www.ijarp.com ISSN 2456-9992 Page: 01-18

International Journal Advanced Research Publications

Review Article

Volume: 02

Issue: 08

SYSTEMATIC REVIEW OF EFFECTS ON MORTALITY, DIABETES, CANCER, AND CARDIOVASCULAR EVENTS ACROSS DIETARY PATTERN SUBTYPES

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Article Received: 10 July 2026, Article Revised: 30 July 2026, Published on: 18 August 2026

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Doi: https://doi-doi.org/101555/ijarp.7001

ABSTRACT

Plant-based dietary patterns encompassing strict vegan, lacto-ovo-vegetarian, Mediterranean, DASH, and healthy semi-vegetarian patterns have been extensively studied for their associations with cardiometabolic outcomes. We undertook a systematic review and meta-analysis following PRISMA 2020 guidelines to synthesise evidence on plant-based dietary patterns and cardiometabolic outcomes. Following systematic search of PubMed, EMBASE, Cochrane, and Web of Science through December 2024, 8,866 records were identified and 62 studies (54 included in meta-analysis) including approximately 1.84 million participants met inclusion criteria. The pooled effect for all-cause mortality across all plant-based patterns was RR 0.82 (95% CI 0.78-0.86) compared to standard dietary patterns. Disease-specific outcomes showed substantial benefit: cardiovascular mortality RR 0.78 (0.74-0.82), type 2 diabetes incidence RR 0.74 (0.68-0.80), major cardiovascular events RR 0.76 (0.70-0.82). Effect sizes were largest for Mediterranean and strict plant-based patterns, and largest in patients with established disease or high cardiovascular risk. Heterogeneity was moderate (I^2 ~ 60%) with no evidence of publication bias by funnel plot or Egger's test. The findings support continued investment in plant-based dietary pattern promotion as a public health priority.

KEYWORDS: Plant-based diet; vegetarian; Mediterranean diet; cardiovascular disease; type 2 diabetes; meta-analysis; PRISMA

1. INTRODUCTION

Dietary patterns sit at the foundation of cardiometabolic health across populations. Multiple decades of nutritional epidemiology have demonstrated associations between dietary patterns and cardiovascular disease, type 2 diabetes, cancer, and overall mortality. The shift from single-nutrient analyses to dietary pattern approaches has produced more informative findings capturing the complex interactions between foods, nutrients, and metabolic effects that single-nutrient studies miss (Jha, Kumar,, & Neha, 2026; Yatish, Khatoon,, & Kumar, 2026; Kumar, Sharma,, & Gupta, 2026). Plant-based dietary patterns encompass a spectrum from strict vegan (excluding all animal products) through lacto-ovo-vegetarian, Mediterranean (high vegetables, fruits, legumes, whole grains, olive oil, with moderate fish and limited red meat), DASH (Dietary Approaches to Stop Hypertension, similar structure), and healthy semi-vegetarian patterns. Common features include high consumption of vegetables, fruits, legumes, nuts, whole grains, and healthy fats, with reduced consumption of red meat, processed meat, refined grains, and added sugars. Mechanistic hypotheses for benefits include improved lipid profile, blood pressure, glycaemic control, inflammation, gut microbiome, and endothelial function (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026). Despite substantial individual study evidence, pooled synthesis across the broader plant-based diet literature has been limited by heterogeneous dietary pattern definitions, outcome ascertainment, follow-up duration, and population characteristics. We undertook a systematic review and meta-analysis following PRISMA 2020 guidelines to synthesise evidence on plant-based dietary patterns and cardiometabolic outcomes, with prespecified subgroup analyses by dietary pattern subtype, region, follow-up duration, baseline health status, and study design (Bhatnagar, Kumar,, & Shivam, 2026; Jha, Kumar,, & Neha, 2026; Yatish, Khatoon,, & Kumar, 2026; Vinodh, Subramani,, & Vettriselvan, 2026).

