Nutrición Hospitalaria

SENPE

Efecto del consumo de frutas y verduras en la disminución del riesgo de deterioro cognitivo leve en pacientes remitidos a centros de reconocimiento médico: revisión sistemática y metaanálisis

The effect of fruit and vegetable consumption on the decreased risk of mild cognitive impairment in patients referring to health examination centers – A systematic review and meta-analysis

10.20960/nh.05723

09/16/2025

RE 5723

The effect of fruit and vegetable consumption on the decreased risk of mild cognitive impairment in patients referring to health examination centers – A systematic review and meta-analysis

Efecto del consumo de frutas y verduras en la disminución del riesgo de deterioro cognitivo leve en pacientes remitidos a centros de reconocimiento médico: revisión sistemática y metaanálisis

Wenqi Hu[1], Shiwei Yang[2], Yahui Hou[3], Min Li[4], Ye Yang[4], Rui Zhao[5], Guang Zhang[3,8]

[1]The First Clinical College. Shandong University of Traditional Chinese Medicine; [2]Department of General Surgery. The First Affiliated Hospital of Shandong First Medical University & Shandong Provincial Qianfoshan Hospital; [3]Department of Health Management. The First Affiliated Hospital of Shandong First Medical University & Shandong Provincial Qianfoshan Hospital; [4]The Clinic of Dazhong News Group. Da Zhong Daily; [5]Department of Clinical Nutrition. The First Affiliated Hospital of Shandong First Medical University & Shandong Provincial Qianfoshan Hospital; [6]Shandong Engineering Research Center of Health Management. Jinan, Shandong. People's Republic of China

Received: 16/01/2025
Accepted: 06/04/2025

Correspondence: Guang Zhang. Department of Health Management. The First Affiliated Hospital of Shandong First Medical University & Shandong Provincial Qianfoshan Hospital. No. 16766, Jingshi Road. Jinan 250014, Shandong. People's Republic of China
e-mail: zg_sdfmu@163.com

Authors' contribution: Wenqi Hu: methodology, data curation, formal analysis, investigation, writing-original draft, visualization. Shiwei Yang: methodology, data curation, formal analysis, investigation, writing-original draft, visualization. Yahui Hou: writing-original draft, writing-review, editing, visualization. Min Li: conceptualization, data curation, visualization, writing-review, editing, supervision, project administration. Rui Zhao: writing-original draft, writing-review, editing, visualization. Guang Zhang: writing-original draft, writing-review, editing, visualization.

Funding: This study was supported by the Shandong Provincial Natural Science Foundation (ZR2023QG014).

Ethics approval and consent to participate: All methods were performed in accordance with relevant guidelines and regulations. However, this study is a systematic review and meta-analysis and does not require ethical approval by the institution.

Data availability: The data used to derive the findings in this study are available from the corresponding author upon reasonable request.

Conflict of interest: The authors declare no conflict of interest.

Artificial intelligence: The authors declare not to have used artificial intelligence (AI) or any AI-assisted technologies in the elaboration of the article.

ABSTRACT

Introduction: nutritional factors play an essential role in the occurrence of cognitive impairment. The present study aimed to investigate the effect of fruit and vegetable consumption on the

decreased risk of mild cognitive impairment in patients referring to health examination centers.

Methods: a comprehensive search was conducted across five electronic bibliographic databases. Two groups of keywords were selected for search in the databases. Two independent researchers screened and selected the studies by examining the titles and abstracts. Two evaluators gathered essential details from the chosen studies. To assess the quality of the studies, appraisal instruments from the Joanna Briggs Institute (JBI) were utilized. Moreover, a meta-analysis was performed focusing on the values of the odds ratio.

Results: 38 studies were entered into the study; 36 studies (94.7 percent) revealed that fruit and vegetable consumption can affect the occurrence of mild cognitive impairment. The values of the odds ratio related to the effect of vegetable consumption and fruit intake on the decreased risk of mild cognitive impairment were between 0.20 to 0.82 and 0.14 to 0.92, respectively. The results showed that vegetable consumption [odds ratio: 0.60 (95 % CI: 0.40 to 0.79)] and fruit intake [odds ratio: (95 % CI: 0.46 to 0.86)] can decrease the risk of MCI.

Conclusions: the results revealed that fruit and vegetable consumption can significantly decrease the risk of mild cognitive impairment. Therefore, it is suggested that preventive plans for fruit and vegetable consumption should be implemented, especially in low- and middle-income countries.

Keywords: Fruit. Vegetable. Mild cognitive impairment. Systematic review. Meta-analysis.

RESUMEN

Introducción: los factores nutricionales desempeñan un papel esencial en la aparición del deterioro cognitivo. El presente estudio tuvo como objetivo investigar el efecto del consumo de frutas y

verduras en la disminución del riesgo de deterioro cognitivo leve en pacientes remitidos a centros de reconocimiento médico.

