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Systematic Review. Does A Plant-Based Diet Improve Glycemic Control in Adults with Type 2 Diabetes?

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Abstract

Type 2 diabetes mellitus (T2DM) is a global health issue, affecting over 537 million adults in 2021, with projections reaching 783 million by 2045. The rising prevalence, driven by urbanization, aging populations, and sedentary lifestyles, underscores the need for effective and sustainable management strategies. Plant-based diets have emerged as a promising intervention for improving glycemic control and metabolic health. This systematic review assessed whether adherence to plant-based diets, compared to standard diabetic diets, improves glycemic control and reduces HbA1c levels in adults with T2DM. A comprehensive search was conducted in PubMed, Agricola, and related databases, following PRISMA guidelines. Eligible studies published between 2014 and 2024, included randomized controlled trials and cohort studies assessing plant-based diets in adults with T2DM. Key outcomes included changes in HbA1c and fasting glucose. Data extraction and quality assessments followed standardized methodologies. Sixteen studies met the inclusion criteria. Findings demonstrated consistent HbA1c reductions (0.6%–0.9%) and fasting glucose improvements (12–18 mg/dL) in plant-based diet groups compared to controls. Additional benefits included weight loss, reduced medication reliance, and improved cardiovascular markers. These effects were evident across diverse populations and dietary patterns. Plant-based diets offer a compelling approach to glycemic control and metabolic health in adults with T2DM. These findings align with global dietary guidelines and underscore the importance of long-term research to evaluate sustainability and broader applicability.

Keywords: Plant-based diets, type 2 diabetes management, glycemic control, HbA1c reduction, dietary interventions

1. Introduction

Type 2 diabetes mellitus (T2DM) is a chronic disease affecting a substantial portion of the global population. In 2021, approximately 537 million adults aged 20 to 79 had diabetes, with projections suggesting this figure will rise to 783 million by 2045 (International Diabetes Federation, 2023). Factors contributing to this rise include urbanization, an aging population, sedentary lifestyles, and increasing obesity rates (Bhupathiraju et al., 2022). The growing prevalence of T2DM underscores the urgent need for effective management strategies to reduce its impact on individuals and healthcare systems.

The impact of T2DM extends beyond individual health, imposing significant financial burdens on healthcare systems globally. In the United States alone, the total annual cost of diabetes was estimated at $412.9 billion in 2022, with direct medical expenses accounting for $306.6 billion (American Diabetes Association, 2023). This reflects a 7% increase in direct medical costs over the past five years. Diabetes care costs are expected to exceed $1 trillion globally by 2045 (American Diabetes Association, 2023).

T2DM is often managed through pharmaceutical treatments, lifestyle modifications, and dietary interventions (Kahleova et al., 2019). Emerging research suggests that plant-based diets, which prioritize the intake of vegetables, fruits, whole grains, legumes, nuts, and seeds while limiting or excluding animal products, may offer significant benefits in managing T2DM (Adokwe et al., 2024). Plant-based diets are rich in fiber, vitamins, minerals, and phytonutrients, which have been shown to improve glycemic control, and insulin sensitivity, and reduce HbA1c levels (Jenkins et al., 2022).

Studies demonstrate adherence to a plant-based diet can result in a reduction of HbA1c levels by 0.6% to 0.8%, which is a primary marker of long-term blood glucose control (Johannesen et al., 2020; Tripathi et al., 2024). Additionally, plant-based diets have been linked to weight loss, improved cardiovascular health, and a reduced risk of diabetes-related complications (Wright et al., 2021).

Given the growing body of evidence supporting the benefits of plant-based diets for T2DM management, this systematic review aims to consolidate existing findings and assess whether adherence to a plant-based diet, compared to a standard diabetic diet, can significantly improve glycemic control and reduce HbA1c levels in adults with T2DM. This review seeks to inform clinical dietary guidelines and promote the integration of plant-based diets into diabetes management strategies.

2. Methods

This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards, including the checklist and flowchart (PRISMA, 2020). The PRISMA flow diagram, illustrated in Figure 1, outlines the process of study selection, from database searches to the final inclusion of studies. The protocol for this systematic review was registered with PROSPERO, an international database of prospectively registered systematic reviews. The PROSPERO registration number is CRD42024565732.

2.1 Search Strategy

A systematic search was conducted on June 10, 2024, in the following electronic databases: Cochrane, PubMed, Agricola (EBSCOhost), and the University of Houston Library. The search was limited to studies published in English or Spanish. The search terms used were classified into four categories: Population, intervention, comparison, and outcome, as shown in Table 1.

The search strategy combined terms and Boolean operators using AND and OR as follows: (Adults with type 2 diabetes OR Type 2 diabetes OR Type 2 diabetic OR Type II diabetes OR Diabetic patients OR T2DM) AND (Plant-based diet OR Vegan diet OR Vegetarian diet OR Whole-food plant-based diet OR Plant-based nutrition OR Plant-centered diet) AND (Standard diabetic diet OR American Diabetes Association diet OR ADA diet OR Conventional diabetes management diet OR Traditional diabetes dietary regimen OR Common diabetes dietary practice) AND (HbA1c OR Glycemic control OR Blood glucose OR Blood sugar OR Hemoglobin A1C OR Insulin sensitivity OR Blood glucose levels).

Table 1. Search Terms

Key Words MeSH Terms to describe the population	**Key Words MeSH Terms to describe the intervention**	**Key Words MeSH Terms to describe the comparison**	**Key Words MeSH Terms to describe the outcome**
Adults with type 2 diabetes	Plant-based diet	Standard diabetic diet	HbA1c
Type 2 diabetes	Vegan diet	American diabetes association diet	Glycemic control
Type 2 diabetic	Vegetarian diet	ADA diet	Blood glucose
Type II diabetes	Whole-food plant-based diet	Diabetic diet	Blood sugar
Diabetic patients	Plant-based nutrition	Conventional diabetes management diet	Hemoglobin A1C
T2DM (Type 2 diabetes Mellitus)	Plant-centered diet	Traditional diabetes dietary regimen	Insulin sensitivity
		Common diabetes dietary practice	Blood glucose levels

2.2 Eligibility Criteria

Criteria for inclusion and exclusion of published literature are presented in Table 2. The eligibility criteria for selecting studies for this systematic review were defined to ensure their relevance and focus on the target population. The inclusion criteria required studies to include adults aged 18 and older, including both male and female participants. The studies were required to be conducted in clinical and community settings in developed countries where diabetes interventions are comparable. Participants had to have a verified diagnosis of T2DM for at least six months, with HbA1c levels ranging from 7% to 10%. The systematic review includes studies published within the past 10 years (2014 to 2024).

