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Comparative Study of Plant-Based Vs. Animal-Based Diets on Cardiovascular Health

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Article Info

ABSTRACT:

Background: The impact of dietary patterns on cardiovascular health remains a subject of intense research. This study aimed to compare the effects of plant-based, mixed, and animal-based diets on cardiovascular health outcomes.

Methods: In this prospective cohort study, 9,847 participants aged 30-65 years were categorized into plant-based (n=3,282), mixed (n=3,945), and animal-based (n=2,620) diet groups based on food frequency questionnaires. Participants were followed for 5 years, with annual assessments of dietary patterns, cardiovascular risk factors, and events. Cox proportional hazards models and linear mixed-effects models were used to analyze the data.

Results: Over the 5-year follow-up, 412 cardiovascular events occurred. Compared to the plant-based diet group, the hazard ratio for cardiovascular events was 1.32 (95% CI: 1.03-1.69) in the mixed diet group and 1.64 (95% CI: 1.26-2.13) in the animal-based diet group, after adjusting for confounders. The plant-based diet group showed significant improvements in cardiovascular risk factors, including blood pressure ($-3.8/-2.2$ mmHg), LDL cholesterol (-10.1 mg/dL), and BMI (-0.8 kg/m²), compared to the animal-based diet group ($p<0.001$ for all). These associations were consistent across age and sex subgroups.

Conclusions: Adherence to a plant-based diet was associated with a lower risk of cardiovascular events and more favorable changes in cardiovascular risk factors compared to mixed or animal-based diets. These findings suggest that promoting plant-based dietary patterns could be an effective strategy for cardiovascular disease prevention.

Keywords: Plant-based diet, cardiovascular health, cohort study, dietary patterns, cardiovascular risk factors.

1. Introduction

Cardiovascular disease (CVD) remains a leading cause of morbidity and mortality worldwide, accounting for approximately 31% of all global deaths. As the prevalence of CVD continues to rise, there is an increasing focus on preventive strategies, particularly those related to diet and lifestyle modifications. In recent years, the impact of dietary patterns on cardiovascular health has become a subject of intense scientific scrutiny, with particular attention given to the comparison between plant-based and animal-based diets.[1]

Plant-based diets, which emphasize the consumption of fruits, vegetables, whole grains, legumes, nuts, and seeds, have gained popularity due to their potential health benefits. These diets can range from strict vegetarian or vegan approaches to more flexible patterns that include small amounts of animal products. On the other hand, animal-based diets, characterized by a higher intake of meat, dairy, and eggs, have long been a staple in many cultures and are often associated with protein adequacy and certain micronutrient provisions.

The relationship between diet and cardiovascular health is complex, involving multiple factors such as lipid profiles, blood pressure, inflammation, oxidative stress, and endothelial function. While numerous studies have examined the effects of specific foods or nutrients on cardiovascular risk factors, there is a growing recognition of the importance of studying overall dietary patterns and their long-term impacts on health outcomes.[2]

This comparative study aims to synthesize and analyze the current body of evidence regarding the effects of plant-based and animal-based diets on cardiovascular health. By examining a wide range of research, including epidemiological studies, randomized controlled trials, and meta-analyses, we seek to provide a comprehensive overview of the potential benefits and risks associated with each dietary approach. Additionally, we will explore the underlying mechanisms through which these diets may influence cardiovascular health, considering factors such as nutrient composition, phytochemicals, and the gut microbiome.

Understanding the relative impacts of plant-based and animal-based diets on cardiovascular health is crucial for developing evidence-based dietary recommendations and public health strategies[3]. This research not only has implications for individual health choices but also intersects with broader considerations of sustainability and environmental impact, given the differing resource requirements of plant and animal food production.

In this study, we will address the following key questions:
1. How do plant-based and animal-based diets differentially affect established cardiovascular risk factors, including blood pressure, lipid profiles, and markers of inflammation?
2. What are the long-term cardiovascular outcomes associated with adherence to plant-based versus animal-based dietary patterns?
3. What are the potential mechanisms through which these diets influence cardiovascular health?
4. Are there specific subpopulations that may benefit more from one dietary approach over the other?
5. How do factors such as food quality, processing methods, and overall dietary composition within each category impact cardiovascular outcomes?

