EXPLORING THE ASSOCIATION BETWEEN EATING A WHOLE FOOD PLANT-BASED DIET AND REDUCING CHRONIC DISEASES: A CRITICAL LITERATURE SYNTHESIS

by

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ABSTRACT

Nearly 70% of the population of the United States is at increased risk for chronic illness because of dietary related health conditions. Half of all adults, 117 million people, have one or more preventable diet associated chronic diseases. The current state of the nation's health is a serious public health concern as 1.5 million Americans die annually due to conditions related to dietary intake. The risks for chronic disease, such as obesity, are greater for segments of the population unable to afford healthier, nutritionally-dense food, especially low populations with low socioeconomic status and communities of color. This has created serious and significant health inequities.

In the United States, healthcare spending accounts for more than 17% of the US economy. Chronic diseases, related conditions, and the health risk behaviors that cause them now account for most health care costs making these diseases a significant public health concern. Eighty-six percent of all health care spending in 2010 was for people with one or more chronic medical conditions.

A literature search was conducted in SCOPUS and PubMed to address the following research question: *Is there an association between eating a whole food plant-based diet and reduced rates of chronic diseases?* This thesis examines the effects of eating a WFPB diet on the risk of chronic diseases and the prevention and mitigation of chronic diseases after diagnosis.

Increasing the dietary intake of whole plant-based diet may help to prevent, reduce or even reverse certain chronic illnesses in the population. A diet consisting largely of unprocessed or primarily unprocessed healthy vegetables, fruits, whole grains, legumes, and beans might enable the US population to address the hyper-endemic level of chronic illnesses that have resulted from more than 40 years of eating the Western or Standard American Diet (SAD).

These results have public health significance because they may help future researchers, public health and medical professionals, and policymakers as they look toward addressing and reducing the level of diet-related illnesses among the population, especially those who regularly experience health inequities.

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PREFACE

Let food be thy medicine--Hippocrates (460-375 B.C.)

"You can't be vegetarian; our family karma is kosher meat!" Over and over as a young teenager at family gatherings I was reminded in no uncertain terms that as the grandson, son, and nephew of kosher butchers, it was against the family's karma for anyone to forego meat. In fact, I was also taught that one serving of meat was not enough. Not only did I have to clean my plate because there were "children starving in China," I needed to eat all that was given to me and then some since my father worked hard for that meat.

These earliest experiences, I am sure, helped to pave the way for my disordered eating habits, teaching me that I should live to eat, rather than eat to live. It has taken me nearly a lifetime to unravel so much of this conditioning to approach food and eating in a saner and healthier way.

The food recovery journey I began in 2010 allowed me to dramatically change my eating habits so that I could lose 130 pounds in 11 months. Giving up sugar in its many forms, high fat foods, and junk and processed foods has been central to my recovery and improved health profile. Most significantly, during these seven years, I returned to graduate school with the goal of serving others also struggling with their health and wellbeing. My lifelong passion for learning coupled with new research skills have allowed me to strive toward this goal. Beginning with a very personal eating journey, I now have a greater understanding of what and how much we eat as a nation and how this relates to the dramatic rise in chronic diseases in America during the past 50 years.

Social work and public health coursework as well as field placement internships have given me opportunities to explore critical issues of health and nutrition such as access and affordability

of healthy food. Gaining knowledge of the social determinants of health, proper nutrition, and theories of behavior change have enabled me to create an overall framework for this inquiry. This thesis comes out my previous research in two Behavior and Community Health Science classes in the Graduate School of Public Health, Program Planning and Proposal Writing and Theories of Human Behavior and Health Education. Its primary goal is to inform public health, social work, and healthcare professionals working with populations at-risk for chronic illness about the association between eating a whole food plant-based diet and the reduction of chronic diseases.

Finally, I am extremely grateful to the members of the thesis committee, especially Dr. Mary Hawk for her wisdom, guidance, and patience shared with me along the way. Also, I am thankful to the faculty, staff, and classmates in both schools, Social Work and Public Health, for the knowledge I have gained and the enduring friendships I have made. Words alone cannot express my heartfelt thanks for all that I have experienced during this process. May I be worthy of the degrees conveyed upon me now and in the future.

1.0 INTRODUCTION

People living in the United States are engaged in daily dietary practices that are associated with enormous suffering and death from chronic diseases. The current state of the nation's health is a serious public health concern as 1.5 million Americans die annually due to conditions related to dietary intake including heart disease, obesity, cancer, type 2 diabetes, kidney disease, Parkinson's, high blood pressure, stroke, and others (CDC, 2016a; Greger & Stone, 2015; HHS, 2015; Katzke, Kaaks, & Kühn, 2015; Makarem, Lin, Bandera, Jacques, & Parekh, 2015; Segal, Rayburn, & Martin, 2016; Song et al., 2016). Communities living with low socio-economic status and communities of color experience more dietary-related chronic diseases, especially higher rates of obesity, Type 2 diabetes, and heart disease than the rest of the population (CDC, 2016a; K. Flegal, Kruszon-Moranm D., & Carroll, 2016; Gadiraju, Patel, Gaziano, & Djousse, 2015). These subpopulations rank lower in their adherence to dietary recommendations than higher income groups (Kirkpatrick, Dodd, Reedy, & Krebs-Smith, 2012). Together, the state of nation's dietary-related health conditions and especially the gross health inequities in certain communities are of great public health significance.

Indeed, grave concerns about the increasing health costs, declining lifespan and expanding waistlines of the population have been among the driving forces behind researchers, scientists, and medical professionals investigating a dietary approach aimed at reversing, preventing, and healing these chronic conditions alongside the more traditional approaches of medication and bariatric

surgery (Campbell & Jacobson, 2013; J. C. Esselstyn, Gendy, Doyle, Golubic, & Roizen, 2014; McDougall et al., 2014; Ornish et al., 1990; Ornish et al., 2008). Many of these chronic diseases and conditions are among the most common, costly, and yet preventable of all health problems (Gerteis et al., 2014). During the past 40 years, the increase of chronic diseases has been related to the population's growing consumption of the Western or Standard American Diet (SAD), a diet high in fats, sugar, salt, highly-refined grains, meat and dairy with few fruits, vegetables or whole grains (Colin-Ramirez et al., 2014; Jacob, 2013; Marsh, Saunders, & Zeuschner, 2015; Murphy, Velazquez, & Herbert, 2015; Murray et al., 2013; Odermatt, 2011; USDA & USHHS, 1990; USDA-ERS, 2015).

The primary purpose of this thesis is to examine what relationship may exist between eating a whole food plant-based (WFPB) and reducing chronic illnesses now plaguing the population. I will outline key dietary-related chronic diseases and the costs of these diseases, including the impact of more than 40 years of consuming the Western or Standard American Diet (SAD) on the population's health. Also, an examination of dietary-related health inequities for those in the population with low SES and communities of color will be presented. A section delineating the methodology employed for the literature search follows. Next, I will put forward the findings of the literature review that will examine the scientific research regarding associations between eating a WFPB diet and reducing heart disease, obesity, type 2 diabetes, and kidney disease. A discussion chapter will explore the implications of the findings, especially their public health significance. Lastly, the conclusion will summarize the major findings, present the limitations, and offer recommendations for future steps.

2.0 BACKGROUND

2.1 CHRONIC DISEASES

The World Health Organization (WHO) defines chronic diseases as those that are not passed from person to person, unlike contagious or communicable diseases, and divides them into four categories: (1) cardiovascular diseases (like heart attacks and stroke), (2) cancers, (3) chronic respiratory diseases and (4) diabetes (WHO, 2017). These diseases are of long duration and usually slow progression. They may result in complete or partial disability, even leading to death. They may be the result of a combination of factors including behavioral factors (diet, for example), environmental conditions, physiology and genetic composition. Worldwide these diseases are associated with 31 million deaths annually and disproportionally affect low- and middle-income countries and communities.

Modifiable risk factors that contribute to chronic diseases include unhealthy diets, lack of physical activity, as well as tobacco smoke and abusive use of alcohol. Cardiovascular diseases account for most deaths, or 17.7 million people annually, followed by cancers (8.8 million), respiratory diseases (3.9 million), and diabetes (1.6 million). These 4 groups of diseases account for 81% of all chronic illness deaths (WHO, 2017). The WHO warns that "NCDs currently cause more deaths than all other causes combined and that such deaths are projected to increase from 38 million in 2012 to 52 million by 2030" (Mendis, 2014, p. 8).

In the United States, the four categories of chronic diseases account for over 400 deaths per 100,000 population annually (Mendis, 2014, p. 10). One of four adults had two or more chronic health conditions in 2012 (Ward, Schiller, & Goodman, 2014). The probability of dying from a

chronic disease for those between the ages of 30 and 70 in the US is 14.3%. Due to behavioral risk factors, especially diet, the US rate of death associated with chronic illnesses is higher when compared to other high-income Western countries such Sweden, 9.9%, France, 11.4%, Germany 12.3%, Italy 9.8%, Australia 9.4% or Asian countries such as South Korea 9.3%, Japan 9.3% or Singapore 10.5% (Mendis, 2014, p. 12).

Worldwide the costs of chronic diseases are staggering. Muka et al. (2015) reports that **"**…chronic conditions undermine national economic development, with estimated losses in national income in excess of 600 billion USD." (p. 271) However, it should be noted that, "the majority of premature NCD deaths are preventable" (Mendis, 2014, p. vii).

2.2 COSTS ASSOCIATED WITH DIETARY-RELATED CHRONIC DISEASES

In the United States, health care spending accounts for more than 17% of the US economy (Dieleman et al., 2016). Chronic illnesses, related conditions, and the health risk behaviors that cause them now account for most of the health care costs, making these diseases a significant public health concern. Eighty-six percent of all health care spending in 2010 was for people with one or more chronic medical conditions (Gerteis et al., 2014). Chronic diseases and conditions—such as heart disease, stroke, cancer, type 2 diabetes, obesity, and arthritis—are among the most common, costly and preventable of all health problems (Gerteis et al., 2014).

