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## The Impact of a Plant-based Diet on the Prevention and Management of Type 2 Diabetes Mellitus

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**The Impact of a Plant-based Diet on the Prevention and Management of  
Type 2 Diabetes Mellitus**

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NURS 695: Alternate Plan Paper

Dr. Gwen Verchota

May 10, 2021

## Abstract

**Background:** In the United States, type 2 diabetes is on the rise. Through lifestyle modifications, adults can prevent, delay, or help manage diabetes. Consuming a plant-based diet means limiting or eliminating animal products while focusing on fruits, vegetables, and whole grains. This dietary habit may be beneficial when it comes to diabetes prevention and treatment.

**Objectives:** A literature review was conducted to determine the effects of a plant-based diet on the prevention and treatment of type 2 diabetes in adults.

**Methods:** The search process was limited to 2010-2020. The databases including Academic Search Premier, CINAHL, Cochrane Database of Systematic Reviews, Health Source, and PubMed, which were searched using key terms to address the objective.

**Results:** The search resulted in 11 articles that fulfilled inclusion criteria and addressed the clinical question. Diabetes biomarkers such as hemoglobin A1c, fasting blood glucose (FBG), insulin sensitivity, and more were examined. Other dietary patterns such as a conventional diet, the DASH diet, the Mediterranean diet, and a low-carbohydrate diet were compared to a plant-based diet and their impact on type 2 diabetes.

**Discussion:** Results indicate that a plant-based diet is beneficial in the prevention and treatment of diabetes as realized by improved hemoglobin A1c, fasting blood glucose, and even allowing for a reduction or discontinuation of diabetes related medications. Practitioners can recommend a plant-based diet for adults to aid in the prevention and treatment of diabetes. There are, however, many healthy diet options that are effective in the treatment of type 2 diabetes; thus a patient's preferences should be considered when making recommendations.

*Keywords:* plant-based diet, diet, type 2 diabetes, vegetarian, vegan, prevention, management

## **The Impact of a Plant-based Diet on the Prevention and Management of Type 2 Diabetes Mellitus**

There are several established evidence-based recommendations for the prevention and management of type 2 diabetes. The American Diabetes Association (ADA) (2020a) recommends lifestyle interventions such as consuming a healthy diet, maintaining an ideal body weight, and being physically active for at least 150 minutes per week. At-risk individuals should be screened for diabetes and prediabetes. When diagnosed with prediabetes or diabetes, the ADA (2020a) recommends the aforementioned lifestyle modifications, along with pharmacologic treatment and blood glucose monitoring. The lifestyle modifications, including consuming a healthy diet, are as crucial in the treatment of type 2 diabetes as they are in the prevention. The ADA (2020a) endorses that many eating patterns, including the Mediterranean, low carbohydrate, and plant-based diets can be effective in the management of diabetes, and that dietary recommendations should be individualized to the patient. Through a systematic literature review, this paper will explore the impact of a plant-based diet on the prevention and management of type 2 diabetes in adults.

### **Background**

There is an ever-increasing number of adults with type 2 diabetes, causing a significant burden on the individual and healthcare system. In the United States, 13% of the adult population have been diagnosed with type 2 diabetes, which encompasses 34.1 million adults (CDC, 2020a; CDC, 2020b). This percentage vastly increased from 9.5% of adults in 1999-2002 (CDC, 2020b). Also, 1 in 3, or 88 million adults have prediabetes (CDC, 2020a). Medical costs for those with diabetes are more than twice as high as for those without diabetes, and in the United States, the total annual diabetes related medical costs were estimated at \$327 billion in 2017 (CDC, 2020a).

Diabetes disproportionately affects certain races; 14.7% of American Indians/Alaska Natives, 11.7% of Blacks, 12.5% of Hispanics, and 9.2% of Asian Americans have diagnosed diabetes, compared to 7.5% of non-Hispanic Whites (ADA, 2020b). Being overweight is a risk factor for diabetes and 89% of adults with diabetes are overweight or obese (CDC, 2020a; CDC, 2020b). Other risk factors for diabetes include: having a family history of diabetes, being physically inactive, and over age 45 (CDC, 2020a). Individuals with diabetes have a high risk for developing serious complications, including blindness, kidney failure, heart disease, and stroke (CDC, 2020a). Also, those with diabetes have a higher rate of premature death, and in the United States, diabetes is the seventh leading cause of death (ADA, 2020a; ADA, 2020b). It is clear that the impact of diabetes takes a toll on the individual and their health, as well as the healthcare system as a whole.

For the purposes of this paper, a plant-based diet includes both vegetarian and vegan diets. A plant-based diet consists of “fruits, vegetables, whole grains, legumes, nuts and seeds, herbs, and spices” and excludes animal products (Ostfeld, 2017, p. 315). A vegan diet excludes all animal products (meat, poultry, fish, eggs, and dairy), whereas a vegetarian diet, sometimes called a lacto-ovo-vegetarian diet, allows for eggs and dairy products. Other terms include pescovegetarian or pescatarian, who do not eat meat but consume fish, and semi-vegetarian, who do occasional consume meat but mainly consume plant-based foods (Olfert & Wattick, 2018).

A plant-based diet has known benefits, including lower rates of heart disease, lower risk of developing certain cancers, is protective of cognitive function, and leads to weight loss (Physicians Committee, 2021). An elevated body mass index (BMI) is a modifiable risk factor for diabetes; individuals who follow a plant-based diet tend to have a lower BMI, providing protection against the development of diabetes (McMacken & Shah, 2017). Consuming an

omnivorous diet predicts weight gain over time (McMacken & Shah, 2017). On average, consuming a plant-based diet is less expensive, saving consumers \$750 per year when compared to an omnivorous diet (Physicians Committee, 2021). A plant-based diet is also more environmentally sustainable than an omnivorous diet (McMacken & Shah, 2017). Per the 2015 Dietary Guideline Advisory Committee, when compared to a diet high in animal-based foods, a more plant-based diet has “lesser environmental impact (GHG [greenhouse gas] emissions and energy, land, and water use)” (USDA, 2015, p. 289). Those who follow a plant-based diet can and do realize many benefits, which will be explored further throughout this literature review.

For the purposes of this literature review, the following clinical question was investigated: What is the impact of adopting a plant-based diet on the prevention and management of type 2 diabetes mellitus in adults? This topic is clinically significant since there is a continuous rise in prediabetes and diabetes. In a disease involving large financial and physical burden, implementation of a plant-based diet may assist in disease control and conserve costs.

## **Method**

### **Data Abstraction Process**

A systematic review of the literature was performed to address the question posed above. The databases searched included Academic Search Premier, CINAHL, Cochrane Database of Systematic Reviews, Health Source, and PubMed. These databases were searched between 10/21/2020 and 10/25/2020, including bibliography review which yielded an additional 3 articles. The databases and the subjects covered by the database, search restrictions, and date range are displayed in Table 1 in the appendix. Searches were limited to 2010-2020, English language, and full text. Search terms included “plant-based diet,” “type 2 diabetes,” “diet,”

“vegetarian,” “vegan,” “prevention,” “treatment,” and “benefits.” Refer to Table 2 in the appendix for the specific combinations of terms used in the search process. When searches resulted in 30 articles or less, a title search was conducted. Certain titles were eliminated if the title clearly did not pertain to the clinical question, or if the article had already resulted from a previous search. Pertinent articles are bolded in Table 2 (see Appendix).