Métodos: se realizó una búsqueda exhaustiva en cinco bases de datos bibliográficas electrónicas. Se seleccionaron dos grupos de palabras clave para la búsqueda en las bases de datos. Dos investigadores independientes examinaron los títulos y resúmenes de los estudios seleccionados. Dos evaluadores recopilaron detalles esenciales de los estudios seleccionados. Para evaluar la calidad de los estudios, se utilizaron instrumentos de evaluación del Instituto Joanna Briggs (JBI). Además, se realizó un metaanálisis centrado en los valores del odds ratio.

Resultados: se incluyeron 38 estudios en el estudio; 36 estudios (94,7 por ciento) revelaron que el consumo de frutas y verduras puede afectar a la aparición del deterioro cognitivo leve. Los valores de la razón de probabilidades relacionados con el efecto del consumo de verduras y la ingesta de frutas sobre la disminución del riesgo de deterioro cognitivo leve fueron de entre 0,20 a 0,82 y 0,14 a 0,92, respectivamente. Los resultados mostraron que el consumo de verduras [odds ratio: 0,60 (IC del 95 %: 0,40 a 0,79)] y la ingesta de frutas [odds ratio: (IC del 95 %: 0,46 a 0,86)] pueden disminuir el riesgo de deterioro cognitivo leve.

Conclusiones: los resultados revelaron que el consumo de frutas y verduras puede disminuir significativamente el riesgo de deterioro cognitivo leve. Por lo tanto, se sugiere que se implementen planes preventivos para el consumo de frutas y verduras, especialmente en países de ingresos bajos y medios.

Palabras clave: Fruta. Verdura. Deterioro cognitivo leve. Revisión sistemática. Metaanálisis.

INTRODUCTION

Mild cognitive impairment (MCI) is a medical condition characterized by memory or cognitive difficulties in individuals compared to ones of

the same age (1). The symptoms of MCI are less severe compared to those associated with Alzheimer's disease or other forms of dementia (2). Individuals with MCI generally maintain the ability to manage their self-care and perform everyday tasks (2). Notably, MCI doesn't cause serious problems in the cognitive performance of people to impair their daily lives (3). MCI is often seen as a critical period for the prevention of Alzheimer's disease, providing a "window of opportunity" to potentially reverse or stabilize cognitive decline (4). During this time, some individuals may experience a return to normal cognitive functioning (4). As a transitional stage between normal aging and the onset of dementia, MCI is considered a key focus for interventions aimed at slowing the progression of dementia (5). Based on the results of a systematic review and meta-analysis performed by Bai et al., it has been found that the global prevalence of MCI in community-dwelling adults aged 50 and older was 15.56 percent (6). Further, findings from another meta-analysis revealed that about 39.2 % of those diagnosed with MCI progress to dementia over time (7). These statistics underscore the partial progression rate of the condition towards more severe neurodegenerative diseases, highlighting the importance of early detection and intervention efforts. These results indicate that despite the relative prevalence of this disease, the disease in only some cases progresses to dementia and Alzheimer's disease. So that and that intervention measures can be helpful.

Mild Cognitive Impairment (MCI) is a reversible condition, and early detection and intervention can prevent the progression to dementia and Alzheimer's disease. Research suggests that approximately one-third of dementia cases could potentially be avoided by managing modifiable risk factors (8). Various elements affect cognitive performance, including age, gender, obesity in mid-life, hypertension in mid-life, sleep disturbances, and insufficient physical activity (9). Dietary habits also significantly impact the likelihood of developing MCI. Healthy eating patterns are a crucial strategy for preventing or

postponing MCI in older adults (10). Increasing evidence indicates that diets with plants are particularly beneficial for preventing cognitive decline. This is largely due to the protective effects of antioxidants found in vegetables and fruits, which are essential for maintaining cognitive health (11). Several preclinical research has demonstrated that the polyphenolic antioxidants of fruits and vegetables can significantly reduce or even prevent neuronal death, thereby potentially lowering the incidence of dementia, particularly in cellular and animal studies (12). Earlier research has indicated that sufficient or high consumption of fruits and/or vegetables is associated with a decreased risk of cognitive impairments (13). In a systematic review, early evidence suggests that there are correlations between food insecurity at various life stages and overall cognitive abilities, executive function, and memory (14,15). The results of another meta-analysis show that increased intake of fruits and vegetables among the elderly has a relationship with a reduced incidence of cognitive disorders in this population group (16).

As mentioned, nutritional factors play an essential role in the occurrence of cognitive impairment and some systematic review and meta-analysis studies have summarized this relationship. However, no systematic review and meta-analysis were performed on the relationship between fruit and vegetable consumption with mild cognitive impairment. Additionally, the impact of fruit intake, vegetable consumption, and the combined intake of both fruits and vegetables may be different (17,18). For these reasons, it is required that a systematic review and meta-analysis study is performed to summarize these findings. Therefore, the present study aimed to investigate the effect of fruit and vegetable consumption on the decreased risk of mild cognitive impairment in patients referring to health examination centers.