According to the Centers for Disease Control and Prevention (CDC) the costs in the United States related to specific chronic diseases continue to rise. The total costs of heart disease and stroke in 2010 were estimated to be $315.4 billion. Of this amount, $193.4 billion was for direct medical costs, not including costs of nursing home care (Go et al., 2014). Muka et al. (2015) in a

systematic review conclude, “In most countries, the highest expenditure was attributable to cardiovascular disease (CVD). Between 12 and 16.5 % of the overall healthcare budget is spent on this one condition alone”. (p. 271)

The total estimated cost of diagnosed diabetes in 2012 was $245 billion (41% increase over 5-year period), including $176 billion in direct medical costs and $69 billion in decreased productivity (HHS, 2015). Decreased productivity includes costs associated with people being absent from work, being less productive while at work, or not being able to work at all because of diabetes (ADA, 2013). Honeycutt et al. (2013) reported that in 2004, “per person annual Medicare expenses attributable to chronic kidney disease (CKD) are $1700 for stage 2, $3500 for stage 3, and $12,700 for stage 4, adjusted to 2010 dollars. Our findings suggest that the medical costs attributable to CKD are substantial among Medicare beneficiaries, even during the early stages; moreover, costs increase as disease severity worsens” (p 1478). Using data from the National Health and Nutrition Examination Survey and Medicare claims, researchers stated that the annual medical cost for CKD for stages 1 – 4 as $49.5 billion dollars (Honeycutt et al., 2013; Landro, 2013).

Obesity has become a significant chronic condition as well as a driver of other chronic diseases and continues to be a serious threat to the population’s well-being. Obesity and overweight may defined as:

> …an excessively high amount of body fat or adipose tissue in relation to lean body mass. Overweight refers to increased body weight in relation to height, which is then compared to a standard of acceptable weight. Body mass index is a common measure expressing the relationship (or ratio) of weight to height. Adults

> with a BMI of 25 to 29.9 are considered overweight, while individuals with a BMI of 30 or more are considered obese. Adults with a BMI of 35 or higher and an obesity-related condition (e.g., diabetes) and adults with a BMI of 40 or higher are considered severely obese. (K. Flegal et al., 2016; Segal et al., 2016)

Obesity and overweight contributes to more than $147 to $210 billion dollars in preventable healthcare spending (Cawley & Meyerhoefer, 2012). Annual medical costs for people who are obese were $1,429 higher than those for people of normal weight in 2006 (Finkelstein, Trogdon, Cohen, & Dietz, 2009). The country's level of obesity fits into a worldwide pattern according to the World Health Organization with 1.5 billion adults overweight and 500 million obese (Okreglicka, 2015). Wang, McPherson, Marsh, Gortmaker, and Brown (2011) offered that "the combination of rising obesity prevalence and increased spending on obese people has been estimated to account for 27% of the growth in US healthcare expenditure between 1987 and 2001. Total healthcare costs attributable to obesity and overweight are projected to double every decade to account for 16–18% of total US healthcare expenditure by 2030". (p. 815)

Finally, about obesity, Finkelstein et al., (2012) discussed the savings that could result if obesity prevention programs prevail: "If obesity were to remain at 2010 levels, the combined savings in medical expenditures over the next 2 decades would be $549.5 billion." (p.568)

2.3 STANDARD AMERICAN DIET AND CHRONIC DISEASES

Nearly 70% of the population of the United States is at increased risk for chronic illness because of dietary related health conditions, according to the Healthy People 2020 guidelines, the Office of Disease Prevention and Health Promotion (ODPHP), and the Robert W. Johnson Foundation. (HHS, 2015; ODPHP, 2014 ; Segal et al., 2016). Table 1 below is excerpted and presents a portion of current DGA 2015-2020 for three calorie intake levels for omnivores (HHS, 2015).

Table 1: Dietary Guidelines for Americans: Healthy U.S.-Style Eating Pattern Recommended Amounts of Food from Each Food Group

CALORIE LEVEL OF PATTERN [1]	**1400**	**1800**	**2200**
FOOD GROUP	Daily Amount of Food from each group (subgroup amounts per week)		
VEGETABLES	**1.5 c-eq[2]**	**2.5 c-eq**	**3 c-eq**
DARK GREEN (C-EQ/WK)	1	1.5	2
RED/ORANGE	3	5.5	6
LEGUMES	.5	1.5	2
STARCHY VEG	3.5	5	6
OTHER VEG	2.5	4	5
FRUITS	**1.5**	**1.5**	**2**
GRAINS	**5 oz-eq[3]**	**6 oz-eq**	**7 oz-eq**
WHOLE **(**OZ-EQ/DAY)	2.5	3	3.5
REFINED	2.5	3	3.5

TABLE 1 CONTINUED

DAIRY	**2.5 c-eq**	**3 c-eq**	**3 c-eq**
PROTEIN FOODS	**4 oz-eq**	**5 oz-eq**	**6 oz-eq**
SEAFOOD (OZ-EQ/WK)	6	8	9
MEATS, POULTRY, EGGS (OZ-EQ/WK)19	19	23	28
NUTS SEEDS, SOY PRODUCTS (OZ-EQ/WK)	3	4	5
OILS	**17g**	**24g**	**29g**
LIMIT CALORIES FOR OTHER USES, CALORIES (% OF CALORIES	110 (8%)	170 (9%)	280 (13%)

1,400 calories designed to meet needs of 2 to 8 –year old children (high end of range).
1,800 and 2,200 calories designed to meet needs of children 9 years and older and adults.
[1] Calorie Level of Pattern is the newer terminology employed by the DGA 2015-2020 that replaces the use of the word Diet.
[2] c-eq = cup equivalent
[3] oz-eq = ounce equivalent

In the opening message of the 8th edition of the Dietary Guidelines for Americans 2015-2020, the former Secretary of U.S. Department of Health and Human Services, Sylvia M. Burwell and the former Secretary of the U.S. Department of Agriculture, Thomas J. Vilsack, wrote, “Today, about half of all American adults—117 million people—have one or more preventable, chronic diseases, many of which are related to poor quality eating patterns and physical inactivity” (HHS, 2015, p. vii). Nearly the entire population continues to consume a diet that is far removed from the

previous or current United States Department of Agriculture (USDA) Dietary Guidelines for Americans (DGA) (Bailey et al., 2015). Lower socio-economic status and race/ethnicity are correlated with lower adherence to the DGA and poorer eating habits (Kirkpatrick et al., 2012; McDaniel & Belury, 2012; Nicklas et al., 2013).

Instead, much of the population follows what is known as the Western or Standard American Diet (SAD). SAD is a calorie-rich, nutrient-poor diet. This diet is composed of primarily animal protein, with highly-refined processed food products, fats and oil, added sugar, and salt-laced foods. Additionally, the population consumes with few whole grains, vegetables, and fruit. Together, this SAD has led to a dramatic increase in the rates of diet-related chronic diseases (Hubert et al., 1983; Flegal et al., 2010; Oliveria, 2016; USDA, 2015).

Chronic illnesses such as cardiovascular diseases, high blood pressure, diabetes mellitus, cancers, kidney disease, liver disease, and obesity have been associated with the nutritional patterns of the SAD (Colin-Ramirez et al., 2014; HHS, 2015; Hu, 2013; Marsh, Saunders, & Zeuschner, 2016; Murphy et al., 2015; Odermatt, 2011; Segal et al., 2016). The SAD is also associated with a chronic inflammatory process that is part of all stages of atherosclerosis development and is recognized as a universal mechanism of various chronic degenerative diseases, such as autoimmune diseases, some cancers or osteoporosis (Okreglicka, 2015).

For more than 40 years, the diet of the United States' population has changed dramatically. There has been a highly significant increase in energy (calorie) intake. On average, there has been an increase of 458 calories per person per day, from 2,038 to 2,496 or 22.5% (see Table 2 below). Nearly the amount of calories, for example, in a McDonalds' Big Mac©, which weighs in at 540 calories with 250 of those calories from fat, (49% DV), as well as 80mg of cholesterol (26% DV), 950mg (40% DV), 9g of added sugars and just 3g of dietary fiber (13%) (McDonalds, 2017). This

per person, per day jump in calories over the past 40 years comes primarily from the food categories of fats and oils, refined grains, and sugar; the same food categories represented in the typical fast food menu item (Oliveria, 2016; USDA-ERS, 2015).

Table 2: SAD 1970 – 2010

Food Groups	Cal /Year 1970	% TOT CAL/ Year	Cal /Year 2010	% TOT CAL/ Year	Change Calories and % Change
Dairy[1]	248	0.12	235	0.09	-13 -0.05%
Cheese	38	0.02	96	0.04	+58 +152.6%
Meats	506	0.24	525	0.21	+19 +0.03%
Grains[2]	409	0.20	581	0.23	+172 + 42.1%[1]
Vegetables	129	0.06	126	0.05	-3 -0.2%
Fruits[3]	67	0.03	81	0.03	+ 14 +20%[2]
Sugars	333	0.16	373	0.15	+ 40 +12%
Fats and Oils	337	0.16	562	0.23	+ 225 +66.7%
Total Calories	**2,038**	**100%**	**2,496**	**100%**	**+ 458 + 22.5%**

[1]Dairy calories do not include Cheese. Dairy fats are excluded from Fats and Oils, but included in Total Calories.

[2]The refined grains accounted for the overwhelming amount of increase in grains calories between 1970 and 2010.

[3]The 20% increase in calories attributed to higher fruit intake is greatly misleading. The actual percentage of calories from fruit per day per person was 3.2% in 1970 and 3.2% in 2010(USDA-ERS, 2015).

According to the United States Department of Agriculture Economic Research Service (USDA-ERS), the intake of just three categories of food alone, fat and oils, cheese, and grains (refined, primarily packaged foods), has increased 455 calories per person per day. These categories increased by 66.7%, 152.6%, and 42.1%, respectively. While combined fruit and vegetable consumption amounted to only 196 calories per person per day in 1970 or just 9.6% of total daily calories. In 2010, the fruit and vegetable per person per day intake was 207 calories or 8.3%, 11 more calories a day, but a 1.3% drop per person per day over forty years. This decrease occurred at the same time the Dietary Guidelines for Americans (DGA) (see Table 3 below for current DGA 2015-2020) actively advocated for far more intake of vegetables and fruits with its variety of food pyramids and my plate programs (HHS, 2015; Liese et al., 2015; McDaniel & Belury, 2012; Nicklas et al., 2013).