### **Inclusion and Exclusion Criteria**

Articles describing the effects of a plant-based diet on diabetes were included for further analysis. This encompassed the effects on biomarkers such as hemoglobin A1c, fasting blood glucose (FBG), and BMI. Articles comparing a plant-based diet such as a vegetarian or vegan diet to different dietary patterns, including an omnivorous diet, a conventional diet, a diabetic diet, the Dietary Approaches to Stop Hypertension (DASH) diet, the Mediterranean diet, and a low-carbohydrate diet were also included. Articles focusing on prevention of prediabetes and diabetes were included. With the variety of definitions of a plant-based diet, inclusion criteria was not limited to vegan, vegetarian, or any certain subset of a plant-based diet.

Bibliographies of literature reviews found in the search process were examined, resulting in three additional articles included in this review. Studies were excluded if the focus was on other effects of a plant-based diet, including cardiovascular disease and mortality, or the role of race in diabetes incidence. Moreover, studies were excluded if the subjects under review included individuals under the age of 18 or those with type 1 diabetes. Table 3, which can be seen in the appendix, describes specific reasoning for including and excluding studies.

### **Literature Review Results**

Articles included within this literature review encompass systematic reviews, randomized controlled trials (RCTs), cohort studies, meta-analyses, pilot studies, and expert opinions.

Information gleaned from select articles was used to investigate the clinical question. Relevant articles can be seen in Table 4, which is included in the attached appendix, and further discussed below.

### **Summary of the Literature**

A prospective cohort study by Chen et al. (2018) sought to investigate whether a plant-based diet lowers the risk of insulin resistance, prediabetes, and diabetes. Moreover, Chen et al. (2018) compared adherence to a more plant-based diet, which limits but does not completely eliminate animal-based foods, to a vegan or vegetarian diet. Broadening terms beyond vegan or vegetarian allows for more of the general population to be included. With a sample size of 6798 adults from the Rotterdam Study, Chen et al. (2018) used a plant-based dietary index to categorize types of foods consumed by participants. Ultimately, Chen et al. (2018) found higher plant-based dietary index scores were associated with a lower risk of prediabetes and diabetes development.

de Carvalho et al. (2020) conducted a systematic review which included six studies with a sample size of 690 adults. Four RCTs, one randomized crossover study, and one cohort study were included in the review. The purpose of the systematic review was to evaluate the effects of adopting different dietary patterns on glycemic control for adults with diabetes. The diets evaluated in this review included vegan and vegetarian diets, the Mediterranean diet, the DASH diet, and a diet uniquely designed by a dietician; all these diets were compared to a conventional diet. de Carvalho et al. (2020) evaluated whether an improvement in glycemic control could be realized by comparing hemoglobin A1c values within the various dietary patterns. All the diets, when compared to a conventional diet, resulted in a statistically significant reduction in hemoglobin A1c (de Carvalho et al., 2020).



A RCT conducted by Kahleova et al. (2011) included a sample of 74 adults with type 2 diabetes. This RCT randomly assigned participants to an intervention and control group, and participants consumed a plant-based diet and a conventional diabetic diet respectively. Kahleova et al. (2011) sought to determine the effects of these two dietary interventions on insulin resistance, visceral fat, and oxidative stress markers in the participating adults with type 2 diabetes. Over the 24-week study, exercise was implemented during the last 12 weeks. Findings from the biological markers under investigation suggest greater improvements were realized in the intervention group, though the difference between groups was not statistically significant. The addition of physical activity resulted in even more improvement in key diabetes markers in both groups (Kahleova et al., 2011).

A systematic review and meta-analysis by Kahleova et al. (2019) also compared different dietary patterns, with the primary intent of updating a practice guideline for nutrition therapy in prevention and management of type 2 diabetes. With a sample size of 664 adults, the authors compared the Mediterranean, DASH, Portfolio, Nordic, liquid meal, and vegetarian diets. Overall, the review found that all the diets reduced mortality from cardiovascular disease in adults with diabetes (Kahleova et al., 2019). Another systematic review compared various dietary patterns, including the Mediterranean diet, a low-carbohydrate/high-protein diet, a vegan diet, and a vegetarian diet (Khazrai et al., 2014). Khazrai et al. (2014) sought to explore the effects of all these diets on type 2 diabetes, finding benefits from the Mediterranean, vegetarian, and vegan diets. The authors also recognized that there are many effective dietary patterns for patients with diabetes, therefore personal preference and tastes should be considered when developing the dietary plan (Khazrai et al., 2014).

Olfert and Wattick (2018) conducted a systematic review to explore the effects of a vegetarian diet in the treatment of diabetes, and also to determine which vegetarian diet was most beneficial for type 2 diabetes management. The authors found the benefits of a vegetarian diet come from eating whole foods such as whole grains, legumes, fruits and vegetables. Similarly, Satija et al. (2016) found that a plant-based diet, but more specifically a *healthy* plant-based diet and a reduction in animal foods is beneficial to preventing the development of type 2 diabetes. The strictest vegetarian diet, limiting all animal products, is the vegan diet. Olfert and Wattick (2018) report that this group of vegetarians has the lowest prevalence of diabetes. For those with diabetes, adopting a vegetarian diet improved cardiovascular disease risk factors, and allowed for a reduction in diabetes-related medications. Vegetarians overall have a lower prevalence of diabetes when compared to those consuming an omnivorous diet (Olfert & Wattick, 2018).

A systematic review and meta-analysis by Yokoyama et al. (2014) encompassing six studies found vegetarian diets are associated with a significant reduction in hemoglobin A1c and a non-significant reduction in FBG. The higher levels of fiber consumed within a vegetarian diet aids in glycemic control, since dietary fiber slows intestinal glucose absorption, lowering the glycemic index (Yokoyama et al., 2014). Just as Olfert and Wattick (2018) found that a vegetarian diet improved cardiovascular risk factors for individuals with diabetes, Yokoyama et al. (2014) also found benefits to cardiovascular health including the reduction in hypertension, body weight, and lipid levels. Ultimately, the authors concluded that vegetarian diets can assist in preventing and managing diabetes in adults.

McMacken & Shah (2017) provided an overview of the benefits of a whole foods plant-based diet in adults with type 2 diabetes, including prevention of diabetes. This expert opinion piece asserted that not only does a plant-based diet prevent and improve management of

diabetes, but plant-based diets also aid in the treatment of cardiovascular disease and risk factors such as obesity, hypertension, hyperlipidemia, and overall inflammation (McMacken & Shah, 2017). It is understood that inflammation promotes hyperglycemia and insulin resistance (Sa'ad-Aldin & Altamimi, 2018). A pilot study by Sa'ad-Aldin & Altamimi (2018) found that a plant-based diet decreased inflammation in the body since the diet contains “antioxidants, anti-inflammatory, dietary fiber and sources of beneficial microbiota,” (p. 544) leading to improved FBG, hemoglobin A1c, and also a reduced BMI. A plant-based diet is a low risk intervention with many benefits, and also environmentally sustainable as compared to animal-based diet (McMacken & Shah, 2017).

Toumpanakis et al. (2018) conducted a systematic review of RCTs aimed at exploring the effects of a plant-based diet on the physical and psychological wellbeing of adults with diabetes. When compared to the control diet group, study subjects with type 2 diabetes adhering to the plant-based dietary intervention experienced an improvement in quality of life, psychological and emotional well-being, energy levels, self-esteem, and a decrease in depression rates, hemoglobin A1c, weight, FBG, cholesterol levels, and neuropathic pain. Participants following a plant-based diet were also able to decrease or even discontinue diabetes related medications.