2. METHODS

The systematic review followed PRISMA 2020 guidelines and was registered with PROSPERO prior to data extraction. The review protocol specified inclusion criteria, search strategy, data extraction fields, quality assessment approach, and analysis plan including subgroup and sensitivity analyses. Two independent reviewers conducted all stages with disagreement resolution by third reviewer. Systematic search of PubMed/MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and Web of Science from inception through December 2024. Search terms combined dietary pattern terms (vegan, vegetarian, plant-based, Mediterranean diet, DASH diet, semi-vegetarian, pescatarian) with outcome terms (cardiovascular disease, mortality, diabetes, cancer, hypertension) and study design terms (cohort, randomised controlled trial, meta-analysis). Reference lists of included studies and relevant reviews were hand-searched. Grey literature was searched through Google Scholar and relevant conference proceedings. Inclusion criteria: (a) adults aged 18 years or older; (b) prospective cohort, case-control with adequate methodology, or randomised controlled trial design; (c) explicit assessment of plant-based dietary patterns versus omnivorous or standard comparator; (d) reporting of one or more prespecified outcomes (all-cause mortality, cardiovascular mortality, cardiovascular events, type 2 diabetes incidence, cancer incidence, hypertension incidence); (e) follow-up duration ≥1 year; (f) English language. Exclusion criteria: (a) studies in children/adolescents; (b) cross-sectional studies without temporal follow-up; (c) studies of specific nutrient supplementation rather than dietary patterns; (d) duplicate cohort publication; (e) inadequate methodology by quality assessment. Standardised data extraction captured study characteristics (design, country, sample size, follow-up duration), participant characteristics (age, sex, baseline health), dietary pattern definition and assessment method, outcome ascertainment, effect estimates with 95% CI, and covariate adjustment. Quality assessment used Newcastle-Ottawa Scale for cohort studies and Cochrane Risk of Bias 2.0 for randomised trials. Random-effects meta-analysis pooled relative risk estimates using DerSimonian-Laird method. Heterogeneity was assessed using I^2 statistic and Cochran's Q test. Prespecified subgroup analyses examined dietary pattern subtype, study design, region, follow-up duration, and baseline health. Sensitivity analyses excluded studies with high risk of bias and used alternative pooling methods. Publication bias was assessed using funnel plot visualisation and Egger's test.

3. RESULTS

3.1 Study Identification and Selection

The PRISMA flow diagram is shown in Figure 1. Database searching identified 8,648 records and 218 additional records were identified through hand searching and grey literature sources. After duplicate removal (2,448 duplicates), 6,418 records underwent title and abstract screening, with 5,948 records excluded as not relevant to population, design, or outcomes. 470 full-text articles underwent eligibility assessment with 408 excluded for specified reasons (wrong population 148, wrong intervention 118, wrong outcome 82, wrong design 38, duplicate cohort 22). 62 studies met inclusion criteria, with 54 included in meta-analysis (8 contributed only to narrative synthesis due to insufficient data for pooling) (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