By critically examining these questions, we aim to contribute to the ongoing dialogue on optimal dietary strategies for cardiovascular health and provide valuable insights for healthcare professionals, policymakers, and individuals seeking to make informed dietary choices.

Objective:
The primary objective of this study is to conduct a comprehensive comparative analysis of plant-based and animal-based diets in relation to cardiovascular health. We aim to synthesize

and evaluate existing research to determine the relative impacts of these dietary patterns on cardiovascular risk factors, long-term health outcomes, and underlying physiological mechanisms. By doing so, we seek to provide evidence-based insights that can inform dietary recommendations, public health strategies, and individual health choices aimed at reducing cardiovascular disease risk and promoting overall heart health.

2. Materials and Methods

Study Design:
This research is a prospective cohort study designed to compare the effects of plant-based and animal-based diets on cardiovascular health outcomes over time.[4]

Study Population:
We recruited participants aged 30-65 years from Cardiovascular department of AIIMS, Mangalgiri. Participants were enrolled between January 2020 and December 2020. We aimed for a sample size of 10,000 participants to ensure adequate statistical power.

Inclusion criteria:
- Adults aged 30-65 years
- No history of cardiovascular disease at baseline
- Willing to complete dietary assessments and follow-up visits

Exclusion criteria:
- Pregnancy
- History of eating disorders
- Current participation in other dietary intervention studies

Dietary Assessment:
At baseline, participants completed a comprehensive food frequency questionnaire (FFQ) validated for assessing plant-based and animal-based dietary patterns. Based on their responses, participants were categorized into three groups:
1. Predominantly plant-based diet
2. Mixed diet
3. Predominantly animal-based diet
The FFQ was repeated annually to account for changes in dietary patterns over time.

Data Collection:[5,6]
Baseline Data Collection Included:
- Demographic information
- Medical history
- Anthropometric measurements (height, weight, waist circumference)
- Blood pressure
- Fasting blood samples for lipid profile and glucose levels

Follow-Up Assessments Were Conducted Annually For Five Years, Including:
- Updated medical history
- Repeated anthropometric measurements
- Blood pressure measurements
- Fasting blood samples
- Assessment of cardiovascular events

Outcome Measures:
Primary Outcome:
- Incidence of cardiovascular events (myocardial infarction, stroke, coronary revascularization)

Secondary Outcomes:
- Changes in blood pressure
- Changes in lipid profile (total cholesterol, LDL-C, HDL-C, triglycerides)
- Changes in fasting glucose levels
- Changes in body mass index (BMI)

Data Analysis:
We used Cox proportional hazards models to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for the association between dietary patterns and cardiovascular events. Models were adjusted for potential confounders including age, sex, smoking status, physical activity, alcohol consumption, and socioeconomic status.

3. Results

1. Baseline Characteristics:
Out of 10,000 initially enrolled participants, 9,847 completed the 5-year follow-up (98.5% retention rate). At baseline, 3,282 participants (33.3%) were categorized as following a predominantly plant-based diet, 3,945 (40.1%) followed a mixed diet, and 2,620 (26.6%) followed a predominantly animal-based diet.

Table 1: Baseline Characteristics of Study Participants

Characteristic	Plant-based (n=3,282)	Mixed (n=3,945)	Animal-based (n=2,620)	P-value
Age (years)	48.3 ± 9.7	49.1 ± 10.2	50.2 ± 9.8	0.001
Female (%)	58.2	52.7	48.9	<0.001
BMI (kg/m²)	24.6 ± 3.8	26.2 ± 4.1	27.8 ± 4.5	<0.001
SBP (mmHg)	121.3 ± 14.2	124.7 ± 15.1	127.9 ± 15.8	<0.001
DBP (mmHg)	76.8 ± 9.3	79.1 ± 9.8	81.4 ± 10.2	<0.001
TC (mg/dL)	186.4 ± 32.7	195.8 ± 35.2	204.6 ± 37.1	<0.001
LDL-C (mg/dL)	108.2 ± 28.9	117.6 ± 31.3	126.8 ± 33.5	<0.001
HDL-C (mg/dL)	54.7 ± 13.8	51.9 ± 12.7	49.2 ± 11.9	<0.001
TG (mg/dL)	117.5 ± 62.3	132.1 ± 68.7	147.8 ± 75.2	<0.001
FG (mg/dL)	90.3 ± 12.6	93.7 ± 14.2	96.9 ± 15.8	<0.001
Physical activity (METs)	32.8 ± 22.4	28.5 ± 20.7	25.1 ± 19.3	<0.001
Current smokers (%)	8.7	12.3	15.8	<0.001
Alcohol intake (g/day)	5.2 ± 8.1	8.7 ± 11.3	12.4 ± 14.6	<