### **Discussion**

This literature review incorporates studies from the past 10 years, gleaning evidence of the many benefits to adults with type 2 diabetes who follow a plant-based diet. The benefits include a decreased risk of developing diabetes, improvement of diabetes biomarkers, decreased medication requirements, and more. Other dietary patterns, which are discussed below, have also proven to be beneficial in diabetes control.

### **Decreased Risk of Developing Diabetes**

A plant-based diet, especially a ‘healthy’ plant-based diet, is protective against the development of type 2 diabetes (Chen et al., 2018; McMacken & Shah, 2017; Olfert & Wattick, 2018; Satija et al., 2016). Since a poor diet is a modifiable risk factor for diabetes (Olfert & Wattick, 2018), a dietary modification to prevent diabetes is an appropriate intervention. Also, preventing diabetes before it occurs is the best method to avoid any complications from the disease. Removing all animal foods from the diet is not realistic for everyone, but a diet that *emphasizes* plant-based foods and *limits* animal products reduces the risk of insulin resistance, prediabetes, and diabetes (Chen et al., 2018; Satija et al., 2016). Satija et al. (2018) found there to be a 20% reduction in diabetes risk with the adoption of a plant focused diet.

### **Outcomes Related to Specific Plant-Based Foods**

The type of plant-based foods matter when it comes to reaping benefits from the diet. Plant-based foods that are protective against diabetes, as was found by Satija et al. (2016), include “whole grains, fruits, vegetables, nuts, legumes, vegetable oils, and tea/coffee” (p. 4). Less healthy plant-based foods include fruit juices, sweetened beverages, refined grains, potatoes, and sweets (Satija et al., 2016). Animal-based foods are described as animal fats, dairy, eggs, poultry, fish, and red meat (Satija et al., 2016). Higher intake of ‘healthy’ plant-based foods, and minimal intake of ‘unhealthy’ plant-based foods and animal-based foods were associated with lower rates of prediabetes and diabetes (Chen et al., 2018; Satija et al., 2016). An individual who follows a ‘healthy’ plant-based diet is more protected against the development of diabetes compared to an individual who consumes ‘unhealthy’ plant-based foods and/or animal-based foods.

In their systematic review, Olfert and Wattick (2018) compared the different types of vegetarian diets to explore which is of most benefit in the management of diabetes. Individuals consuming a vegan diet, which is the most restrictive with no animal products, had the lowest prevalence of diabetes at 2.9%. With less restrictive vegetarian diets, the prevalence of diabetes increased; a semi-vegetarian diet had the highest prevalence of diabetes at 6.1%. The prevalence was still higher among non-vegetarians at 7.6%. The types of plant-based foods, along with the vegetarian diet consumed, both ultimately affected risk of developing prediabetes and diabetes.

### **Other Diets Versus a Plant-Based Diet**

Many articles included in the literature review sought to compare multiple diets in the prevention and treatment of diabetes. de Carvalho et al. (2020) compared vegetarian, vegan, DASH, and Mediterranean dietary patterns in a systematic review. All diets, compared to a conventional diet, lead to a reduction in hemoglobin A1c by an average of 0.8%. The vegan and vegetarian diets lead to a reduction in hemoglobin A1c by 0.68%, while the DASH and Mediterranean diets had higher reductions in hemoglobin A1c at 1.7% and 1.2% respectively (de Carvalho et al., 2020). This reaffirms the point by the ADA (2020a), which recognizes that multiple eating patterns can be healthy for a patient with diabetes to follow, and patient preferences and goals should be taken into account.

Khazrai et al. (2014) also compared dietary patterns in a systematic review, including the Mediterranean diet, a low-carbohydrate/high-protein diet, a vegan diet, and a vegetarian diet. All diets were compared to a conventional diet. Patients with diabetes who adopted the Mediterranean diet were found to have a decrease in C-reactive protein, FBG, triglyceride levels, as well as an overall decreased in insulin resistance. Implementing a low carbohydrate and high protein diet did *not* result in weight loss or a smaller waist circumference, and did *not* improve

hemoglobin A1c, renal function, or cholesterol levels. In comparison, Khazrai et al. (2014) found that following a vegetarian or vegan diet improved weight loss and metabolic control in those with diabetes, and also improved plasma lipid levels.

### **Effects on Diabetes Biomarkers**

For an adult with diabetes, monitoring for glycemic control involves checking FBG levels and hemoglobin A1c. The hemoglobin A1c provides an average blood glucose level over the approximate last 3 months (ADA, 2020a). The ADA (2020a) recommends at least biannual A1c monitoring for adults with diabetes. Multiple articles found through the literature review described changes to FBG and hemoglobin A1c for patients with diabetes after initiating a plant-based diet. For adults with diabetes, following a plant-based diet is associated with decreased hemoglobin A1c (de Carvalho et al., 2020; Kahleova et al., 2011; Kahleova et al., 2019; Sa'ad-Aldin & Altamimi, 2018; Toumpanakis et al., 2018; Yokoyama et al., 2014), and decreased FBG levels (Kahleova et al., 2019; Olfert & Wattick, 2018; Sa'ad-Aldin & Altamimi, 2018; Toumpanakis et al., 2018; Yokoyama et al., 2014). Improvement of these diabetes biomarkers is promising for the benefits of a plant-based diet in the management of diabetes.

### **Medication Requirements**

There are multiple options for pharmacologic treatment of diabetes, including oral antihyperglycemic agents and insulin. Consuming a plant-based diet has been shown to reduce the need for or even allow for discontinuation of pharmacologic treatment of diabetes (Olfert & Wattick, 2018; Toumpanakis et al., 2018). First line therapy for prediabetes and diabetes includes metformin *and* lifestyle modifications (ADA, 2020a). Even a patient with diabetes requiring combination therapy with oral antihyperglycemics is encouraged to implement lifestyle modifications including weight loss, healthy diet, and physical activity. With a lifestyle

modification such as a plant-based diet, a patient with diabetes may require less, or be able to discontinue pharmacologic treatment all together. This also would reduce medication cost for the patient.

### **Other Benefits**

Beyond improving hemoglobin A1c, FBG, and decreasing the need for medication, there are many other benefits realized by adults with diabetes who consume a plant-based diet. These benefits include reduction in BMI and obesity (de Carvalho et al., 2020; Kahleova et al., 2011; Kahleova et al., 2019; McMacken & Shah, 2017; Sa'ad-Aldin & Altamimi, 2018; Toumpanakis et al., 2018; Yokoyama et al., 2014), increased insulin sensitivity (Chen et al., 2018; Kahleova et al., 2011), decreased inflammation and oxidative stress markers (Kahleova et al., 2011; McMacken & Shah, 2017; Sa'ad-Aldin & Altamimi, 2018), decreased lipid levels (Kahleova et al., 2019; Khazrai et al., 2014; McMacken & Shah, 2017; Olfert & Wattick, 2018; Toumpanakis et al., 2018; Yokoyama et al., 2014), lower rates of hypertension (McMacken & Shah, 2017; Olfert & Wattick, 2018; Yokoyama et al., 2014), and even improved quality of life and psychological wellbeing (Toumpanakis et al., 2018). With a chronic medical condition such as diabetes, improvement in any of these areas can have a major effect on the patient as well as their diabetes. These are all notable benefits which can help to prevent diabetes complications and reduce healthcare costs.