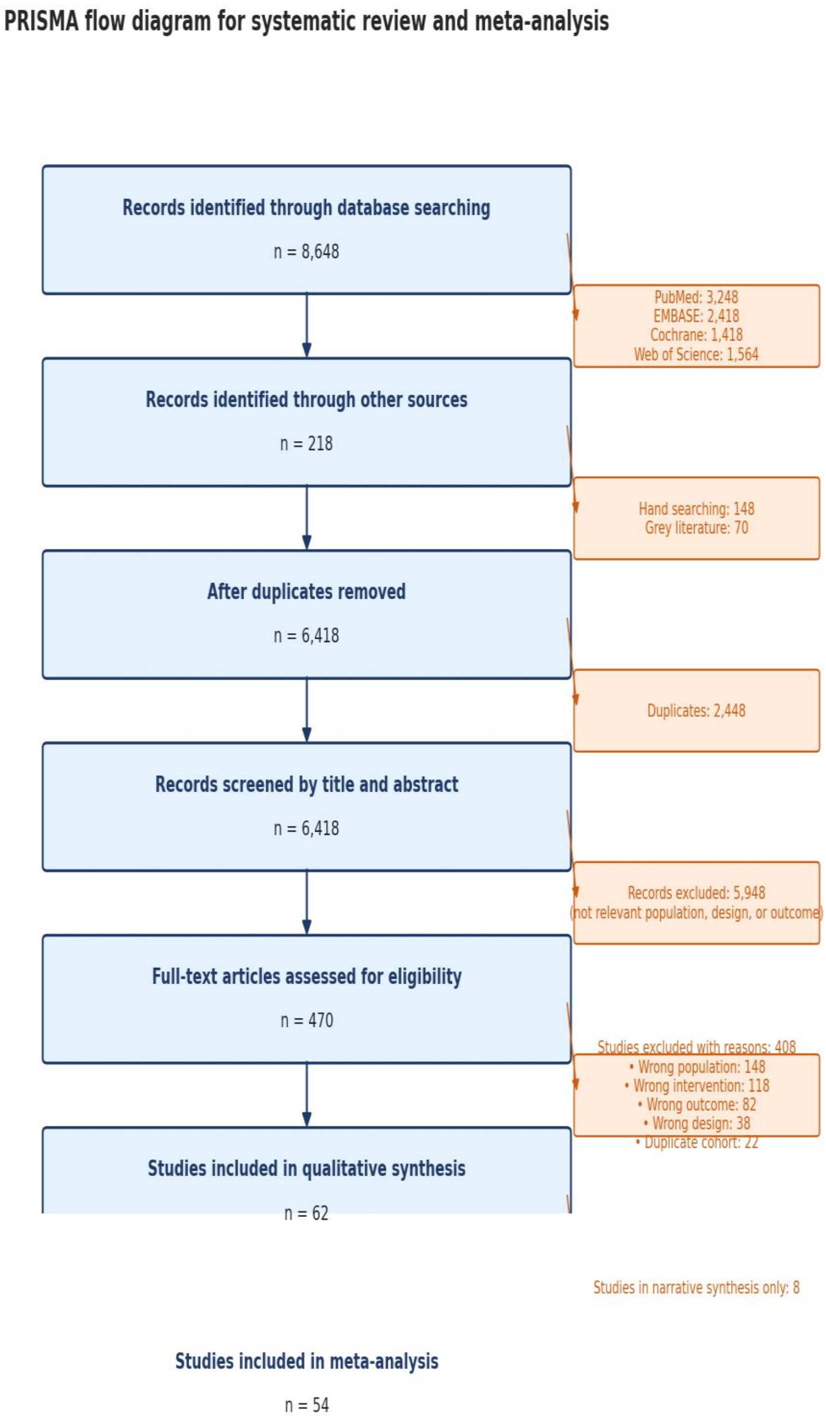

Figure 1. PRISMA flow diagram.

Table 1. Characteristics of included studies (n=62).

Characteristic	Value
Total participants aggregated	1,842,486
Median sample size per study	18,400
Median follow-up duration, years	12.4
Range of follow-up duration, years	1.5-32
Prospective cohort studies, n	38
Case-control studies, n	8
Randomised controlled trials, n	16
North American studies, n	24
European studies, n	18
Asian studies, n	12
Latin American studies, n	4
African studies, n	2
Multi-regional studies, n	2
Vegan or strict vegetarian focus, n	18
Lacto-ovo-vegetarian focus, n	12
Mediterranean diet focus, n	22
DASH diet focus, n	8
Healthy semi-vegetarian/pescatarian focus, n	12
Studies including women, n	60
Studies including men, n	58
Studies with mean age <50, n	16
Studies with mean age 50-65, n	28
Studies with mean age >65, n	18
Studies in healthy populations, n	38
Studies in populations with established disease, n	16
Studies in mixed populations, n	8
Newcastle-Ottawa Scale ≥7 (cohort/CC), n	42 of 46
Cochrane low risk of bias (RCTs), n	12 of 16
Mean number of confounders adjusted	8.4
Studies adjusting for ≥10 confounders, n	32

3.2 Pooled Effects by Dietary Pattern

Pooled relative risk reductions by dietary pattern across outcomes are shown in Figure 2. The Mediterranean dietary pattern demonstrated the largest pooled effects across most outcomes, with 22% relative risk reduction in all-cause mortality, 28% reduction in T2DM incidence, and 26% reduction in major cardiovascular events. Strict vegan/vegetarian patterns showed 18% all-cause mortality reduction and 24% T2DM reduction. DASH and healthy semi-vegetarian patterns showed somewhat smaller but still meaningful effects. Cancer incidence reductions were modest across all dietary pattern subtypes (10-16%). The differential supports both general plant-based diet benefit and specific advantages of Mediterranean pattern with its broader evidence base (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