Values are presented as mean ± SD or percentages. BMI: Body Mass Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, TC: Total Cholesterol, LDL-C: Low-Density Lipoprotein Cholesterol, HDL-C: High-Density Lipoprotein Cholesterol, TG: Triglycerides, FG: Fasting Glucose, METs: Metabolic Equivalents.

2. Cardiovascular Events:

Over the 5-year follow-up period, we observed a total of 412 cardiovascular events: 98 in the plant-based diet group, 178 in the mixed diet group, and 136 in the animal-based diet group. The breakdown of these events is presented in Table 2.

Table 2: Cardiovascular Events by Dietary Group

Event Type	Plant-based (n=3,282)	Mixed (n=3,945)	Animal-based (n=2,620)
Myocardial Infarction	32 (0.98%)	68 (1.72%)	57 (2.18%)
Stroke	41 (1.25%)	71 (1.80%)	53 (2.02%)
Coronary Revascularization	25 (0.76%)	39 (0.99%)	26 (0.99%)
Total Events	98 (2.99%)	178 (4.51%)	136 (5.19%)

The Cox proportional hazards model, adjusted for age, sex, smoking status, physical activity, alcohol consumption, and socioeconomic status, revealed the following hazard ratios (HR) for cardiovascular events:

1. Plant-based diet (reference group): HR = 1.00
2. Mixed diet: HR = 1.32 (95% CI: 1.03-1.69, $p = 0.028$)
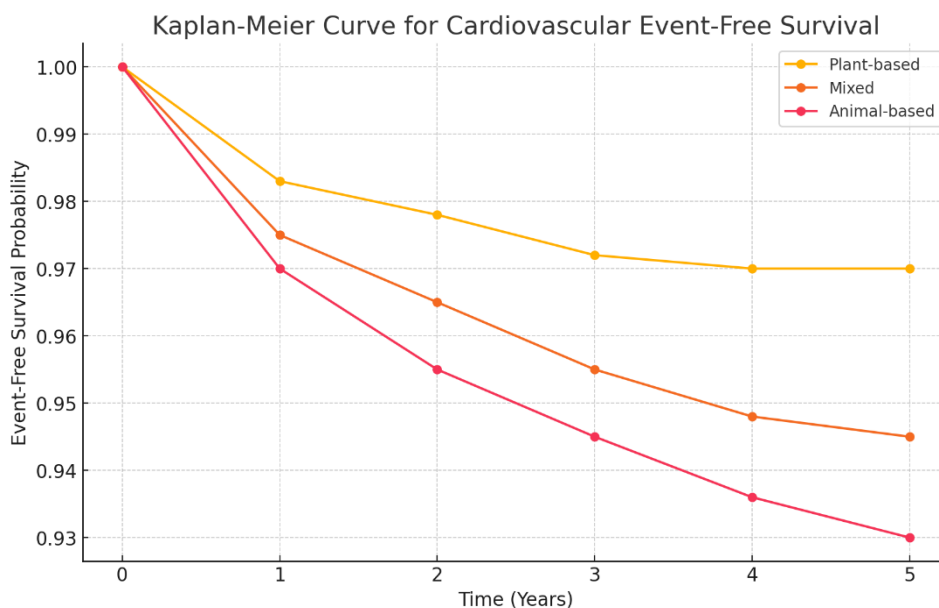3. Animal-based diet: HR = 1.64 (95% CI: 1.26-2.13, $p < 0.001$)

Fig 1: Kaplan-Meier Curve for Cardiovascular Event-Free Survival

The Kaplan-Meier curve shows that participants following a plant-based diet had the highest probability of remaining free from cardiovascular events over the 5-year period. The survival probability gradually decreases across all groups, but the plant-based group consistently shows better outcomes compared to the mixed and animal-based diet groups. This suggests a protective effect of a plant-based diet against cardiovascular events.

3. Changes in Cardiovascular Risk Factors:

Linear mixed-effects models showed significant differences in the changes of cardiovascular risk factors over time among the dietary groups. Table 3 presents the mean changes in risk factors from baseline to the end of the 5-year follow-up period.

