DOI: https://doi.org/10.54393/df.v6i2.187

DIET FACTOR
Journal of Nutritional & Food Sciences
https://www.dietfactor.com.pk/index.php/df
ISSN (E): 2789-8105, (P): 2789-8091
Volume 6, Issue 3 (July-Sep 2025)

Original Article

OPEN ACCESS

Plant-Based Diet Adherence and Type 2 Diabetes Risk Factors

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ARTICLE INFO

Keywords:
Plant-Based Diet, Type 2 Diabetes, BMI, Fasting Glucose, HbA1c

How to Cite:
Bashir, T., Mehmood, A., & Nazeer, R. (2025). Plant-Based Diet Adherence and Type 2 Diabetes Risk Factors: Plant-Based Diet: Type 2 Diabetes Risk Factors. DIET FACTOR (Journal of Nutritional and Food Sciences), 6(2), 31-34. https://doi.org/10.54393/df.v6i2.187

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Received Date: 12th April, 2025
Revised Date: 11th June, 2025
Acceptance Date: 17th June, 2025
Published Date: 30th June, 2025

ABSTRACT

Type 2 diabetes (T2D) prevalence is increasing worldwide. Dietary patterns, particularly plant-based diets, have been linked to improved glycemic control and lower T2D risk. **Objectives:** To analyze the relationship between plant-based dietary patterns and risk factors for T2D using publicly available secondary data. **Methods:** This cross-sectional secondary data analysis utilized data from the 2019 National Health and Nutrition Examination Survey (NHANES). Adults aged 20–65 years were categorized into four dietary patterns based on 24-hour dietary recalls: vegan, vegetarian, semi-vegetarian, and omnivore. Risk factors analyzed included body mass index (BMI), fasting blood glucose, and HbA1c. Statistical analyses were performed using SPSS version 27.0. ANOVA and post-hoc tests assessed differences among groups, while Spearman correlation evaluated associations between plant-based diet adherence and T2D risk factors. The p-values <0.05 were considered statistically significant. **Results:** The study included 5,200 adults (52% female; mean age 42.3 ± 12.5 years Mean BMI differed significantly among dietary groups, with vegans showing the lowest (23.1 ± 2.9 kg/m^2; 95% CI: 22.9–23.3) and omnivores the highest (27.2 ± 3.7 kg/m^2; 95% CI: 27.0–27.4). Fasting glucose and HbA1c were also lowest among vegans and highest in omnivores, indicating better glycemic control with higher adherence to plant-based diets. Higher plant-based diet adherence was associated with lower BMI, fasting glucose, and HbA1c, suggesting reduced metabolic risk. **Conclusions:** Plant-based diets are associated with reduced T2D risk factors. Public health strategies should promote plant-based eating patterns to mitigate the growing burden of T2D.

INTRODUCTION

The chronic illness known as type 2 diabetes (T2D) is characterized by elevated blood sugar levels brought on by either inadequate or resistant insulin production. Globally, the prevalence of T2D has reached pandemic levels, affecting over 537 million adults in 2021 and projected to rise further in the next decades [1]. Diet and other lifestyle variables are important in preventing type 2 diabetes. Plant-based diets that prioritize fruits, vegetables, whole grains, legumes, and nuts while reducing animal products may be beneficial for metabolism. Evidence suggests that these diets improve insulin sensitivity, reduce body weight, and lower chronic inflammation [2-4]. Observational studies indicate that vegetarian and vegan diets are linked to reduced T2D incidence, but cross-population analyses are limited [5]. Type 2 diabetes (T2D) represents a major public health challenge worldwide, with escalating prevalence driven by aging populations, urbanization, and lifestyle changes [6]. In recent decades, dietary shifts toward higher consumption of processed foods, refined carbohydrates, animal products, and saturated fats have paralleled rising T2D rates [7]. In contrast, plant-based diets—rich in fiber, antioxidants, micronutrients, and phytochemicals—are thought to confer metabolic benefits through multiple pathways, including improved insulin sensitivity, modulation of gut microbiota, reduction of oxidative stress, and mitigation of low-grade inflammation