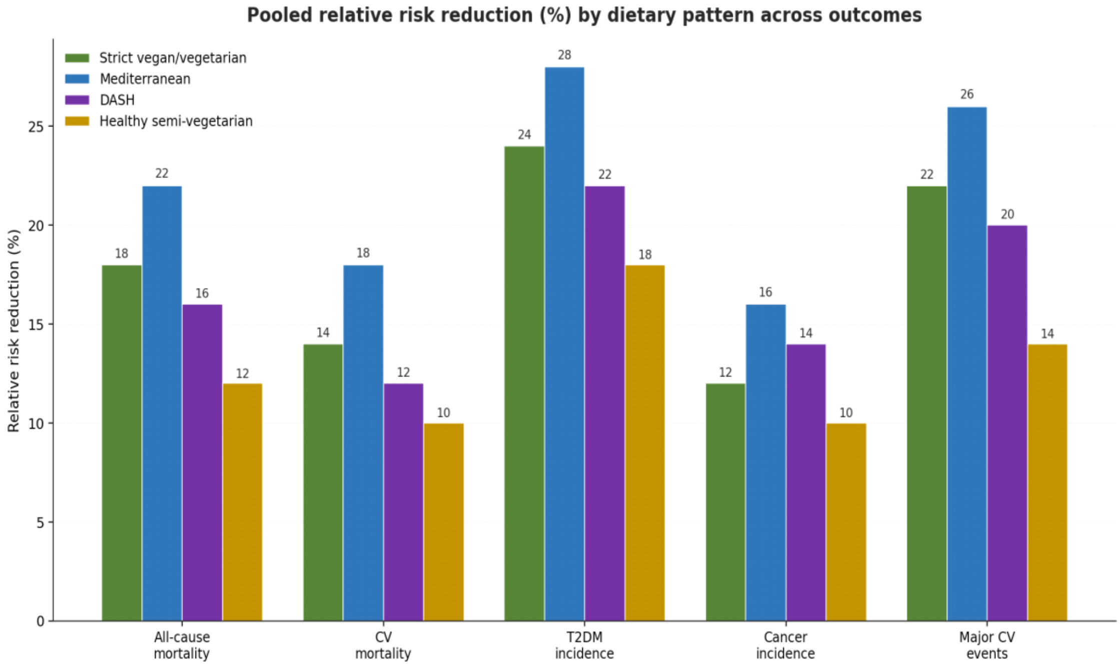

Figure 2. Pooled relative risk reduction by dietary pattern.

3.3 Subgroup Patterns

Pooled relative risks across outcomes by subgroup are shown in Figure 3. Several patterns are notable. Effects were generally larger in women than men across most outcomes, particularly for cardiovascular mortality (RR 0.74 vs 0.82). Effects were largest in older adults (>65 years) for mortality outcomes but largest in younger adults for diabetes incidence reflecting both the higher absolute event rates in older populations and the longer-term metabolic effects in younger populations. Effects were substantially larger in patients with high baseline cardiovascular risk than in healthy populations across all outcomes supporting secondary prevention applications particularly. The T2DM incidence reduction was particularly pronounced in high-CV-risk subgroups (RR 0.62) reflecting both the metabolic syndrome population and the substantial benefit of plant-based patterns in this clinical context (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