METHODS

This systematic review and meta-analysis were officially registered with PROSPERO and adhered to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (19). All methods were performed in accordance with relevant guidelines and regulations. However, this study is a systematic review and meta-analysis and does not require ethical approval by the institution.

Search strategy

A comprehensive search was conducted across five electronic bibliographic databases: Scopus, PubMed, Medline, Web of Science, and Embase, with the search completed by November 05, 2024. Two groups of keywords were selected for search in the databases. The keywords of the first group were “veget*” OR “fruit*” OR “juice” and the keywords in the second group were “Mild Cognitive Impairment*” OR “mild cognitive defect*” OR “mild neurocognitive disorder*” OR “mild cognitive disorder*” OR “MCI”.

Eligibility criteria

A range of study types with the English language were incorporated into the systematic review. Moreover, all studies on the persons referring to health examination centers were entered into the study. However, this study excluded review and meta-analysis articles, editorial letters, case reports, and papers presented at conferences.

Study selection

All articles retrieved from the databases were transferred into Endnote for evaluation, where any duplicates were identified and eliminated. Two independent researchers (W.H. and G.Z.) then screened the studies by examining the titles and abstracts to determine their relevance. Articles with unrelated titles and abstracts were discarded. The full texts of the remaining articles were thoroughly examined by the researchers to verify the criteria.

Relevant studies were subsequently included in the review. In instances of disagreement between the two primary researchers, a third researcher (S.Y.) was consulted to resolve the issue.

Quality assessment

To assess the quality of the studies, appraisal instruments from the Joanna Briggs Institute (JBI) designated for case-control, cross-sectional, and cohort research were utilized. The JBI checklist serves as an effective instrument to examine the quality across different studies (20). Upon filling out these checklists, the positive responses were summed to calculate an overall score. Subsequently, based on this score, the studies were classified into three distinct groups: low quality, moderate quality, and high quality.

Data extraction

In this phase, two evaluators gathered essential details from the chosen studies. These details encompassed the author's identity, publication year, design of the study, nation, sample size, gender distribution, age range, consumption type, tools, outcome, and findings.

Data analysis

The concordance among evaluators was assessed using Cohen's kappa coefficient (21). The resulting kappa values for the various stages were recorded at 0.91 and 0.93, respectively. Beyond the descriptive results, a meta-analysis was performed focusing on the values of odds ratio. For subgroup analyses, countries were categorized into low and middle-income (LMIC) and high-income (HIC) groups, following the World Bank's classifications (22). In the study also. The research was grouped into four geographic areas: Europe, East/Southeast Asia, the Middle East, and the Americas. The studies were temporally divided based on whether they occurred before or

after the year 2015. All data processing was carried out using STATA version 14.2.

RESULTS

Search results and study selection

In this study, we collected 1,353 articles from multiple databases. From this source, 313 duplicated papers were removed. Following this, two researchers scrutinized the titles and abstracts of the 1040 remaining articles. After this preliminary assessment, 1,000 articles were eliminated either because they failed to meet the inclusion criteria or because they met the criteria for exclusion. Consequently, the full texts of 40 articles were thoroughly evaluated, and 38 of these were ultimately chosen to be entered into the study. The process is depicted in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram (Fig. 1).

Specification of the articles

Tables I and II outline the details of the articles incorporated into this systematic review. Among the 38 qualified studies, 11 studies were conducted using a cohort design, 9 studies using a cross-sectional design, and 18 studies using a case-control design. 4 studies have been carried out in Singapore, 11 studies in China, 6 studies in the United States, 2 studies in Taiwan, 4 studies in Malaysia, 4 studies in South Korea, and 1 study in each of the countries of India, France, Micronesia, Mexico, Greece, Netherland, Egypt, and the Central African Republic. Also, 1 study was conducted jointly in countries of China, Ghana, India, Mexico, Russia, and South Africa.

Among these studies, all 38 papers were performed on males and females. The age range of the subjects studied in the reviewed papers was between 40 and 90 years old. Also, the frequency of

participants in 16 studies (42.1 percent) was lower than 500 people, in 9 studies (23.7 percent) was between 500 and 1000 persons, and in 13 studies (34.2 percent) was higher than 1,000 persons. 20 studies were simultaneously conducted on fruits and vegetables, 5 studies on fruits, 7 studies on vegetables, and 6 studies on juice.

The quality evaluation of the studies incorporated in the review was conducted using the JBI critical appraisal checklist. From the overall selection, 32 papers were identified as high quality, three as moderate quality, and three as low quality.