Consumption of meats and sugars increased slightly in comparison to the other categories, 3.6% and 10.4%, respectively, during the same 40-year period, together representing 36% of the daily caloric intake. Most significant, combined with fats and oils and refined grains these four categories represent 84% of the total daily calories eaten by the average person; far above the suggested dietary intake even in the earliest years of the Dietary Guidelines for Americans that suggested nearly on-half that amount (S. Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010; USDA & USHHS, 1990).

Overall, the SAD consumed by the population as portrayed in the USDA-ERS in Table 2 has laid the groundwork for the hyperendemic obesity rates in the country and the many chronic illness related to these high levels of dietary intake (ODPHP, 2014 ; Sauder et al., 2015; Segal et al., 2016). C. Esselstyn (2015) and Greger (2015) suggested that consuming foods from the three categories of cheese, refined grains, and fats/oils plus high sodium foods (especially found in processed meats and cheeses) are directly associated with the population's obesity rates.

Changes in the SAD have been linked to the fifteen leading causes of premature death, taking the lives of 1.6 million Americans annually (Feigin et al., 2016; Greger, 2015; Murray et al., 2013). These illnesses include the range of heart diseases, cancer, diabetes, obesity, Parkinson's, high blood pressure, and others (Jacob, 2013; Marsh et al., 2016; Odermatt, 2011). SAD is associated with 82% of Americans having at least one risk factor for heart disease. Thirty-three percent of American adults have very high levels of cholesterol and more than 50 million Americans have high blood pressure (CDC, 2016a). High blood pressure, high cholesterol, and smoking are key risk factors for heart disease. About half of Americans (47%) have at least one of these three risk factors (Fryar, Chen, & Li, 2012). Seventy-one million American adults (33.5%) have high low-density lipoprotein (LDL), or bad cholesterol (CDC, 2011). The SAD is implicated in mortality due to cancer, diabetes, liver disease, and obesity, adversely affecting the health and well-being of the population as it is associated with the deaths of over 700,000 Americans a year (Feigin et al., 2016; Murray et al., 2013).

The diet of most Americans continues to be lacking in the intake of vegetables and fruits. Only 25% of Americans ate at least one fruit serving a day, and only about 1 in 10 ate the minimum recommended amount of vegetables (HHS, 2015; Ogden, Carroll, Kit, & Flegal, 2014). Regarding antioxidants and phytonutrients, the average amount of kale, for example, consumed per week was

approximately half a teaspoon while beer intake represented the fifth largest source of antioxidants in the SAD (Hung, Joshipura, Jiang R, & al., 2004).

In an article published within the *American Journal of Preventive Medicine*, the Standard American Diet was summarized as follows:

> …. meats and total grains were supplied generally in recommended proportions, total vegetables, total fruit, whole fruit, and milk were supplied in suboptimal proportions that changed very little over time. Saturated fat, sodium, and calories from solid fat, alcoholic beverages, and added sugars were supplied in varying degrees of unhealthy abundance over the years. Supplies of dark-green/orange vegetables and legumes and whole grains were entirely insufficient relative to recommendations, with virtually no change over time. (S. M. Krebs-Smith, Reedy, & Bosire, 2010)

The population's continued lack of healthier eating may well consign future generations to experience the fully preventable onslaught of chronic diseases that their parents and grandparents now face. For some in the population the current situation is exacerbated because of either living in low social economic status (SES) and/or being a member of a community of color.

2.4 STANDARD AMERICAN DIET AND HEALTH INEQUITIES

The risks for chronic disease including higher rates of obesity are greater for segments of the population unable to afford healthier, nutritionally-dense food, especially those with low SES and communities of color creating serious health inequities (CDC, 2016a; Ogden et al., 2014; Segal et

al., 2016). In communities of color, 48.4% of African Americans and 42.6 of Latinos are considered obese compared to 36.4% whites and 12.6% Asian Americans (K. Flegal et al., 2016). Too often, this portion of the population lacks adequate access to purchase food and knowledge about choosing healthier options (Peeters & Backholer, 2017; Wahlqvist, 2004).

To make matters worse, communities with limited access to full service grocery stores or big box stores with full grocery selections find themselves in "food deserts" (Hardin-Fanning, 2013; Segal et al., 2016). Much research has been undertaken to understand the negative relationship of living where access to heathier foods is limited. Residents in these communities are usually of lower economic status and experience negative health outcomes (Kirkpatrick et al., 2012; Segal et al., 2016).

Whether the communities are geographically isolated or lack adequate public transportation, residents in low socioeconomic-status neighborhoods struggle to find ways to access affordable nutritiously-dense foods. Too often, such areas are served by fast food restaurants, corner markets, or gasoline stations/quick markets offering only calorie-dense, nutritionally-poor foods filled with sugar, fat, and salt (Baker et al., 2006; Segal, 2016). In addition, many families in these neighborhoods face food insecurity, having to choose between paying the rent or feeding their families. Access and affordability challenges can create the perfect storm for unhealthy eating and poor health outcomes (Drewnowski, Aggarwal, Hurvitz, Monsivais, & Moudon, 2012).

3.0 METHODS

A literature search was conducted on Scopus and PubMed to address the following research question: *Is there an association between eating a whole food plant-based diet and reductions in the incidence and effects of chronic diseases?* This thesis examines the impact of a WFPB diet not only for reducing risk for chronic disease but also preventing and reversing disease after diagnosis. Inclusion criteria were articles published in English between 2007 and 2017 in order to focus upon the most recent research studies. In addition, several older, seminal articles were included because of their groundbreaking influence in the field that has led to significant research and the development of the field of lifestyle medicine. The search took place between January 8 and March 21, 2017. Articles found through the electronic search were supplemented with other articles identified through citation snowball sampling and a grey literature search of foundation and government reports.

The key words and phrases listed in Table 2 below were searched in multiple combinations. Initial searches followed a pattern of ("x disease" AND diet AND mortality) including appropriate terms to limit the years to the most recent research and only peer-reviewed journal articles.

Table 3: Search Terms and Results

Scopus and PubMed Search Terms	Articles Produced
"cardiovascular diseases" AND "Western diet" AND mortality	36
"Diabetes" AND "Western diet" AND mortality	97
"obesity" AND "Western diet" AND mortality	21
"high blood pressure" AND "Western diet" AND mortality	4
"Parkinson's disease" AND "Western diet" AND mortality	2
"liver cancer" AND "Western diet" AND mortality	1
"kidney disease" AND "Western diet" AND mortality	6
"prostate cancer" AND "Western diet" AND mortality	23
"chronic diseases AND "western diet" AND mortality	23

Table 3 Continued	
“chronic diseases” AND “plant based diet”	74
“chronic diseases” AND “vegan diet”	19
“chronic diseases” AND vegetables OR fruits AND “health benefits”	60
“plant based diet” OR “vegan diet” AND “weight loss”	41
“vegan diet” AND “obesity”	34
"plant based diet" AND “high blood pressure”	12
"plant based diet" AND “prostate cancer”	16
"plant based diet" AND “kidney disease”	5
"plant based diet" AND “ischemic heart disease”	8
“Plant-based diet” AND “diabetes”	33
"plant based diet" AND “CVD” OR “cardiovascular disease”	26
“plant based diet AND “heart disease”	20
Total Number of Articles# Total Number of Articles appearing 1 time Total Number of Additional Articles and Government Publications	561 278 62

This is an aggregate as many articles appeared multiple searches

Significant overlap existed in the results. Many publications found in Scopus overlapped with those found in PubMed. Also, overlap occurred because many of the articles found in the search (“chronic diseases” AND “plant based diet”) and (“chronic diseases” AND “vegan diet”), for example, were the identical. Articles discovered in specific disease searches overlapped as well. Search terms such as “obesity,” “diabetes,” and “cardiovascular disease” resulted in overlapping multiple matches because researchers often examined the several chronic diseases in the same study.

After reviewing abstracts of the non-duplicated articles, 126 were deemed relevant and reviewed. Relevant articles included those that (1) showed associations between plant-based eating (plant-based diet and vegan) and disease amelioration, prevention, or reversal; (2) or were seminal studies during the 1970s and 1980s that included plant-based eating in the protocol as ways to treat chronic diseases. An additional 34 peer-reviewed journal articles and government reports referenced in the literature were included if they fit the initial search inclusion criteria.