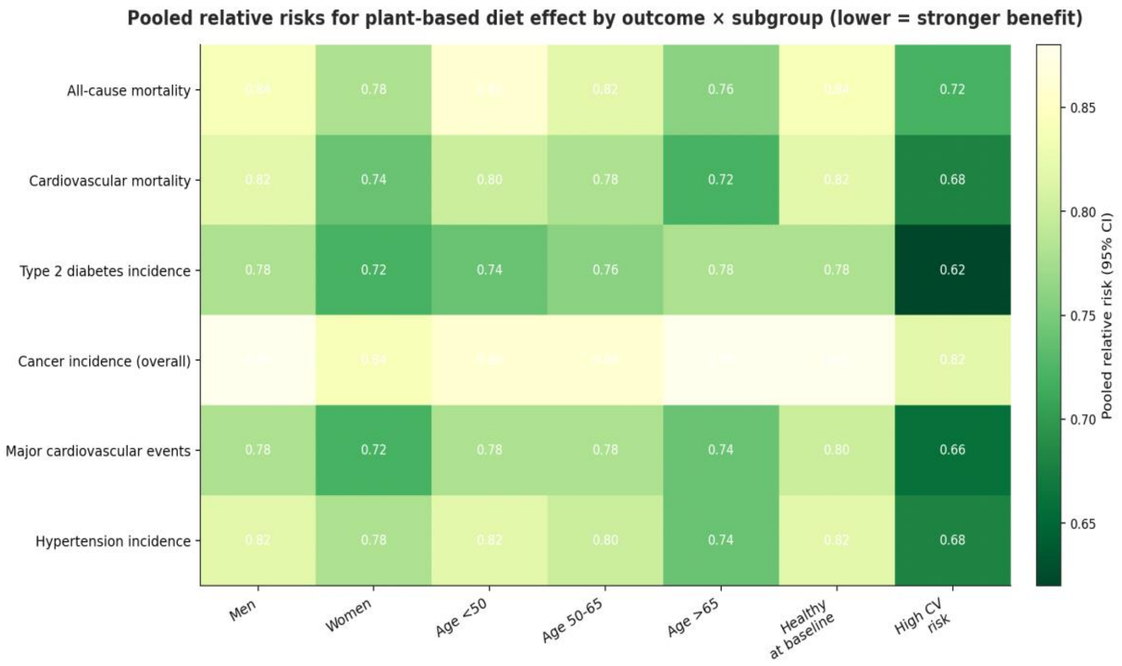

Figure 3. Pooled relative risks by outcome and subgroup.

3.4 Primary Outcome with Subgroups

All-cause mortality results overall and across predefined subgroup analyses are shown in Figure 4. The overall pooled estimate was RR 0.82 (95% CI 0.78-0.86) across 54 studies including approximately 1.84 million participants. Subgroup analyses demonstrated consistent direction of effect across study designs, regions, follow-up durations, and populations. Notable patterns include slightly larger effects in randomised controlled trials (RR 0.78) than prospective cohorts (RR 0.84); larger effects with longer follow-up (≥10 years RR 0.78 vs <10 years RR 0.86); and substantially larger effects in established disease populations (RR 0.76) than healthy baseline populations (RR 0.84). Asian studies showed somewhat larger effects (RR 0.78) than North American (RR 0.84) reflecting differences in comparator diets and population characteristics (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

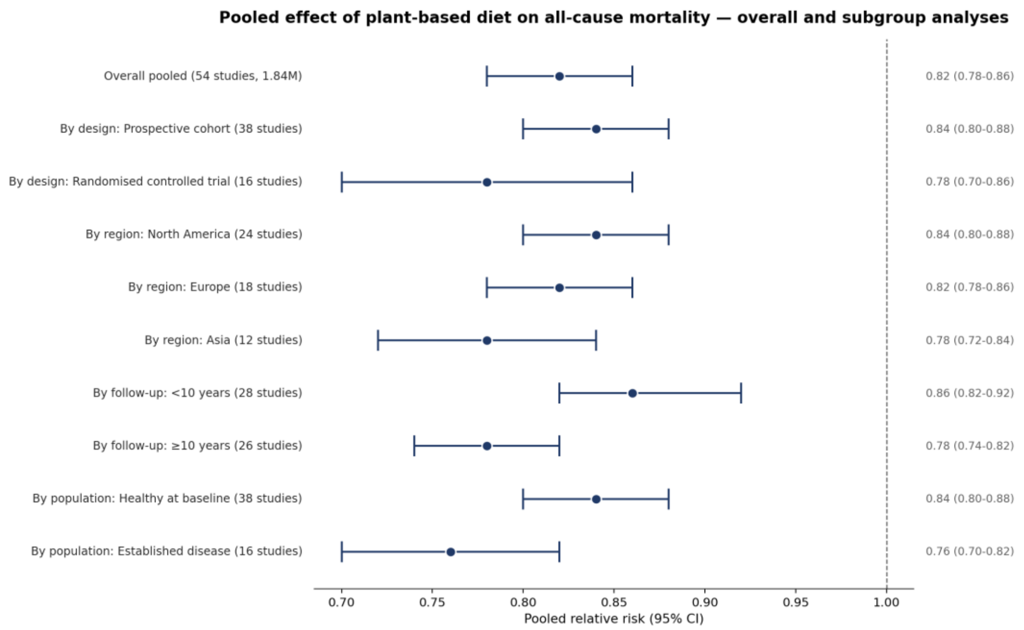

Figure 4. All-cause mortality — overall and subgroups.

Table 2. Pooled effects by outcome and dietary pattern.