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[8]. Interventional trials have also demonstrated that transitioning to vegetarian or vegan diets yields improvements in glycemic control, weight loss, and lipid profiles among individuals with T2D [9]. However, many existing studies focus on specific populations or clinical settings, and there is still limited evidence from large, representative datasets that classify varying degrees of plant-based adherence (e.g., semi-vegetarian, vegetarian, vegan) in relation to multiple T2D risk markers [10]. Therefore, by leveraging the NHANES 2019 dataset, this study aims to fill this gap by exploring how gradations of plant-based dietary patterns are associated with BMI, fasting glucose, and HbA1c in a broad adult population, thereby contributing to the evidence base for diet-based preventive strategies in diabetes.

The aim of this study was to evaluate the association between plant-based dietary patterns and T2D risk factors (BMI, fasting glucose, HbA1c).

METHODS

This cross-sectional secondary data analysis utilized data from the 2019 National Health and Nutrition Examination Survey (NHANES). The dataset was accessed and extracted in 2024, while the statistical analysis was performed between January and March 2025 conducted at the Centers for Disease Control and Prevention (CDC). Written informed consent was taken. As this design captures associations at a single point in time, causal relationships between dietary patterns and type 2 diabetes risk factors cannot be inferred conducted by the Centers for Disease Control and Prevention (CDC). NHANES collects demographic, dietary, and health-related data using standardized methods, and publicly available datasets were obtained from the NHANES website. The survey employs a complex, multistage probability sampling design to obtain a nationally representative sample of the U.S. population. This design was considered in data collection, and the weighted nature of NHANES enhances generalizability of the findings. Participants aged 20–65 years with complete dietary recall, BMI, fasting glucose, and HbA1c data were included, while those with missing data or diagnosed type 1 diabetes were excluded. Dietary patterns were classified based on 24-hour dietary recall into four groups: vegan (no animal products), vegetarian (no meat or fish but dairy/eggs allowed), semi-vegetarian (occasional meat or fish consumption less than three times per week), and omnivore (regular meat or fish consumption). Key risk factors were assessed as follows: BMI was calculated as weight (kg)/height^2 (m^2), fasting glucose (mg/dL) was measured using standard laboratory methods, and HbA1c (%) was determined by high-performance liquid chromatography (HPLC). Statistical analyses were conducted using SPSS version 27.0, with continuous variables reported as mean ± standard deviation (SD). Before applying ANOVA, assumptions of normality (Shapiro–Wilk test and inspection of histograms) and homogeneity of variance (Levene's test) were assessed and met. Group differences were then examined using one-way ANOVA followed by Tukey's post-hoc test, and correlations between plant-based diet adherence (coded 1–4, vegan to omnivore) and type 2 diabetes (T2D) risk factors were evaluated using Spearman correlation coefficients, with significance set at $p<0.05$. As this analysis used publicly available secondary data, no direct human subject interaction occurred, and institutional review board (IRB) approval was not required.

RESULTS

The study included data of 5,200 adults aged 20–65, with 52% female and a mean age of 42.3 ± 12.5 years. Although no a priori power calculation was performed due to the secondary nature of this analysis, the relatively large NHANES sample size (n=5,200) provides adequate statistical power to detect small-to-moderate effect sizes in comparisons across dietary groups. Prior studies using NHANES data with comparable sample sizes have successfully identified associations between dietary patterns and metabolic outcomes, supporting the adequacy of the sample for this analysis. Table 1 presents that participants were categorized according to dietary habits as vegan (n=312), vegetarian (n = 598), semi-vegetarian (n = 1,024), and omnivore (n = 3,266). Mean Body Mass Index (BMI) differed significantly among dietary groups ($p < 0.01$), with vegans showing the lowest mean BMI (23.1 ± 2.9 kg/m^2), followed by vegetarians (24.5 ± 3.2 kg/m^2), semi-vegetarians (25.8 ± 3.5 kg/m^2), and omnivores (27.2 ± 3.7 kg/m^2) (Table 1).

