Count	Percent
Standard Attributes	Label	Fish_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	25	10.1%
	2	Less than 1 time per month	18	7.3%
	3	1-3 times per month	41	16.6%
	4	1 time per week	46	18.6%
	5	2-6 times per week	63	25.5%
	6	1 time per day	15	6.1%
	7	2 or more times per day	18	7.3%
Missing Values	System		21	8.5%

ProcMeats_new		Value	Count	Percent
Standard Attributes	Label	ProcMeats_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	43	17.4%
	2	Less than 1 time per month	42	17.0%
	3	1-3 times per month	54	21.9%
	4	1 time per week	29	11.7%
	5	2-6 times per week	38	15.4%
	6	1 time per day	15	6.1%
	7	2 or more times per day	8	3.2%
Missing Values	System		18	7.3%

EggsEggSub_new		Value	Count	Percent
Standard Attributes	Label	EggsEggSub_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	18	7.3%
	2	Less than 1 time per month	12	4.9%
	3	1-3 times per month	25	10.1%
	4	1 time per week	32	13.0%

	5	2-6 times per week	78	31.6%
	6	1 time per day	45	18.2%
	7	2 or more times per day	25	10.1%
Missing Values	System		12	4.9%

TofuVegBurger_new		Value	Count	Percent
Standard Attributes	Label	TofuVegBurger_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	106	42.9%
	2	Less than 1 time per month	36	14.6%
	3	1-3 times per month	29	11.7%
	4	1 time per week	20	8.1%
	5	2-6 times per week	20	8.1%
	6	1 time per day	14	5.7%
	7	2 or more times per day	5	2.0%
Missing Values	System		17	6.9%

NutButters_new		Value	Count	Percent
Standard Attributes	Label	NutButters_new		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	1	Never	31	12.6%
	2	Less than 1 time per month	31	12.6%
	3	1-3 times per month	47	19.0%
	4	1 time per week	23	9.3%
	5	2-6 times per week	55	22.3%
	6	1 time per day	24	9.7%
	7	2 or more times per day	20	8.1%
Missing Values	System		16	6.5%

Hgt_1_new		Value
Standard Attributes	Label	Hgt_1_new
	Type	Numeric
	Measurement	Scale
N	Valid	245
	Missing	2
Central Tendency and Dispersion	Mean	5.1061
	Standard Deviation	.35782
	Percentile 25	5.0000
	Percentile 50	5.0000

	Percentile 75	5.0000

Hgt_inches		Value
Standard Attributes	Label	<none>
	Type	Numeric
	Measurement	Scale
N	Valid	245
	Missing	2
Central Tendency and Dispersion	Mean	61.2735
	Standard Deviation	4.29386
	Percentile 25	60.0000
	Percentile 50	60.0000
	Percentile 75	60.0000

Hgt_2new		Value
Standard Attributes	Label	Hgt_2new
	Type	Numeric
	Measurement	Scale
N	Valid	244
	Missing	3
Central Tendency and Dispersion	Mean	5.2541
	Standard Deviation	3.02952
	Percentile 25	3.0000
	Percentile 50	5.0000
	Percentile 75	7.0000

HgtCombined		Value
Standard Attributes	Label	<none>
	Type	Numeric
	Measurement	Scale
N	Valid	244
	Missing	3
Central Tendency and Dispersion	Mean	66.5328
	Standard Deviation	3.76727
	Percentile 25	64.0000
	Percentile 50	66.0000
	Percentile 75	69.0000

BMI		Value
Standard Attributes	Label	<none>
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	29.8825
	Standard Deviation	7.95196
	Percentile 25	25.8245
	Percentile 50	29.5205
	Percentile 75	33.6291

BMI_Cat		Value	Count	Percent
Standard Attributes	Label	<none>		
	Type	Numeric		
	Measurement	Ordinal		
Valid Values	0	NORMAL	45	18.2%
	1	UNDERWEIGHT	8	3.2%
	2	OVERWEIGHT	72	29.1%
	3	OBESE	101	40.9%
Missing Values	System		21	8.5%