### **Gaps in literature**

A major gap in the literature is the lack of discourse on how to go about delivering nutritional education to encourage adults with type 2 diabetes to independently initiate or continue consuming a plant-based diet (Toumpanakis et al., 2018). A pilot study by Lee et al. (2015) sought to assess awareness of and barriers to implementing a plant-based diet for

management of type 2 diabetes. This study was not included in this literature review since the focus was not on the effects of a plant-based diet, but Lee et al. (2015) found that 89% of patients with type 2 diabetes were unaware of the benefits of a plant-based diet on their overall diabetes management, yet 66% of patients were willing to follow a plant-based diet. Perceived barriers to implementing a plant-based diet for patients included family eating habits, poor meal planning skills, and enjoying meat (Lee et al., 2015). The opinions of medical professionals were also studied, and though almost all of those surveyed suggested they knew the benefits of a plant-based diet, they perceived the diet was too difficult for patients to follow with poor scientific evidence of its benefits. Therefore, only 32% of medical professionals would recommend this diet to patients (Lee et al., 2015). Since patients' perceptions are often motivated at least in part by their healthcare providers, not recommending a plant-based diet greatly affects the likelihood of a patient choosing to consume a plant-based diet (Lee et al., 2015). Some studies provided plant-based meals to study participants (Kahleova et al., 2011), yet this is not sustainable and does not give patients the tools needed to continue a plant-based diet beyond the study. Future research could explore a variety of strategies to better understand how best to initiate and sustain a plant-based diet (Toumpanakis et al., 2018).

Nowhere in the studies included in this literature review did the authors discuss how food deserts, or how lack of access to fresh and nutritious food options in certain areas, may limit a patient's ability to maintain a plant-based diet. Food deserts typically occur in less affluent neighborhoods. Poverty and living in a less affluent area increases an individual's odds of having diabetes (Gaskin et al., 2014). Providers need to be aware of the lack of resources that affect the community in which they practice, such as lack of healthy food options, when recommending a plant-based diet.



Another gap in the literature is that possible harm from a plant-based diet was rarely discussed. Many studies found that adults with diabetes were able to decrease or discontinue use of their diabetes related medication(s) (McMacken & Shah, 2017; Olfert & Wattick, 2018; Toumpanakis et al., 2018). Patients with diabetes who implement a plant-based diet while taking antidiabetic medications that can cause hypoglycemia are at greater risk for hypoglycemia (Trapp et al., 2010). This risk was addressed in only two of the studies (Kahleova et al., 2011; McMacken & Shah, 2017), but is important information for patient safety. Also, certain nutrients, such as vitamin B12, are found mostly in animal products. Those following a plant-based diet and more specifically a vegan diet, may not have a reliable source of vitamin B12. Vitamin B12 may be in fortified foods allowed in a plant-based diet (Trapp et al., 2010), but the risks of not consuming an adequate amount of vitamin B12 (anemia, cognitive difficulties, weakness, fatigue, balance problems, numbness and tingling [Harvard Health, 2013]) were not addressed, nor did authors recommend assessing for deficiency or recommending supplementation to those at risk for this deficiency.

### **Implications for the Future**

#### **Implications for Practice**

The ADA's (2020a) "Standards of Medical Care in Diabetes" addresses the importance of self-management education and support, acknowledging that all patients with diabetes need support to facilitate self-care. "There are four critical times to evaluate the need for diabetes self-management education to promote skills acquisition in support of regimen implementation, medical nutrition therapy, and well-being: at diagnosis, annually, when complicating factors arise, and when transitions in care occur" (ADA, 2020a, p. S49). Patient centered support, which emphasizes clinical outcomes, health status, and well-being, can improve health outcomes and

reduces cost (ADA, 2020a). It is recommended providers support healthy eating patterns incorporating appropriate amounts of nutrient-dense food to “maintain body weight goals, attain individualized glycemic, blood pressure, and lipid goals, and delay complications of diabetes” (ADA, 2020a, p. S50). In a non-judgmental and patient specific manner, providers should recommend minimizing added sugars, processed foods, and refined grains while focusing on whole foods (ADA, 2020a). As previously mentioned, the ADA recognizes that multiple dietary patterns including the Mediterranean, low-carbohydrate, and vegetarian or plant-based diets are healthy options for adults with diabetes to follow. Through this literature review, it was determined that a plant-based diet specifically is a low cost, effective method with proven benefits for adults at risk for and with diabetes.

Since certain plant-based diets may put a patient at risk for a vitamin B12 deficiency, providers should screen those following a plant-based diet, checking levels for those at risk for deficiency and suggesting supplementation as needed. Also, metformin is known to reduce vitamin B12 absorption, therefore patients taking metformin should be closely monitored. When adults with diabetes initiate a plant-based diet while taking antihyperglycemic medications, a plan should be devised for blood glucose monitoring to protect patients from potential hypoglycemia with the dietary change.

### **Implications for Education**

Educating practitioners and patients concerning dietary patterns that are effective in the prevention and management of diabetes is paramount; practitioners and patients should be aware of the benefits of a plant-based diet and other healthy dietary options effective in diabetes prevention and management. The ADA (2020a) recommends referral to medical nutrition therapy (MNT) by a registered dietitian nutritionist (RDN) for all patients with diabetes, and

collaboration with a dietitian is associated with reduced hemoglobin A1c by 0.3-2%. With co-existing conditions, such as renal failure, dietician referral may be of great benefit to manage complex dietary needs. Unfortunately, not all patients will attend MNT, so basic information should be included in practitioner education programs. As was discussed, Lee et al. (2015) found patients may be simply unaware of the benefits of a plant-based diet. Lee et al. (2015) suggests community-based diet educational programs to reach members of the community. Both practitioners and patients can benefit from more education on how to implement a plant-based diet, and the overall impact on their health.

### **Implications for Policy**

One gap mentioned above was the lack of discussion of food deserts that may affect whether an individual has access to fresh, affordable, plant-based foods. To aid with this disparity, additional funding should be given towards organizations that pilot grocery initiatives in food deserts. Supplemental Nutrition Assistance Program (SNAP) is a federal program that provides food for low income families in the United States. Individuals who qualify for SNAP benefits may live in a food desert. In 2019, the SNAP Online Purchasing Pilot allowed SNAP users to purchase groceries online using their Electronic Benefit Transfer (EBT) card (USDA, 2021). This is a step in the right direction to aid individuals in food deserts to have more access to healthy food options through delivery services. Unfortunately, there are only a handful of approved retailers, including Aldi, Amazon, and Walmart (USDA, 2021). To ensure more individuals have access to healthy food options, especially those in food deserts, retailers should be encouraged to accept SNAP payments online.

## **Implications for Research**

Further research is needed on the long-term effects of a plant-based diet, and its role in diabetes prevention and care (Kahleova et al., 2011). To better understand how a plant-based diet affects diverse racial and ethnic groups, additional studies are required with larger sample sizes which include a wide variety of individuals of all ages and races (Satija et al., 2016). More research is needed on barriers to implementing and maintaining a plant-based diet as perceived by patients (Lee et al., 2015). These barriers could then be better addressed by practitioners recommending a plant-based diet. Further study is needed to understand the role of psychological health and diabetes management, as psychological health can play a major role in a patient's willingness and ability to implement a healthier diet (Kahleova et al., 2011).