Main findings

Among the 38 studies, only 2 studies with moderate quality levels did not show a significant relationship between vegetable consumption and the change in the risk of mild cognitive impairment. 36 studies (94.7 percent) revealed that fruit and vegetable consumption can affect the occurrence of mild cognitive impairment.

The values of the odds ratio related to the effect of vegetable consumption and fruit intake on the decreased risk of mild cognitive impairment were between 0.20 to 0.82 and 0.14 to 0.92, respectively. Also, the values of the odds ratio related to insufficient fruit and vegetable consumption on the increased risk of this disease were between 1.03 to 2.52 and 1.49 to 1.82. The lowest odds ratio was observed in the relationship between the MIND diet (plant-based foods) and the decreased risk of this impairment (OR: 0.20) and the highest odds ratio was related to the association between total vegetable consumption and the increased risk of MCI (OR: 2.52). The lowest odds ratio was seen in the relationship between total fruit consumption and the decreased risk of this impairment (OR: 0.14) and the highest odds ratio was also related to the association between total fruit consumption and the increased risk of MCI (OR: 1.82). Only two studies investigated the combination effect of fruit

and vegetable consumption on the risk of MCI. The results of these studies showed that a few daily consumptions of fruits/vegetables can increase the odds ratio related to the risk of MCI by 1.77 and the hazard ratio of this risk by 1.38.

Results of the meta-analysis

Regarding the high heterogeneity of the results, the meta-analysis of the odds ratio values was performed using a random effect model. Figure 2 shows the meta-analysis results related to the odds ratio of the relationship between vegetable and fruit consumption and decreased risk of mild cognitive impairment, respectively. The results showed that vegetable consumption [odds ratio: 0.60 (95 % CI: 0.40 to 0.79)] and fruit intake [odds ratio: (95 % CI: 0.46 to 0.86)] can decrease the risk of MCI.

Table III describes the findings of subgroup analysis for the odds ratio values of these relationships. On consumption of vegetables and fruits, the results showed that the decrease in risk of MCI was higher in high-income countries, east/southwest Asia/Oceania, and after 2015.

DISCUSSION

Given the prevalence of cognitive impairment in different countries, it is very important to identify factors affecting the incidence of these impairments. One of these factors is the consumption of fruits and vegetables. Mild cognitive impairments are a warning stage that can be controlled to prevent more serious consequences. However, the results of studies on fruit and vegetable consumption and the occurrence of this disorder have not been summarized in previous studies. Therefore, the present study aimed to investigate the effect of fruit and vegetable consumption on the decreased risk of mild cognitive impairment in patients referring to health examination centers.

Nutrición Hospitalaria

Thirty-six studies (94.7 percent) revealed that fruit and vegetable consumption can affect the occurrence of mild cognitive impairment. Therefore, it can be concluded that fruit and vegetable consumption has a significant effect on the increased risk of MCI. However, it should be noted that to increase the effectiveness of fruit and vegetable consumption on MCI, the consumption of other foods should be controlled (23). The consumption of some unhealthy foods, such as fast foods, can reduce the effect of fruits and vegetables (24,25), and the consumption of healthy foods, such as dairy products and fish, can increase the effect of these foods on mild cognitive impairment (26,27). Nicklaus and Remy also concluded that practices related to complementary feeding, such as timing and food diversity, are likely linked to the development of healthy dietary patterns, including the consumption of fruits and vegetables (28).

Research has also indicated a relationship where increased consumption of plants is associated with better cognitive preservation, particularly when fruits and vegetables are consumed together (29-31). Recent research emphasizes the necessity of both fruit and vegetable intake to support cognitive health in the elderly. It can be because of several mechanisms, which will be explained below.

Fruits and vegetable consumption may lower the risk of mild cognitive impairment (MCI) due to their numerous health advantages, including their roles in reducing inflammation and oxidative stress, boosting metabolic processes, improving vascular health, and enhancing the conduction of nerve signals (32). The benefits of fruits and vegetables are due to the contribution of nutrients and phytochemicals such as antioxidants, flavonoids, folate, vitamin C, and vitamin D. Firstly, fruits and vegetables are rich sources of dietary antioxidants such as those found in berries, which may influence the onset of MCI. The brain is particularly vulnerable to oxidative harm, and either oxidative stress or insufficient antioxidant defenses are likely contributors to the development and progression of both dementia and possibly MCI