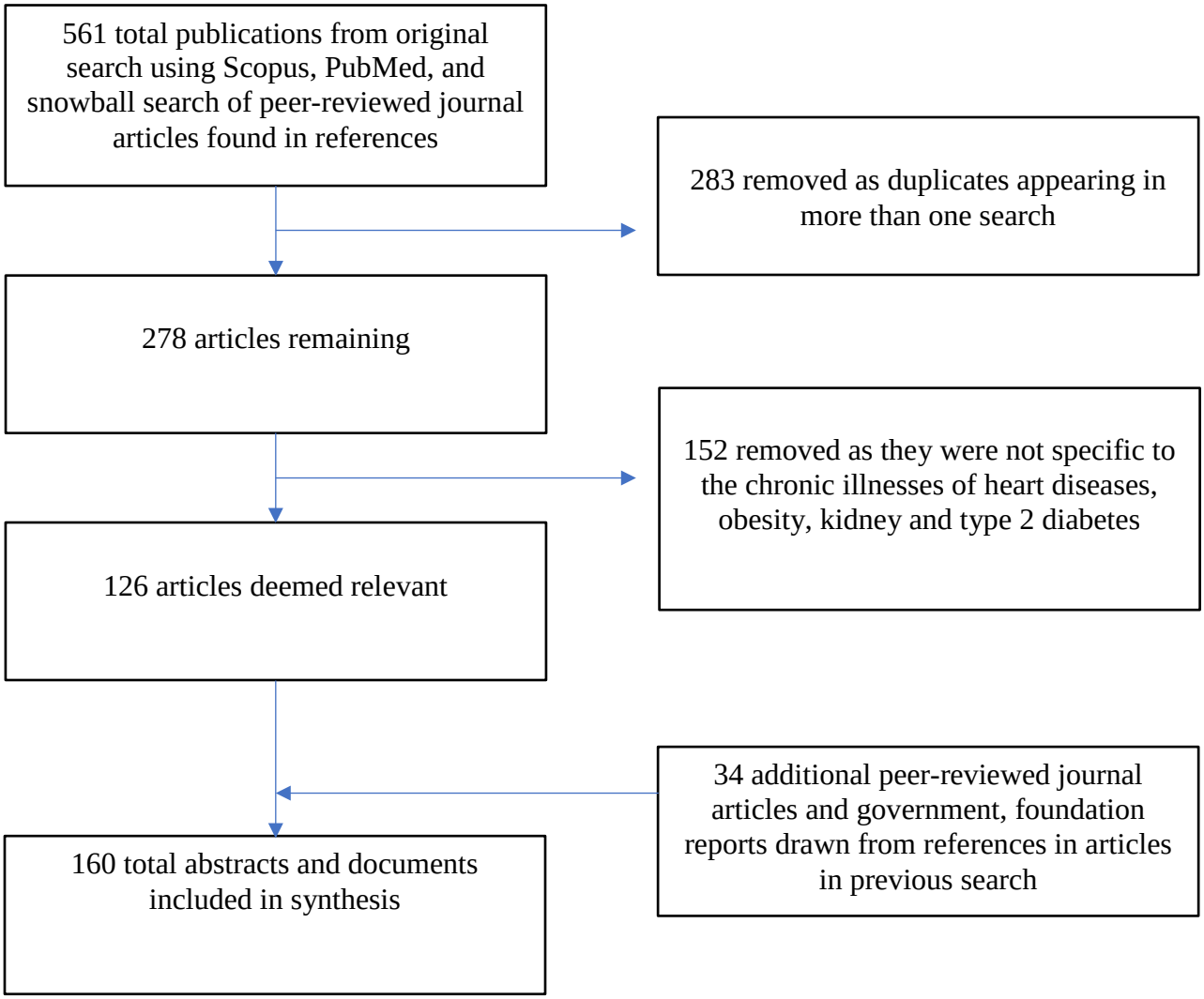

Figure 1. Flowchart of Selection Criteria

4.0 FINDINGS

4.1 DEFINING A WHOLE FOOD PLANT-BASED DIET

A whole food plant-based diet (WFPB), plant-based diet (PBD) or vegan diet are the terms used in the literature to refer to a way of eating that is based upon consuming whole unprocessed or primarily unprocessed foods. P. Tuso, Stoll, and Li (2015) suggested defining a whole food plant-based diet as follows:

> Plant-based nutrition is the predominant consumption of plant-based, whole foods to obtain macronutrients (carbohydrates, protein, and fats), micronutrients (vitamins and minerals), and bioactive components (e.g., flavonoids, plant sterols, polyphenols) that optimize body function. It is a conscious and mindful decision to maximize the health benefits per calorie while minimizing potential harmful exposures. (p. 62)

Eating foods such as fruits, vegetables, whole grains, legumes, and beans as well as primarily unprocessed foods, for example, like tofu and tempeh from soy beans, comprise the bulk of the WFPB diet. Also, included are the limited intake of whole fats from avocados, nuts, seeds, and olives (but not their processed oil derivatives). The typical WFPB diet recommends against consuming any animal-based foods such as beef, pork, chicken, fish, dairy, butter, and eggs. And

it excludes added sugars, salt, fat, and processed (junk) foods (Böni, 2016; Li, 2014; Martin, Zhang, Tonelli, & Petroni, 2013; Orlich et al., 2013; P. J. Tuso, Ismail, Ha, & Bartolotto, 2013). Current statistics suggests that 5% of the population considers themselves vegetarians who avoid meat but eat dairy and 2% follow a vegan or WFPB diet avoiding dairy and eggs (Le & Sabate, 2014).

Interestingly, for the first time, the new 2015–2020 Dietary Guidelines for Americans (DGA) include both vegetarian and vegan approaches to meeting the necessary nutritional requirements (HHS, 2015). Also, the Academy for Nutrition and Dietetics (AND) in 2016 issued, also for the first time, a substantive position paper stating that "appropriately planned vegetarian, including vegan diets, are healthful, nutritionally adequate, and may provide health benefits in the prevention and treatment of certain diseases" (Melina, Craig, & Levin, 2016, p. 1970).

Most of the research studies use the terminology vegan or plant-based diets (PBD) to refer to eating patterns that focus on the most nutritious, mostly plant-based and least calorie-dense approach to WFPB eating. Katz and Meller (2014) describe this standard as "emphasis on plant foods direct from nature, avoidance of harmful fats" and suggest that "optimal eating is associated with increased life expectancy, dramatic reduction in lifetime risk of all chronic diseases, and amelioration of gene expression" (p. 83). Bone, (2016); Campbell II & Campbell, (2012) Esselstyn et al, (2014); Katz & Meller, (2014), Tuso et al, (2013); and Greger, (2015), and Young, (2016) have argued that a WFPB way of eating is most optimum. This approach to food consumption is echoed by Wirt and Collins (2009) in their detailed study of diet quality and all-cause mortality.

However, not all researchers used this definition when they labelled their studies "plant-based." This is important to note for possible confounding concerns. Many researchers considered the typical Mediterranean diet or the derivative approach of the Dietary Approaches to Stop

Hypertension (DASH) as plant-based diets. While the diets encourage significant intake of plant foods like WFPB diets, these other diets included the intake of low fat or non-fat dairy, fish, lean animal protein as well as fats in the form of oils, thereby excluding them from the accepted WFPB dietary definition (Heller, 2017).

4.2 DIETARY LINK TO CHRONIC DISEASES

Starting in the 1970's, the work of Nathan Pritikin, an early lifestyle medical pioneer (Pritikin & McGrady, 1979) and Ornish et al. (1990) sought to investigate dietary intake and its influence of health and wellness. Many of the earliest studies included non-WFPB diets foods such as dairy and fish. In addition, several trials included lifestyle modifications such as smoking cessation and stress management. To understand the evolution of the research it is important to include examples of these studies as they laid the groundwork for later ones that focused solely on using a WFPB dietary intervention.

In a groundbreaking research study beginning in the 1980's conducted by the (Campbell, 2006; Campbell, 2007) the China – Cornell – Oxford Project, a retrospective investigation known as the China Study, sought to understand the link between diet and cancer. The research was conducted in China where there was a shared, large gene pool of homogenous Wan clan descendants. Therefore, scientists could control for any possible confounding genetic factors that may have influenced the results were the population heterogeneous. Campbell and associates were able to isolate the influence of macro-nutrients in this research, and examined associations between plant versus animal protein intake and cancer rates in the population. Results pointed to even higher rates of cancer associated with higher levels of animal protein intake in a population where higher

rates of cancer where the norm (Li, 1981; Campbell, 2007). Campbell's work resonated with other researchers who followed his lead examining the influence of macro-nutrients and chronic illnesses, while being able to control for possible confounding due to genetic make-up. There were limitations to these studies as they were observational in nature and limited to rural communities where the population engaged in physical labor and the age of those included was under 65 years of age (Campbell, 2007).

As noted earlier, not all research examining dietary lifestyle changes presented participants with a strictly WFPB diet. Many such studies also include social support groups, meditation and relaxation techniques, smoking cessation and exercise. In a seminal study, which utilized a prospective RCT study design, Ornish et al. (1990) sought to determine whether comprehensive lifestyle changes without drugs affected coronary atherosclerosis (CAD). Participants (n=48) were assigned to two groups. The experimental group of 28 patients who ate a low-fat vegetarian diet stopping smoking, learned stress management training, and engaged in moderate exercise. The control group of 20 received care as usual. Using available medical technology, 195 coronary artery lesions were analyzed at 1 year in the control group versus 28 in the intervention group. The results showed that the average percentage diameter stenosis, coronary artery lesions, regressed or reverted to a healthier state from 40·0 (SD 16·9)% to 37·8 (16·5)% in the experimental group yet progressed from 42·7 (15·5)% to 46·1 (18·5)% in the control group. When larger lesions that were greater than 50% stenosed were examined, the average percentage diameter stenosis regression was greater in the experimental group 61·1 (8·8)% to 55·8 (11·0)% than the control group, where the disease progressed from 61·7 (9·5)% to 64·4 (16·3)%. Overall, 82% of intervention-group patients saw their disease move towards regression, something that had not been accomplished

before without the use of medication. This research encouraged others to investigate vegetarian and eventually WFPB dietary changes in order to reverse and heal heart diseases.

Ornish et al. (1998) in a follow-up study known as The Lifestyle Heart Trial again demonstrated that intensive lifestyle changes may lead to regression of coronary atherosclerosis after 1 year. However, this time he examined the feasibility of patients sustaining intensive lifestyle changes for a total of 5 years without lipid-lowering drugs. Using a 10% fat whole foods vegetarian diet, aerobic exercise, stress management training, smoking cessation, and group psychosocial support the researchers measured adherence to intensive lifestyle changes, changes in coronary artery percent diameter stenosis, as well as cardiac events. More than 70% of the participants from both the experimental and control group completed the study.

Again, the experimental group showed more significant results with a lessening of the stenosis while the heart disease progressed in the control group. In addition, twenty-five cardiac events occurred in 28 patients in the experimental group vs 45 events in 20 of the control group's patients during the 5-year follow-up, with a risk ratio for any event for the control group, 2.47 [95% confidence interval, 1.48-4.20]. More reversal of coronary atherosclerosis occurred after 5 years than after 1 year in the experimental group. In contrast, in the control group, coronary atherosclerosis continued to affect the patients with more than twice as many experiencing cardiac events occurred.