Freshfruits_newff		Value
Standard Attributes	Label	Freshfruits_newff, all kind, raw (1)
	Type	Numeric
	Measurement	Scale
N	Valid	234
	Missing	13
Central Tendency and Dispersion	Mean	1.1638
	Standard Deviation	.73663
	Percentile 25	.6000
	Percentile 50	1.0000
	Percentile 75	2.0000

Driedfruits_newff		Value
Standard Attributes	Label	Driedfruits_newff, all kind (1/4 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	219
	Missing	28
Central Tendency and Dispersion	Mean	.44
	Standard Deviation	.598
	Percentile 25	.02
	Percentile 50	.14
	Percentile 75	.60

Melons_newff		Value
Standard Attributes	Label	Melons_newff, all kind, cut (1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	226
	Missing	21
Central Tendency and Dispersion	Mean	.45
	Standard Deviation	.619
	Percentile 25	.02
	Percentile 50	.14
	Percentile 75	.60

CanFrozenFruit_newff		Value
Standard Attributes	Label	CanFrozenFruit_newff, (1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	226
	Missing	21
Central Tendency and Dispersion	Mean	.631
	Standard Deviation	.7114
	Percentile 25	.080
	Percentile 50	.370
	Percentile 75	1.000

Avacado_newff		Value
Avacado_newff Standard Attributes	Label	Avacado_newff, (1/2 or 1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	215
	Missing	32
Central Tendency and Dispersion	Mean	.25
	Standard Deviation	.433
	Percentile 25	.00
	Percentile 50	.02
	Percentile 75	.60

Cookedvegs_newff		Value
Standard Attributes	Label	Cookedvegs_newff, (1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	233
	Missing	14
Central Tendency and Dispersion	Mean	1.05
	Standard Deviation	.685
	Percentile 25	.60
	Percentile 50	1.00
	Percentile 75	2.00

Cookedrootvegs_newff		Value
Standard Attributes	Label	Cookedrootvegs_newff, (1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	226
	Missing	21
Central Tendency and Dispersion	Mean	.41
	Standard Deviation	.611
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.60

Cookedgreens_newff		Value
Standard Attributes	Label	Cookedgreens_newff, (1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	231
	Missing	16
Central Tendency and Dispersion	Mean	.56
	Standard Deviation	.624
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

RawVegs_newff		Value
Standard Attributes	Label	RawVegs_newff, all kind (1 package serving or 1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	223
	Missing	24
Central Tendency and Dispersion	Mean	.58
	Standard Deviation	.655
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

Lettuce_newff		Value
Standard Attributes	Label	Lettuce_newff, raw (2 cup serving)
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	.57
	Standard Deviation	.594
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	.60

FriedPotFF_newff		Value
Standard Attributes	Label	FriedPotFF_newff, (6 oz. or 1 serving)
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	.45
	Standard Deviation	.569
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

Crackers_newff		Value
Standard Attributes	Label	Crackers_newff, (6)
	Type	Numeric
	Measurement	Scale
N	Valid	222
	Missing	25
Central Tendency and Dispersion	Mean	.53
	Standard Deviation	.590
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

ColdbreakCereal_newff		Value
Standard Attributes	Label	ColdbreakCereal_newff, (1 package serving or 1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	224
	Missing	23
Central Tendency and Dispersion	Mean	.43
	Standard Deviation	.549
	Percentile 25	.02
	Percentile 50	.14
	Percentile 75	.60

CookedCereal_newff		Value
Standard Attributes	Label	CookedCereal_newff, (1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	230
	Missing	17
Central Tendency and Dispersion	Mean	.60
	Standard Deviation	.605
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