(33). Secondly, these foods are also rich in flavonoids, which are believed to support cognitive function through their neuroprotective effects, improving neuronal activity and promoting the growth of new neurons (34). Thirdly, a significant amount of folate found in fruits and vegetables plays a role in DNA methylation, a process critical for aging and the development of dementia, by acting as a methyl donor (35). Additionally, folate influences the expression of both β-secretase and γ-secretase, enzymes involved in the production of Aβ and the formation of amyloid plaques (35). Folate also plays a role in reducing tau protein phosphorylation and the subsequent development of neurofibrillary tangles by indirectly modulating the activity of protein phosphatase cyclin-dependent kinase and glycogen synthase kinase (35). Furthermore, a deficiency in vitamin B within the diet can lead to elevated levels of homocysteine, which is directly neurotoxic and can impair neurotransmitter synthesis through the 1-carbon pathway (36). Several randomized controlled trials have indicated that high-dose vitamin B supplementation may decelerate brain shrinkage in individuals with mild cognitive impairment (37,38). Additionally, research has suggested a relationship between plasma vitamin C levels and cognitive function (39,40). It has been observed that individuals with mild cognitive impairment have lower plasma vitamin C levels compared to healthy individuals, and a vitamin C-rich diet could lower the risk of cognitive decline (41). The protective effects on cognitive health may particularly be attributed to high fruit consumption, which is a major source of vitamin C (33). Ultimately, the cognitive advantages derived from fruit and vegetable intake are likely due to the presence of various bioactive compounds rather than any single nutrient. Indeed, dietary supplements have not consistently shown effectiveness in preventing dementia among older adults (42-44).

However, there are probable differences between the effect of fruit and vegetable consumption on the risk of mild cognitive impairments, which can be because of different compounds in these products. In

addition to the direct effect, vegetables, and fruits can indirectly affect the risk of MCI through different ways. Sufficient fruit consumption, particularly the fiber found in fruits, could support cognitive health by aiding in long-term weight control and decreasing the likelihood of developing type 2 diabetes and metabolic syndrome (45), while the inorganic nitrates present in green leafy vegetables are believed to enhance cognitive functions by safeguarding cardiovascular health (46,47). The results of the meta-analysis in the present study showed that vegetable consumption [0.60 (95 % CI: 0.40 to 0.79)] and fruit intake [0.66 (95 % CI: 0.46 to 0.86)] can decrease the risk of MCI. Which group of vegetables or fruits is more beneficial depends on the type of fruit or vegetable and their consumption pattern. Moreover, this may be the reason for the differences between the results of different studies. So the range of odds ratio values related to the effect of fruit and vegetable consumption on the decreased risk of MCI in the present study was between 0.20 and 0.92.

The observed potential U-shaped correlation between the intake of vegetables and mild cognitive impairment (MCI) is intriguing. This may be attributed to the specific types of vegetables consumed by individuals who eat large quantities of them. For instance, certain vegetables such as leafy greens with high amounts of vitamin K and folate might show greater protective benefits against cognitive decline compared to other types (44). Additionally, it is important to consider that increased fruit consumption might lead to hyperglycemia in older adults with diabetes mellitus. Based on the Clinical Practice Guideline, it is advised that diabetic patients consume two servings of fruits daily that are rich in dietary fiber and have a low glycemic index to maintain effective glycemic control (48). To supply the required nutrients, Lalji et al. state that daily consumption of four to five portions of fruits and vegetables is generally recommended (49). However, fruit and vegetable consumption must be balanced. Jung et al. found that the excessive

intake of these foods can be associated with adverse effects particularly for people with diabetes and hypertension because fruits have a high level of natural sugars and canned vegetables have a high sodium level (50).

In terms of vegetable type, tomatoes, and onions were identified as the most consumed vegetables. Tomatoes are rich in lycopene, a significant bioactive compound (51). Lycopene acts as a natural neuroprotective agent and is thought to support cognitive health and address various neurological conditions such as cerebral ischemia, Parkinson’s disease (PD), Alzheimer's disease (AD), and depression (52). Onions contain quercetin, another potent flavonoid (53). The study also highlighted that tropical fruits are abundant in natural antioxidants like phenolic and polyphenolic compounds, flavonoids, and ascorbic acid, more so than fruits from temperate climates (54). Tropical fruits including bananas, guavas, jackfruits, papayas, dragon fruits, and mangoes are noted because of their high dietary fiber content and generally low to moderate glycaemic indices. These properties may enhance glycemic management in older adults with diabetes (55). Therefore, the intake of tropical fruits can protect diabetic older adults from cognitive decline (48).

Among various products, the results showed that the lowest odds ratio was observed in the relationship between the MIND diet (plant-based foods) and the decreased risk of this impairment (OR: 0.20). Therefore, it seems that fruits and vegetable intake associations with consumption of other useful product can make highest effect on the decreased risk of MCI. The observed decrease in risk may be linked to various neuroprotective components found in the MIND diet. For example, fish rich in omega-3 fatty acids possess antioxidant and anti-inflammatory properties (56), while mushrooms play a role in preventing the formation of beta-amyloid (57). Algae are known for their neuroprotective attributes (58), and soy enhances cognitive abilities through its antioxidant content (59). The compound allicin in garlic helps in slowing the breakdown of acetylcholine (60). Similarly,

epigallocatechin gallate in tea decreases oxidative stress (61). Corn is another source of antioxidants that contribute to neuroprotection (62). Edible plant oils, which are high in essential fatty acids, have neuroprotective benefits and have a higher unsaturated fatty acid content than animal oils (63). Additionally, the abundant vitamins in fruits and vegetables slow cognitive deterioration (64), and nutrients like polyunsaturated fatty acids and polyphenols are known to improve cognitive performance (65).