These early researchers then began to branch out, seeking to investigate if there was any kind of relationship or association between eating a solely WFPB diets and the many other chronic conditions. Esselstyn et al., (1995); Ornish et al., (1998); Anderson, Smith & Washnock, (1999); McCarty, (1999); Nestle, (1999) and others created a growing body of scientific peer-reviewed research that began to associate a whole food plant-based way of eating with reversing some

chronic diseases, preventing others and the overall improvement of the public's health. Randomized-controlled trials (RCTs), retrospective and prospective studies, case control studies and other peer-reviewed studies continued to be conducted and their results published within the last twenty years. Also, Esselstyn, (1995); Barnard et al., (2005); Ornish et al., (2008); Barnard et al., (2009); Sarter, Campbell, & Fuhrman, (2008); McDougall et al.,(2014); Yadav et al., (2016); Clinton et al., (2015); and Chuang, et al. (2016) targeted cardiovascular disease, hypertension, high blood pressure, obesity, diabetes, strokes, osteoarthritis, digestive cancers, liver disease, kidney disease, prostate cancers, lung diseases, brain disease, breast cancer, and Parkinson's disease in their research studies.

4.3 WFPB DIET AND THREE CHRONIC DISEASES

Three critical chronic conditions: heart diseases, obesity, and kidney diseases including type 2 diabetes adversely affect millions of the adults as well as a growing number of children in the United States. This is especially the case for those living in lower SES and communities of color as noted above (Cawley, 2012; Go, 2014; Rao, 2008; Hogan, 2011; Odermatt, 2011; HHS, 2015; Segal, 2016).

4.3.1 HEART DISEASES

Heart disease is the number one killer in the United States (Campbell II & Campbell, 2012; CDC, 2016b; Dignan, 2014; C. Esselstyn, Jr, Ellis, Medendorp, & Crowe, 1995; Greger & Stone, 2015; HHS, 2015; Murray et al., 2013). The most common underlying cause of cardiovascular disease

(CVD) is the narrowing of the coronary arteries, the leading cause of heart attack and stroke (National Institutes of Health, 2014). Specifically, according to the National Heart, Lung and Blood Institute, research suggests that coronary heart disease (CHD) begins with damage to the lining and inner layers of the coronary (heart) arteries. The primary factors that contribute to this damage including smoking, intake of high amounts of certain fats and cholesterol in the blood, high-blood pressure, high amount of sugar in the blood because of diabetes or insulin resistance, and inflammation of blood (NIH, 2014). Also, there may be genetic, family history factors that influence CHD (Trenkwalder, Kessler, & Schunkert, 2017).

Esselstyn, Jr. (1995) evaluated the effects of a whole food plant-based diet on patients with heart disease. Initially, the study included fish and some dairy, however, the protocol changed as the study progressed, becoming completely whole foods plant-based. Participants who took cholesterol-lowering drugs were allowed to continue to do so. The diet was otherwise completely a WFPB diet with very low amounts of fats allowed. At first, the only goal was to reduce the 22 patients' cholesterol levels below 150mg/dL. Five patients dropped out. The 17 remaining patients completed the program. During the previous eight years before beginning the program, this cohort had survived 29 coronary events including angina, bypass procedures, heart attacks, strokes, and angioplasty. Biweekly, for five years, patients recorded their weight, blood pressure, and blood cholesterol. Before the program began, the average subject's blood cholesterol was measured at 246 mg/dL. During the next four years of the study this number dropped to 132, past the hypothesized target. LDL cholesterol levels dramatically decreased along with the number of coronary events (Esselstyn Jr, 2008).

Eleven years later, only one coronary event occurred among those 17 patients remaining in the trial to completion. The most significant result of this study was the reversal of the heart

disease. Seventy percent of these subjects' clogged arteries re-opened. Examination of these participants found increased blood flow by 30%. The 30% blood flow increase represented the difference between experiencing a coronary episode or not experiencing one during this time (Esselstyn et al., 1995).

Li (2014) examined associations of individuals eating vegetarian diets and their risk for chronic diseases. The diets that were rated as in high in vegetables and fruits and therefore rich in antioxidants, phytochemicals, and fiber while low in cholesterol and total fat showed the best results. Compared to individuals eating an SAD omnivore diet, all-cause heart related diseases were significantly lower for those consuming a predominantly plant-based diet (PBD) (Boeing et al., 2012). presented evidence in a critical review that increasing the consumption of plant-based foods, in particular, vegetables and fruit reduced the risk of chronic heart disease, hypertension, and stroke.

Kottler, Ferdowsian, and Barnard (2009) examined the effects of PBD on dyslipidemia, plasma lipids levels, a primary risk factor for CVD and related heart diseases. Referencing first-line therapy guidelines for CVD that recommend a dietary intervention should be tried before surgery in certain cases, the authors questioned what diet would constitute an "optimal dietary regimen." (p. 947) After conducting a search on the Medline and Cochrane Collaboration databases of research from 1966 to February 2009, Kottler, (2009) concluded that of the 4 types of plant-based diets considered, those that combined nuts, soy, and/or fiber showed the greatest effects. These combination diets (PBD with nuts, soy, and/or fiber) lowered plasma low-density lipoprotein cholesterol up to 35% in studies included.

Harland and Garton (2016) in a recent review that updated evidence for plant-based diets and heart disease and other chronic illnesses, reported that individuals following a plant-based diet

had a 20–25% lower risk of developing CVD than those eating the SAD. Several RCTS have demonstrated that those following a plant-based approach to eating have lower total cholesterol, low-density lipoprotein-cholesterol, and lower blood pressure as well as modest reductions in inflammatory and endothelial markers. Additionally, a PBD was found to produce greater effects in terms of reducing blood levels of lipids and cholesterol associated with atherosclerosis. These are the most critical factors related to diseases of the heart.(Dignan, 2014; Harland & Garton, 2016; Rinaldi, Campbell, Fournier, O'Connor, & Madill, 2016).

Aune et al. (2016) in a systematic review of prospective studies evaluated the relationship between whole grain consumption, another critical element of PBD, and cardiovascular disease risk. Researchers sought the dose-response relationship between specific grains, CVD, and all-cause mortality. Reductions in relative risk for coronary heart disease, CVD, and other chronic illness and all-cause mortality were found to be associated with increased whole grain consumption. Reductions in risk were observed up to an intake of 210-225 g/day (seven to seven and a half servings/day) and for whole grain bread, whole grain breakfast cereals, and added bran.

> The summary relative risks per 90 g/day increase in whole grain intake (90 g is equivalent to three servings – for example, two slices of bread and one bowl of cereal or one and a half pieces of pita bread made from whole grains) was 0.81 (95% CI 0.75 to 0.87) for coronary heart disease…0.78 (0.73 to 0.85) for cardiovascular disease. (p. 1)

McDougall et al. (2014), another researcher who examined the impact of plant-based diet interventions on chronic diseases, reported the effects of a short, 10-day program for individuals participating as part of retreat cohort. Eating a low-fat, starch-based, oil-free plant-based-diet

WFPB diet participants were encouraged to intake food without limitation, “ad libitum”, a unique design for such a study. No stress reduction techniques were offered. Only light to moderate exercise opportunities were presented. The data was then collected and aggregated from the residential program retreat cohorts from 2002 to 2011, with an n of 1615. The retrospective analysis of key biomarker measurements was taken from baseline (beginning the program) to day 7 of the 10-day retreat. Patients whose initial biomarkers showed a risk of experiencing a cardiovascular event within the next 10 years at baseline was >7.5% saw a 27% drop in risk to 5.5% at day 7 of the program. The median (IQR) decrease in total cholesterol was 22 (29) mg/dl ($p < .001$).

Researchers have also examined specific nutrients and aspects of eating a plant-based diet such as the consumption of dietary fiber from beans and healthy fats obtained from nuts on heart disease. Anderson, Smith, and Washnock (1999) focused on the impact of dietary fiber from a PBD on CVD. Dietary fiber was found to have major protective benefits against CVD and coronary artery disease (CAD) as it was also shown to decrease levels of serum cholesterol and LDL-cholesterol, two biomarkers for heart disease. Wien and Couch (2011) sought to elucidate the recommendations of the Dietary Guidelines for Americans 2010 that encouraged the consumption of nuts as a means to help encourage a shift to a more plant-based diet for managing chronic diseases. Examinations of epidemiological studies, clinical trials, meta- and pooled-analysis revealed that frequent nut consumption reduced heart disease risk. Nut-enhanced diets containing 67g (2.4 oz.) of nuts eaten daily produced estimated mean reductions of Total Cholesterol (TC) (-10.9 mg/dl) and LDL-C (10.2 mg/dl) levels. In addition, reductions the ratios of LDL-C to HDL-C (-0.22) and TC to HDL-C (-0.24) were found, and, nut intake improved blood lipid levels in a dose-related manner.

P. Tuso et al. (2015) in a review of research examining the effect of diet on atherogenesis and CAD prevention on a cellular level showed polyphenols derived from dietary plant intake were found to offer protective benefits on vascular endothelial cells. These substances were seen as possible antioxidants that prevent the oxidation of low-density lipoprotein (LDL), a significant biomarker for heart disease risk. The authors suggested that a shift toward a more plant-based diet may offer protective effects against atherosclerotic CAD by increasing supportive endothelial factors in the circulation at the same time reducing factors that are dangerous to endothelial cells.

4.3.2 OBESITY

Obesity rates continue to be a major health concern among the public health professionals, the medical community, government officials, academics, and the public. Obesity is also a risk factor for a variety of other chronic illnesses. (CDC, 2016a; K. Flegal et al., 2016; K. M. Flegal, Carroll, M. D. Ogden, C. L., & Curtin, L. R., 2010; Segal et al., 2016). Obesity rates for communities of color are significantly more pronounced than those in the rest of the population (CDC, 2016a; K. Flegal et al., 2016; Segal et al., 2016). Obesity rates are higher among adult blacks (48.4 percent), Latinos (42.6 percent), and American Indian/Alaska Natives (42.3 percent) than among Whites (36.4 percent) and Asian Americans (12.6 percent). The disparities are highest among women: Black women have an obesity rate of 57.2 percent, Latinos of 46.9 percent, Whites of 38.2 percent, and Asians of 12.4 percent. Black women are twice as likely to be severely obese as White women. For men, blacks have an obesity rate of 38.0 percent, compared with Latinos of 37.9 percent, and Whites of 34.7 percent (Segal et al., 2016).