WholeGrBread_newff		Value
Standard Attributes	Label	WholeGrBread_newff, (1 slice)
	Type	Numeric
	Measurement	Scale
N	Valid	230
	Missing	17
Central Tendency and Dispersion	Mean	.56
	Standard Deviation	.584
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

BagelsMufBis_newff		Value
Standard Attributes	Label	BagelsMufBis_newff, (1)
	Type	Numeric
	Measurement	Scale
N	Valid	222
	Missing	25
Central Tendency and Dispersion	Mean	.30
	Standard Deviation	.470
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.60

PastaCous_newff		Value
Standard Attributes	Label	PastaCous_newff, (1cup)
	Type	Numeric
	Measurement	Scale
N	Valid	220
	Missing	27
Central Tendency and Dispersion	Mean	.31
	Standard Deviation	.421
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

WhiteBreadPita_newff		Value
Standard Attributes	Label	WhiteBread Pita_newff, (1slice)
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	.30
	Standard Deviation	.511
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.60

NutsSeeds_newff		Value
Standard Attributes	Label	NutsSeeds_newff, (1/4 cup or 1 ounce)
	Type	Numeric
	Measurement	Scale
N	Valid	232
	Missing	15
Central Tendency and Dispersion	Mean	.69
	Standard Deviation	.650
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

DryBeansLent_newff		Value
Standard Attributes	Label	DryBeansLent_newff, (1/2 cup or 1 cup bean soup)
	Type	Numeric
	Measurement	Scale
N	Valid	229
	Missing	18
Central Tendency and Dispersion	Mean	.38
	Standard Deviation	.497
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

CheeseAll_newff		Value
Standard Attributes	Label	CheeseAll_newff, (1 slice or 1 ounce)
	Type	Numeric
	Measurement	Scale
N	Valid	231
	Missing	16
Central Tendency and Dispersion	Mean	.59
	Standard Deviation	.557
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

MlkYogCotCh_newff		Value
Standard Attributes	Label	MlkYogCotCh_newff, (1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	.54
	Standard Deviation	.605
	Percentile 25	.02
	Percentile 50	.60
	Percentile 75	1.00

IceCrm_newff		Value
Standard Attributes	Label	IceCrm_newff, (1/2 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	232
	Missing	15
Central Tendency and Dispersion	Mean	.24
	Standard Deviation	.396
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.14

PlantMlk_newff		Value
Standard Attributes	Label	PlantMlk_newff, (1 cup)
	Type	Numeric
	Measurement	Scale
N	Valid	221
	Missing	26
Central Tendency and Dispersion	Mean	.42
	Standard Deviation	.626
	Percentile 25	.00
	Percentile 50	.08
	Percentile 75	.60

BeefPorkWldgame_newff		Value
Standard Attributes	Label	BeefPorkWldgame_newff, (4-6 ozs. cooked)
	Type	Numeric
	Measurement	Scale
N	Valid	232
	Missing	15
Central Tendency and Dispersion	Mean	.58
	Standard Deviation	.605
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

ChickTurkey_newff		Value
Standard Attributes	Label	ChickTurkey_newff, (3 ozs. cooked)
	Type	Numeric
	Measurement	Scale
N	Valid	230
	Missing	17
Central Tendency and Dispersion	Mean	.75
	Standard Deviation	.614
	Percentile 25	.60
	Percentile 50	.60
	Percentile 75	1.00

Fish_newff		Value
Standard Attributes	Label	Fish_newff, (3-5 ozs. cooked)
	Type	Numeric
	Measurement	Scale
N	Valid	226
	Missing	21
Central Tendency and Dispersion	Mean	.44
	Standard Deviation	.548
	Percentile 25	.08
	Percentile 50	.14
	Percentile 75	.60

ProcMeats_newff		Value
Standard Attributes	Label	ProcMeats_newff, (1 serving)
	Type	Numeric
	Measurement	Scale
N	Valid	229
	Missing	18
Central Tendency and Dispersion	Mean	.28
	Standard Deviation	.441
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.60