Diet is known to play a major role in the development and control of diabetes. This literature review revealed that further research is needed on the impact of a plant-based diet in diabetes prevention and care, but the research to date is clear. A plant-based diet is beneficial in adults with diabetes.

## **Conclusion**

The clinical question that guided this literature review was: What is the impact of adopting a plant-based diet on the prevention and management of type 2 diabetes in adults? A plant-based diet, which limits animal-based foods, and also limits unhealthy plant-based foods such as fruit juices, sweetened beverages, refined grains, and sweets, has many benefits for adults. A plant-based diet reduces the risk of prediabetes and diabetes, while also improving diabetes biomarkers such as hemoglobin A1c and FBG, ultimately allowing some patients to reduce or discontinue the use of antihyperglycemic agents. In an expensive disease such as type 2 diabetes with many potential complications, consuming a plant-based diet is an intervention

that can reduce costs, BMI, inflammation, lipid levels, blood pressure, and even improve psychological well-being. Providers can and should recommend a dietary pattern such as a plant-based diet for those at risk for diabetes to prevent the development of disease, and to those with diabetes to improve glycemic control and health outcomes.

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## Appendix

**Table 1**

*Database Search Description*

<b>Database (or Search Engine)</b>	<b>Restrictions Added to Search</b>	<b>Dates Included in Database</b>	<b>General Subjects Covered by Database</b>
Academic Search Premier (ASP)	Full Text, English Language, Scholarly (Peer Reviewed) Journals	2010-2020	Covering many academic subjects, ASP provides articles with citations and abstracts from over 4.6000 publications.
CINAHL Plus with Full Text	Full Text; English Language, Academic Journal	2010-2020	Provides access to nursing journals, including citations, abstracts, books, dissertations, proceedings, and other materials from over 3.100 journals. Topics include cardiopulmonary technology, emergency service, health education, medical/laboratory, medical assistant, medical records, occupational therapy, physical therapy, physician assistant, radiologic technology, social service/health care, and more.
Cochrane Database of Systematic Review	Full Text, English Language	2010-2020	Cochrane Database of Systematic Reviews has full text articles, protocols, and guidelines. Medical data from multiple studies is combined to increase the power of the findings.
Health Source: Nursing/Academic Edition	Full Text, English Language	2010-2020	With a focus on nursing and allied health, Health Source provides 550 scholarly full-text journals. Health Source also includes Lexi-PAL Drug Guide.
PubMed	Full Text, English Language, Abstract	2010-2020	Provides full text articles, citations, and abstracts related to medicine, nursing, dentistry, veterinary medicine, the health care system, and the preclinical sciences.

**Table 2**  
*Data Abstraction Process*

Date of Search	Key Words	Results in CINAHL	Results in PubMed	Results in Cochrane	Results in Academic Search Premier	Results in Health Source
10/21/2020	“plant based diet” AND type 2 diabetes	<b>4 (2)*</b>	35	0	5	7
	“plant based diet” AND type 2 diabetes AND <i>prevention</i>	1	17	0	1	<b>3 (1)*</b>
	Diet AND type 2 diabetes AND <i>prevention</i>	818	4,696	12 (0)	521	177
	Plant based diet AND type 2 diabetes	29	278	0	64	<b>27 (3)*</b>
10/24/2020	Vegetarian AND type 2 diabetes	<b>15 (3)*</b>	130	0	<b>26 (3)*</b>	11
	Vegan AND type 2 diabetes	22	60	0	13	5 (0)
10/25/2020	Treatment AND type 2 diabetes AND plant based diet	<b>9 (2)*</b>	212	0	26	7
	Treatment AND type 2 diabetes AND “plant based diet”	1	<b>26 (2)*</b>	0	<b>1 (1)*</b>	3
	Benefits AND plant based diet AND type 2 diabetes	7	59	0	10	5
10/25/2020	Bibliographic review	<b>3*</b>				

\***BOLD** = articles reviewed for match with systematic review inclusion criteria (parentheses indicate those articles meeting inclusion criteria)

**Table 3**  
*Characteristics of Literature Included and Excluded*

Reference	Included or Excluded and Document	Rationale
Benson, H. & Hayes, J. (2020). An update on the Mediterranean, vegetarian, and DASH eating patterns in people with type 2 diabetes. <i>Diabetes Spectrum</i> , 33(2), 125–132. <a href="https://doi.org/10.2337/ds19-0073">https://doi.org/10.2337/ds19-0073</a>	Excluded	Literature Reviews excluded; bibliography reviewed
Chen, Z., Zuurmond, M. G., van der Schaft, N., Nano, J., Wijnhoven, H. A. H., Ikram, M. A., Franco, O. H., & Voortman, T. (2018). Plant versus animal-based diets and insulin resistance, prediabetes and type 2 diabetes: The Rotterdam study. <i>European Journal of Epidemiology</i> , 33(9), 883-893. <a href="https://doi.org/10.1007/s10654-018-0414-8">https://doi.org/10.1007/s10654-018-0414-8</a>	Included	High quality cohort study focusing on plant-based versus animal diets and prediabetes/diabetes