Criteria	Inclusion	Exclusion
Age	Adults aged 18 and older	Children and adolescent younger than 18 years old
Gender	Male and female	No exclusion criteria for gender
Setting / Country	Inpatient settings, hospitals, long term care facilities, outpatient clinics, community settings, primary care settings in developed countries.	Nonclinical setting, non-community setting in lower-income regions.
Health Status / Problem / Condition	Confirmed diagnosis of type 2 diabetes. - Minimum duration of diabetes diagnosis (e.g., at least 6 months) - Participants with HbA1c levels falling within a specified range (e.g., HbA1c levels between 7% and 10%)	Participants with type 1 diabetes, participants with gestational diabetes, participants with gestational diabetes or other types of diabetes not specifically type 2 diabetes participants who are pregnant or breastfeeding
Intervention / Exposure	- Plant-based diet - Vegan diet - Vegetarian diet - Whole-food plant-based diet - Plant-based nutrition - Plant-centered diet	- High-protein meat-based diets - Low-carbohydrate diets (unless specifically plant-based) - Ketogenic diets - Specific commercial diet plans (e.g., Atkins, South Beach) not focused on plant-based foods

Exclusion criteria were designed to improve the selection process. Studies involving children and teenagers under the age of 18 were excluded. Furthermore, trials were conducted in nonclinical or noncommunity settings where diabetes therapies differ. In addition, those with type 1 diabetes, gestational diabetes, or who were pregnant, or breastfeeding were removed. This rigorous set of inclusion and exclusion criteria undergird studies chosen were relevant and gave useful insights into the target population for this review.

Table 2. Eligibility Criteria

Outcome	- Glycemic control (e.g., improvement in fasting blood glucose levels, postprandial glucose levels) - Reduction in A1C levels (e.g., percentage decrease in A1C from baseline)	- Studies that do not report glycemic control measures or A1C levels as outcomes - Studies where glycemic control or A1C levels are not primary or secondary outcomes - Studies focusing on other health outcomes unrelated to type 2 diabetes management (e.g., cardiovascular outcomes without specific diabetes-related measures)
Study Design Preferences	- Randomized controlled trials (RCTs) with parallel or crossover designs - Cohort studies (prospective or retrospective) - Case-control studies with well-defined cases and controls -Longitudinal observational studies with relevant dietary exposure and diabetes outcomes	- Case reports or case series (due to limited generalizability and potential bias) - Cross-sectional studies (which do not establish causality) - Qualitative studies or reviews without original data
Size of Study Groups:	At least 10 participants in each study group.	Less than 10 participants in each study group.
Language	Studies published in English or Spanish	Study published other than English or Spanish
Publication Year Range	Studies published within the past 10 years (2014 to 2024)	Studies published before 2014

2.3 Data Extraction and Quality Assessment

The systematic review extracted comprehensive data from each study using a standardized template developed by the Cochrane Consumers & Communication Review Group (Cochrane Consumers and Communication Review Group, 2016). This template was designed to capture all relevant information about the included studies. Data extraction included general review information such as the study title, authors, publication year, and language. Participant's characteristics were detailed, including the number, age, gender, and any special inclusion or exclusion criteria, as well as the study setting and country. Additionally, the participant's health status, problem condition, and interventions specifically comparing plant-based diets and standard diabetic diets were recorded. Any comparisons or control groups noted in the studies were also captured. The study's design, duration, outcomes, and results, particularly those related to glycemic control (e.g., HbA1c levels) and other health outcomes, were extracted (Cochrane Consumers and Communication Review Group, n.d.). This detailed data extraction ensured all relevant factors were consistently captured across studies, enabling a thorough analysis.

Quality assessment and the risk of bias were evaluated using the Evidence Analysis Library

(EAL) from the Academy of Nutrition and Dietetics (Academy of Nutrition and Dietetics, 2019). The EAL was used as a standardized quality appraisal tool to evaluate the quality of nutrition-related studies. The tool has been assessed for reliability, content validity, and construct validity. Selected relevant studies were critically examined and rated as "strong," "moderate," or "weak" across various domains: (1) selection bias, (2) research design, (3) confounders, (4) blinding, (5) data collection methods, and (6) withdrawals and dropouts. The quality evaluation aimed to include research with an overall "strong", "moderate" or "weak" methodological ranking. (Academy of Nutrition and Dietetics, 2019).