Table 1: Mean BMI Across Dietary Patterns

Dietary Pattern	Mean BMI (kg/m^2)
Vegan	23.1 ± 2.9
Vegetarian	24.5 ± 3.2
Semi-vegetarian	25.8 ± 3.5
Omnivore	27.2 ± 3.7

The study represents fasting glucose and HbA1c levels varied significantly across dietary groups ($p<0.01$), with the lowest values observed in vegan participants, followed by vegetarians, semi-vegetarians, and omnivores. Mean fasting glucose was 92 ± 8 mg/dL in vegans and 102 ± 12 mg/dL in omnivores, while mean HbA1c was 5.4 ± 0.3% and 5.9 ± 0.5%, respectively, indicating better glycemic control among individuals adhering to plant-based diets (Table 2).

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Table 2: Comparison of Fasting Glucose and Hba1c Across Dietary Patterns

Dietary Pattern	Fasting Glucose (mg/dL)	HbA1c (%)
Vegan	92 ± 8	5.4 ± 0.3
Vegetarian	95 ± 10	5.6 ± 0.4
Semi-vegetarian	98 ± 11	5.7 ± 0.4
Omnivore	102 ± 12	5.9 ± 0.5

The study presents higher adherence to plant-based diets was significantly associated with lower BMI ($r = -0.31$, $p<0.01$; 95% CI: −0.34 to −0.28), fasting glucose ($r = -0.28$, $p<0.01$; 95% CI: −0.31 to −0.25), and HbA1c ($r = -0.29$, $p<0.01$; 95% CI: −0.32 to −0.26), indicating reduced metabolic risk (Table 3).

Table 3: Correlation Between Plant-Based Diet Adherence and Diabetes Risk Indicators

Variables	Correlation coefficient (r)	p-Value
BMI	−0.31	<0.01
Fasting Glucose	−0.28	<0.01
HbA1c	−0.29	<0.01

DISCUSSION

This secondary analysis demonstrates that greater adherence to plant-based diets is associated with lower BMI, fasting glucose, and HbA1c markers strongly linked to T2D risk. These results are consistent with global findings that dietary composition exerts a pivotal influence on metabolic health [11, 12]. A large-scale meta-analysis by Clemente-Suárez *et al.* reported a 23 % lower relative risk of developing T2D among individuals following plant-based patterns [13]. Similarly, Lv *et al.* found that vegetarian and vegan diets significantly reduced HbA1c and BMI in patients with T2D [14]. These outcomes closely mirror the gradients observed in our NHANES data, suggesting a dose-response relationship between plant-based adherence and glycemic outcomes. Earlier studies reported that plant-based diets enhance insulin sensitivity by improving gut-microbiota diversity, lowering endotoxemia, and reducing low-grade inflammation [15, 16]. Additionally, replacing animal fats with plant-derived unsaturated fats and fibers improves hepatic glucose metabolism and lipid profiles [17]. From a public-health standpoint, promoting semi-vegetarian or predominantly plant-based eating could yield measurable reductions in diabetes burden [18, 19]. However, the quality of plant-based diets remains crucial unrefined, fiber-rich foods confer benefits, whereas refined starches or sweetened plant products may not [8, 20]. The cross-sectional design limits causal inference, and the 24-hour dietary recall may not capture habitual intake. Additionally, reliance on self-reported 24-hour dietary recall introduces the possibility of recall bias and under- or over-reporting of specific foods, which may affect classification accuracy of dietary patterns. Nonetheless, using nationally representative NHANES data enhances generalizability and aligns with emerging evidence linking plant-forward diets to improved cardiometabolic health.

CONCLUSIONS

Plant-based dietary patterns are significantly associated with lower BMI, fasting glucose, and HbA1c, indicating reduced T2D risk. Promoting plant-based diets at the population level may be a feasible strategy for T2D prevention

Authors Contribution

Conceptualization: TB, AM, RN
Methodology: TB, AM, RN
Formal analysis: TB, AM, RN
Writing, review and editing: TB

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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