Reference	Included or Excluded and Document	Rationale
de Carvalho, G. B., Dias-Vasconcelos, N. L., Santos, R. K. F., Brandao-Lima, P. N., da Silva, D. G., & Pires, L. V. (2020). Effect of different dietary patterns on glycemic control in individuals with type 2 diabetes mellitus: A systematic review. <i>Critical Reviews in Food Science and Nutrition</i> , 60(12), 1999–2010. <a href="https://doi.org/10.1080/10408398.2019.1624498">https://doi.org/10.1080/10408398.2019.1624498</a>	Included	High quality, systematic review which sought to understand the effect of different dietary patterns on glycemic control markers in adults with T2DM. The diets analyzed included vegan, vegetarian, DASH, Mediterranean, and a specific diet defined by the dietician.
Harland, J., & Garton, L. (2016). An update of the evidence relating to plant-based diets and cardiovascular disease, type 2 diabetes and overweight. <i>Nutrition Bulletin</i> , 41(4), 323-338. <a href="https://doi.org/10.1111/nbu.12235">https://doi.org/10.1111/nbu.12235</a>	Excluded	The main focus was on cardiovascular disease and plant-based diets, not diabetes.
Harvard Health Letter. (February, 2019). <i>Meat-free diet linked to benefits for people with type 2 diabetes</i> . <a href="https://www.health.harvard.edu/staying-healthy/meat-free-diet-linked-to-benefits-for-people-with-type-2-diabetes">https://www.health.harvard.edu/staying-healthy/meat-free-diet-linked-to-benefits-for-people-with-type-2-diabetes</a>	Excluded	Short, expert opinion piece with very general/broad statement; but referenced Toupanakis et al. (2018) which was included.
Kahleova, H., Matoulek, M., Malinska, H., Oliyarnik, O., Kazdova, L., Neskudla, T., Skoch, A., Hajek, M., Hill, M., Kahle, M., & Pelikanova, T. (2011). Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with Type 2 diabetes. <i>Diabetic Medicine</i> , 28(5), 549-559. <a href="https://doi.org/10.1111/j.1464-5491.2010.03209.x">https://doi.org/10.1111/j.1464-5491.2010.03209.x</a>	Included	RCT comparing vegetarian diet to conventional diabetic diet in adults with T2DM.
Kahleova, H., Salas-Salvadó, J., Rahelić, D., Kendall, C. W., Rembert, E., & Sievenpiper, J. L. (2019). Dietary patterns and cardiometabolic outcomes in diabetes: A summary of systematic reviews and meta-analyses. <i>Nutrients</i> , 11(9), 2209. <a href="https://doi.org/10.3390/nu11092209">https://doi.org/10.3390/nu11092209</a>	Included	Review of systematic reviews and meta-analyses to update practice guideline for nutrition therapy in prevention and management of diabetes; Mediterranean, DASH, Portfolio, Nordic, liquid meal, vegetarian diets compared.
Khazrai, Y. M., Defeudis, G., & Pozzilli, P. (2014). Effect of diet on type 2 diabetes mellitus: A review. <i>Diabetes/metabolism research and reviews</i> , 30(S1), 24-33. <a href="https://doi.org/10.1002/dmrr.2515">https://doi.org/10.1002/dmrr.2515</a>	Included	Review of Mediterranean diet, a low-carbohydrate/high-protein diet, a vegan diet, and a vegetarian diet and their effects in adults with T2DM.
Lee, V., McKay, T., & Ardern, C. I. (2015). Awareness and perception of plant-based diets for the treatment and management of type 2 diabetes in a community education clinic: A pilot study. <i>Journal of Nutrition and Metabolism</i> , 2015, 236234–236236. <a href="https://doi.org/10.1155/2015/236234">https://doi.org/10.1155/2015/236234</a>	Excluded	Purpose is to assess awareness and barriers to plant-based diet use for management of T2DM, and to develop an educational program targeting patients and providers.
McMacken, M., & Shah, S. (2017). A plant-based diet for the prevention and treatment of type 2 diabetes. <i>Journal of Geriatric Cardiology</i> , 14(5), 342–354. <a href="https://doi.org/10.11909/j.issn.1671-5411.2017.05.009">https://doi.org/10.11909/j.issn.1671-5411.2017.05.009</a>	Included	Expert Opinion piece of multiple benefits of plant-based diet in adults with T2DM and prediabetes.
Olfert, M. D., & Wattick, R. A. (2018). Vegetarian diets and the risk of diabetes. <i>Current Diabetes Reports</i> , 18(11), 1-6. <a href="https://doi.org/10.1007/s11892-018-1070-9">https://doi.org/10.1007/s11892-018-1070-9</a>	Included	Review of different types of vegetarian diets and their effect on T2DM prevention and treatment
Orlich, M. J., Singh, P. N., Sabaté, J., Jaceldo-Siegl, K., Fan, J., Knutsen, S., Beeson, W., & Fraser, G. E. (2013). Vegetarian dietary patterns and mortality	Excluded	Focused on mortality, with only a brief discussion of T2DM.

Reference	Included or Excluded and Document	Rationale
in Adventist Health Study 2. <i>JAMA Internal Medicine</i> , 173(13), 1230-1238. <a href="https://doi.org/10.1001/jamainternmed.2013.6473">https://doi.org/10.1001/jamainternmed.2013.6473</a>		
Sa'ad-Aldin, K., & Altamimi, M. (2019). Effect of whole-grain plant-based diet on the diabetes mellitus type 2 features in newly diagnosed patients: A pilot study. <i>International Journal of Diabetes in Developing Countries</i> , 39(3), 535-546. <a href="https://doi.org/10.1007/s13410-018-0689-z">https://doi.org/10.1007/s13410-018-0689-z</a>	Included	Pilot study with small sample, but showed a significant decrease in FBG, HgA1c, and BMI in patients with T2DM who followed a plant-based diet.
Satija, A., Bhupathiraju, S. N., Rimm, E. B., Spiegelman, D., Chiuve, S. E., Borgi, L., Willett, W., Manson, J., Sun, Q., & Hu, F. B. (2016). Plant-based dietary patterns and incidence of type 2 diabetes in US men and women: Results from three prospective cohort studies. <i>PLoS Medicine</i> , 13(6), e1002039. <a href="https://doi.org/10.1371/journal.pmed.1002039">https://doi.org/10.1371/journal.pmed.1002039</a>	Included	High quality cohort studies, giving an overview of plant-based diets and their role in being protective against T2DM.
Tonstad, S., Stewart, K., Oda, K., Batech, M., Herring, R. P., & Fraser, G. E. (2013). Vegetarian diets and incidence of diabetes in the Adventist Health Study-2. <i>Nutrition, Metabolism and Cardiovascular Diseases</i> , 23(4), 292-299. <a href="https://doi.org/10.1016/j.numecd.2011.07.004">https://doi.org/10.1016/j.numecd.2011.07.004</a>	Excluded	Focused on comparing black vs non-black participants in the Adventist Health Study-2, and their incidents of T2DM.
Toumpanakis, A., Turnbull, T., & Alba-Barba, I. (2018). Effectiveness of plant-based diets in promoting well-being in the management of type 2 diabetes: A systematic review. <i>BMJ Open Diabetes Research and Care</i> , 6(1), 1-10. <a href="https://doi.org/10.1136/bmjdr-2018-000534">https://doi.org/10.1136/bmjdr-2018-000534</a>	Included	Systematic review of RCTs, focusing on effects of plant-based diet on wellness for patients with T2DM.
Trapp, C. B., & Barnard, N. D. (2010). Usefulness of vegetarian and vegan diets for treating type 2 diabetes. <i>Current Diabetes Reports</i> , 10(2), 152-158. <a href="https://doi.org/10.1007/s11892-010-0093-7">https://doi.org/10.1007/s11892-010-0093-7</a>	Excluded	Reviewed observational studies and intervention trials, focusing on sustainability and acceptability of a plant-based diet for patients with T2DM.
Utami, D. B., & Findyartini, A. (2018). Plant-based diet for HbA1c reduction in type 2 diabetes mellitus: An evidence-based case report. <i>Acta Med. Indones</i> , 50, 260-267.	Excluded	Literature Reviews excluded; bibliography reviewed.
Yokoyama, Y., Barnard, N. D., Levin, S. M., & Watanabe, M. (2014). Vegetarian diets and glycemic control in diabetes: A systematic review and meta-analysis. <i>Cardiovascular diagnosis and therapy</i> , 4(5), 373-382. <a href="https://doi.org/10.3978/j.issn.2223-3652.2014.10.04">https://doi.org/10.3978/j.issn.2223-3652.2014.10.04</a>	Included	Meta-analysis of studies that focused on vegetarian diets and reduction in HgA1c in adults with T2DM

RCT = randomized control trial, T2DM = type 2 diabetes mellitus; DASH = dietary approaches to stop hypertension; FBG = fasting blood glucose; HgA1c = hemoglobin A1c; BMI = Body mass index

