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Original Article

Associations between plant-based dietary patterns and risks of cognitive impairment and dementia: A systematic review and dose-response meta-analysis

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ABSTRACT

Background: Evidence remains inconclusive regarding plant-based diets preventing cognitive impairment and dementia, as certain plant-based foods, including refined carbohydrates, sweets, sugar-sweetened beverages, and trans fats, may increase dementia risk.
Objectives: To quantitatively synthesize prospective cohort studies on associations between adherence to plant-based diets and the risks of cognitive impairment and dementia.
Design: Systematic review and meta-analysis. This study adhered to the PRISMA guidelines and was registered on PROSPERO (No: CRD42024501334).
Setting: Studies published until December 2025 were systematically identified using AgeLine, CINAHL, Embase, MEDLINE, PsycINFO, Scopus, and Web of Science.
Participants: The study population comprised adults aged ≥ 20 years with no cognitive impairment at baseline.
Intervention: Studies were enrolled if the participants (1) assessed dietary patterns characterized by higher plant-based food consumption and decreased or ceased consumption of animal-based foods or (2) used established dietary indices, including overall plant-based diet index (PDI), healthful plant-based diet index (hPDI), and unhealthful plant-based diet index (uPDI).
Measurements: Data extraction, risk of bias assessment, and the GRADE approach for assessing certainty of evidence were performed independently by three reviewers. A random-effects model with restricted maximum

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likelihood was used to calculate pooled risk ratios and 95% confidence intervals. The dose-response meta-analysis used two-stage dose-response regression.
Results: The meta-analysis based on seven studies (number of participants: 221,380; number of cases of incident cognitive impairment and dementia: 5668) indicated that participants with greater adherence to plant-based diets had significantly lower risks of cognitive impairment and dementia (pooled risk ratio, 0.74; 95% confidence interval, 0.56–0.97; $I^2 = 92.3\%$) than those with lower adherence. Dose-response relationships modeled using restricted cubic splines indicated that overall PDI and hPDI were negatively associated with risks of cognitive impairment and dementia, whereas uPDI was significantly positively associated with these risks.
Conclusions: This meta-analysis suggests that adherence to plant-based diets, particularly those rich in healthful plant foods, may be associated with a lower risk of cognitive impairment and dementia. However, given the residual heterogeneity and the inherent limitations of observational study designs, large randomised controlled trials are warranted to establish causality.

1. Introduction

Cognitive impairment and dementia represent major global health challenges, with annual costs of approximately US$1 trillion worldwide [1]. Various dietary patterns have been proven to be associated with the prevention of cognitive impairment and dementia, such as the Mediterranean [2,3] and Nordic [4] diets.

Plant-based diets, which emphasise plant-derived foods with simultaneously reduced or ceased consumption of animal products, have gained considerable attention in recent years for their potential to prevent cognitive impairment and dementia [5–7]. The suggested protective mechanisms of plant-based diets against cognitive impairment involve various classes of bioactive compounds that support metabolic and vascular health through anti-inflammatory pathways [8–10]. However, these diets may exclude certain animal products, such as yogurt and fish, that are potentially beneficial for preventing neurocognitive diseases [11,12]. Moreover, not all plant-based diets confer equivalent health benefits. While some plant foods (whole grains, fruits, vegetables, nuts, and legumes) may be protective, others (refined grains, sugar-sweetened beverages, and sweets) may be linked to a higher dementia risk [13–15]. Satija et al. distinguished healthful from unhealthful plant-based dietary patterns to address this heterogeneity [16]. Given the varying effects of plant-based foods, the differential effects of plant-based diets on the risks of cognitive impairment and dementia remain limited and inconclusive [5,7,17–19].

To address this knowledge gap, a systematic review and meta-analysis of prospective studies was conducted to investigate the association between plant-based diets and the risks of cognitive impairment and dementia. Furthermore, the dose-response relationship between adherence to plant-based diets and the risks of cognitive impairment and dementia was evaluated.

2. Methods

This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [20]. The study protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) registry (registration number: CRD42024501334). Ethical approval was obtained from the Institutional Review Board of Dalin Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Taiwan (approval number: B11403022).

2.1. Data sources and searches

AgeLine, CINAHL, Embase, MEDLINE, PsycINFO, Scopus, and Web of Science databases were comprehensively searched without language restrictions for relevant articles published from database inception to December 2025.

2.2. Study selection

To ensure a systematic approach, the population, exposure, comparator, and outcomes (PECO) framework was adopted. The study population comprised adults aged $\geq$ 20 years with no cognitive impairment at baseline. The exposure was adherence to plant-based diets, defined as a higher consumption of plant-based foods with a simultaneous lower consumption or exclusion of animal-based foods, including vegetarian or vegan diets. For studies that classified adherence to plant-based diets using overall plant-based diet indices (PDIs), healthful plant-based diet indices (hPDIs), or unhealthful plant-based diet indices (uPDIs), the association with overall PDI was included in the pooled risk estimate [16]. For studies that used dietary indices, a risk estimate comparing the highest and lowest quantiles was used to represent the best and poorest adherence, respectively. For studies that compared priori-defined dietary patterns, the study estimates comparing diets that were most restrictive of animal-based foods (e.g. vegan diets) with those that were least restrictive (e.g. omnivorous diets) were considered. The outcome was the incidence of cognitive impairment (e.g. minimal cognitive impairment, dementia) during the follow-up period, as assessed in the enrolled studies based on relevant International Classification of Diseases (ICD) codes or the results of cognitive screening tests. Moreover, the reference lists of the retrieved articles were searched to identify additional studies. A detailed search strategy (eTable 1 in the Supplement) was developed under the guidance of an expert librarian.

The inclusion criteria were as follows: (1) having a cohort design, (2) including a comparator group, and (3) reporting risk estimates (e.g. odds ratio [OR], relative risk, hazard ratio [HR] with a corresponding 95 % confidence interval [CI]) or providing sufficient raw data for their calculation. The exclusion criteria were (1) focusing on pescatarians (adding fish and seafood to a vegetarian diet), (2) having a cross-sectional design (excluded to avoid reverse causation), (3) being irrelevant to the present study's objective, (4) involving paediatric populations, (5) focusing on animal models, and (6) being published as review articles, case reports, editorials, or letters.