On consumption of vegetables and fruits, the results subgroup analysis showed that the decrease in risk of MCI was higher in high-income countries, east/ southwest Asia/ Oceania, and after 2015. It may be because of differences in the nutritional habits between Asian people, particularly the population of East Asia and European and American people. For example, staples in Asian diets often include rice, noodles, and cereals, while Western diets prefer wheat-based products such as bread and pasta. Additionally, East Asians commonly consume fish, beans, and soy products for protein, while the Western population favors meat-based proteins. Differences in food preparation methods also contribute to the distinctiveness between these dietary cultures (66). Also, the results show that high-income countries compared to low- and medium-income countries may place greater emphasis on healthy diets and include preventive measures to reduce cognitive impairment in their intervention plans. Also, access to healthy foods can be associated with higher costs, which limits their use in low- and middle-income countries (67).

As a limitation, the studies didn’t consider the difference between people with different demographic characteristics in the relationship between fruit and vegetable consumption and the decreased risk of MCI. Moreover, in the reviewed studies, the effects of fruit and vegetable consumption were reported separately but not together. Therefore, it is suggested that the combined impacts of their consumption on mild cognitive impairment be examined in the next studies. Furthermore, it is required that the effect of fruit and

vegetable intake along with the consumption of other foods in different cultures is investigated to eliminate the role of confounders.

CONCLUSIONS

In total, the results showed that fruit and vegetable consumption can significantly decrease the risk of mild cognitive impairment. So, the range of odds ratio values related to this relationship was between 0.20 and 0.92. The results also indicated that the decrease in risk of MCI was higher in high-income countries and east/southwest Asia/Oceania. Therefore, it is suggested that preventive plans for fruit and vegetable consumption should be implemented, especially in low- and middle-income countries. Also, it is recommended that the effectiveness of these interventional plans is investigated in the next cohort studies.

Nutrición Hospitalaria

REFERENCES

1. Anderson ND. State of the science on mild cognitive impairment (MCI). CNS Spectr 2019;24(1):78-87. DOI: 10.1017/S1092852918001347
2. Kasper S, Bancher C, Eckert A, Forstl H, Frolich L, Hort J, et al. Management of mild cognitive impairment (MCI): The need for national and international guidelines. World J Biol Psychiatry 2020;21(8):579-94. DOI: 10.1080/15622975.2019.1696473
3. Seo M, Watanabe T, Yamada T, Morita T, Kawasaki M, Kikuchi A, et al. The clinical relevance of mild cognitive impairment in acute heart failure: A comparison with cognitive impairment. J Cardiol 2024;83(4):243-9. DOI: 10.1016/j.jjcc.2023.08.017
4. Malek-Ahmadi M. Reversion From Mild Cognitive Impairment to Normal Cognition: A Meta-Analysis. Alzheimer Dis Assoc Disord 2016;30(4):324-30. DOI: 10.1097/WAD.0000000000000145
5. Morris JC. Mild cognitive impairment and preclinical Alzheimer's disease. Geriatrics 2005;Suppl:9-14.
6. Bai W, Chen P, Cai H, Zhang Q, Su Z, Cheung T, et al. Worldwide prevalence of mild cognitive impairment among community dwellers aged 50 years and older: a meta-analysis and systematic review of epidemiology studies. Age and ageing 2022;51(8):afac173. DOI: 10.1093/ageing/afac173
7. Mitchell AJ, Shiri-Feshki M. Rate of progression of mild cognitive impairment to dementia--meta-analysis of 41 robust inception cohort studies. Acta Psychiatr Scand 2009;119(4):252-65. DOI: 10.1111/j.1600-0447.2008.01326.x
8. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. Lancet 2017;390(10113):2673-734. DOI: 10.1016/S0140-6736(17)31363-6
9. Jia L, Du Y, Chu L, Zhang Z, Li F, Lyu D, et al. Prevalence, risk factors, and management of dementia and mild cognitive impairment in adults aged 60 years or older in China: a cross-

sectional study. Lancet Public Health 2020;5(12):e661-e71. DOI: 10.1016/S2468-2667(20)30185-7