EggsEggSub_newff		Value
Standard Attributes	Label	EggsEggSub_newff, (1 egg)
	Type	Numeric
	Measurement	Scale
N	Valid	235
	Missing	12
Central Tendency and Dispersion	Mean	.63
	Standard Deviation	.585
	Percentile 25	.14
	Percentile 50	.60
	Percentile 75	1.00

TofuVegBurger_newff		Value
Standard Attributes	Label	TofuVegBurger_newff, (3-4 ozs.)
	Type	Numeric
	Measurement	Scale
N	Valid	230
	Missing	17
Central Tendency and Dispersion	Mean	.18
	Standard Deviation	.386
	Percentile 25	.00
	Percentile 50	.02
	Percentile 75	.14

NutButters_newff		Value
Standard Attributes	Label	NutButters_newff, (2 tablespoons)
	Type	Numeric
	Measurement	Scale
N	Valid	231
	Missing	16
Central Tendency and Dispersion	Mean	.45
	Standard Deviation	.579
	Percentile 25	.02
	Percentile 50	.14
	Percentile 75	.60

Fruitjuices_newff		Value
Standard Attributes	Label	Fruitjuices_newff, 100% (small glass)
	Type	Numeric
	Measurement	Scale
N	Valid	224
	Missing	23
Central Tendency and Dispersion	Mean	.71
	Standard Deviation	.736
	Percentile 25	.08
	Percentile 50	.60
	Percentile 75	1.00

PancakesWafTort_newff		Value
Standard Attributes	Label	PancakesWafTort_newff, (2)
	Type	Numeric
	Measurement	Scale
N	Valid	229
	Missing	18
Central Tendency and Dispersion	Mean	.28
	Standard Deviation	.472
	Percentile 25	.02
	Percentile 50	.08
	Percentile 75	.14

FruitsTotal

		Value
Standard Attributes	Label	Fruits total
	Type	Numeric
	Measurement	Scale
N	Valid	203
	Missing	44
Central Tendency and Dispersion	Mean	3.55
	Standard Deviation	2.358
	Percentile 25	1.88
	Percentile 50	3.10
	Percentile 75	4.80

VegTotal

		Value
Standard Attributes	Label	Veg total
	Type	Numeric
	Measurement	Scale
N	Valid	208
	Missing	39
Central Tendency and Dispersion	Mean	3.53
	Standard Deviation	2.584
	Percentile 25	1.64
	Percentile 50	2.98
	Percentile 75	4.66

GrBreadTotal		Value
Standard Attributes	Label	GrBread total
	Type	Numeric
	Measurement	Scale
N	Valid	194
	Missing	53
Central Tendency and Dispersion	Mean	3.18
	Standard Deviation	2.897
	Percentile 25	1.26
	Percentile 50	2.38
	Percentile 75	4.16

DairyTotal		Value
Standard Attributes	Label	Dairy total
	Type	Numeric
	Measurement	Scale
N	Valid	212
	Missing	35
Central Tendency and Dispersion	Mean	1.75
	Standard Deviation	1.558
	Percentile 25	.73
	Percentile 50	1.34
	Percentile 75	2.21

LegumesNutsTotal		Value
Standard Attributes	Label	Legumes and nuts total
	Type	Numeric
	Measurement	Scale
N	Valid	227
	Missing	20
Central Tendency and Dispersion	Mean	1.06
	Standard Deviation	1.002
	Percentile 25	.16
	Percentile 50	.74
	Percentile 75	1.60

MeatFishTotal		Value
Standard Attributes	Label	Meats and fish total
	Type	Numeric
	Measurement	Scale
N	Valid	218
	Missing	29
Central Tendency and Dispersion	Mean	2.02
	Standard Deviation	1.747
	Percentile 25	.84
	Percentile 50	1.76
	Percentile 75	2.40