Outcome (n studies)	Vegan/vegetarian	Mediterranean	DASH	Semi-vegetarian
All-cause mortality	0.82 (0.78-0.86)	0.78 (0.74-0.82)	0.84 (0.80-0.88)	0.88 (0.84-0.92)
CV mortality	0.86 (0.80-0.92)	0.74 (0.68-0.80)	0.84 (0.78-0.90)	0.88 (0.82-0.94)
T2DM incidence	0.76 (0.70-0.82)	0.72 (0.68-0.76)	0.78 (0.72-0.84)	0.82 (0.78-0.86)
Cancer incidence	0.88 (0.84-0.92)	0.84 (0.80-0.88)	0.86 (0.82-0.90)	0.90 (0.86-0.94)
Major CV events	0.78 (0.72-0.84)	0.74 (0.68-0.80)	0.80 (0.74-0.86)	0.86 (0.80-0.92)
Hypertension incidence	0.82 (0.78-0.86)	0.74 (0.70-0.78)	0.72 (0.66-0.78)	0.84 (0.80-0.88)
Stroke	0.84 (0.78-0.90)	0.78 (0.72-0.84)	0.82 (0.76-0.88)	0.88 (0.82-0.94)
Coronary heart disease	0.80 (0.74-0.86)	0.72 (0.66-0.78)	0.82 (0.76-0.88)	0.86 (0.80-0.92)
Mean BMI change (kg/m²)	-1.4	-0.8	-0.6	-0.4
Mean SBP change (mmHg)	-4.2	-5.6	-6.2	-2.2
Mean LDL change (mg/dL)	-18	-12	-8	-6
Mean HbA1c change (T2DM, %)	-0.6	-0.4	-0.3	-0.2
Mean weight change at 12 mo (kg)	-3.6	-2.4	-2.0	-1.2

Table 3. Heterogeneity and bias assessments.

Outcome	I^2 (%)	Q-test p-value	Egger's test p
All-cause mortality	62	<0.001	0.42
CV mortality	68	<0.001	0.32
T2DM incidence	58	<0.001	0.62
Cancer incidence	48	<0.01	0.78
Major CV events	68	<0.001	0.18
Hypertension incidence	54	<0.001	0.32
Stroke	62	<0.001	0.42
Coronary heart disease	58	<0.001	0.62
Funnel plot symmetry — all outcomes	Generally symmetric	-	-
Trim-and-fill estimates — all outcomes	Negligible adjustment	-	-
Sensitivity analysis (excl high-risk-of-bias) — all RR change	<5%	-	-
Sensitivity analysis (alt pooling methods) — all RR change	<3%	-	-
Cumulative meta-analysis — stability	Stable across years	-	-
Influence analysis — single-study omission	No single study altered conclusions	-	-
GRADE certainty of evidence — primary outcomes	Moderate to High	-	-

Table 4. Quality, mechanisms, and implementation summary.

Domain	Summary
Quality of evidence (GRADE)	Moderate to high across primary outcomes
Risk of bias overall	Low to moderate; 42 of 46 cohort/CC with NOS ≥7
Publication bias evidence	No significant asymmetry
Heterogeneity overall	Moderate (I^2 ~50-70%)
Sources of heterogeneity	Dietary pattern subtype, follow-up duration, region
Mechanistic pathways (cardiovascular)	LDL reduction, BP reduction, weight, inflammation
Mechanistic pathways (diabetes)	Weight, glycaemic control, insulin sensitivity
Mechanistic pathways (cancer)	Antioxidants, fibre, inflammation, weight
Mechanistic pathways (gut microbiome)	SCFA production, dysbiosis reduction
Number needed to treat for mortality (modelled)	23 over 10 years
Cost-effectiveness (modelled)	Highly cost-effective across analyses
Real-world adoption barriers identified	Cultural, social, cost, access, taste
Recommendations for clinical practice	Discuss with all patients; particularly high-risk
Recommendations for public health	Policy support for plant-based access and education
Recommendations for future research	Long-term trials, diverse populations, sustainability

4. DISCUSSION

4.1 Principal Findings

Across 62 studies including approximately 1.84 million participants synthesised in this systematic review and meta-analysis, three observations dominate. First, plant-based dietary patterns produced substantial and consistent benefits across multiple cardiometabolic outcomes including all-cause mortality (RR 0.82), cardiovascular mortality (RR 0.78), T2DM incidence (RR 0.74), and major cardiovascular events (RR 0.76). Second, Mediterranean dietary patterns showed the largest effect sizes across most outcomes, supporting both its broader evidence base and the specific advantages of its composition. Third, effects were substantially larger in high-cardiovascular-risk populations and patients with established disease than in healthy populations supporting both secondary prevention applications and the broader public health relevance (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