2.3. Data extraction and quality assessment

The titles and abstracts were independently screened by three reviewers (C.-Y.W., H.L., and H.M.). Discrepancies were resolved either through discussion until consensus or through adjudication by another reviewer (T.-Y.T.). The extracted data included study characteristics (e.g. author names, publication year, and country), participant characteristics (e.g. age and diet), diet-scoring systems, comorbidities, outcome categories, and effect estimates with corresponding measures of uncertainty. Study quality was assessed using the Newcastle-Ottawa Scale (NOS) [21]. The certainty of evidence was evaluated using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) methodology [22].

2.4. Data synthesis and analysis

Data analysis was performed by calculating a pooled risk ratio (RR) using a random-effects meta-analysis with the restricted maximum

likelihood (REML) approach of HR, relative risk, OR from each study with a low incidence (<10 %) of cognitive outcomes [23,24]. The risk estimate from each study that had the highest level of statistical adjustment was included. Heterogeneity was evaluated using the Cochran Q-test and I^2 statistic [25,26]. Sensitivity analyses were conducted to assess the robustness of the overall findings. These included the evaluation of the impact of different levels of risk of bias, types of diet scoring systems, and outcome measures. Publication bias was assessed visually using Egger's tests [27].

In a subset of studies that defined adherence to plant-based dietary patterns using PDI, we performed a dose-response meta-analysis to assess potential nonlinearity. We conducted a two-stage random-effects dose-response meta-analysis with the REML approach to summarize the relationship between treatment dose and outcome [28,29]. Nonlinearity was modelled using 2-stage restricted cubic splines, with three knots placed at the 10th, 50th, and 90th percentiles of the exposure distribution; the REML approach was used for model fitting [30]. Wald tests were used for spline coefficients to assess potential nonlinearity.

The dose value was defined as the median plant-based diet index score for each exposure category within the study. If the median was not reported, the midpoint of the category, calculated as the average of the lower and upper boundaries, was used. The components used to construct plant-based diet indices may be slightly modified depending on the study population or, in some cases, researchers may develop their own scoring systems. Therefore, similar scores may not reflect equivalent degrees of adherence to plant-based diets across studies. To address this issue and enhance comparability, all scores were rescaled proportionally to a standardised range of 20–100. The original scores were converted according to a standardised scale. If person-years of follow-up by dose category were not reported, we estimated the person-years for each dose category by assuming that the mean follow-up time within each dose category was equal to the overall mean follow-up time reported in the enrolled studies.

All statistical analyses were conducted using R software (version 4.4.1; Foundation for Statistical Computing, Vienna, Austria). The meta-analyses were performed using the 'metagen' function from the *meta* package, while dose-response meta-analyses were conducted using the *dosresmeta* package. Restricted cubic spine models were implemented using the *rcs* package. A two-sided P value of <0.05 was considered statistically significant.

3. Results

3.1. Characteristics of the included studies

Fig. 1 shows the literature search and study selection process, and the exclusion reasons for studies after comprehensive assessment are reported in eTable 2 in the Supplement. Seven prospective cohort studies [17–19,31–34] were included in the final quantitative synthesis, five of which had a low risk of bias (eFig. 1 in the Supplement). Table 1 shows the characteristics of the studies included in this meta-analysis. Collectively, these studies comprised 221 380 participants, with 5668 cases of incident cognitive impairment or dementia. The median follow-up duration was 10 years (range, 5–30 years). The median age of the participants at baseline was 63.9 years (range 53.0–79.6 years). Among the included studies, four were conducted in Asia, two in Europe, and one in North America. Regarding dietary assessment methods, four studies [17–19,32] assessed adherence to plant-based diets using PDI, one study [33] evaluated adherence to plant-based diets using a food frequency questionnaire, and two studies [31,34] compared individuals following a vegetarian or vegan diet with non-vegetarians. In five of the seven included studies [18,19,31,33], incident cases of cognitive impairment and dementia were confirmed using validated questionnaires assessing symptoms or medication use. The remaining two studies [17,34] relied on ICD codes for case identification (Table 2). Four studies addressed potential reverse causation through lag analyses, excluding participants who developed cognitive impairment during the early follow-up periods. Exclusion windows ranged from 1 year (Giem et al.) [31] to 5 years (de Crom et al.) [18], with intermediate lag periods of 2 years (Tsai et al.) [34] and 3 years (Wu et al.) [17] (Table 2). Statistical adjustments varied across the included studies, with most adjusting for dementia risk factors, such as age, sex, cerebrovascular disease, education level, physical activity, and history of alcohol consumption and smoking (eTable 3 in the Supplement).

Table 1
Overview of the included prospective cohort studies.

Study	Country	Database	Mean Age at Baseline	Female (%)	Sample Size	Event Number	Follow-Up Duration (yrs)	Dietary Assessment	Exposure vs. Comparator
Giem et al., 1993 [31]	USA	California residents	65.0	NA	204	20	30.0	Dietary pattern*	Long-term vegan vs. nonvegetarian
Wu et al., 2019 [32]	Singapore	Singapore Chinese Health Study	53.0	59.2	16 948	2443	19.7	PDI, hPDI	PDI and hPDI, comparing extreme quantiles
Shang et al., 2021 [33]	China	China Health and Nutrition Survey	63.9	50.8	2307	364	7.0	FFQ	Beans and mushroom dietary pattern, comparing extreme quantiles
Tsai et al., 2022 [34]	Taiwan	Tzu Chi Vegetarian Study	57.9	63.1	5710	121	9.0	Dietary pattern*	Vegetarian vs. nonvegetarian
Zhu et al., 2022 [19]	China	Chinese Longitudinal Healthy Longevity Survey	79.6	46.3	6136	NA	10.0	PDI, hPDI, uPDI	PDI, hPDI, and hPDI, comparing extreme quantiles
de Crom et al., 2023 [18]	Netherlands	population-based Rotterdam Study	64.1	58.0	9543	1472	14.5	PDI, hPDI, uPDI	PDI, hPDI, and hPDI, comparing extreme quantiles
Wu et al., 2023 [17]	UK	UK Biobank cohort study	56.5	55.2	180 532	1248	5.0	PDI, hPDI, uPDI	PDI, hPDI, and hPDI, comparing extreme quantiles

FFQ = food frequency questionnaire; hPDI = healthful plant-based diet index; PDI = plant-based diet index; UK= United Kingdom; uPDI = unhealthful plant-based diet index; USA = United States of America.