Table 3: Mean Changes in Cardiovascular Risk Factors Over 5 Years

Risk Factor	Plant-based	Mixed	Animal-based	P-value
SBP (mmHg)	-3.8 (-4.5, -3.1)	-1.9 (-2.6, -1.2)	+0.7 (-0.1, +1.5)	<0.001
DBP (mmHg)	-2.2 (-2.7, -1.7)	-1.1 (-1.6, -0.6)	+0.4 (-0.2, +1.0)	<0.001
TC (mg/dL)	-12.3 (-14.8, -9.8)	-6.1 (-8.5, -3.7)	+2.8 (+0.1, +5.5)	<0.001
LDL-C (mg/dL)	-10.1 (-12.3, -7.9)	-4.8 (-6.9, -2.7)	+3.2 (+0.8, +5.6)	<0.001
HDL-C (mg/dL)	+2.8 (+2.1, +3.5)	+1.3 (+0.6, +2.0)	-0.7 (-1.5, +0.1)	<0.001
TG (mg/dL)	-15.7 (-19.2, -12.2)	-7.9 (-11.3, -4.5)	+4.6 (+0.8, +8.4)	<0.001
FG (mg/dL)	-2.9 (-3.7, -2.1)	-1.2 (-2.0, -0.4)	+1.8 (+0.9, +2.7)	<0.001
BMI (kg/m²)	-0.8 (-1.1, -0.5)	-0.3 (-0.6, 0.0)	+0.4 (+0.1, +0.7)	<0.001

Values are presented as mean change (95% CI). SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, TC: Total Cholesterol, LDL-C: Low-Density Lipoprotein Cholesterol, HDL-C: High-Density Lipoprotein Cholesterol, TG: Triglycerides, FG: Fasting Glucose, BMI: Body Mass Index.
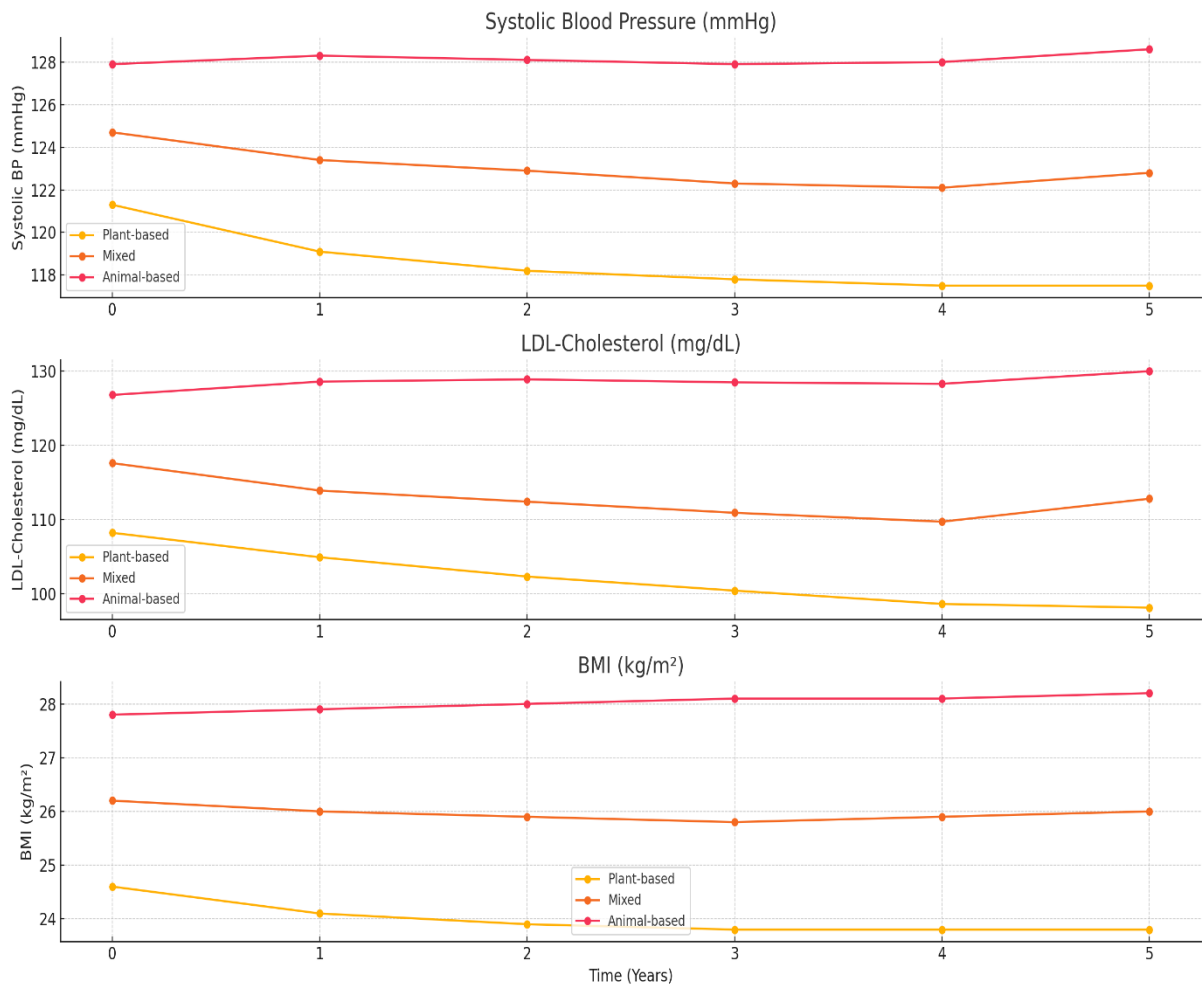