The levels of obesity occurring in communities of colors, especially may be described as fitting the criteria for a “wicked problem,” that is, one that belies a simple or singular answer

(Kolko, 2012). Kolko (2012) described the overall health and well-being of the nation's population as "wicked problems". The definition of "a wicked problem [as] a social or cultural problem that is difficult or impossible to solve for as many as four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems" (NP) certainly describes what communities of color face with regard to obesity.

Citing the work of Horst, one of the earliest to formalize a theory of wicked problems, Kolko (2012) enumerated Horst's ten characteristics of these difficult and complex social issues. Perhaps most significant in terms of addressing the wicked problem of the nation's health as presented here is the understanding that each wicked problem is really a symptom of another problem and that there is always more than one reason or explanation for the problem. Horst and Webber (1973) argued that the intricate web of socio-economic political systems presents, for example, "a change in education will cause new behavior in nutrition." (p. 165)

Understanding the complexity of tackling the wicked problem of obesity has led some researchers to look to WFPB diets as a significant pathway to counter the effects of the political and economic system that has contributed so much to the current state of the nation's health. Research studies by Barnard, Scialli, Turner-McGrievy, Lanou, and Glass (2005); (Berkow & Barnard, 2006; Dewell & Ornish, 2007; D. J. Jenkins et al., 2014; Tapsell, Dunning, Warensjo, Lyons-Wall, & Dehlsen, 2014; Turner-McGrievy, Davidson, Wingard, Wilcox, & Frongillo, 2015) and others have shown positive associations of the effects of a WFPB diet on obesity rates. McCarty (1999) in an early dietary review of vegan proteins noted that consumption of soy showed improvements in weight loss. "Higher in non-essential amino acids than most animal-derived food proteins, and as a result should preferentially favor glucagon production ...the insulin-sensitizing

properties of many vegan diets – high in fiber, low in saturated fat – should amplify these effects by down-regulating insulin secretion…promote weight loss." (p. 459)

Berkow and Barnard (2006) conducted a review of the literature to better understand the degree to which a WFPB diet may mediate weight loss. More than 40 studies were identified and examined for the existence of confounding variables such as smoking and physical activity, body weight, and body-mass index (BMI). Also, differences between vegetarians and non-vegetarians were noted. Observational studies included in this literature review focused on primarily, but not-exclusively, lacto-ovo vegetarians who consumed dairy. The results indicated that on average the weight and BMI of both male and female vegetarians, was anywhere from 3% to 20% lower than that of non-vegetarians. The prevalence of obesity ranged from 0% to 6% in vegetarians and from about 5% to 45% in non-vegetarians. However, potentially confounding variables in these studies included: health conscious individuals who previously articulated vegetarian buying habits at health food stores; subpopulations of small groups such as Seventh Day Adventists, and members of the Church of Jesus Christ, of Latter Day Saints (Mormons) whose religious beliefs preclude intake of certain foods that might influence the results (alcohol and caffeine, in particular); and young, European adults who self-reported their dietary intake habits. The results of RCTs suggested that dietary factors influencing calorie intake and possibly thermic effect of food may be responsible for these differences. Because vegetarian diets are associated with reduced body weight and lower rates of obesity, vegetarians generally have a lower risk for chronic disease.

Barnard et al. (2005) investigated the effect of a low-fat, plant-based diet as an intervention for weight-loss with overweight, post-menopausal women. In an outpatient setting, 64 overweight, postmenopausal women in an RCT (low-fat, vegan diet or a control diet based on National Cholesterol Education Program guidelines) the without energy intake limits, and were asked to maintain

the same level of exercise unchanged. Dietary intake, body weight and composition, resting metabolic rate, thermic effect of food, and insulin sensitivity were measured at baseline and 14 weeks. The mean ± standard deviation intervention-group body weight decreased 5.8 ± 3.2 kg, compared with 3.8 ± 2.8 kg in the control group (P = .012). In a regression model of predictors of weight change, including diet group significant effects were found for the diet group (P < .05). Researchers found that the diet was associated with significant weight loss, despite the absence of prescribed limits on portion size or energy intake.

Boeing et al. (2012) conducted a meta-analysis of study results for obesity and other chronic diseases. Evidence suggested that increased consumption of vegetables and fruit may prevent body weight gain. In another meta-analysis, Tapsell, Dunning, et al. (2014) concluded that increased vegetable consumption is a key component in many weight loss programs. However, they suggested that establishing the evidence that vegetable consumption per se assists with weight loss may be difficult because "creating a dietary energy deficit involves the whole diet, so research on the effects of vegetables may need to consider the whole-dietary model." (p. 1529)

Tapsell, Batterham, et al. (2014) in another RCT sought to further evaluate the direct evidence for the effects of vegetable intake on weight loss, in particular, researchers aimed to assess the effect of higher vegetable consumption. Using a single blind parallel controlled trial, 120 overweight adults (mean body mass index=29.98 kg/m(2)) were randomized to two calorie deficit healthy diet support groups that differed only by doubling the serving (portion) sizes of vegetables in the comparison group. Following 12 months, the study sample lost 6.5+/-5.2 kg (P<0.001 time) with no difference between groups (P>0.05 interaction). Vegetable intake increased in both groups. Greater weight loss occurred for both in the first 3 months. Weight change was significantly correlated with higher proportions of calorie consumed as vegetables (rho=-0.217, P=0.024).

Weight loss was sustained for 12 months by both groups (P=0.005). In the short term, the results offered, “consuming a higher proportion of the dietary energy as vegetables may support a greater weight loss and the dietary pattern appears sustainable.” (p. 785) In other words, eating fewer calorie-dense foods, such as vegetables, thus restricting total caloric intake leads to weight loss.

Turner-McGrievy et al. (2015) sought to determine the effect of several plant-based diets on weight loss. Participants were enrolled in a 6-month, five-arm, RCT. Weekly group meetings were required for the experimental groups only, the omnivorous group were exempt from this requirement, serving a control. Instead, these participants attended monthly meetings supplemented with weekly e-mail learning. Diets did not emphasize energy restriction. Overweight adults (body mass index 25-49.9 kg/m(2); age 18-65 y, 19% non-white, and 27% men) were randomized to five groups. All groups were instructed to follow a low-fat, low-glycemic index diet without energy (calorie) restrictions. The participants were encouraged to eat as much plant-based foods such as fruits, vegetables, whole grains, and legumes/beans including limited amounts of nuts and nut butters, avocados, seeds, and olives with the focus on lower fat food options: vegan (no animal products) (n = 12), vegetarian (included eggs and dairy) (n = 13), pesco-vegetarian (fish and shellfish along with eggs and dairy) (n = 13), semi-vegetarian (meat, poultry, fish, shellfish, eggs and dairy with limits on red meat and poultry) (n = 13), or omnivorous (all food groups) (n = 12). Fifty (79%) participants completed the study. Using an “intention-to-treat analysis,” the linear trend for weight loss throughout the five groups was statistically significant at both 2 month ($P < 0.01$) and 6 month ($P < 0.01$) intervals. At 6 months, the vegan group weight loss in (-7.5% +/- 4.5%) was significantly different from the omnivorous (-3.1% +/- 3.6%; $P = 0.03$), semi-vegetarian (-3.2% +/- 3.8%; $P = 0.03$), and pesco-vegetarian (-3.2% +/- 3.4%; $P = 0.03$) groups. Also, participants eating a PBD decreased their fat and saturated fat more than the

pesco-vegetarian, semi-vegetarian, and omnivorous groups at both 2 months and 6 months ($P < 0.05$). Researchers concluded that PBDs, vegan diets, may result in greater weight loss than more modest non-PBD programs.

D. J. Jenkins et al. (2014) looked to determine the longer-term effects of a diet that was both low-carbohydrate and plant-based on weight loss with additional concerns about the impact on low-density lipoprotein cholesterol (LDL-C). Using a parallel design study of 39 self-selected, overweight, Canadian hyperlipidaemic men and postmenopausal women at a nutrition research center for a short-term intervention. Participants consumed either a low-carbohydrate WFPB diet of their own choice containing increased plant protein and fat from gluten, soy products, nuts and vegetable oils or a high-carbohydrate lacto-ovo (dairy included) vegetarian diet for 6 months after completing 1-month metabolic (all foods provided) approach of these diets. The prescribed macronutrient intakes for the low-carbohydrate and high-carbohydrate diets were: 26% and 58% of calories from carbohydrate, 31% and 16% from protein and 43% and 25% from fat, respectively. 23 participants (50% test, 68% control) finished the 6-month ad libitum two-armed study. The results showed increased weight-loss for approximate 4 kg weight reduction on the initial metabolic study was increased to -6.9 kg on low-carbohydrate and -5.8 kg on high-carbohydrate 6-month ad libitum treatments (treatment difference (95% CI) -1.1 kg (-2.1 to 0.0), $p=0.047$). This intervention showed promise for weight reduction for the participants eating a low-carbohydrate WFPB diet, however, concerns about confounding exist due to self-selected, uncontrolled, differing levels of protein and fat intake for participants.

4.3.3 KIDNEY RELATED DISEASES AND TYPE 2 DIABETES

Diabetes mellitus, or type 2 diabetes, is a disease that occurs when blood glucose levels, also called blood sugar, are too high. Blood glucose is the main source of energy and comes from the dietary intake. Insulin, a hormone made by the pancreas, helps glucose derived from food get into the cells to be used for energy (NIDDKD, 2017). With Type 2 diabetes the body does not make or incorporate insulin well. Untreated or progressive diabetes may lead to chronic kidney disease (CKD) (NIDDKD, 2017). As of 2014, 29.1 million people in the United States, or 9.3 percent of the population, had diabetes. Diabetes affects 1 in 4 people over the age of 65. About 95 percent of cases in adults are type 2 diabetes (Albright, 2008). Unfortunately, more than 1 in 4 in the population did not know that they had this chronic disease.

Diabetes is the leading cause of chronic kidney disease (CKD) and failure (CDC, 2016b). Diabetes was listed as the primary cause of kidney failure in 44% of all new cases in 2011. In 2011, 49,677 people of all ages began treatment for kidney failure due to diabetes. 228,924 people of all ages with kidney failure due to diabetes were living on chronic dialysis or with a kidney transplant (CDC, 2014).