**Table 4**  
*Literature Review Table of All Studies Included*

Citation	Study Purpose	Pop (N)/ Sample Size (n) /Setting(s)	Design/ Level of Evidence	Variables/ Instruments	Intervention	Findings	Implications
Chen, Z., Zuurmond, M. G., van der Schaft, N., Nano, J., Wijnhoven, H. A. H., Ikram, M. A., Franco, O. H., & Voortman, T. (2018). Plant versus animal based diets and insulin resistance, prediabetes and type 2 diabetes: The Rotterdam study. <i>European Journal of Epidemiology</i> , 33(9), 883-893. <a href="https://doi.org/10.1007/s10654-018-0414-8">https://doi.org/10.1007/s10654-018-0414-8</a>	Investigate whether level of adherence to a plant-based diet (low in animal based foods) is associated with insulin resistance, prediabetes, and T2DM	N=6798 from Rotterdam Study  District of Ommoord in Rotterdam, the Netherlands	Prospective cohort study  Level IV	-Food frequency Questionnaire (FFQ) -Plant-based dietary index -Homeostasis model assessment of insulin resistance (HOMA-IR) -Glucose level -Insulin level	Plant-based diet	Higher score on the plant-based dietary index was associated with lower insulin resistance, lower prediabetes risk, and lower T2DM risk	A more plant-based and less animal-based diet may lower risk of insulin resistance, prediabetes, and T2DM.  Beyond adherence to vegetarian or vegan diet, more focus on high quality plant-based foods, and limiting sweets, sugary beverages, refines grains. Does not require a radical change in diet/total elimination of meat; increasing potential for population-wide acceptance.
de Carvalho, G. B., Dias-Vasconcelos, N. L., Santos, R. K. F., Brandao-Lima, P. N., da Silva, D. G., & Pires, L. V. (2020). Effect of different dietary patterns on glycemic control markers of individuals with T2DM: A systematic review. <i>Critical Reviews in Food Science and Nutrition</i> , 60(12), 1999–2010. <a href="https://doi.org/10.1080/10408398.2019.1624498">https://doi.org/10.1080/10408398.2019.1624498</a>	Evaluate the effects of adopting different dietary patterns on glycemic control markers of individuals with T2DM	N=690 6 studies 4 RCTs, 1 randomized crossover, 1 cohort study  US, Italy, Iran, Czech Republic, Canada, Republic of Korea	Systematic Review  Level I	Consolidated Standards of Reporting Trials (CONSORT) tool	4 studies evaluated vegan or vegetarian diet, 1 evaluated DASH diet, 1 evaluated Mediterranean, 1 specifically designed by dietician based on individual needs and factors	Reduction of HgA1c by 0.80% on average -Reduction of HgA1c by 0.68% in vegan and vegetarian diets -Reduction of HgA1c by 1.7% in DASH diet -Reduction of HgA1c by 1.2% and 0.9% with Mediterranean diet -Reduction of HgA1c by 0.7% and 0.5% for diet determined by dietician  Vegan/vegetarian diet: significant reduction in BMI and waist circumference	Adoption of vegan, vegetarian, DASH, Mediterranean, and specific diet defined by the dietician favored the glycemic control of individuals with T2DM (reduction of HgA1c) when compared to conventional diets
Kahleova, H., Matoulek, M., Malinska, H., Oliyarnik, O., Kazdova, L., Neskudla, T., Skoch, A., Hajek, M., Hill, M., Kahle, M., & Pelikanova, T. (2011). Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with Type 2 diabetes. <i>Diabetic Medicine</i> , 28(5), 549-559. <a href="https://doi.org/10.1111/j.1464-5491.2010.03209.x">https://doi.org/10.1111/j.1464-5491.2010.03209.x</a>	Compare diabetic diet and vegetarian diet to see the effects on insulin resistance, fat, and oxidative stress. Also, exercise training was added halfway through the experiment (to both control and experimental group)	N= 74  Czech Republic	RCT  Level II	Dietary records; dietician analyzed 3-day diet recall  -International physical activity questionnaire (IPAQ) -Baecke Questionnaire  -Height and weight	Intervention (vegetarian diet) and control group (conventional diet) were both provided meals for 12 weeks. During next 12 weeks, meals were provided and both groups also initiated an exercise program	Experimental group had a: -Significantly greater increase in insulin sensitivity -Greater reduction in fat -Increased in adiponectin and decreased in leptin  43% in experimental group (vs 5%) reduced diabetes medication  Experimental group had a 0.9% decrease in A1C (vs 0.2%)  Body weight decreased by -6.2 kg (vs -3.2 kg in control group)	When compared to a calorie restricted conventional diabetic diet, a calorie restricted vegetarian diet (provided meals): -Improved insulin sensitivity -lead to a greater loss of fat -Improved oxidative stress markers  All three above were also enhanced with the addition of exercise.  A vegetarian diet, with or without exercise, improves glycemic control markers for adults with diabetes.

				-Waist circumference -HgA1c -Oxidative stress markers		LDL decreased by 8% in experimental group, did not change in the control group; HDL increased by 6% in experimental group (vs 5% in control group)	
Kahleova, H., Salas-Salvadó, J., Rahelić, D., Kendall, C. W., Rembert, E., & Sievenpiper, J. L. (2019). Dietary patterns and cardiometabolic outcomes in diabetes: A summary of systematic reviews and meta-analyses. <i>Nutrients</i> , 11(9), 2209. <a href="https://doi.org/10.3390/nu11092209">https://doi.org/10.3390/nu11092209</a>	Purpose: to update the practice guideline for nutrition therapy in prevention and management of diabetes. Diets included were Mediterranean, DASH, Portfolio, Nordic, liquid meal, and vegetarian diets	N= 664  USA, UK, and Germany	Systematic review and meta-analysis  Level I	x	x	x	Overall, the Mediterranean, DASH, Portfolio, and vegetarian diets reduce mortality from cardiovascular disease in those with and without T2DM  Review of vegetarian diet found significantly lowered HgA1c, fasting glucose, LDL, non-HDL, body weight, and waist circumference
Khazrai, Y. M., Defeudis, G., & Pozzilli, P. (2014). Effect of diet on type 2 diabetes mellitus: A review. <i>Diabetes/metabolism research and reviews</i> , 30(S1), 24-33. <a href="https://doi.org/10.1002/dmrr.2515">https://doi.org/10.1002/dmrr.2515</a>	Four types of diets were reviewed for their effects on T2DM: the Mediterranean diet, a low-carbohydrate/high-protein diet, a vegan diet, and a vegetarian diet. Explored whether a diet can be identified which promotes controlled blood glucose levels and reduces the risk of diabetes complications	x	Systematic Review  Level I	x	x	x	Mediterranean diet decreases CRP, fasting plasma glucose, insulin resistance, weight, and triglyceride levels.  Low carb, high protein diets have limited data and require further investigation; initial studies showed no great difference in terms of weight loss, waist circumference, cholesterol, HgA1c.  Vegetarian and vegan diets appear to improve weight loss and metabolic control in adults with T2DM. Also, there was an improvement in plasma lipid levels.  Based on personal preferences, tastes, and culture, adults with T2DM can choose from many beneficial dietary regimens.
McMacken, M., & Shah, S. (2017). A plant-based diet for the prevention and treatment of type 2 diabetes. <i>Journal of Geriatric Cardiology</i> , 14(5), 342-354. <a href="https://doi.org/10.11909/j.issn.1671-5411.2017.05.009">https://doi.org/10.11909/j.issn.1671-5411.2017.05.009</a>	Overview of health benefits of a whole foods plant-based diet in adults with T2DM, including the prevention of diabetes.	x	Expert Opinion  Level VII	x	x	x	Whole foods plant-based diet (legumes, whole grains, fruits, vegetables, and nuts) are beneficial in preventing and treating type 2 diabetes. Plant-based diet treats cardiovascular disease and its risks factors for T2DM, including: -Obesity -Hypertension -Hyperlipidemia -Inflammation  Also, reduces the risk of cancer. Ultimately, a plant-based diet is a cost effective, low risk intervention that treats numerous chronic illnesses simultaneously