* Dietary pattern: vegan, vegetarian (lacto- or lacto-ovo-vegetarian).

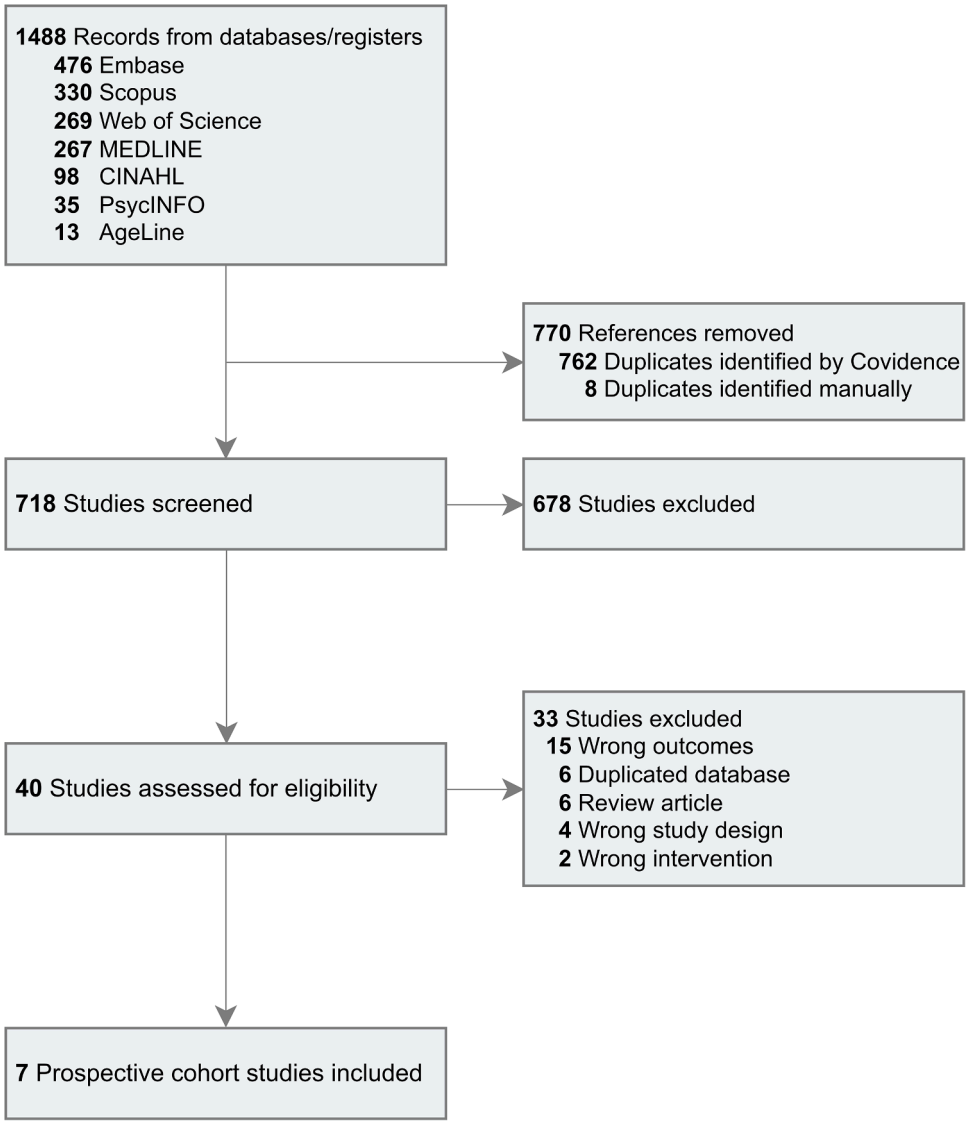

Fig. 1. Flow diagram of the literature search and included studies.

3.2. Associations of adherence to plant-based diets with the risks of cognitive impairment and dementia

Greater adherence to plant-based diets was associated with a lower risk of cognitive impairment and dementia (Fig. 2). The random-effects meta-analysis yielded a pooled RR of 0.74 (95 % CI, 0.56–0.97), with high heterogeneity among studies ($I^2 = 92.3$ %, $P < 0.01$). Egger's test revealed no evidence of publication bias ($P = 0.95$; eFig. 2 in the Supplement), however, with only seven included studies, the statistical power of this test is limited [35]. The results of the sensitivity analyses of studies with a low risk of bias, those using various scoring systems, and those using different outcome assessment methods are presented in eTable 4 in the Supplement. The certainty of evidence for the association between greater adherence to plant-based diets and lower risks of cognitive impairment and dementia was low (eTable 5 in the Supplement).

3.3. Results of subgroup analyses and meta-regression

eTable 6 in the Supplement presents the results of the subgroup analyses based on study characteristics, participant characteristics, dietary pattern, and outcome categories. Baseline age likely contributed to the heterogeneity in the study findings. Among participants aged ≥ 65 years at baseline, the random-effects pooled RR was 0.45 (95 % CI, 0.39–0.52, $I^2 = 0$ %), suggesting strong associations between adherence to plant-based diets and the risks of cognitive impairment and dementia. In contrast, among participants aged < 65 years at baseline, the pooled RR was 0.90 (95 % CI, 0.77–1.04, $I^2 = 57.5$ %). Meta-regression analysis revealed that the participants' mean age at baseline explained 45.7 % of the total variance across the studies. Results stratified by geographical region explained 48.5 % of the total variance. Notably, no heterogeneity was observed in dietary patterns or diet classification methods.