10. Zhou G, Liu S, Yu X, Zhao X, Ma L, Shan P. High prevalence of sleep disorders and behavioral and psychological symptoms of dementia in late-onset Alzheimer disease: A study in Eastern China. Medicine (Baltimore) 2019;98(50):e18405. DOI: 10.1097/MD.0000000000018405
11. Mottaghi T, Amirabdollahian F, Haghighatdoost F. Fruit and vegetable intake and cognitive impairment: a systematic review and meta-analysis of observational studies. Eur J Clin Nutr 2018;72(10):1336-44. DOI: 10.1038/s41430-017-0005-x
12. Patel AK, Rogers JT, Huang X. Flavanols, mild cognitive impairment, and Alzheimer's dementia. Int J Clin Exp Med 2008;1(2):181-91.
13. Ashby-Mitchell K, Peeters A, Anstey KJ. Role of dietary pattern analysis in determining cognitive status in elderly Australian adults. Nutrients 2015;7(2):1052-67. DOI: 10.3390/nu7021052
14. Na M, Dou N, Ji N, Xie D, Huang J, Tucker KL, Gao X. Food Insecurity and Cognitive Function in Middle to Older Adulthood: A Systematic Review. Adv Nutr 2020;11(3):667-76. DOI: 10.1093/advances/nmz122
15. Koyanagi A, Veronese N, Stubbs B, Vancampfort D, Stickley A, Oh H, et al. Food insecurity is associated with mild cognitive impairment among middle-aged and older adults in South Africa: findings from a nationally representative survey. Nutrients 2019;11(4):749.
16. Zhou Y, Wang J, Cao L, Shi M, Liu H, Zhao Y, et al. Fruit and Vegetable Consumption and Cognitive Disorders in Older Adults: A Meta-Analysis of Observational Studies. Front Nutr 2022;9:871061. DOI: 10.3389/fnut.2022.871061

17. Liu RH. Potential synergy of phytochemicals in cancer prevention: mechanism of action. J Nutr 2004;134(12 Suppl):3479S-85S. DOI: 10.1093/jn/134.12.3479S
18. Slavin JL, Lloyd B. Health benefits of fruits and vegetables. Adv Nutr 2012;3(4):506-16. DOI: 10.3945/an.112.002154
19. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg 2010;8(5):336-41. DOI: 10.1016/j.ijsu.2010.02.007
20. Ma L-L, Wang Y-Y, Yang Z-H, Huang D, Weng H, Zeng X-T. Methodological quality (risk of bias) assessment tools for primary and secondary medical studies: what are they and which is better? Military Medical Research 2020;7:1-11.
21. Cohen J. A coefficient of agreement for nominal scales. Educational and psychological measurement 1960;20(1):37-46.
22. Yu B, Yuan Z, Yu Z, Xue-song F. BTEX in the environment: An update on sources, fate, distribution, pretreatment, analysis, and removal techniques. Chemical Engineering Journal 2022;435:134825. DOI: 10.1016/j.cej.2022.134825
23. Dunham A, Johnson EJ. Fruits, vegetables, and their components and mild cognitive impairment and dementia: A review. Food Reviews International 2013;29(4):409-40. DOI: 10.1080/87559129.2013.818015
24. Cecchini M, Sassi F, Lauer JA, Lee YY, Guajardo-Barron V, Chisholm D. Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. The Lancet 2010;376(9754):1775-84. DOI: 10.1016/S0140-6736(10)61514-0
25. Feng T, Feng Z, Jiang L, Yu Q, Liu K. Associations of health behaviors, food preferences, and obesity patterns with the incidence of mild cognitive impairment in the middle-aged and elderly population: An 18-year cohort study. Journal of Affective Disorders 2020;275:180-6. DOI: 10.1016/j.jad.2020.06.038

26. Kim KY, Yun J-M. Association between diets and mild cognitive impairment in adults aged 50 years or older. Nutrition Research and Practice 2018;12(5):415-25. DOI: 10.4162/nrp.2018.12.5.415
27. Iriondo-DeHond M, Miguel E, Del Castillo MD. Food byproducts as sustainable ingredients for innovative and healthy dairy foods. Nutrients 2018;10(10):1358. DOI: 10.3390/nu10101358
28. Nicklaus S, Remy E. Early origins of overeating: tracking between early food habits and later eating patterns. Current obesity reports 2013;2:179-84. DOI: 10.1007/s13679-013-0055-x
29. Nurk E, Refsum H, Drevon CA, Tell GS, Nygaard HA, Engedal K, et al. Cognitive performance among the elderly in relation to the intake of plant foods. The Hordaland Health Study. British journal of nutrition 2010;104(8):1190-201. DOI: 10.1017/S0007114510001807
30. Whyte AR, Rahman S, Bell L, Edirisinghe I, Krikorian R, Williams CM, et al. Improved metabolic function and cognitive performance in middle-aged adults following a single dose of wild blueberry. Eur J Nutr 2021;60(3):1521-36. DOI: 10.1007/s00394-020-02336-8
31. Wu L, Sun D, Tan Y. Intake of Fruit and Vegetables and the Incident Risk of Cognitive Disorders: A Systematic Review and Meta-Analysis of Cohort Studies. J Nutr Health Aging 2017;21(10):1284-90. DOI: 10.1007/s12603-017-0875-6
32. Wood E, Hein S, Mesnage R, Fernandes F, Abhayaratne N, Xu Y, et al. Wild blueberry (poly) phenols can improve vascular function and cognitive performance in healthy older individuals: a double-blind randomized controlled trial. The American journal of clinical nutrition 2023;117(6):1306-19. DOI: 10.1016/j.ajcnut.2023.03.017