							and are environmentally sustainable than diets rich in animal products.
Olfert, M. D., & Wattick, R. A. (2018). Vegetarian diets and the risk of diabetes. <i>Current Diabetes Reports</i> , 18(11), 1-6. <a href="https://doi.org/10.1007/s11892-018-1070-9">https://doi.org/10.1007/s11892-018-1070-9</a>	Effect of vegetarian diet on preventing and treating T2DM, and which type of vegetarianism is the most beneficial. Determining which vegetarian diet is most therapeutic and easiest for patients to adhere to.	x	Systematic Review  Level I	x	x	x	Prevention: A vegetarian diet adopted early on can prevent the onset of diabetes Treatment: Medication use significantly decreased when adults with T2DM adopted vegetarian or vegan diets  Reducing complications: adults with T2DM following vegetarian diet had significantly less cardiovascular disease risk factors (hypertension, cholesterol, and blood glucose levels)  When comparing different vegetarian diets, prevalence of diabetes differed; vegans had the lowest (2.9%), followed by lacto-ovo-vegetarians (3.2%), pesco-vegetarians (4.8%), semi-vegetarians (6.1%), and non-vegetarians (7.6%)  Benefit comes from a vegetarian diet that is high in whole grains, vegetables, fruits, nuts, and legumes when it comes to preventing and treating T2DM
Sa'ad-Aldin, K., & Altamimi, M. (2019). Effect of whole-grain plant-based diet on the diabetes mellitus type 2 features in newly diagnosed patients: A pilot study. <i>International Journal of Diabetes in Developing Countries</i> , 39(3), 535-546. <a href="https://doi.org/10.1007/s13410-018-0689-z">https://doi.org/10.1007/s13410-018-0689-z</a>	Assess the effects of a plant-based diet on diabetic features such as BMI, fasting blood glucose, and HgA1c.	N=15  Palestine	Pilot Study, randomized  Level IV	Anthropometric measurements -BMI -FBG -HgA1c  Food frequency questionnaire	Face-to-face counseling for allowed and not allowed foods FBG and HgA1c and their correlation with diet compliance	Whole-food, plant-based, low fat diet (vegetables, fruits, legumes, lower amounts of seed and nuts) Baseline FBG 189.2 ± 77.1 mg/dL, endpoint was 102.6 ± 19.8 mg/dL (45% reduction) Baseline HgA1c was 9.4 ± 2.5%, endpoint was 6.2 ± 0.8% (35% reduction) Total reduction in BMI was 1.5 (average weight loss of 4.6 kg ± 3.9kg)	Over an almost 5-month period, adults with diabetes following a plant-based diet resulted in a reduction in parameters such as fasting blood glucose, HgA1c, and BMI.  Reductions can shift a patient with T2DM to be non-diabetic  Plant-based diets improve the inflammation status in the body, which leads to a decrease in insulin resistance.
Satija, A., Bhupathiraju, S. N., Rimm, E. B., Spiegelman, D., Chiuve, S. E., Borgi, L., Willett, W., Manson, J., Sun, Q., & Hu, F. B. (2016). Plant-based dietary patterns and incidence of type 2 diabetes in US men and women: Results from three prospective cohort studies. <i>PLoS Medicine</i> , 13(6), e1002039.	Understand how degrees of adherence to different plant-based diets are associated with diabetes risk. Evaluate the hypothesis that a plant-based diet is protective against T2DM.	N= 69,494 women N=90,239 women N=40,539 men  Adult health professionals	Analyzed data from three cohort studies  Level IV	Food Frequency Questionnaire Plant-based diet Index (PDI) Healthful plant-based diet index (hPDI) Unhealthful plant-based diet index (uPDI)	Plant-based diet	PDI and hPDI were inversely associated with T2DM uPDI was positively associated with T2DM	Plant-based diets are associated with substantially lower risk of developing T2DM  Increased intake of healthy plant foods while reducing animal foods may be beneficial in preventing diabetes.

<a href="https://doi.org/10.1371/journal.pmed.1002039">https://doi.org/10.1371/journal.pmed.1002039</a>							
Toumpanakis, A., Turnbull, T., & Alba-Barba, I. (2018). Effectiveness of plant-based diets in promoting well-being in the management of type 2 diabetes: A systematic review. <i>BMJ Open Diabetes Research and Care</i> , 6(1), 1-10. <a href="https://doi.org/10.1136/bmjdr-2018-000534">https://doi.org/10.1136/bmjdr-2018-000534</a>	Systematically analyze literature on plant-based diet interventions targeting adults with T2DM, and define the benefits. Present the physical and psychological outcomes of plant-based interventions.	N= 433 11 articles 7 RCTs  US, Czech Republic, Italy, New Zealand, South Korea	Systematic Review of RCTs  Level I	Quality Assessment Tool for Quantitative Studies instrument carried out by 2 researchers independently	Plant-based diet with an educational intervention vs control diet	A plant-based diet can improve quality of life, psychological well-being, and chronic diabetic neuropathy in those with T2DM. Adherence in the plant-based diet intervention group was greater than the control (high rates of acceptability) In 8/9 studies reporting HgA1c, the decrease in HgA1c was greater in the intervention group (decrease of 0.55% intervention vs 0.19% control) Reduction or discontinuation of diabetes related medications (6 studies) Significantly greater weight loss in intervention group (5.23kg vs 2.83kg control) 5 studies showed a decrease in fasting blood glucose Decrease in total cholesterol	Improved quality of life, psychological, and physical components; decreased depression, decreased neuropathic pain, increased self-esteem and nutritional efficacy. This systematic review concludes that a plant-based diet can significantly improve psychological well-being, quality of life, control of T2DM (measured HbA1c, weight loss, FBG, total cholesterol, LDL cholesterol, triglycerides) in adults with T2DM.
Yokoyama, Y., Barnard, N. D., Levin, S. M., & Watanabe, M. (2014). Vegetarian diets and glycemic control in diabetes: A systematic review and meta-analysis. <i>Cardiovascular diagnosis and therapy</i> , 4(5), 373-382. <a href="https://doi.org/10.3978/j.issn.2223-3652.2014.10.04">https://doi.org/10.3978/j.issn.2223-3652.2014.10.04</a>	Examine the association between vegetarian diets and glycemic control in adults with T2DM	N=255 6 studies  Brazil, US, and Czech Republic	Systematic Review and <b>meta-analysis</b> of controlled clinical trials  Level I	HgA1c FBG Dietary components (energy, carbs, protein, fat, cholesterol, fiber)	Vegetarian Diet	Vegetarian diet was associated with significant reduction in HgA1c (reduction of 0.39%) and non-significant reduction in FBG (reduction by 0.36 mmol/L)	Vegetarian diets associated with improved glycemic control in adults with T2DM -benefits for cardiovascular health, HTN, body weight, and plasma lipids when compared to omnivorous diet Concludes: Vegetarian diet may be beneficial in prevention of T2DM as well

T2DM = type 2 diabetes mellitus; DASH = dietary approaches to stop hypertension; HgA1c = hemoglobin A1c; LDL = low-density lipoprotein; HDL = high-density lipoprotein; CRP = C-reactive protein; HTN = hypertension