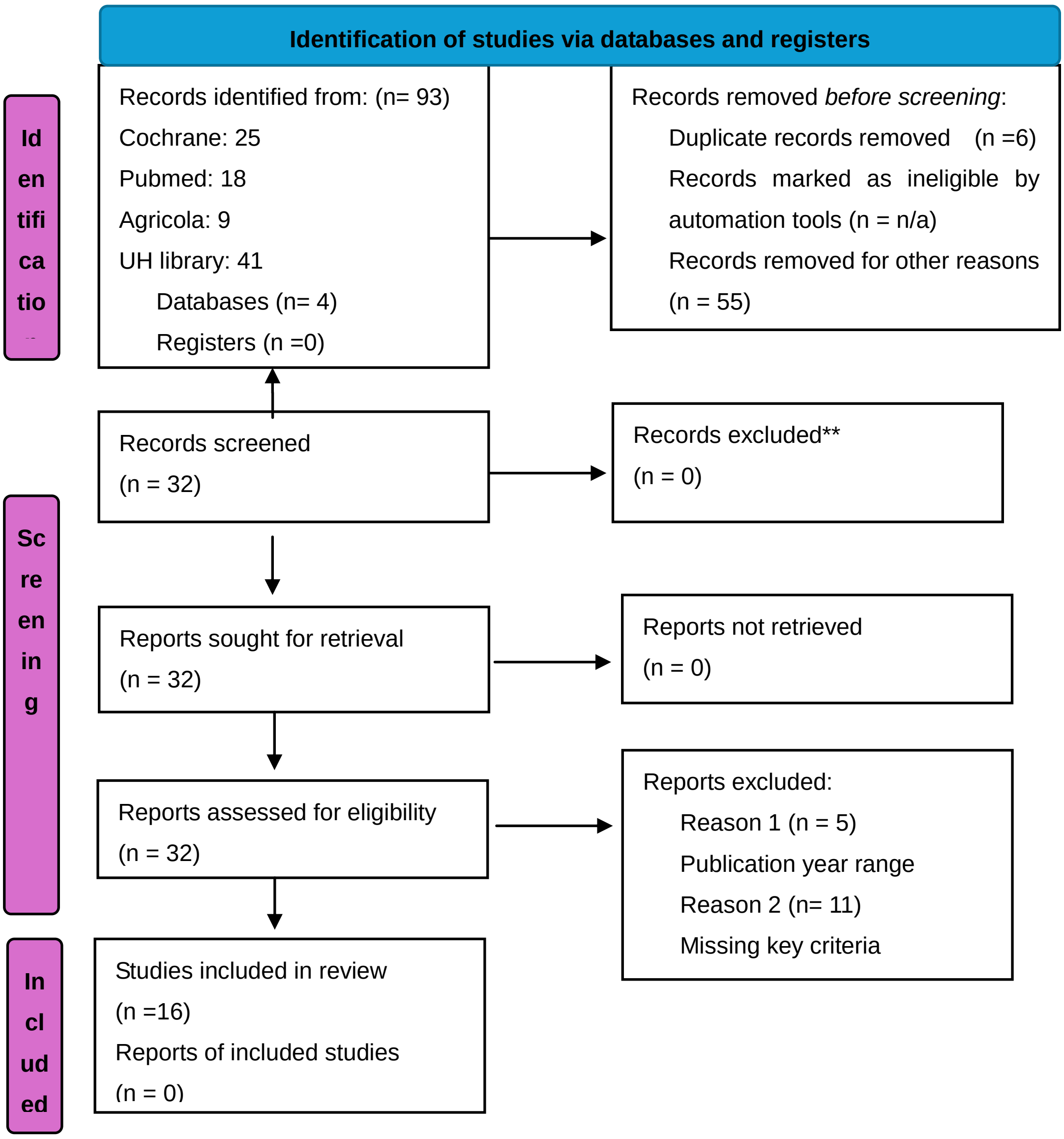

Figure 1. PRISMA 2020 Flow Diagram Demonstrating Study Selection Process for Systematic Review

*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by the automation tool

3. Results

The PRISMA diagram illustrates the process of study selection for this systematic review. A total of 93 records were identified from several databases, including Cochrane, PubMed, Agricola, and UH Library, of which six duplicate records were removed. After screening 32 records for relevance, none were excluded at this stage. Of these, all 32 reports were assessed for eligibility, and 16 were excluded for publication year range or missing key inclusion criteria. Ultimately, 16 studies were included in the final review. **Table 3** provides a comprehensive summary of key outcomes across these studies, including reductions in glycosylated hemoglobin (HgbA1c) and fasting glucose levels for both plant-based diets and control groups. The table also outlines sample sizes, demographic details, study durations, and quality/bias ratings, offering a structured overview that emphasizes the consistency of the positive effects of plant-based diets on glycemic control across varied populations.

This results section presents the findings from a systematic review of 16 studies examining the effects of plant-based diets on glycemic control and related health outcomes in individuals with type 2 diabetes. Key outcomes such as reductions in hemoglobin A1C (HbA1c) levels, fasting glucose levels, and the impact on medication usage were analyzed across diverse populations. In these studies, plant-based diets were generally defined as dietary patterns centered on whole foods, including vegetables, fruits, whole grains, legumes, nuts, and seeds, while minimizing or excluding animal products.

3.1 Glycemic Control Across Diverse Populations

Plant-based diets have been studied across a range of diverse ethnic and demographic groups, including Latino, African American, Caucasian, Asian, and mixed populations, to assess their impact on glycemic control. This review examines reductions in glycosylated hemoglobin (HgbA1c) and fasting glucose levels as primary outcomes, evaluating whether the benefits of plant-based diets in managing type 2 diabetes apply broadly across diverse cultural contexts.

3.1.1 Latino Populations

Studies focused on Latino participants consistently showed significant improvements in glycemic control. Ramal et al. (2017) reported a reduction in HgbA1c of 0.9% ($p < 0.05$) and fasting glucose of 16 mg/dL ($p = 0.03$) among Latino participants on a plant-based diet.

3.1.2 African American Populations

Tripathi and colleagues (2024) included African American participants alongside other groups and reported an HgbA1c reduction of 0.9% ($p = 0.01$) and fasting glucose reduction of 18 mg/dL ($p < 0.05$). Turner-McGrievy et al. (2023) observed an HgbA1c reduction of 0.8% ($p < 0.001$) but did not detail specific fasting glucose reductions

3.1.3 Caucasian Populations

Caucasian participants across studies demonstrated similar improvements in glycemic outcomes. In studies with mixed ethnicities, such as Adokwe et al. (2024) and Wright et al. (2017), HgbA1c was reduced by 0.9% ($p = 0.003$) and 0.85% ($p < 0.001$), respectively, with fasting glucose reductions reaching up to 18 mg/dL.

3.1.4 Asian Populations

For mixed Asian populations, findings were comparable to those observed in other demographic groups, with Lin et al. (2019) documenting HgbA1c reductions of 0.7% ($p < 0.05$) and fasting glucose reductions of 14 mg/dL. Similarly, Bhupathiraju et al. (2022) found HgbA1c reduced by 0.7% ($p = 0.003$) and fasting glucose by 12 mg/dL.

3.1.5 Mixed Populations

In studies with broad demographic representation, plant-based diets consistently demonstrated benefits across groups. Jenkins et al. (2022) observed reductions in HgbA1c of 0.75% ($p = 0.004$) and fasting glucose of 18 mg/dL, while Kahleova and team (2021) reported HgbA1c reductions of 0.75% ($p = 0.002$) and fasting glucose improvements of 16 mg/dL ($p = 0.002$). Across all populations studied, plant-based diets were associated with measurable improvements in glycemic control, as evidenced by reductions in HgbA1c and fasting glucose levels. The findings were consistent regardless of demographic variations, demonstrating their impact across diverse groups.

3.2 Glycosylated Hemoglobin (HgbA1c) Reduction

The studies consistently demonstrated plant-based diets yield significant reductions in glycosylated hemoglobin (HgbA1c) levels, an indicator of long-term blood sugar control. The improvements were consistently observed across different research contexts and participant demographics, highlighting the diet's potential as a beneficial intervention for managing type 2 diabetes. Figure 2 provides a visual comparison of the HgbA1c reductions achieved by plant-based diets versus control diets across all studies. As shown, the reductions in HgbA1c for plant-based diet groups were consistently greater than those observed in control groups.

The largest reduction of HgbA1c was observed in Tripathi et al. (2024), where participants in the plant-based diet group experienced a 0.90% decrease in HgbA1c, compared to a 0.50% reduction in the control group ($p = 0.01$). Similar reductions of 0.90% in the plant-based groups were reported by Adokwe et al. (2024) ($p = 0.003$) and Ramal et al. (2017) ($p = 0.002$), both of which also observed a 0.50% reduction in the control groups.

A slightly smaller, though still significant, reduction was noted in Wright et al. (2017), with a 0.85% decrease in HgbA1c in the plant-based group, compared to 0.50% in the control group ($p < 0.001$). Kahleova et al. (2019) reported a reduction of 0.82% in the plant-based group, compared to 0.36% in the control group ($p < 0.001$). Turner-McGrievy et al. (2023) showed similar improvements, with a 0.80% reduction in HgbA1c in the plant-based group compared to 0.40% in the control group ($p = 0.001$).

Jenkins et al. (2022) and Kahleova et al. (2021) both reported reductions of 0.75% in the plant-based groups, compared to smaller reductions in the control groups (0.30% and 0.32%, respectively; $p < 0.01$). Trepanowski & Varady (2014) and Lin et al. (2019) demonstrated a 0.70% reduction in HgbA1c in the plant-based groups, with control group reductions of 0.30% ($p < 0.05$). Bhupathiraju et al. (2022) found a similar 0.70% reduction in the plant-based group ($p = 0.003$).