3.4. Results of dose-response meta-analysis

A dose-response meta-analysis was performed using data from four studies [17–19,32] that assessed adherence to plant-based diets using similar plant-based diet indices (PDI, hPDI, and uPDI). These studies accounted for 96.3 % (213 159 participants) of all participants and 91.1 % (5163 patients) of all cognitive impairment or dementia cases. Index values ranged from 34.0 to 58.0 for overall PDI, 35.6 to 61.0 for hPDI, and 37.2 to 65.0 for uPDI, with higher values indicating greater adherence to the respective dietary pattern. The detailed plant-based dietary index components across studies are presented in eTable 7 in the supplement. Minor variations in diet assessment methods across the studies necessitated a proportional transformation of index values to a

Table 2
Overview of the included prospective cohort studies.

Study	Outcome Category	Outcome Diagnostic Tool	Lag-period exclusion of early incident events
Giem et al., 1993 [31]	Dementia	Chart review	Exclude participants with a history of cognitive impairment before enrollment or within 1 year after study start
Wu et al., 2019 [32]	Cognitive impairment	Singapore-modified MMSE with education-specific cut-off points	NA
Shang et al., 2021 [33]	Cognitive decline	Telephone Interview for Cognitive Status (modified version)	NA
Tsai et al., 2022 [34]	Cognitive impairment	ICD-9-CM codes	Exclude participants with a history of cognitive impairment before enrollment or within 2 years after study start
Zhu et al., 2022 [19]	Cognitive impairment	MMSE	NA
de Crom et al., 2023 [18]	Dementia	DSM-III	Exclude participants in the first 5 years of follow-up in sensitivity analysis
Wu et al., 2023 [17]	Dementia	ICD-10 codes	Excluded those diagnosed with depression or dementia in the first 3 years of follow-up

DSM = Diagnostic and Statistical Manual of Mental Disorders; ICD = International Classification of Diseases; MCI = mild cognitive impairment; MMSE = Mini-Mental State Examination; NA=Not available.

standardised range of 20–100 (eTable 8 in the Supplement), with study-specific distributions presented in eFig. 3 in the Supplement section. The dose-response meta-analysis revealed nonlinear negative associations between adherence to plant-based diets and the risks of cognitive impairment and dementia; this negative association became non-significant at very high consumption levels (Fig. 3A). When adherence was assessed using the hPDI, significant negative associations were observed, indicating that greater adherence to a healthy plant-based diet was associated with a lower risk of cognitive impairment and dementia (Fig. 3B). Conversely, uPDI showed significant positive associations, suggesting that greater adherence to an unhealthy plant-based diet was associated with higher risks of cognitive impairment and dementia (Fig. 3C). The Wald test revealed potential nonlinearity for all associations.

4. Discussion

To the best of our knowledge, this study represents the most comprehensive quantitative assessment of the association between adherence to plant-based diets and the risk of cognitive impairment and dementia. The results of this meta-analysis of prospective cohort studies indicate that greater adherence to plant-based diets is associated with lower risks of cognitive impairment and dementia. The dose-response analysis revealed trends toward negative associations between PDI and the risk of cognitive impairment and dementia, with significant inverse associations found for hPDI. Conversely, higher uPDI values were associated with higher cognitive impairment and dementia risk. Our dose-response meta-analysis also integrated dose ranges and cutoff points from different studies, providing a higher granularity of the curves describing the associations of PDI, hPDI, and uPDI with the risks of cognitive impairment and dementia.

Previous systematic reviews have demonstrated the positive effects of plant-based diets on the prevention of cognitive impairment and dementia. However, these studies did not provide quantitative summary estimates [36–38]. Meta-analyses from 2021 [5] and 2025 [7] demonstrated that compared with omnivorous diets, vegetarian diets showed no associations with lower risk of cognitive impairment; however, both meta-analyses aggregated fewer than three studies. A meta-analysis from 2025 [7] demonstrated an association between healthy plant-based diets and a lower risk of cognitive impairment, but in addition to the abovementioned drawbacks, it incorporated cross-sectional studies. Furthermore, it did not present dose-response relationships for plant-based diets. To enhance causal inference, only prospective cohort studies were included to investigate the association between plant-based diets and cognitive impairment. Additionally, we presented the dose-response effects for overall plant-based diets, healthy plant-based diets, and unhealthy plant-based diets.

In our meta-analysis, higher adherence to plant-based diets was associated with a lower risk of cognitive impairment. However, different reference groups across studies may have contributed to heterogeneity. When the reference groups were more oriented toward heavy meat