Some communities of color are extremely vulnerable to diabetes and kidney disease. Blacks are 1.7 times as likely to develop diabetes as whites. The prevalence of diabetes among blacks has quadrupled during the past 30 years. Among blacks age 20 and older, about 2.3 million have diabetes. In addition,10.8% of blacks in that age group are more likely than non-Hispanic whites to develop diabetes and to experience greater disability from diabetes-related complications such as amputations, adult blindness, kidney failure, and increased risk of heart disease and stroke. Death rates for blacks with diabetes are 27 percent higher than for whites (CDC, 2014).

Diet is known to be an important factor in the development, progression and nature of diabetes. Individuals diagnosed with diabetes are normally instructed to follow a prescribed diet in order preclude diabetic episodes, future chronic illness, and mortality (NIDDKD, 2017; CDC, 2016b). A growing number of T2D and CKD studies have begun to turn toward plant protein, instead of animal protein, as a pathway to slow the progression of the disease and improve the population's health (Huang et al., 2013). Several studies have looked to plant-based diets as a way to lower advanced glycation end products (AGE) associated with the disease (Goraya, Simoni, Jo, & Wesson, 2013; Moorthi, Vorland, & Gallant, 2017). Furthermore, substituting soy or other vegetable proteins for animal protein may also decrease biomarkers and in the long term reduce the risk of developing renal disease in type 2 diabetes (Trapp & Barnard, 2010). The diet rich in vegetables and fruits, therefore, may offer benefits for both the carbohydrate and lipid concerns associated with diabetes (Jenkins et al., 2003).

WFPB diets may delay progress of CKD, provide endothelial protection, help control blood pressure, and provide vital nutrients to the cells (Hogan, 2011). Such nutrients not only assist in kidney disease management, but also provide protection against costly complications (Hogan, 2011). Replacing unhealthy saturated fat with healthier fat from plant-based food has been long recommended for reducing the risk of CVD and may also help with health risks associated with CKD (Huang, Lindholm, Stenvinkel, & Carrero, 2013; Okreglicka, 2015).

Via an observational study design, Chen et al. (2016) found that plant protein intake was positively associated with lower levels of uremic toxins and lower serum phosphorous levels, key markers of CKD progress. Thus, a higher proportion of dietary protein from plant sources might be associated with lower mortality in chronic kidney disease. 14,866 NHANES III participants 20 years or older were stratified by estimated glomerular filtration rate (eGFR) (a measure of blood

creatinine used for best detecting kidney function and disease stage). Plant and total protein consumption was estimated from 24-hour dietary recalls. Mean values for plant protein consumption and plant protein to total protein ratio were 24.6 ± 13.2 (SD) g/d and 33.0% ± 14.0%, respectively. Adjusted for a variety of possible confounders (smoking e.g.), each 33% increase in plant protein to total protein ratio was not associated with mortality (HR, 0.88; 95% CI, 0.74-1.04) in the eGFR ≥ 60 mL/min/1.73 m2 subpopulation, but was associated with lower mortality risk (HR, 0.77; 95% CI, 0.61-0.96) in the eGFR < 60 mL/min/1.73 m2 subpopulation. The authors suggested that future studies are warranted to determine the causal role of plant protein intake in reducing mortality in those with eGFR < 60 mL/min/1.73 m2.

Barnard et al. (2009) investigated the association of low-fat vegetarian and vegan diets with chronic illnesses. A comparison of a low-fat vegan diet and conventional diabetes diet recommendations on glycaemia, weight, and plasma lipids was constructed. Free-living individuals with type 2 diabetes were randomly assigned to a low-fat vegan diet (n = 49) or a diet following 2003 American Diabetes Association guidelines (conventional, n = 50) for 74 weeks. Biomarkers including glycated hemoglobin (Hb A(1c)) and plasma lipids were assessed at weeks 0, 11, 22, 35, 48, 61, and 74. Hb A(1c) changes from the beginning baseline to 74 week or last available measurement values were -0.34 and -0.14 for vegan and conventional diets, respectively (P = 0.43). While both diets were associated with sustained reductions in weight and plasma lipid concentrations, in an analysis controlling for medication changes, a low-fat vegan diet appeared to improve glycaemia and plasma lipids more than did conventional diabetes diet recommendations. The authors suggested that more research was needed to determine whether the observed differences provide clinical benefit for complications of diabetes.

Satija et al. (2016) examined the association of an overall plant-based diet and hypothesized healthy and unhealthy versions of a plant-based diet with T2D incidence in three prospective cohort studies in the US. This methodology was important because not all plant-based foods are beneficial for individuals with T2D. Using the data from Nurses' Health Study (1984-2012, the Nurses' Health Study 2 (1991-2011), and men from the Health Professionals Follow-Up Study (1986-2010), all free of chronic diseases at baseline. Dietary data were collected every 2-4 years using a semi-quantitative food frequency questionnaire. The researchers created an overall plant-based diet index (PDI), where plant-based foods received positive scores, while animal foods received reverse scores. A healthful plant-based diet index (hPDI) and an unhealthful plant-based diet index (uPDI) were documented since not at all plant-based foods (too high in sugar, for example) may be considered healthy. There were just 16,162 participant incidents of T2D cases noted during 4,102,369 person-years of follow-up.

> In pooled multivariable-adjusted analysis, both PDI and hPDI were inversely associated with T2D (PDI: hazard ratio [HR] for extreme deciles 0.51, 95% CI 0.47-0.55, p trend < 0.001; hPDI: HR for extreme deciles 0.55, 95% CI 0.51-0.59, p trend < 0.001). The association of T2D with PDI was considerably attenuated when we additionally adjusted for body mass index (BMI) categories (HR 0.80, 95% CI 0.74-0.87, p trend < 0.001), while that with hPDI remained largely unchanged (HR 0.66, 95% CI 0.61-0.72, p trend < 0.001). uPDI was positively associated with T2D even after BMI adjustment (HR for extreme deciles 1.16, 95% CI 1.08-1.25, p trend < 0.001). (p. 2)

According to the authors there were limitations due to self-reported diet assessment, with the possibility of measurement error, and confounding given the observational nature of the research design. However, the study did suggest that when high quality plant-based diets were followed there was a positive association with a substantially lower risk of developing T2D.

Tonstad et al. (2013) conducted one of the few studies specifically including Black participants evaluating diets and chronic illnesses. Looking to evaluate the relationship of diet to incident diabetes among non-Black and Black participants in the Adventist Health Study-2, 15,200 men and 26,187 women (17.3% blacks) across the U.S. and Canada who were free of diabetes and who provided key demographic and lifestyle data participated. Participants were separated into five groups: vegan (no animal products), lacto-ovo-vegetarian (included dairy and eggs), pesco-vegetarian (included fish and seafood), semi-vegetarian (included dairy and fish) or non-vegetarian (reference group). A follow-up questionnaire after two years requested information on whether there was development of diabetes. Controlling for such lifestyle behaviors as alcohol consumption, smoking, exercise and age, cases of diabetes were reported in 0.54% of vegans, 1.08% of lacto-ovo-vegetarians, 1.29% of pesco-vegetarians, 0.92% of semi-vegetarians and 2.12% of non-vegetarians. Blacks had an increased risk compared to non-blacks (odds ratio [OR] 1.364; 95% confidence interval [CI], 1.093-1.702). A multiple logistic regression analysis was conducted that controlled for possible confounders (age, gender, education, income, television watching, physical activity, sleep, alcohol use, smoking and BMI). The results showed that vegans (OR 0.381; 95% CI 0.236-0.617), lacto ovo vegetarians (OR 0.618; 95% CI 0.503-0.760) and semi-vegetarians (OR 0.486, 95% CI 0.312-0.755) had a lower risk of diabetes than non-vegetarians. In non-black vegan, lacto-ovo and semi-vegetarian diets were protective against diabetes (OR 0.429, 95% CI 0.249-0.740; OR 0.684, 95% CI 0.542-0.862; OR 0.501, 95% CI

0.303-0.827); however, among blacks only vegan and lacto-ovo vegetarian diets were protective (OR 0.304, 95% CI 0.110-0.842; OR 0.472, 95% CI 0.270-0.825). It is important to note these associations were strengthened when BMI was removed from the analyses. Vegetarian diets (vegan, lacto-ovo, semi-vegetarian) were associated with both a substantial and independent reduction in the onset of diabetes. Moreover, in blacks the dimension of the protection associated with plant-based vegetarian diets was as great as the excess risk associated with black ethnicity.

5.0 DISCUSSION

A nascent, but growing body of scientific research shows a positive association between eating a diet based upon whole, unprocessed plant foods as a means to prevent, stop the progression of, and even reverse some dietary-induced chronic illnesses. A combination of small RCTs, observational, and retrospective studies elucidated the positive effects of plant-based nutrition. While results of the WFPB diet are promising, it is apparent that there is a substantial need for increased research with larger studies that are prospective in design. Also, such research needs a more standardized and consistent approach to defining exactly what constitutes a WFPB diet for study design purposes.

The findings of the research presented in the thesis point to a growing recognition of the benefits of eating a WFPB diet as beneficial with its inclusion as a recognized pattern of eating according to the latest Dietary Guidelines for Americans 2015-2020 and support from the Academy of Nutrition and Dietetics (AND) as a way to address the problem of chronic diseases. This recognition is important given the dramatic changes in the eating patterns of the population that have increase calorie consumption (especially fats/oil, refined grains, added sugar) by more than 22% in the past 40 years.

Early studies were labelled “lifestyle” interventions as they included smoking cessation, stress reduction, exercise and other similar protocols alongside the dietary changes and limitations. These first studies offered a broad definition of plant-based diets including dairy and fish intake.

As the initial research results showed the potential positive dietary impact of plant-based eating on the chronic conditions, especially heart disease in the earliest studies, new designs were offered limiting the protocols to only vegan, plant-based diets. (The term "Vegan" was used in many studies since this term was much more well-known and easily distinguishable from vegetarian or pesco-vegetarian diets.)