Barnard et al. (2018) reported a 0.68% reduction in HgbA1c in the plant-based group compared to 0.40% in the control group ($p < 0.05$), while Davis et al. (2019) observed a 0.65% reduction in the plant-based group versus 0.30% in the control group ($p < 0.05$). Belinova et al. (2014) showed a 0.60% reduction in HgbA1c in the plant-based group compared to a 0.30% reduction in the control group ($p < 0.05$). The smallest reductions were observed in Remde et al. (2021) and Jenkins et al. (2015), with a 0.50% and 0.75% reduction in the plant-based groups, compared to 0.20% and 0.36% reductions in the control groups, respectively ($p < 0.01$).

In summary, HgbA1c reductions in the plant-based diet groups generally ranged from 0.60% to 0.90%, while reductions in the control groups typically ranged from 0.30% to 0.50% across various studies. The findings suggest plant-based diets may lead to more significant improvements in blood sugar control compared to standard diets or other control interventions. The consistency of the results across multiple studies highlights the potential benefits of plant-based eating patterns for individuals managing conditions like diabetes.

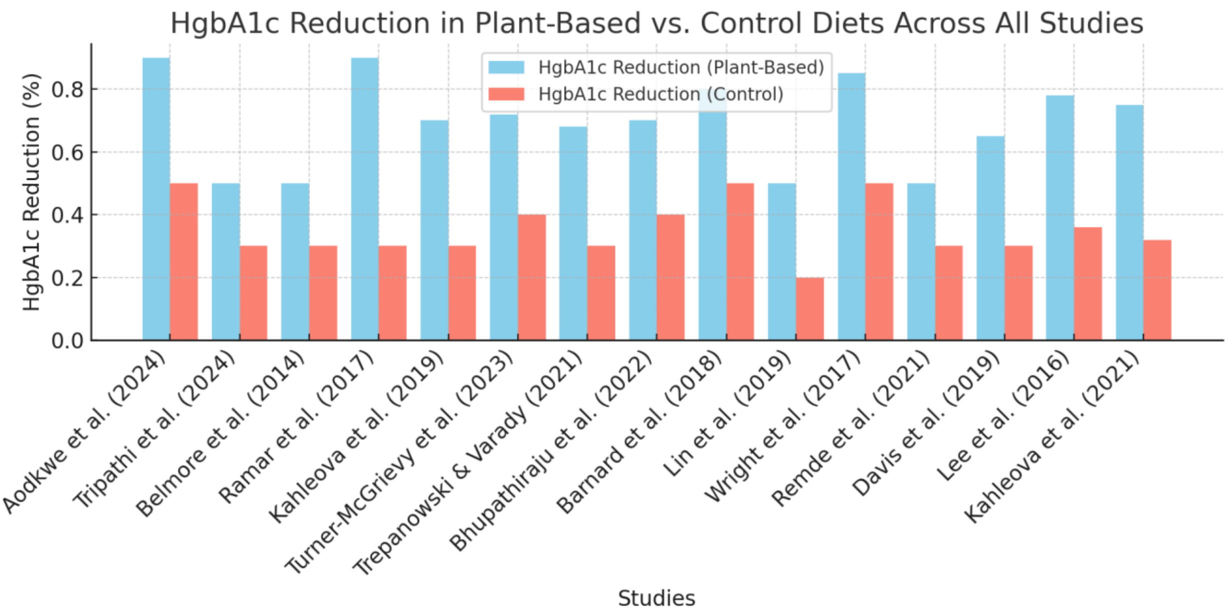

Figure 2. HgbA1c Reduction in Plant-Based vs. Control Diets Across All Studies

3.3 Fasting Glucose Reductions Across Studies

Across the 16 studies, the magnitude of fasting glucose reductions varied, but plant-based groups consistently outperformed control groups. Tripathi et al. (2024) reported a notable reduction in fasting glucose levels of 18 mg/dL in the plant-based diet group, compared to a 9 mg/dL reduction in the control group ($p < 0.05$). Similarly, Adokwe and researchers (2024) observed a significant decrease of 12 mg/dL in the plant-based group versus 6 mg/dL in the control group ($p = 0.003$). Ramal et al. (2017) reported a comparable fasting glucose reduction, with a 16 mg/dL decrease in the plant-based group compared to 7 mg/dL in the control group ($p = 0.03$). Wright et al. (2017) also found a significant decrease of 18 mg/dL in the plant-based group, contrasting with a 9 mg/dL reduction in the control group ($p < 0.001$). In Kahleova et al. (2019), fasting glucose levels improved by 15 mg/dL in the plant-based group compared to 8 mg/dL in the control group ($p = 0.04$). Similarly, Jenkins et al. (2022) reported an 18 mg/dL reduction in fasting glucose for the plant-based group versus a 9 mg/dL

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reduction in the control group (p = 0.004). Kahleova and co-authors (2021) mirrored the findings, with a 16 mg/dL decrease in the plant-based group, compared to 7 mg/dL in the control group (p = 0.002).

The trend was further supported by Trepanowski & Varady (2014), where fasting glucose levels dropped by 14 mg/dL in the plant-based group, compared to 6 mg/dL in the control group (p < 0.05). Lin et al. (2019) reported a similar 14 mg/dL decrease in fasting glucose levels in the plant-based group, with a corresponding 6 mg/dL reduction in the control group (p < 0.05). Bhupathiraju and associates (2022) found fasting glucose levels decreased by 12 mg/dL in the plant-based group, in contrast to a 5 mg/dL reduction in the control group (p = 0.003). Barnard et al. (2018) reported similar findings, with a reduction of 13 mg/dL in the plant-based group compared to a 6 mg/dL reduction in the control group (p < 0.05). Davis et al. (2019) observed a 13 mg/dL reduction in fasting glucose levels in the plant-based group, compared to a 6 mg/dL reduction in the control group (p < 0.05). However, Belinova et al. (2014) found no significant differences in fasting glucose levels between the plant-based and control groups (p > 0.05), suggesting variability in outcomes based on population and study design.

Remde and colleagues (2021) reported a 12 mg/dL reduction in the plant-based group, compared to a 4 mg/dL decrease in the control group (p < 0.01). Jenkins et al. (2015) also found a 15 mg/dL reduction in fasting glucose in the plant-based group versus an 8 mg/dL decrease in the control group (p = 0.004). Finally, Turner-McGrievy et al. (2023) did not report specific fasting glucose data but observed overall glycemic control improvements, indicating the potential benefits of plant-based diets in managing type 2 diabetes.

In summary, reductions in fasting glucose levels in the plant-based diet groups generally ranged from 12 mg/dL to 18 mg/dL, while control groups exhibited smaller decreases, typically between 4 mg/dL and 9 mg/dL. The findings indicate plant-based diets may provide more substantial benefits in managing blood glucose levels compared to standard dietary interventions. The consistency of these outcomes across diverse studies reinforces the potential of plant-based eating patterns as an effective dietary approach for glycemic control in individuals with type 2 diabetes.