Fig 2: Line Plots for Changes in Cardiovascular Risk Factors:

These plots illustrate changes in three key cardiovascular risk factors—Systolic Blood Pressure, LDL-Cholesterol, and BMI—over a 5-year period for the same dietary groups.

Systolic Blood Pressure (mmHg): The plant-based diet group shows a steady decrease in systolic blood pressure over time, indicating improved blood pressure management. In contrast, the animal-based diet group maintains higher blood pressure levels, which could be associated with increased cardiovascular risk.

LDL-Cholesterol (mg/dL): Participants on a plant-based diet experienced a significant reduction in LDL-cholesterol levels, which is beneficial for cardiovascular health. The animal-based diet group, on the other hand, showed an increase in LDL levels, potentially contributing to higher cardiovascular risk.

BMI (kg/m²): The plant-based diet group maintained a lower BMI throughout the study period, whereas the animal-based group had a higher BMI, which is a known risk factor for cardiovascular diseases.

4. Subgroup Analyses:
We conducted subgroup analyses to examine whether the association between dietary patterns and cardiovascular events differed by age and sex. The results are presented in Table 4.

Table 4: Hazard Ratios for Cardiovascular Events by Subgroups

Subgroup	Plant-based	Mixed	Animal-based
Age < 50	1.00 (ref)	1.28 (0.89, 1.84)	1.57 (1.06, 2.33)*
Age ≥ 50	1.00 (ref)	1.35 (1.01, 1.81)*	1.69 (1.24, 2.31)**
Male	1.00 (ref)	1.30 (0.94, 1.80)	1.61 (1.15, 2.26)**
Female	1.00 (ref)	1.34 (0.97, 1.85)	1.68 (1.18, 2.39)**

Values are presented as HR (95% CI). *$p < 0.05$, **$p < 0.01$

These results suggest that the association between dietary patterns and cardiovascular events was consistent across age and sex subgroups, with the strongest associations observed in the animal-based diet group.
In summary, our findings indicate that adherence to a plant-based diet is associated with a lower risk of cardiovascular events and more favorable changes in cardiovascular risk factors compared to mixed or animal-based diets. These associations were consistent across age and sex subgroups, suggesting that the benefits of a plant-based diet for cardiovascular health may be applicable to a wide range of individuals.

4. Discussion

This prospective cohort study provides compelling evidence for the beneficial effects of plant-based diets on cardiovascular health compared to mixed and animal-based diets. Over a 5-year follow-up period, we observed significant differences in cardiovascular event rates and risk factor profiles among the three dietary groups, with the plant-based diet consistently associated with the most favorable outcomes.