Within the last 10 – 15 years, more and more studies have been conducted using some form of a WFPB diet in research to evaluate its effect on heart disease, obesity and kidney diseases, in particular, Type 2 diabetes. The research showed a positive association between eating a WFPB diet and other mostly plant-based diets such as the Mediterranean and DASH (Dietary Approaches to Stop Hypertension) approaches as a means to prevent, stop the progression of, and even reverse dietary-induced chronic diseases, especially heart disease. WFPB eating was effective in addressing weight loss for those considered obese. Studies of Type 2 diabetes and CKD patients demonstrated positive results in managing their chronic conditions with increased intake of the appropriate whole food plant-based nutrition.

Results from numerous plant-based diet interventions on heart disease showed the impact of this way of treatment. These studies reflect the possibility of securing new, less prescription-based, and less costly, non-invasive approaches to improving health outcomes. In particular, the results pointed to the need for more preventive, first-line treatment approaches and greater education about the benefits of a WFPB diet for health care professionals.

Obesity stood out as both a chronic illness and a driving force behind both heart disease and kidney diseases. Considered by some a "wicked problem," it withstands a simple, direct intervention unlike those presented for CVD or CAD. Research using WFPB diets in comparison

to other diets in RCTs addressing obesity did present positive weight-loss results. However, none of the studies evaluated offered longitudinal weight-loss management using a WFPB diet.

Preventing the develop of or halting the progression of Chronic Kidney disease (CKD) and Type 2 diabetes may occur with the use of a plant-based diet. Researchers found positive associations with eating a WFPB diet and improved wellness for individuals living with Type 2 diabetes and kidney disease. Plant-based protein and fats have been shown to be healthy alternatives to animal-based versions. One study showed the ability of eating a WFPB to prevent or limit the onset of Type 2 diabetes in African-Americans, a subpopulation that suffers higher rates of the chronic disease. Also, the research showed that there seem be greater benefits from eating a wider variety of plant-based nutrition than initial thought. Updated education about appropriate WFPB diets for medical practitioners, health care professionals and patients seems to be indicated from the findings.

Significantly, the findings point to great difficulty ensuring the population's ability to adhere to dietary guidelines. Historically, there has been low adherence for the past DGA and only limited research has addressed adherence levels for WFPB diets beyond the scope of the studies. A few notable exceptions are unique subpopulations such as the Seventh Day Adventists. Also, low SES and low nutritional literacy has been associated with lower levels of dietary adherence.

The results showed a severe lack of WFPB dietary intervention research targeted towards low SES populations and communities of color. These populations suffer from higher rates of all three chronic diseases presented; heart disease, obesity and Type 2 Diabetes and CKD. The implications of this finding show a need for greater diversity of targeted participants for WFPB dietary interventions especially low SES and communities of color.

6.0 CONCLUSION

6.1 SUMMARY

Increasing the dietary intake of whole plant-based foods may help to prevent, reduce or even reverse certain chronic illnesses in the population. A WFPB diet consists largely of unprocessed or primarily unprocessed healthy vegetables, fruits, whole grains, legumes, beans, and plant-based fats. The US population might begin to address the hyperendemic level of chronic diseases that have resulted from 40 years of eating the SAD by consuming more foods from whole plant-based sources with little or no processing as a positive way of improving the health of the public.

More specifically, early lifestyle medical approaches pointed toward the possibility of dietary interventions as way to address the rise of chronic diseases. Limited, but growing research has shown that eating a whole food plant-based diet may help to prevent, alleviate, or reverse chronic heart disease, support weight loss for those who are obese, and treat effectively or prevent Type 2 diabetes and Chronic Kidney Disease (CKD).

The new Dietary Guidelines for Americans in conjunction with the latest research support an increased role for plant-based diets as nutritionally sound and a way to improve the population's health. In the past, however, the population in general has failed to significantly adhere to the guidelines. Additional focus is needed to encourage increased adherence.

Communities of color and individuals and families who live in low SES populations suffer from higher rates of the chronic conditions presented here. Insufficient WFPB dietary research has been directly addressed to their needs.

6.2 LIMITATIONS

There are several significant limitations to this literature synthesis. Though not exhaustive, the search methods employed here captured many of the trends in these studies and important findings related to using a WFPB diet as a positive intervention on behalf of the public's health and wellbeing.

A critical limitation for this research was the exact nature of how researchers defined WFPB eating. The terms "plant-based diet" and "vegan diet" came the closest to the definition of a WFPB diet as described by Esselstyn et al. (1995) and Tuso, Stoll, and Li (2015). The earliest studies by Ornish et al. (1990) and others included non-plant foods as part of their plant-based diets. These seminal studies set the foundation for much of the later work. Some researchers sought to use diet as the sole means to alleviate these diseases, while others sought to use food as a non-invasive and non-prescription-based alternative approach that included lifestyle changes. These preliminary efforts created ambiguity in the definition of WFPB dietary research that still exists today. The researchers were certainly interested in the effects of diet on chronic diseases, however, these studies included in their protocols lifestyle modifications such as smoking cessation, stress reduction and exercise that may have been responsible for confounding errors.

Another limitation was the fact that many studies examined the effects of WFPB dietary-intake on multiple chronic diseases at the same time. Researchers often sought to measure the

impact of diet on weight-loss for obesity and on other chronic conditions such Type 2 diabetes and CVD simultaneously.

Retrospective studies in which participants filled out food diaries have raised concerns about accuracy and recall bias. Also, the problem of minimal nutritional information and knowledge may have affected the accurate classification of certain food items.

The findings of the thesis have limited generalizability. Many of the studies described herein were small in nature, short in length of time, and often without a distinct control group. In addition, several of the studies may have been influenced by self-selection bias of the participants who actively sought participation in heart disease, type 2 diabetes or weight-reduction research. Also, there is a dearth of research evaluating the effects of WFPB diets on low SES and communities of color.

Finally, as in all such research the effects of genetic predisposition, prior healthcare treatment and experiences, environmental exposure, and the lifestyle patterns of individuals and communities in the population may have influenced outcomes of the research cited.

6.3 RECOMMENDATIONS

For more than 40 years, a wide range of public health professionals as well as government officials have raised concerns about the increase in chronic illnesses and the link between these illnesses and dietary intake. As described in this literature synthesis, increasing interest is being shown with regard to the nascent, but positive impact of eating a WFPB diet on chronic diseases. This interest needs to be fostered and supported for future efforts. The latest Dietary Guidelines for Americans (DGA) 2015-2020 report included and recommended, for the first time, a separate vegan or WFPB

approach toward healthy eating (HHS, 2015). Also, these latest guidelines presented healthier approaches for omnivores diets with increase recommendations for plant-based foods, especially fruits, vegetables and whole grains. The Academy for Nutrition and Dietetics (AND) issued a position statement supporting a vegan diet as not only nutritionally sound but beneficial to reduce chronic diseases (Melina et al., 2016). These efforts join a rising chorus of national scientists, researchers and health care professionals supporting the use of a WFPB nutrition as a possible early-stage approach for medical practitioners to reduce chronic illnesses (Hart, 2015; Tuso, 2013; Esselstyn, 2015).

Amidst these calls to action three significant concerns need to be addressed with regard to the findings presented here. First, increased funding for better designed, population-wide, longitudinal studies is needed. This research would seek to investigate an optimum plant-based way of eating by comparing the most favorable current approaches that have already shown positive results. Using the DGA 2015-2020 as part of this research would add to the growing body of knowledge supporting healthier dietary changes for the nation's public health. This support would also encourage more rigorous study designs. In addition, this research must focus upon ways to increase adherence to healthier eating patterns that will be recommended. Regardless of well-intentioned research protocols and intervention designs, increasing and maintaining adherence continues to be of great concern for long-term benefits. The findings presented above point toward this critical need.

Second, there is a dire need for much greater focus and funding toward carrying out WFPB research that may directly involve and benefit low SES and communities of colors. The findings of this thesis demonstrated the severe lack of attention to these populations that find themselves suffering from across-the-board higher rates of these chronic diseases, due in part to a combination

of limited nutritional literacy, the lack of access to and affordability of healthy plant-based foods (Vanstone et al., 2013).

Third, across the entire population, nearly 70% of the population of the United States is at increased risk for chronic illness because of dietary related health conditions. Half of all adults, 117 million people, have one or more preventable diet associated chronic diseases. While the recommended research agenda noted above needs to be promptly addressed, it is critical that individuals and families become empowered to take more responsibility for their dietary intake on a daily basis. The current ambiguity that exists with regard to the federal government's role in protecting the public health of the population in the arena of nutrition and food policy calls upon health professionals to embrace a greater role to ameliorate this critical problem. The current state of the SAD only exacerbates this situation.

The authors of DGA 2015-2020, quite aware of the current state of the nation's health, presented in chapter 3, "Everyone Has a Role in Supporting Healthy Eating Patterns," the Social Ecological Model (SEM) specifically designed for health professionals to encourage healthier food choices among the population. Adapted from CDC, the model offers insights for these professionals to better understand the SEM, especially ways to help individuals "enhance their knowledge, attitudes, and motivation to make healthy choices." (np)

Highlighting the need for collective action by health professionals on the front lines, the DGA 2015-2020 emphasize the various sectors that need to better align and collaborate - food producers, suppliers, and retailers. Also, more attention is required for settings where nutritional assistance programs and educational learning opportunities tailored to the needs of the community may be offered. The role of professionals working directly with individuals is reinforced through

knowledge and skill transfer like meal planning, cooking classes, label reading and gardening in order to encourage lifelong healthier food intake patterns.

APPENDIX: SUGGESTED PLANT-BASED NUTRITION RESOURCES

www.vndpg.org - The Vegetarian Nutrition Dietetic Practice Group (VNDPG)

www.vegetariannutrition.net - VNDPG consumer website with evidence-based nutrition

www.vrg.org - Vegetarian Resource Group (VRG) nutrition information

www.PCRM.org - Physicians Committee for Responsible Medication (PRCM) promotes preventive medicine including WFPB diets

www.veganhealth.org - Offers evidence-based nutrition for plant-based diets

www.nutritionfacts.org - Presents peer-reviewed, referenced video-clips, and blogs on WFPB nutrition and lifestyle medicine

www.vegweb.com - VegWeb presents vegetarian recipes, community, and a blog

www.vegetarian-nutrition.info - VNI offers relevant resources, articles and news

Figure 2: Suggest Plant-Based Nutrition Resources

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