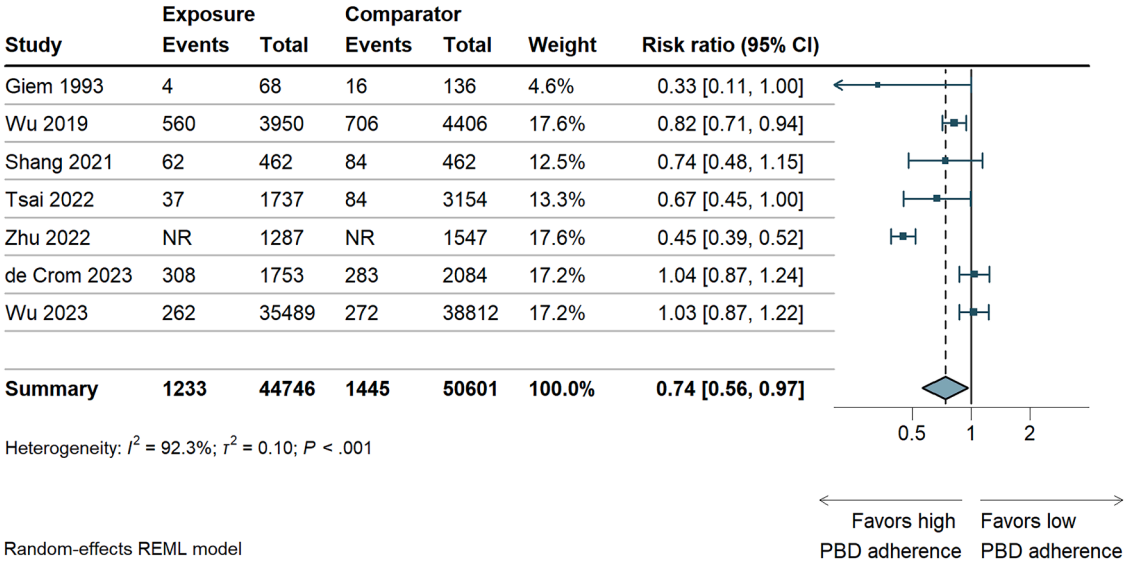

Fig. 2. Forest plot of studies examining the association between plant-based diets and the risks of cognitive impairment and dementia. CI = confidence interval; NR = not reported; PBD = plant-based diet; REML = restricted maximum likelihood.

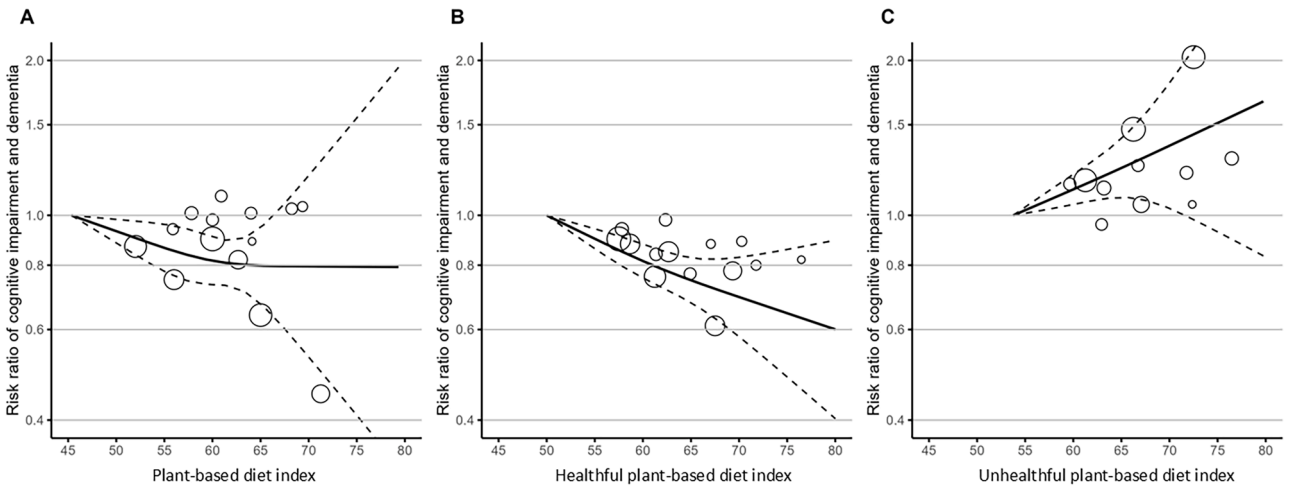

Fig. 3. Restricted cubic splines of the association between plant-based diets and the risks of cognitive impairment and dementia. Association among the four studies [17–19,32] that used the plant-based diet index (A), healthful plant-based diet index (B), and unhealthful plant-based diet index (C). Solid lines indicate the restricted cubic splines of the association between dietary indices and the risks of cognitive impairment and dementia, whereas dashed lines represent 95 % confidence intervals. Circles represent the reported risk ratios of cognitive impairment and dementia at different dietary index values in each study. Circle size is proportional to study weight.

consumption, the positive association between plant-based diets and dementia risk became more pronounced. For instance, Giem et al. (1993) [31] used "heavy meat eaters" as the reference group, and their participants with long-term plant-based diets demonstrated a substantial association with lower dementia risk (HR = 0.33). Conversely, Tsai et al. (2022) [34] used volunteers from a Buddhist foundation as the reference group. Despite being non-vegetarian, these participants maintained relatively healthier dietary patterns owing to their foundation affiliation, resulting in a modest effect size.

Subgroup analyses and meta-regression also identified that heterogeneity was mainly attributable to participants' mean baseline age and geographical region, explaining 45.7 % and 48.5 % of the among-study heterogeneity, respectively. Although current research lacks sufficient age-stratified comparisons to determine whether older adults derive greater benefits from plant-based diets than younger adults, most available evidence suggests that this dietary pattern can reduce the risk of chronic diseases, including stroke, cardiovascular disease, and diabetes, as well as all-cause mortality among older adults [39]. For older adults, plant-based diets rich in antioxidant and anti-inflammatory compounds may support muscle mass maintenance while meeting protein requirements, helping preserve normal physical function. These dietary patterns are also potentially associated with a lower risk of cognitive decline [40]. Regarding geographical variations, the observed differences by geographic region may reflect variations in dietary composition, cooking methods, food processing techniques, and eating behaviours. Asian plant-based diets traditionally emphasise soy products, fermented foods, and rice prepared by steaming or stir-frying, whereas Western plant-based diets typically feature legumes, nuts, and whole grains prepared using different methods. Notably, Western populations tend to consume higher proportions of ultra-processed plant foods compared with traditional Asian dietary patterns that prioritise minimally processed whole foods, a distinction consistent with our finding that unhealthful plant-based diets were associated with increased cognitive impairment risk. In addition, previous research has suggested that ethnic differences in insulin sensitivity and plant-based dietary patterns may explain the differential effects of plant-based diets on cardiometabolic outcomes between Asian and Western populations [41–43]. However, given that the current evidence is limited and inconclusive, further studies are required to confirm these patterns.