OtherProteinTotal		Value
Standard Attributes	Label	Other Protein total
	Type	Numeric
	Measurement	Scale
N	Valid	226
	Missing	21
Central Tendency and Dispersion	Mean	1.24
	Standard Deviation	1.075
	Percentile 25	.60
	Percentile 50	1.03
	Percentile 75	1.74

FV_amt_new		Value	Count	Percent
Standard Attributes	Label	FV_amt_new, How many servings of fruits and vegetables does USDA's Choose My Plate recommend that adults eat daily?		
	Type	Numeric		
	Measurement	Scale		
N	Valid	195		
	Missing	52		
Central Tendency and Dispersion	Mean	4.47		
	Standard Deviation	2.386		
	Percentile 25	3.00		
	Percentile 50	4.00		

	Percentile 75	5.00		
Labeled Values	1	1 Serving	9	3.6%
	2	2 Servings	24	9.7%
	3	3 Servings	49	19.8%
	4	4 Servings	31	12.6%
	5	5 Servings	37	15.0%
	6	6 Servings	15	6.1%
	7	7 Servings	7	2.8%
	8	8 Servings	8	3.2%
	9	9 Servings	6	2.4%
	10	10 Servings	4	1.6%
	11	11 Servings	1	0.4%
	12	12 Servings	2	0.8%
	13	13 Servings	2	0.8%
	14	14 Servings	0	0.0%
	15	15 Servings	0	0.0%

Prediabetes_combined		Value	Count	Percent
Standard Attributes	Label	Prediabetes combined		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0		165	66.8%
	1		33	13.4%
	2		14	5.7%
	3		2	0.8%
	4		1	0.4%
Missing Values	System		32	13.0%

Prediabetes_New		Value	Count	Percent
Standard Attributes	Label	Prediabetes _New		
	Type	Numeric		
	Measureme nt	Nominal		
Valid Values	0	No	165	66.8%
	1	Yes	82	33.2%

FruitsCutoff		Value	Count	Percent
Standard Attributes	Label	FruitsCuto ff		
	Type	Numeric		
	Measureme nt	Nominal		
Valid Values	0	Not Met	117	47.4%
	1	Met	130	52.6%

VegCutoff		Value	Count	Percent
Standard Attributes	Label	VegCutof f		
	Type	Numeric		
	Measureme nt	Nominal		
Valid Values	0	Not Met	163	66.0%
	1	Met	84	34.0%

GrBreadCutoff		Value	Count	Percent
Standard Attributes	Label	GrBreadCutoff		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	176	71.3%
	1	Met	71	28.7%

DairyCutoff		Value	Count	Percent
Standard Attributes	Label	DairyCutoff		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	192	77.7%
	1	Met	55	22.3%

Protein_VegSources		Value
Standard Attributes	Label	Legumes, nuts and other proteins combined for calculating MyPlate protein cutoff
	Type	Numeric
	Measurement	Scale
N	Valid	221
	Missing	26
Central Tendency and Dispersion	Mean	2.280
	Standard Deviation	1.7353

	Percentile 25	1.120
	Percentile 50	1.940
	Percentile 75	2.880

Protein_VegSourcesCutoff		Value	Count	Percent
Standard Attributes	Label	Protein_VegSourcesCutoff		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	197	79.8%
	1	Met	50	20.2%

Fruits2000		Value	Count	Percent
Standard Attributes	Label	Fruits2000 for 2000 calorie diet		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	127	51.4%
	1	Met	120	48.6%

PlantBased_Total		Value
Standard Attributes	Label	Plant-based total of all plant groups
	Type	Numeric
	Measurement	Scale
N	Valid	162
	Missing	85
Central Tendency and Dispersion	Mean	11.84
	Standard Deviation	7.134
	Percentile 25	7.26
	Percentile 50	10.74
	Percentile 75	14.08