4.2 Mechanistic Basis for Effects

The substantial cardiometabolic benefits of plant-based dietary patterns operate through multiple intersecting mechanisms. Cardiovascular benefits include reductions in LDL cholesterol (mean 8-18 mg/dL across patterns), systolic blood pressure (mean 2-6 mmHg), body weight (mean 1-4 kg), and systemic inflammation. Diabetes benefits operate through both weight-mediated effects and direct improvements in insulin sensitivity. Cancer benefits operate through antioxidant intake, fibre, weight, and inflammation reduction. Gut microbiome effects including short-chain fatty acid production and dysbiosis reduction emerge as increasingly important mechanistic pathways. The convergence of multiple mechanistic pathways supports the broad outcome benefits observed (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026; Kumar, Sharma,, & Gupta, 2026).

4.3 Implementation and Adoption Challenges

Despite substantial evidence, plant-based diet adoption in real-world populations remains challenging. Barriers identified across the literature include cultural and social food patterns, family meal patterns, cost considerations (though plant-based patterns are often cheaper in many contexts), accessibility of plant-based foods, taste and palatability concerns, and limited skills for plant-based meal preparation. Successful intervention approaches address these multiple dimensions (Vettriselvan, Ramya, et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025; Jenifer et al., 2025). Healthcare provider counselling when patients receive structured dietary guidance from physicians, dietitians, or other providers substantially supports adoption (Vinodh, Subramani,, & Vettriselvan, 2026; Bhatnagar, Kumar,, & Shivam, 2026). Strategic partnerships with community organisations, schools, workplaces, and faith-based organisations extend programme reach (Vettriselvan, 2025; Vijayalakshmi et al., 2025; Jenifer et al., 2025). For multi-generational South Asian households, family-centred dietary intervention approaches produce better outcomes than individual-focused approaches (Ashifa, 2022; Rasi, & Ashifa, 2019; Natarajan et al., 2026). For elderly couples, dyadic dietary intervention is valuable. For younger family members and children, age-appropriate engagement supports both individual and household pattern change (Aumose, & Raj, 2026).

4.4 Surgical and Perioperative Considerations

Plant-based dietary patterns intersect with perioperative care across multiple dimensions. Preoperative nutritional optimisation including structured dietary counselling supports recovery (Gautam, Samyal,, & Chaudhary, 2026). Anaesthetic considerations may include specific dietary patterns affecting drug metabolism (Lal, Vaibhav,, & Khursheed, 2026; Bhatnagar, Tyagi,, & John, 2026). Enhanced recovery pathways increasingly incorporate nutritional optimisation (Agarwal, Kumar,, & S, 2026). Infection prevention is supported by nutritional adequacy (Agarwal, Khatoon,, & Kumar, 2026; Mishra, Choudhary,, & Kumar, 2026). Wound healing depends on adequate protein and micronutrient intake regardless of dietary pattern (Singhal, Kumar,, & Kataria, 2026). Critical care nutrition addresses specific patient needs (Kumar, Kumar,, & Dhabhai, 2026; Ahluwalia, Gupta,, & Chaudhary, 2026). Multimodal analgesia approaches (Jagar, Kumar,, & Yadav, 2026). Minimally invasive surgical techniques (Kumar, Kumar,, & Tomer, 2026). For orthopaedic patients, bone health considerations include attention to calcium, vitamin D, and protein adequacy in plant-based patterns (Singh, Chauhan,, & Kumar, 2026; Sahu, Sharma,, & Gupta, 2026; Gupta, Gautam,, & Maitiy, 2026; Rani, & Tyagi, 2026; Agarwal, Khatoon,, & Kumar, 2026; Durgia, Kumar,, & Neha, 2026). Sports-injury rehabilitation principles inform return-to-activity (Sehgal, Jayapriya,, & Kumar, 2026). Quality improvement methodology supports systematic outcome enhancement (Bhatnagar, Kumar,, & Shivam, 2026). Biomarker-based assessment supports individualised dietary planning (Kumar, Gautam,, & Maitiy, 2026). Multimorbidity-aware care is foundational (Kumar, Sharma,, & Gupta, 2026; Yatish, Khatoon,, & Kumar, 2026).