Our meta-analysis identified a dose-response relationship between PDI and the risks of cognitive impairment and dementia. For clinical interpretation, the highest PDI scores reflected the greatest plant-based and lowest animal food consumption, the lowest PDI scores reflected the lowest plant-based and greatest animal food consumption, and intermediate scores reflected the high intake of both food groups. In our study, the dose-response relationship between adherence to plant-based diets and dementia risk was nonlinear. Increased consumption of plant-based foods may be linked to lower dementia risk; however, this potential protective association plateaued at intermediate scores and became non-significant dose response relationship at very high PDI scores (Fig. 3A). This nonlinear relationship may be attributable to the uniform use of PDI across the included studies to measure plant diet adherence. Although the studies used the same PDI, the varying compositions of plant-based diets affected their associations with cognitive impairment and dementia risk. Specifically, some studies reported that individuals consuming large quantities of plant-based foods may also consume more unhealthful plant-based foods, which may diminish the overall protective effects against cognitive impairment. These findings align with those of previous studies. The studies by Wu et al. (2023) [17] and de Crom et al. (2023) [18] demonstrated that higher adherence to plant-based diets according to the PDI was not associated with lower dementia risk. However, both studies included Western participants, suggesting that plant-based diets in these populations may correlate with a higher average intake of unhealthful plant foods, including soft drinks and sweets [43]. The association trends between PDI and dementia risk in both studies paralleled those observed for unhealthful plant-based diets, supporting this hypothesis. Conversely, Wu et al. (2019) [32] concluded that plant-based diets were associated with lower dementia risk. The association trends with dementia risk were similar for PDI and hPDI, possibly indicating that their study participants with greater adherence to plant-based diets also maintained a higher intake of healthful plant-based foods. These observations are similar to our dose-response meta-analysis results, demonstrating that hPDI values were significantly associated with lower risks of cognitive impairment and dementia in a dose-response relationship. In contrast, our study found that uPDI values were significantly and dose-dependently associated with a higher risk of cognitive impairment and dementia. To illustrate the clinical implications, greater consumption of healthful plant foods combined with lower intake of both animal foods and unhealthful plant foods was significantly associated with lower risks of cognitive impairment and dementia in a dose-response relationship. The converse pattern, characterised by greater consumption of unhealthful plant foods combined with lower intake of both healthful plant foods and animal foods, was associated with dose-dependent higher risks of

these cognitive outcomes.

Our findings also support the current dietary guidelines for cognitive health. The results align with the 2025–2030 Dietary Guidelines for Americans, which emphasize limiting highly processed foods, sugar-sweetened beverages, and refined carbohydrates, while prioritizing whole plant foods such as vegetables, fruits, whole grains, nuts, and seeds [44,45]. Several mechanisms may explain the associations between different plant-based dietary patterns and the risks of cognitive impairment and dementia. Healthful plant-based diets, rich in polyphenols, antioxidants, unsaturated fatty acids, and micronutrients, reduce oxidative stress and neuroinflammation, enhance endothelial function, and improve lipid metabolism, processes implicated in cognitive decline pathogenesis, particularly in older adults [46–48]. Healthful plant-based foods contain high concentrations of compounds such as fibre, magnesium, iron, folic acid, and vitamins B1, C, and E that collectively reduce inflammation and modify gut microbiome composition, ultimately being associated with lower dementia risk [36,38], and lower prevalence of dementia-associated risk factors, including hypertension, diabetes, obesity, cardiovascular disease, and stroke [49–54]. Conversely, unhealthful plant-based diets rich in refined grains and sugar-sweetened beverages impair neuronal function through insulin resistance, oxidative stress from disrupted fat metabolism, and increased inflammation, thereby elevating the risk of cognitive impairment [13,14].

4.1. Strengths and limitations

A key strength of this meta-analysis is the systematic, comprehensive assessment of prospective cohort studies and their dose-response relationships between adherence to plant-based diets and the risks of cognitive impairment and dementia. However, this study has several limitations. First, this meta-analysis included only studies conducted in high- and middle-income countries, raising concerns about the generalisability of the findings to populations in low-income countries. Notably, most studies included in the dose-response analysis involved Asian populations; thus, caution should be exercised when extrapolating the results to other demographic groups. Second, as with all cohort studies, this meta-analysis was inherently susceptible to selection bias and unmeasured confounding effects. Survey responses regarding diet were also highly subject to social desirability bias, which may have affected the results. Third, dietary exposure was assessed using self-reported food frequency questionnaires, which likely led to differential misclassifications. This problem is particularly relevant because most studies did not include repeated dietary assessments. These biases tend to weaken associations toward the null, potentially resulting in an underestimation of the true effect. Fourth, although greater adherence to plant-based diets was found to be associated with lower risks of cognitive impairment and dementia, and geographical region and participants' mean age at baseline explained the heterogeneity to some extent, some residual heterogeneity remained unexplored. Fifth, pooling risk measures from different follow-up periods may present potential challenges. Generally, HR, RR, and OR can be pooled from studies with low incidence rates ($< 10\,\%$); however, the results should be interpreted with caution because of the inherent limitations of pooling different risk measures [23,24]. Sixth, the study pooled cognitive impairment, cognitive decline, and dementia as a single composite outcome, with outcomes assessed using heterogeneous methods, including questionnaires, MMSE, ICD codes, and DSM criteria. While sensitivity analysis showed that this did not significantly contribute to heterogeneity, caution is warranted when interpreting results based on pooled heterogeneous outcome definitions. Seventh, only four of the seven studies performed lag analyses, excluding early events. Reverse causation from preclinical cognitive decline influencing dietary patterns cannot be excluded from the pooled estimates. Eighth, given that the dose-response analysis was based on only four studies and required the transformation of dietary index scores to a standardised scale, these findings should be interpreted with caution. Finally, this meta-analysis used aggregate data from individual studies rather than individual-level data, which limits the direct applicability of the conclusions to individual cases.