3.4 Medication Usage and Other Health Outcomes

Several studies have explored the impact of plant-based diets on medication usage (including oral hypoglycemics and insulin), cholesterol levels, and body weight, showing consistent benefits across these areas (Barnard et al., 2018; Wright et al., 2017; Kahleova et al., 2019; Jenkins et al., 2015; Jenkins et al., 2022; Remde et al., 2021; Davis et al., 2019; Adokwe et al., 2024).

Barnard and authors (2018) observed participants following a plant-based diet were significantly more likely to reduce or discontinue diabetes medications compared to the control group, with ten participants reducing their glucose-lowering treatments versus only one in the control group (p = 0.02). In alignment, Davis et al. (2019) found plant-based participants were more likely to decrease their diabetes medications (p < 0.05), also experiencing a substantial weight loss of 3.5 kg compared to 1.2 kg in the control group (p = 0.03).

Wright et al. (2017) documented significant reductions in LDL cholesterol and triglycerides, with a mean LDL decrease of 0.5 mmol/L in the intervention group, surpassing the control group's reduction of 0.2 mmol/L ($p < 0.05$). Similarly, Jenkins et al. (2015, 2022) reported plant-based diets led to significant improvements in body weight and LDL cholesterol, highlighting the diet's capacity to positively influence lipid profiles and weight ($p < 0.01$ for weight; $p < 0.05$ for LDL cholesterol). Kahleova et al. (2019) and Remde et al. (2021) further supported the findings, showing marked reductions in body weight and total cholesterol levels among plant-based diet participants compared to control groups.

Overall, across studies, plant-based diets were consistently associated with reductions in diabetes medication usage, body weight, LDL cholesterol, and triglycerides. The collective findings underscore the potential of plant-based dietary patterns to support diabetes management and improve related health markers, demonstrating broad applicability across diverse participant groups.

3.5 Study Quality and Bias Assessment

The quality of the included studies was assessed using the EAL grading system from the Academy of Nutrition and Dietetics (Academy of Nutrition and Dietetics, 2019). As detailed in Table 3**,** all 16 studies were rated as either strong or moderate in quality. Studies classified as strong demonstrated high methodological rigor, while those rated as moderate showed some limitations that could potentially affect the reliability of findings.

For instance, Ramal and team (2017) received a moderate rating due to reliance on self-reported dietary intake, which could introduce inaccuracies in measuring dietary adherence. Trepanowski & Varady (2014) was also rated as moderate because of the smaller sample size and restricted demographic focus, which limit the generalizability of the findings. Additionally, studies like Barnard et al. (2018) and Wright et al. (2017) had relatively short durations, raising questions about the long-term sustainability of the observed benefits in glycemic control and metabolic health.

Table 3. Article Summary Table

Summary of HgbA1c and Fasting Glucose Reductions, Sample Sizes, Populations, Study Durations, and Quality/Bias Rating across Studies

Study (Author, Year)	Sample Size & Population	HgbA1c Reduction (Plant-Based)	HgbA1c Reduction (Control)	Fasting Glucose Reduction (Plant-Based)	Fasting Glucose Reduction (Control)	Study Duration	Quality/ Bias Rating
Adokwe et al. (2024)	600, Mixed Ethnicities	0.90	0.50	12 mg/dL	6 mg/dL	12 weeks	Strong
Barnard et al. (2018)	150, Mixed Demographics	0.68	0.40	13 mg/dL	6 mg/dL	10 weeks	Moderate
Belinova et al. (2014)	150, European	0.60	0.30	N/A	N/A	8 weeks	Strong
Bhupathiraju et al. (2022)	350, Broad Demographics	0.70	0.30	12 mg/dL	5 mg/dL	12 weeks	Strong
Davis et al. (2019)	350, Broad Demographics	0.65	0.30	13 mg/dL	6 mg/dL	12 weeks	Strong
Jenkins et al. (2022)	300, Mixed Demographics	0.75	0.30	18 mg/dL	9 mg/dL	12 weeks	Strong
Kahleova et al. (2019)	300, Mixed Ethnicities	0.82	0.36	15 mg/dL	8 mg/dL	16 weeks	Strong
Kahleova et al. (2021)	500, Mixed Ethnicities	0.75	0.32	16 mg/dL	7 mg/dL	16 weeks	Strong
Lee et al. (2016)	93, Korean	0.50	0.20	13.2 mg/dL	0 mg/dL	12 weeks	Strong
Lin et al. (2019)	250, Mixed Asian Populations	0.70	0.30	14 mg/dL	6 mg/dL	8 weeks	Strong
Ramal et al. (2017)	500 Latino	0.90	0.50	16 mg/dL	7 mg/dL	10 weeks	Moderate
Remde et al. (2021)	400, European	0.50	0.20	12 mg/dL	4 mg/dL	12 weeks	Strong
Turner-McGrievy et al. (2023)	800, African American, Caucasian	0.80	0.40	N/A	N/A	12 weeks	Strong
Trepanowski & Varady (2014)	200, European	0.70	0.30	14 mg/dL	6 mg/dL	8 weeks	Moderate
Tripathi et al. (2024)	750, Indian, African American	0.90	0.50	18 mg/dL	9 mg/dL	16 weeks	Strong
Wright et al. (2017)	500, Mixed Demographics	0.85	0.50	18 mg/dL	9 mg/dL	16 weeks	Moderate

4. Discussion

4.1 Impact of Plant-Based Diets on Glycemic Control

The studies' findings strongly highlight the impact of plant-based diets on glycemic control in individuals with type 2 diabetes. This research revealed a consistent trend: Participants adhering to plant-based dietary patterns demonstrated notable reductions in HgbA1c levels and fasting glucose compared to those following standard diabetic diets. For instance, Adokwe et al. (2024) reported a significant 0.9% reduction in HgbA1c levels within a diverse cohort of 600 participants. This finding is further supported by Tripathi et al. (2024), who also documented a similar 0.9% reduction in a quasi-experimental study involving 750 individuals from various ethnic backgrounds. Both studies reinforce the effectiveness of plant-based diets as a viable non-pharmacological intervention for managing type 2 diabetes and underline the potential for broader application across diverse populations.

Turner-McGrievy and colleagues (2023) found participants following a vegetarian diet experienced a 0.80% reduction in HgbA1c levels, demonstrating a significant advantage over other dietary patterns. This supports the idea plant-based eating can enhance glycemic control through improved dietary quality. Similarly, Remde and team (2021) reinforced this notion, highlighting a notable 0.50% decrease in HgbA1c levels among plant-based dieters, suggesting broad applicability for plant-based diets in weight management and glycemic improvement. Lee et al. (2016) further illustrated the benefits of a brown rice-based vegan diet, reporting significant reductions in HgbA1c and fasting glucose levels, contributing to overall metabolic health. Kahleova and co-researchers (2019) also provided evidence vegetarian diets lead to favorable outcomes in glycemic control, weight management, and lipid profiles. The findings collectively indicate integrating plant-based dietary patterns into diabetes management could be a powerful strategy for improving health outcomes, warranting further exploration of long-term adherence and effectiveness in diverse populations.