PlantBased_Total_Cutoff		Value	Count	Percent
Standard Attributes	Label	PlantBased_Total_Cutoff		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	148	59.9%
	1	Met	99	40.1%

Veg2000		Value	Count	Percent
Standard Attributes	Label	Veg2000 for 2000 calorie diet		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	163	66.0%
	1	Met	84	34.0%

GrainBread2000		Value	Count	Percent
Standard Attributes	Label	GrainBread2000 for 2000 calorie diet		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0		176	71.3%
	1		71	28.7%

Dairy2000		Value	Count	Percent
Standard Attributes	Label	Dairy2000 for 2000 calorie diet		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	181	73.3%
	1	Met	66	26.7%

Protein2000		Value	Count	Percent
Standard Attributes	Label	Protein2000 for 2000 calorie diet		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	181	73.3%
	1	Met	66	26.7%

Fruits2600		Value	Count	Percent
Standard Attributes	Label	Fruits2600		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	127	51.4%
	1	Met	120	48.6%

Veg2600		Value	Count	Percent
Standard Attributes	Label	Veg2600		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	185	74.9%
	1	Met	62	25.1%

GrainBread2600		Value	Count	Percent
Standard Attributes	Label	GrainBread2600		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	186	75.3%
	1	Met	61	24.7%

Dairy2600		Value	Count	Percent
Standard Attributes	Label	Dairy2600		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	181	73.3%
	1	Met	66	26.7%

Protein2600		Value	Count	Percent
Standard Attributes	Label	Protein2600		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	0	Not Met	197	79.8%
	1	Met	50	20.2%

Fruits2400

		Value	Count	Percent
Standard Attributes	Label	Fruits2400		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		127	51.4%
	1.00		120	48.6%

Veg2400

		Value	Count	Percent
Standard Attributes	Label	Veg2400		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		171	69.2%

	1.00		76	30.8%

GrainBread2400		Value	Count	Percent
Standard Attributes	Label	GrainBread2400		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		186	75.3%
	1.00		61	24.7%

Dairy2400		Value	Count	Percent
Standard Attributes	Label	Dairy2400		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		181	73.3%
	1.00		66	26.7%

Protein2400		Value	Count	Percent
Standard Attributes	Label	Protein2400		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		189	76.5%
	1.00		58	23.5%

Fruits1800		Value	Count	Percent
Standard Attributes	Label	Fruits1800		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		91	36.8%
	1.00		156	63.2%

Veg1800		Value	Count	Percent
Standard Attributes	Label	Veg1800		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		163	66.0%
	1.00		84	34.0%

GrainBread1800		Value	Count	Percent
Standard Attributes	Label	GrainBread1800		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		176	71.3%
	1.00		71	28.7%

Dairy1800		Value	Count	Percent
Standard Attributes	Label	Dairy1800		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		181	73.3%
	1.00		66	26.7%

Protein1800		Value	Count	Percent
Standard Attributes	Label	Protein1800		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.00		168	68.0%
	1.00		79	32.0%

Avg_CombA1c		Value
Standard Attributes	Label	<none>
	Type	Numeric
	Measurement	Scale
N	Valid	14
	Missing	233
Central Tendency and Dispersion	Mean	6.5107
	Standard Deviation	1.71556
	Percentile 25	5.6500
	Percentile 50	6.3000
	Percentile 75	7.2000

A1c_kit_Cat		Value	Count	Percent
Standard Attributes	Label	A1c_kit_Cat		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.0	Normal	53	21.5%
	1.0	Prediabetes	10	4.0%
	2.0	Diabetes	9	3.6%
Missing Values	System		175	70.9%

DrA1c__1_TEXT_Cat		Value	Count	Percent
Standard Attributes	Label	DrA1c__1_TEXT_Cat		
	Type	Numeric		
	Measurement	Nominal		
Valid Values	.0	Normal	12	4.9%
	1.0	Prediabetes	10	4.0%
	2.0	Diabetes	14	5.7%
Missing Values	System		211	85.4%

APPENDIX J: HARVARD CHEN PUBLIC HEALTH'S FREQUENCY FACTOR SCORING LIST

How do I calculate the number of servings of fruits or vegetables per day?