4.2. Implications and conclusions

In conclusion, this systematic review and meta-analysis suggests that greater adherence to plant-based diets, particularly those rich in healthy plant-based foods, is associated with lower risks of cognitive impairment and dementia. Increasing the intake of healthy plant-based foods while minimising unhealthy plant-based foods within daily energy requirements may be associated with a lower risk of dementia. Although these results suggest a potential link between plant-based dietary approaches and a lower risk of dementia, residual heterogeneity and low certainty of evidence (GRADE assessment) necessitate validation through large-scale randomised controlled trials.

Declaration of the use of generative AI and AI-assisted technologies

Generative AI was used only for grammar checking and sentence correction.

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Additional information

The primary data of the present study were presented orally at the 2024 WONCA APR Conference in Singapore.

CRediT authorship contribution statement

Jui-Hsiu Tsai: Writing – review & editing, Writing – original draft, Validation, Resources, Project administration. **Tou-Yuan Tsai:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Hua Li:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Cheng-Yu Wang:** Writing – review & editing, Data curation. **Yu-Kang Tu:** Validation, Supervision. **Huei-Kai Huang:** Validation, Supervision. **Hsin Ma:** Investigation, Data curation. **Yu-Lin Hsieh:** Investigation, Data curation. **Chuan-Sheng Hung:** Visualization. **Shih-Chieh Shao:** Validation, Supervision. **Eric H Chou:** Validation, Investigation. **Chin-Lon Lin:** Supervision. **Ming-Nan Lin:** Writing – review & editing, Supervision, Resources, Project administration, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjpad.2026.100521.