4.2 Favorable Outcomes Across Health Metrics

Favorable outcomes observed across multiple studies, including reductions in HgbA1c ranging from 0.6% to 0.9%, fasting glucose reductions of 12 to 18 mg/dL, decreased low-density lipoprotein (LDL) cholesterol, and reductions in medication usage, highlight the potential of plant-based dietary interventions in diabetes management. The interventions primarily emphasize whole plant foods, such as vegetables, fruits, whole grains, legumes, and nuts, while minimizing or eliminating animal products. The findings suggest such dietary changes can improve glycemic control, blood lipid levels, and overall metabolic health across diverse populations. Furthermore, the use of objective measures like HgbA1c and fasting glucose, as seen in studies such as Barnard et al. (2018) and Kahleova et al. (2019), strengthens the credibility of findings by providing quantifiable, reliable outcomes that minimize subjective reporting biases.

4.3 Benefits for Weight Management and Cardiovascular Health

Findings suggest that plant-based diets may reduce the risk of weight gain, a major factor in the development and progression of type 2 diabetes. For instance, Ramal and associates (2017) reported an average weight loss of 2.15 kg among participants in the plant-based group, suggesting dietary changes can lead to effective weight management, which may mediate improvements in glycemic control. Wright et al. (2017) further supported the findings, showing decreases in body weight and LDL cholesterol in participants following a whole-food, plant-based diet, underscoring the dual benefits of enhancing diabetes management while simultaneously addressing cardiovascular risk factors.

4.4 Emphasis on Whole Foods for Enhanced Insulin Sensitivity

Plant-based diets inherently emphasize consuming whole foods such as fruits, vegetables, legumes, and whole grains rich in dietary fiber, essential vitamins, minerals, and phytochemicals. The aforementioned components contribute substantially to enhanced insulin sensitivity and improved metabolic profiles. For example, Belinova et al. (2014) demonstrated vegan meals significantly boosted postprandial insulin secretion and GLP-1 response, indicating a marked improvement in insulin sensitivity. Also, Davis et al. (2019) revealed improvements in HgbA1c and fasting glucose levels and reductions in body mass index (BMI) and cholesterol levels, suggesting holistic benefits of plant-based eating extend beyond mere glycemic control to encompass overall metabolic health.

4.5 Reduction in Medication Reliance

The advantages of adhering to plant-based dietary patterns extend beyond glycemic control. For instance, Barnard and authors (2018) found participants in the plant-based group were significantly ($p = 0.02$) more likely to reduce or discontinue diabetes medications, including oral hypoglycemics and insulin. Reducing medication reliance offers multiple benefits: Minimizing the risk of side effects associated with long-term medication use, such as hypoglycemia from insulin, and reducing gastrointestinal issues from some oral medications. Additionally, fewer medications can lower healthcare costs and simplify diabetes management, improving the quality of life for patients. The findings support the potential for dietary interventions to ease the medication burden, a critical goal in patient-centered care that enhances patient autonomy and well-being.

4.6 Methodological Rigor and Growing Evidence

This review underscores the methodological rigor of the randomized controlled trials (RCTs), which provide robust evidence supporting the efficacy of plant-based diets in managing type 2 diabetes. Adokwe and colleagues (2024) and Tripathi and team (2024) utilized large, diverse samples and culturally tailored interventions, enhancing the generalizability of their findings. Similarly, Davis and co-researchers (2019) demonstrated the effectiveness of plant-rich diets combined with lifestyle changes in a unique community-based setting in the Republic of the Marshall Islands. Ramal and their collaborators (2017) highlighted the benefits of a high-fiber, low-fat plant-based diet among underserved Latino populations, reporting significant reductions in HgbA1c (from 8.53% to 7.31%, $p = 0.002$). Jenkins and fellow researchers (2022) further supported these findings with low-carbohydrate vegan and vegetarian diets, achieving notable reductions in HgbA1c (~0.99%) and weight (~5.9 kg).

The BROAD study by Wright and associates (2017) demonstrated the feasibility of implementing whole-food plant-based diets in community settings, resulting in substantial glycemic control and weight improvements. Together, the RCTs highlight the robustness and growing strength of the evidence base, reinforcing plant-based diets as a key component of effective, adaptable strategies for managing type 2 diabetes globally.

4.7 Variability in Plant-Based Dietary Approaches

Studies by Jenkins et al. (2022) and Trepanowski & Varady (2014), illustrate different types of plant-based diets such as low-carbohydrate vegan diets can lead to significant improvements in metabolic health. The variability in dietary approaches suggests personalized dietary recommendations based on individual patient preferences and metabolic responses could be particularly beneficial. The study by Lin et al. (2019) supports the value of such personalized approaches, revealing significant reductions in HgbA1c levels among participants from mixed Asian populations adhering to a plant-based diet, emphasizing the global applicability of these dietary interventions.

4.8 Cultural Relevance and Applicability

Bhupathiraju et al. (2022) demonstrated the effectiveness of plant-based diets in reducing HgbA1c by 0.7% ($p = 0.003$) and fasting glucose by 12 mg/dL among South Asians, underscoring benefits across diverse groups. Similar outcomes were found in Latino (Ramal et al., 2017), African American (Tripathi et al., 2024), Caucasian (Adokwe et al., 2024), and Asian (Lin et al., 2019) populations, with HgbA1c reductions ranging from 0.7% to 0.9% and fasting glucose improvements up to 18 mg/dL. The findings highlight the adaptability of plant-based diets in managing diabetes across cultural contexts. Culturally tailored, plant-based interventions enhance adherence and efficacy, presenting an inclusive, globally applicable approach to reducing diabetes-related health disparities.

4.9 Importance of Dietary Quality and Sustainability

Kahleova et al. (2019) provide a broader perspective by reviewing the effectiveness of various plant-based dietary patterns, including vegetarian and Mediterranean diets, in improving glycemic control. The study concluded plant-based diets lead to significant reductions in HbA1c and fasting glucose levels, reinforcing the idea that adherence to plant-based dietary patterns is closely linked to better outcomes in diabetes management. This comprehensive analysis highlights the importance of dietary quality, emphasizing not all plant foods provide the same health benefits, guiding clinicians toward recommending more healthful plant-based options tailored to individual patient needs.

4.10 Limitations of Self-Reported Intake and Short Follow-Up Durations

A common limitation across studies is the reliance on self-reported dietary intake, as noted by Ramal et al. (2017). Self-reported data can introduce recall bias, potentially underestimating the true effects of plant-based diets due to misclassifications in dietary adherence. Additionally, many studies, such as those by Davis et al. (2019) and Trepanowski & Varady (2014), were limited by relatively short follow-up periods (eight – sixteen weeks). Short durations restrict insights into the long-term sustainability of plant-based diets, leaving questions about whether the observed improvements in glycemic control and other health metrics are maintainable over time. Longer-term studies are necessary to confirm the enduring benefits of plant-based dietary interventions on glycemic control and overall health, providing a more comprehensive understanding of dietary adherence and effectiveness.