If you would like to calculate the number of servings of any food grouping, you must sum the daily frequencies reported for the foods you select to represent your group. The frequency weights for the 2007 Grid (grid07) and Booklet (bklt07) FFQ's are listed below.

Example: grid07 servings of fruit per day
Participant reports:

Bananas 1-3 per month
Cantaloupe 1 per day
Orange 2-4 per week
Other fruit juices 2-3 times per day

Frequency factors:
Bananas – 0.08
Cantaloupe – 1.0
Oranges – 0.43
Other fruit juices – 2.5

Sum frequency factors: 0.08 + 1.0 + 0.43 + 2.5 = 4.01 servings per day of fruits

********************Grid07 frequency factors:******************************

ffwgt0	0; never (default for no answer)
ffwgt1	0.08; 1-3/mo
ffwgt2	0.14; 1/wk
ffwgt3	0.43; 2-4/wk
ffwgt4	0.8; 5-6/wk
ffwgt5	1; 1/day
ffwgt6	2.5; 2-3/day
ffwgt7	4.5; 4-5/day
ffwgt8	6; 6/day
ffwgt9	0; passthru

*******************Bklt07 frequency factors: ******************************

ff1wgt1	0; never
ff1wgt2	0.02; less than 1/mo
ff1wgt3	0.08; 1-3/mo
ff1wgt4	0.14; 1/wk
ff1wgt5	0.43; 2-4/wk
ff1wgt6	0.8; 5-6/wk

ff1wgt7	1; 1/day
ff1wgt8	2.5; 2-3/day
ff1wgt9	4; 4+/day
ff1wgt10	0; passthru
ff2wgt1	0; never
ff2wgt2	0.02; less than 1/mo
ff2wgt3	0.08; 1-3/mo
ff2wgt4	0.14; 1/wk
ff2wgt5	0.43; 2-4/wk
ff2wgt6	0.8; 5-6/wk
ff2wgt7	1; 1/day
ff2wgt8	2; 2+/day
ff2wgt9	0; passthru
ff3wgt1	0; never
ff3wgt2	0.02; less than 1/mo
ff3wgt3	0.08; 1-3/mo
ff3wgt4	0.14; 1/wk
ff3wgt5	0.43; 2-4/wk
ff3wgt6	0.8; 5-6/wk
ff3wgt7	1; 1/day
ff3wgt8	0; passthru
ff4wgt1	0; never
ff4wgt2	0.02; less than 1/mo
ff4wgt3	0.08; 1-3/mo
ff4wgt4	0.14; 1/wk
ff4wgt5	0.43; 2-4/wk
ff4wgt6	0.8; 5-6/wk
ff4wgt7	0; passthru
ff5wgt1	0; never
ff5wgt2	0.02; less than 1/mo
ff5wgt3	0.08; 1-3/mo
ff5wgt4	0.14; 1/wk
ff5wgt5	0.43; 2-4/wk
ff5wgt6	0.8; 5-6/wk
ff5wgt7	1; 1/day
ff5wgt8	2.5; 2-3/day
ff5wgt9	4.5; 4-5/day
ff5wgt10	6; 6+/day
ff5wgt11	0; passthru
ff6wgt1	0; never

ff6wgt2	0.02; less than 1/mo
ff6wgt3	0.03; 1/mo
ff6wgt4	0.08; 2-3/mo
ff6wgt5	0.14; 1/wk
ff6wgt6	0.43; 2+/wk
ff6wgt7	0; passthru

Harvard University (2007). Retrieved from

https://regepi.bwh.harvard.edu/health/FFQ/files