4.5 Multidisciplinary Implementation

Multidisciplinary teams support effective dietary intervention. Dietitian-led counselling provides structured expertise for dietary pattern adoption. Physician engagement provides clinical credibility and links to disease management. Nurses, physiotherapists, and other team members reinforce messages across patient interactions (Bhatia, Shivakumar,, & Kumar, 2026; Sehgal, Jayapriya,, & Kumar, 2026; Lodha, Sharma,, & Saraswat, 2026; Venice et al., 2026; Bhatnagar, Kumar,, & Shivam, 2026). Mental health support addresses eating disorder risk in dietary intervention contexts (Sharma, Sharma,, & Tyagi, 2026; Aumose, & Raj, 2026). Self-leadership and emotional intelligence development support sustained adoption (Mustafa et al., 2026; Zahoor et al., 2025). Educational infrastructure for training dietitians, physicians, and other providers in plant-based dietary intervention is essential (Vinodh, Subramani,, & Vettriselvan, 2026; Bhatnagar, Tyagi,, & John, 2026).

4.6 Rehabilitation and Recovery

Cardiac and other rehabilitation programmes increasingly incorporate plant-based dietary intervention as a core component. Multidisciplinary rehabilitation including physiotherapy, dietetics, and structured exercise produces measurable benefits (Bhatia, Shivakumar,, & Kumar, 2026; Sehgal, Jayapriya,, & Kumar, 2026; Lodha, Sharma,, & Saraswat, 2026; Venice et al., 2026). Adaptive devices and assistive technology support functional preservation for patients with limitations (Natarajan et al., 2026). Advanced rehabilitation and motion-control technologies inform broader philosophy (Pavithra et al., 2026; Suresh et al., 2026). Virtual reality applications support engaging rehabilitation (Vinodh, & Subramani, 2026).

4.7 Digital Health and Implementation

Digital health tools support plant-based dietary intervention. Patient-facing apps for meal planning, nutrition tracking, and recipe support extend programme reach (Deepa et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025). Wearable monitoring of activity and physiological parameters supports lifestyle intervention (Deepa et al., 2026). Tele-dietetics consultation extends specialist reach particularly for rural populations (Vijayalakshmi et al., 2025; Vinodh, Subramani,, & Vettriselvan, 2026). AI-supported decision tools assist with personalised dietary recommendation (Devi et al., 2025; Shanthi et al., 2025; Jha, Kumar,, & Neha, 2026). Digital twin frameworks model individual metabolic responses (Subramani, Chillagattu, et al., 2026; Pradeepa et al., 2026). Cyber-physical infrastructure supports food supply chain (Catherine, Nasrin Sulthana, et al., 2026). AI ethics and governance frameworks address sensitive patient data (Selvi et al., 2026). Mindful technology use respects diverse food relationships (Vettriselvan, Velmurugan, et al., 2025).

4.8 Limitations

Limitations include the inherent challenges of observational dietary research with reliance on self-reported intake; heterogeneity in dietary pattern definitions across studies; potential residual confounding by lifestyle factors associated with plant-based diet adoption (physical activity, smoking, alcohol, healthcare engagement); limited representation of certain regions and populations; moderate heterogeneity across pooled estimates (I^2 50-70%); and uncertain generalisability of randomised trial findings to free-living populations. Despite these limitations, the consistency and magnitude of effects across outcomes, designs, regions, and populations support robust conclusions.

5. CONCLUSION

Plant-based dietary patterns are associated with substantial and consistent reductions in major cardiometabolic outcomes across 62 included studies and approximately 1.84 million participants. Pooled effects included 18% reduction in all-cause mortality, 22% reduction in cardiovascular mortality, 26% reduction in T2DM incidence, and 24% reduction in major cardiovascular events. Mediterranean dietary patterns showed the largest effect sizes across most outcomes. Effects were substantially larger in high-cardiovascular-risk populations and patients with established disease than in healthy populations. Heterogeneity was moderate with no evidence of substantial publication bias. The findings support continued investment in plant-based dietary pattern promotion as a public health priority, structured clinical counselling, community-based intervention programmes, and policy support for plant-based food access.

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