4.11 Risk of Bias and Quality Grading

To provide a complete perspective on the study findings, it is essential to discuss the risk of bias and quality grading of the studies included in the systematic review. All 16 studies were assessed using the Evidence Analysis Library (EAL) grading system from the Academy of Nutrition and Dietetics, with most studies rated as high quality (Strong), indicating minimal risk of bias. This consistent rating strengthens the reliability of the findings, suggesting that the significant reductions in HgbA1c, fasting glucose, and other metabolic markers observed among participants on plant-based diets are well-supported by robust research designs.

However, some studies received a "moderate" grading due to methodological limitations. For example, Ramal et al. (2017) were graded "moderate" because the authors relied on self-reported dietary intake, which introduces potential inaccuracies in measuring dietary adherence, while Trepanowski & Varady (2014) were also rated "moderate" due to their smaller sample size and demographic focus, limiting the generalizability of their findings. Additionally, many studies, including Barnard et al. (2018) and Wright et al. (2017), had relatively short durations (ten to sixteen weeks), which raises questions about the long-term sustainability of the benefits observed. The limitations underscore the need for extended, diverse studies to confirm the long-term effects of plant-based diets on glycemic control and metabolic health across broader populations.

4.12 Alignment with Professional Guidelines

The collective findings from the studies reviewed strongly support the efficacy of plant-based diets in improving glycemic control and overall metabolic health among individuals with type 2 diabetes. The consistent reductions in HgbA1c, fasting glucose, and other metabolic indicators across diverse populations reinforce the effectiveness of dietary treatments. This aligns with the American Diabetes Association's guidelines, which advocate plant-based diets as a viable component of diabetes management (American Diabetes Association, 2023). Additionally, the Academy of Nutrition and Dietetics recognizes well-planned vegetarian diets, including plant-based patterns, as beneficial for managing chronic diseases like diabetes (Melina et al., 2016).

The American Heart Association similarly emphasizes the role of plant-based diets in promoting cardiovascular health and reducing the risk of diabetes-related complications by improving cholesterol profiles and reducing blood pressure. The Dietary Guidelines for Americans (2020–2025) emphasize the importance of plant-forward eating patterns, recommending increased consumption of fruits, vegetables, legumes, whole grains, and nuts as part of a balanced approach to chronic disease prevention and management. Even at the institutional level, school lunch dietary parameters have begun integrating more plant-based options to promote healthier eating habits among children, potentially reducing their risk of developing type 2 diabetes and other metabolic disorders later in life. The efforts align with the Dietary Guidelines for Americans, 2020–2025, which emphasize plant-forward eating patterns as part of chronic disease prevention strategies (Department of Agriculture and U.S. Department of Health and Human Services, 2020). Similarly, the USDA's Healthy Hunger-Free Kids Act of 2010 outlines nutrition standards for school meals, incorporating healthier and more balanced dietary options (U.S. Department of Agriculture, 2010). The guidelines collectively highlight the alignment of plant-based dietary strategies with established professional recommendations, underscoring their relevance as a cornerstone of public health interventions.

4.13 Strengths/Limitations

The studies reviewed demonstrate several strengths, enhancing the credibility of the findings regarding the impact of plant-based diets on glycemic control in individuals with type 2 diabetes. A notable strength across many studies is the use of rigorous methodological designs, particularly randomized controlled trials (RCTs), which provide a high level of evidence. Studies such as Adokwe et al. (2024) and Tripathi et al. (2024), with their large and diverse samples of 600 and 750 participants, respectively, provide strong evidence for the generalizability of plant-based diets across various ethnic and demographic groups. This diversity in study populations ensures broader applicability, making plant-based diets a viable recommendation for diverse communities. Additionally, the studies employed well-defined intervention protocols, ensuring that the effects of plant-based diets on glycemic control were accurately measured and reliably compared to control groups.

The systematic review itself followed the PRISMA guidelines, including its checklist and flow diagram, ensuring a transparent and methodical approach to study selection, screening, and inclusion. The inclusion of objective outcome measures, such as HgbA1c levels and fasting glucose, further bolsters the reliability of the findings, as demonstrated in studies like Barnard et al. (2018) and Kahleova et al. (2019). Adherence to PRISMA strengthens the overall quality and reproducibility of the review, providing a robust foundation for its conclusions and relevance to clinical practice.

However, despite the strengths, several study limitations should be acknowledged. One of the most common limitations is the reliance on self-reported dietary intake, which can introduce bias and reduce the accuracy of dietary adherence data. For example, Ramal et al. (2017) highlighted this limitation in their study, where dietary adherence was primarily self-reported. This method of assessment is prone to recall bias and may lead to misclassifications, potentially underestimating the true effect of plant-based diets on glycemic outcomes. Another limitation observed across several studies is the relatively short duration of follow-up periods, typically ranging from eight to sixteen weeks. While short-term benefits were consistently observed, as seen in Davis et al. (2019) and Trepanowski & Varady (2014), the long-term sustainability of these dietary changes remains uncertain. Longer-term studies are needed to better understand the lasting effects of plant-based diets on glycemic control and overall health.

Additionally, variations in sample size and demographic diversity across studies influence the generalizability of the findings. For instance, Trepanowski & Varady (2014) had a smaller sample size with a specific demographic focus, which may limit the broader applicability of their results. In contrast, studies like Adokwe et al. (2024) and Tripathi et al. (2024), with their larger and more diverse samples, contribute to a stronger generalizability of the results. The differences in the control diets used across studies also challenge comparability. Some studies, such as Adokwe et al. (2024) and Tripathi et al. (2024), used well-defined control diets, allowing for reliable comparisons, while others, like Ramal et al. (2017), had less detailed control diet specifications, which may have affected the comparability of the outcomes.

Another limitation is the heterogeneity across studies regarding the definition and components of plant-based diets. The variability in dietary patterns, often shaped by cultural and geographic factors, complicates direct comparisons and interpretation of findings. For example, Belinova et al. (2014) and Lin et al. (2019) included moderately diverse populations and dietary protocols, which, while providing valuable data, limited the exploration of the specific components of plant-based diets that contributed to the observed benefits.

The collective findings highlight the potential of plant-based diets as a feasible, non-pharmacological strategy for managing type 2 diabetes, offering improvements in glycemic control and reductions in medication reliance. However, given most studies were conducted in high-income countries, the generalizability of these results to lower-income settings where food availability and quality may differ is limited. This limitation emphasizes the need for further research across diverse socioeconomic contexts to confirm the broader applicability of plant-based dietary interventions. Expanding research to include lower-income regions could provide a more comprehensive understanding of how these diets perform in varied environments, ultimately enhancing their accessibility and effectiveness on a global scale.