References

[1] Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. The Lancet 2020;396:413–46.
[2] Valls-Pedret C, Sala-Vila A, Serra-Mir M, Corella D, de la Torre R, MÁ Martínez-González, et al. Mediterranean diet and age-related cognitive decline: a randomized clinical trial. JAMA Intern Med 2015;175:1094–103.
[3] Chen H, Dhana K, Huang Y, Huang L, Tao Y, Liu X, et al. Association of the Mediterranean Dietary Approaches to stop hypertension intervention for neurodegenerative delay (MIND) diet with the risk of dementia. JAMA Psychiatry 2023;80:630–8.
[4] Jafari RS, Behrouz V. Nordic diet and its benefits in neurological function: a systematic review of observational and intervention studies. Front Nutr 2023;10:1215358.
[5] Iguacel I, Huybrechts I, Moreno LA, Michels N. Vegetarianism and veganism compared with mental health and cognitive outcomes: a systematic review and meta-analysis. Nutr Rev 2021;79:361–81.
[6] Pistollato F, Iglesias RC, Ruiz R, Aparicio S, Crespo J, Lopez LD, et al. Nutritional patterns associated with the maintenance of neurocognitive functions and the risk of dementia and Alzheimer's disease: a focus on human studies. Pharmacol Res 2018;131:32–43.
[7] Bizzozero-Peroni B, Díaz-Goñi V, Fernández-Rodríguez R, Martínez-Vizcaíno V, Jiménez-López E, Visier-Alfonso ME, et al. Plant-based diets and mental and neurocognitive health outcomes: a systematic review with meta-analysis. Nutr Rev 2025.
[8] Caracciolo B, Xu W, Collins S, Fratiglioni L. Cognitive decline, dietary factors and gut-brain interactions. Mech Ageing Dev 2014;136-137:59–69.
[9] Wang T, Masedunskas A, Willett WC, Fontana L. Vegetarian and vegan diets: benefits and drawbacks. Eur Heart J 2023;44:3423–39.
[10] Medawar E, Huhn S, Villringer A, Veronica Witte A. The effects of plant-based diets on the body and the brain: a systematic review. Transl Psychiatry 2019;9:226.
[11] Gijsbers L, Ding EL, Malik VS, de Goede J, Geleijnse JM, Soedamah-Muthu SS. Consumption of dairy foods and diabetes incidence: a dose-response meta-analysis of observational studies12. Am J Clin Nutr 2016;103:1111–24.
[12] Zhang M, Picard-Deland E, Marette A. Fish and marine omega-3 polyunsatured fatty acid consumption and incidence of type 2 diabetes: a systematic review and meta-analysis. Int J Endocrinol 2013;2013:501015.
[13] Agarwal P, Ford CN, Leurgans SE, Beck T, Desai P, Dhana K, et al. Dietary sugar intake associated with a higher risk of dementia in community-dwelling older adults. J Alzheimers Dis 2023;95:1417–25.
[14] Cao GY, Li M, Han L, Tayie F, Yao SS, Huang Z, et al. Dietary fat intake and cognitive function among older populations: a systematic review and meta-analysis. J Prev Alzheimers Dis 2019;6:204–11.
[15] Moore E, Mander A, Ames D, Carne R, Sanders K, Watters D. Cognitive impairment and vitamin B12: a review. Int Psychoger 2012;24:541–56.
[16] Satija A, Bhupathiraju SN, Rimm EB, Spiegelman D, Chiuve SE, Borgi L, et al. Plant-based dietary patterns and incidence of type 2 diabetes in US men and women: results from three prospective cohort studies. PLoS Med 2016;13:e1002039.
[17] Wu H, Gu Y, Meng G, Wu H, Zhang S, Wang X, et al. Quality of plant-based diet and the risk of dementia and depression among middle-aged and older population. Age Ageing 2023;52:afad070.
[18] de Crom TOE, Steur M, Ikram MK, Ikram MA, Voortman T. Plant-based dietary patterns and the risk of dementia: a population-based study. Age Ageing 2023;52:afad178.
[19] Zhu A, Yuan C, Pretty J, Ji JS. Plant-based dietary patterns and cognitive function: a prospective cohort analysis of elderly individuals in China (2008-2018). Brain Behav 2022;12:e2670.
[20] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71.
[21] Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The newcastle-ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa Hospital Research Institute website; 2019.
[22] Shao S-C, Kuo l-T, Huang Y-T, Lai P-C, Chi C-C. Using grading of recommendations assessment, development, and evaluation (GRADE) to rate the certainty of evidence of study outcomes from systematic reviews: a quick tutorial. Dermatologica Sinica 2023;41:3–7.
[23] Symons MJ, Moore DT. Hazard rate ratio and prospective epidemiological studies. J Clin Epidemiol 2002;55:893–9.
[24] Greenland S., Rothman K.J., Lash T.L. Measures of effect and measures of association. Chapter 4. 3rd ed 2008.
[25] Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002;21:1539–58.
[26] Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ (Clinical research ed) 2003;327:557–60.
[27] Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629–34.
[28] Greenland S, Longnecker MP. Methods for trend estimation from summarized dose-response data, with applications to meta-analysis. Am J Epidemiol 1992;135:1301–9.
[29] Orsini N, Bellocco R, Greenland S. Generalized least squares for trend estimation of summarized dose–response data. Stata J 2006;6:40–57.
[30] Liu Q, Cook NR, Bergström A, Hsieh C-C. A two-stage hierarchical regression model for meta-analysis of epidemiologic nonlinear dose–response data. Comput Stat Data Anal 2009;53:4157–67.
[31] Giem P, Beeson WL, Fraser GE. The incidence of dementia and intake of animal products: preliminary findings from the Adventist Health Study. Neuroepidemiology 1993;12:28–36.
[32] Wu J, Song X, Chen GC, Neelakantan N, van Dam RM, Feng L, et al. Dietary pattern in midlife and cognitive impairment in late life: a prospective study in Chinese adults. Am J Clin Nutr 2019;110:912–20.
[33] Shang X, Hodge AM, Hill E, Zhu Z, He M. Associations of dietary pattern and sleep duration with cognitive decline in community-dwelling older adults: a seven-year follow-up cohort study. J Alzheimers Dis 2021;82:1559–71.
[34] Tsai JH, Huang CF, Lin MN, Chang CE, Chang CC, Lin CL. Taiwanese vegetarians are associated with lower dementia risk: a prospective cohort study. Nutrients 2022;14:588.
[35] Page MJ, Higgins JPT, Sterne JAC. Chapter 13: assessing risk of bias due to missing evidence in a meta-analysis. et al., editors. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, editors. Cochrane handbook for systematic reviews of interventions version 65 (updated august 2024). Cochrane; 2024.
[36] Medawar E, Huhn S, Villringer A, Veronica Witte A. The effects of plant-based diets on the body and the brain: a systematic review. Transl Psychiatry 2019;9:226.
[37] Baroni L, Sarni AR, Zuliani C. Plant foods rich in antioxidants and Human cognition: a systematic review. Antioxidants (Basel) 2021:10.
[38] Griffiths A, Matu J, Tang EYH, Gregory S, Anderson E, Fairley A, et al. Foods, dietary patterns, and risk of vascular dementia: a systematic review. Nutr Metab (Lond) 2024;21:105.
[39] Reedy J, Krebs-Smith SM, Miller PE, Liese AD, Kahle LL, Park Y, et al. Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults. J Nutr 2014;144:881–9.
[40] Ren L, Tang Y, Yang R, Hu Y, Wang J, Li S, et al. Plant-based dietary pattern and low muscle mass: a nation-wide cohort analysis of Chinese older adults. BMC Geriatr 2023;23:569.
[41] Hsu WC, Lau KHK, Matsumoto M, Moghazy D, Keenan H, King GL. Improvement of insulin sensitivity by isoenergy high carbohydrate traditional Asian diet: a randomized controlled pilot feasibility study. PLOS ONE 2014;9:e106851.
[42] Jaacks LM, Kapoor D, Singh K, Narayan KM, Ali MK, Kadir MM, et al. Vegetarianism and cardiometabolic disease risk factors: differences between South Asian and US adults. Nutrition 2016;32:975–84.
[43] Satija A, Malik V, Rimm EB, Sacks F, Willett W, Hu FB. Changes in intake of plant-based diets and weight change: results from 3 prospective cohort studies. Am J Clin Nutr 2019;110:574–82.
[44] US Department of Agriculture. Dietary guidelines for americans, 2025-2030. 10th edition ed. U.S. Government Printing Office; 2025.
[45] Committee DGA. Scientific report of the 2025 dietary guidelines advisory committee. U.S. Department of Agriculture, Agricultural Research Service; 2025.
[46] Rajaram S, Jones J, Lee GJ. Plant-based dietary patterns, Plant foods, and age-related cognitive decline. Adv Nutr 2019;10:S422–Ss36.
[47] Ros E. Can specific nutrients, foods, or dietary patterns modulate cognitive function in (older) adults? Latest evidence from randomized controlled trials. Curr Opin Clin Nutr Metab Care 2021;24:511–20.
[48] Huang Z, Qiu G, Yang B, Shao Y, Lin S, Zhou H, et al. Healthful plant-based diets and cognitive function in older adults: mediation by nutritional status and modification by urban-suburban location and gender in a Shanghai community-based study. Nutrients 2026;18.
[49] Lin CR, Tsai JH, Wu SS, Chang YP, Wen YH, Liu JS, et al. Quantitative comorbidity risk assessment of dementia in Taiwan: a population-based cohort study. Medicine 2018;97:e0298.
[50] Qian F, Liu G, Hu FB, Bhupathiraju SN, Sun Q. Association between plant-based dietary patterns and risk of type 2 diabetes: a systematic review and meta-analysis. JAMA Intern Med 2019;179:1335–44.
[51] Chen JH, Lin KP, Chen YC. Risk factors for dementia. J Formos Med Assoc 2009;108:754–64.
[52] Tran E, Dale HF, Jensen C, Lied GA. Effects of plant-based diets on weight status: a systematic review. Diabetes Metab Syndr Obes 2020;13:3433–48.
[53] Tuso PJ, Ismail MH, Ha BP, Bartolotto C. Nutritional update for physicians: plant-based diets. Perm J 2013;17:61–6.
[54] Melina V, Craig W, Levin S. Position of the academy of nutrition and dietetics: vegetarian diets. J Acad Nutr Diet 2016;116:1970–80.