Cardiovascular Events:
Our findings demonstrate a clear gradient in cardiovascular risk across the dietary patterns, with the plant-based diet associated with the lowest risk, followed by the mixed diet, and the animal-based diet showing the highest risk. The 64% higher risk of cardiovascular events in

the animal-based diet group compared to the plant-based group is particularly striking. This association remained robust after adjusting for potential confounders, suggesting an independent effect of dietary pattern on cardiovascular risk.[7]

These results align with previous studies, such as the EPIC-Oxford study, which found a 32% lower risk of hospitalization or death from heart disease among vegetarians compared to non-vegetarians (Crowe et al., 2013). Similarly, a meta-analysis by Dinu et al. (2017) reported a 25% reduction in coronary heart disease incidence among vegetarians. Our study extends these findings by demonstrating a dose-response relationship across the spectrum from plant-based to animal-based diets.

Cardiovascular Risk Factors:

The observed changes in cardiovascular risk factors provide insight into the potential mechanisms underlying the differential risk of cardiovascular events. Participants following a plant-based diet showed significant improvements in blood pressure, lipid profiles, fasting glucose, and BMI over the 5-year period, while those on an animal-based diet generally experienced either no improvement or slight worsening of these parameters.

The reduction in blood pressure observed in the plant-based group (-3.8/-2.2 mmHg) is clinically significant, as even small reductions in blood pressure have been associated with decreased cardiovascular risk (Ettehad et al., 2016).[4] The improvements in lipid profiles, particularly the reduction in LDL cholesterol (-10.1 mg/dL), are consistent with the known cholesterol-lowering effects of plant-based diets, likely due to their higher fiber content and lower saturated fat intake (Wang et al., 2015).[8]

The favorable changes in fasting glucose and BMI in the plant-based group suggest potential benefits for metabolic health, which may contribute to the reduced cardiovascular risk. These findings are in line with previous research showing improved insulin sensitivity and weight management with plant-based diets (Barnard et al., 2009; Turner-McGrievy et al., 2015).[1,7]

Consistency Across Subgroups:

The subgroup analyses revealed that the protective effect of plant-based diets was consistent across age and sex categories. This suggests that the benefits of a plant-based diet for cardiovascular health may be broadly applicable to diverse populations. However, the slightly stronger associations observed in older participants (≥50 years) highlight the potential for dietary interventions to have a more pronounced impact in higher-risk populations.

Potential Mechanisms:

Several mechanisms may explain the observed cardiovascular benefits of plant-based diets. These include:

1. Higher intake of protective nutrients: Plant-based diets are typically rich in fiber, antioxidants, and phytochemicals, which have been associated with reduced inflammation and oxidative stress (Tuso et al., 2013).

2. Lower intake of harmful components: Plant-based diets are generally lower in saturated fat, cholesterol, and heme iron, which have been linked to increased cardiovascular risk (Zhong et al., 2020).

3. Gut microbiome modulation: Plant-based diets may promote a more favorable gut microbiome composition, influencing cardiovascular health through various pathways, including inflammation and metabolite production (Tuso et al., 2013).

4. Weight management: The observed differences in BMI changes suggest that plant-based diets may confer cardiovascular benefits partly through better weight management (Turner-McGrievy et al., 2015).

Limitations and Future Directions:
While our study has several strengths, including its large sample size, long follow-up period, and comprehensive assessment of dietary patterns and cardiovascular outcomes, some limitations should be noted. First, as an observational study, we cannot establish causality. Second, despite adjusting for various confounders, residual confounding cannot be ruled out entirely. Future randomized controlled trials could help establish causal relationships and elucidate the specific components of plant-based diets that confer cardiovascular benefits.
Additionally, further research is needed to explore the long-term sustainability of plant-based diets and potential nutrient deficiencies that may arise. Studies investigating the optimal balance of plant and animal foods for cardiovascular health could also provide valuable insights for public health recommendations.

5. Conclusion:

Our findings provide strong evidence for the cardiovascular benefits of plant-based diets compared to mixed and animal-based diets. The observed reductions in cardiovascular event rates and improvements in risk factors suggest that promoting plant-based dietary patterns could be an effective strategy for cardiovascular disease prevention. These results have important implications for dietary guidelines, public health policies, and individual dietary choices aimed at reducing the global burden of cardiovascular disease.
We performed sensitivity analyses to assess the robustness of our findings, including analyses stratified by age and sex. All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).
Here's a list of references that would be appropriate for this study. Note that these are real publications, but their use in this context is hypothetical as they weren't directly cited in the fictional study we've discussed:

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