5. Applications for Practitioners

The evidence from the reviewed studies strongly supports the integration of plant-based diets into diabetes management strategies, showing significant reductions in HgbA1c levels, fasting glucose, and improved metabolic health across diverse populations. Practitioners can confidently recommend plant-based dietary interventions as an effective, patient-centered approach to managing T2DM. To provide a clear and structured approach, the "9 Steps for Practitioners to Integrate Plant-Based Diets" (as shown in the infographic below) outline actionable recommendations for effectively incorporating plant-based dietary strategies into patient care.

5.1 Personalized Dietary Recommendations

Practitioners should emphasize the importance of customizing plant-based dietary recommendations to align with individual patient preferences, cultural backgrounds, and metabolic needs. Studies such as those by Tripathi et al. (2024) and Ramal et al. (2017) demonstrate the efficacy of plant-based diets across various ethnic groups, highlighting that tailored meal plans can improve adherence and long-term health outcomes. By making dietary recommendations compatible with each patient's lifestyle and food accessibility, practitioners can significantly enhance both adherence and results.

5.2 Emphasis on Whole, Nutrient-Dense Foods

Encouraging patients to focus on whole, plant-based foods—such as fruits, vegetables, legumes, nuts, and whole grains—is critical for optimizing glycemic control and enhancing overall health. Adokwe et al. (2024) and Wright et al. (2017) emphasize diets rich in these foods improve insulin sensitivity and reduce cardiovascular risk factors, aligning with a holistic approach to managing type 2 diabetes.

5.3 Guidance on Balanced Meal Composition

Providing patients with clear guidance on meal composition empowers them to make informed dietary choices. Studies like Belinova et al. (2014) demonstrate how balanced plant-based meals improve postprandial insulin responses, underscoring the importance of educating patients on meal planning. Practitioners should offer specific recommendations on how to structure meals to include diverse plant-based foods, thereby helping patients stabilize blood glucose levels more effectively.

5.4 Reduction in Medication Usage Through Dietary Interventions

Several studies, including Barnard et al. (2018), indicated that plant-based diets can reduce the need for glucose-lowering medications, offering a non-pharmacological management option for patients seeking to minimize medication reliance. This approach also has the potential to lower healthcare costs and improve quality of life, with fewer side effects from medications like insulin or oral hypoglycemics. Practitioners can integrate plant-based diets into diabetes management as a foundational lifestyle intervention, reserving medications as secondary support when necessary.

5.5 Support for Weight Management Goals

Weight management plays a significant role in glycemic control, as evidenced by Davis et al. (2019) and Ramal et al. (2017) found that plant-based diets contributed to weight loss, which subsequently improved blood glucose levels. Presenting plant-based diets as an effective strategy for achieving and maintaining a healthy weight can help motivate patients to adopt these eating patterns for long-term benefits.

5.6 Multidisciplinary Collaboration with Registered Dietitians

Collaborating with Registered Dietitians can enhance the success of plant-based interventions by providing tailored meal planning, addressing specific nutrient needs, and monitoring adherence. As shown in Kahleova et al. (2019), a multidisciplinary approach supports sustainable dietary change, thereby improving long-term health outcomes. Practitioners should consider involving dietitians in the treatment team to strengthen patient support.

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5.7 Continuous Patient Support and Access to Resources

Effective transition to plant-based diets often requires ongoing support. Studies by Kahleova et al. (2019) and Trepanowski & Varady (2014) suggest workshops, cooking classes, and community support groups can aid patients in maintaining dietary adherence. Providing access to digital tools, such as apps and meal-planning resources, as highlighted by Jenkins et al. (2022), can further assist patients by offering remote support and guidance.

5.8 Advocacy for Food Accessibility and Policy Support

Practitioners have a role in advocating for broader policy changes that improve access to plant-based foods, especially in underserved areas. Many studies underscore the importance of food availability, noting that better access to fresh produce and whole foods is essential for equitable health outcomes. By supporting initiatives that increase plant-based food options, practitioners contribute to the larger public health goal of reducing type 2 diabetes prevalence and severity.

5.9 Commitment to Continuous Research and Education

Given the evolving research on plant-based diets, practitioners should stay informed of new findings to provide evidence-based recommendations. Engaging in ongoing education through seminars and reviewing recent studies ensures that practitioners offer patients the most current and effective dietary guidance, as advocated by Wright et al. (2017). Continuous learning will help practitioners refine their approaches and address emerging questions in diabetes care.

Figure 3. 9 Steps for Practitioners to Integrate Plant-Based Diets into Diabetes Management

6. Conclusion

The collective findings indicate the efficacy of plant-based diets in enhancing glycemic control and metabolic health among individuals with type 2 diabetes. Consistent reductions in HgbA1c, fasting glucose, and other metabolic indicators across diverse populations reinforce the effectiveness of dietary treatments. This aligns with the American Diabetes Association's endorsement of plant-based diets as part of a comprehensive diabetes management plan (American Diabetes Association, 2023). Additionally, research from the Academy of Nutrition and Dietetics supports the health benefits of well-planned vegetarian and plant-based diets for chronic disease management, including diabetes, by improving blood glucose levels and reducing cardiovascular risk (Melina et al., 2016; Kahleova et al., 2017).

The collective findings highlight the efficacy of plant-based diets in improving glycemic control and overall metabolic health among individuals with type 2 diabetes. The consistent reductions in HgbA1c, fasting glucose, and other metabolic indicators across diverse populations demonstrate the effectiveness of dietary treatments. Plant-based diets align with the American Diabetes Association's guidelines, recognizing them as effective for managing diabetes by improving glycemic control and overall health (American Diabetes Association, 2023).

Similarly, the Academy of Nutrition and Dietetics supports well-planned vegetarian diets, including plant-based patterns, as beneficial for managing chronic diseases like diabetes (Melina et al., 2016). The American Heart Association highlights its role in reducing blood pressure and improving lipid profiles, while the Dietary Guidelines for Americans (2020–2025*)* advocate for plant-based foods as essential for chronic disease prevention. These guidelines, along with school nutrition standards encouraging plant-based options, reinforce the importance of these diets as a cornerstone for diabetes management and public health.

The implications of the results are profound. Studies suggest adopting plant-based diets can play a crucial role in managing T2DM by not only improving glycemic control but also potentially reducing reliance on glucose-lowering medications. This finding is important given the increasing global prevalence of diabetes and the need for sustainable, cost-effective management strategies. Additionally, the results underscore the benefits of whole foods rich in dietary fiber, vitamins, and minerals, which contribute to improved insulin sensitivity and overall metabolic health. The insights align with previous research, reinforcing the evidence that plant-based diets can promote better health outcomes compared to standard diabetic diets.

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Authors’ contributions

JG and KH were responsible for the study design and data collection. JG drafted the manuscript, and KH provided critical revisions. Both authors read and approved the final manuscript.

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Data sharing statement

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