33. Scarmeas N, Anastasiou CA, Yannakoulia M. Nutrition and prevention of cognitive impairment. Lancet Neurol 2018;17(11):1006-15. DOI: 10.1016/S1474-4422(18)30338-7
34. Macready AL, Kennedy OB, Ellis JA, Williams CM, Spencer JP, Butler LT. Flavonoids and cognitive function: a review of human randomized controlled trial studies and recommendations for future studies. Genes Nutr 2009;4(4):227-42. DOI: 10.1007/s12263-009-0135-4
35. Zhang X, Bao G, Liu D, Yang Y, Li X, Cai G, et al. The association between folate and Alzheimer's disease: a systematic review and meta-analysis. Frontiers in neuroscience 2021;15:661198. DOI: 10.3389/fnins.2021.661198
36. Selhub J. Folate, vitamin B12 and vitamin B6 and one carbon metabolism. J Nutr Health Aging 2002;6(1):39-42.
37. Smith AD, Smith SM, de Jager CA, Whitbread P, Johnston C, Agacinski G, et al. Homocysteine-lowering by B vitamins slows the rate of accelerated brain atrophy in mild cognitive impairment: a randomized controlled trial. PLoS One 2010;5(9):e12244. DOI: 10.1371/journal.pone.0012244
38. Douaud G, Refsum H, de Jager CA, Jacoby R, Nichols TE, Smith SM, et al. Preventing Alzheimer's disease-related gray matter atrophy by B-vitamin treatment. Proc Natl Acad Sci USA 2013;110(23):9523-8. DOI: 10.1073/pnas.1301816110
39. Travica N, Ried K, Sali A, Scholey A, Hudson I, Pipingas A. Vitamin C Status and Cognitive Function: A Systematic Review. Nutrients 2017;9(9):960. DOI: 10.3390/nu9090960
40. Travica N, Ried K, Hudson I, Sali A, Scholey A, Pipingas A. Gender Differences in Plasma Vitamin C Concentrations and Cognitive Function: A Pilot Cross-Sectional Study in Healthy Adults. Curr Dev Nutr 2020;4(4):nzaa038. DOI: 10.1093/cdn/nzaa038
41. Pearson JF, Pullar JM, Wilson R, Spittlehouse JK, Vissers MCM, Skidmore PML, et al. Vitamin C Status Correlates with

Markers of Metabolic and Cognitive Health in 50-Year-Olds: Findings of the CHALICE Cohort Study. Nutrients 2017;9(8):831. DOI: 10.3390/nu9080831

42. Davin A, Ceretti A, Mimmi MC, Cereda C, Guaita A. Habitual consumption of fruit, folic acid and cobalamin as risk/protection factors for the incidence of dementia: Data from the" InveCe. Ab" study: Prevention (nonpharmacological)/Nutrition. Alzheimer's & Dementia 2020;16:e043654. DOI: 10.1002/alz.043654
43. Barnard ND, Bunner AE, Agarwal U. Saturated and trans fats and dementia: a systematic review. Neurobiol Aging 2014;35(Suppl 2):S65-73. DOI: 10.1016/j.neurobiolaging.2014.02.030
44. Smith L, Lopez Sanchez GF, Veronese N, Soysal P, Oh H, Kostev K, et al. Association of Fruit and Vegetable Consumption With Mild Cognitive Impairment in Low- and Middle-Income Countries. J Gerontol A Biol Sci Med Sci 2023;78(8):1410-6. DOI: 10.1093/gerona/glad055
45. Dreher ML. Whole Fruits and Fruit Fiber Emerging Health Effects. Nutrients. 2018;10(12):1833. 10.3390/nu10121833.
46. Sundqvist ML, Larsen FJ, Carlstrom M, Bottai M, Pernow J, Hellenius ML, et al. A randomized clinical trial of the effects of leafy green vegetables and inorganic nitrate on blood pressure. Am J Clin Nutr 2020;111(4):749-56. DOI: 10.1093/ajcn/nqaa024
47. Ojagbemi A, Okekunle AP, Olowoyo P, Akpa OM, Akinyemi R, Ovbiagele B, et al. Dietary intakes of green leafy vegetables and incidence of cardiovascular diseases. Cardiovasc J Afr 2021;32(4):215-23. DOI: 10.5830/CVJA-2021-017
48. Malek Rivan NF, Shahar S, Fakhruddin NNINM, You YX, Che Din N, Rajikan R. The effect of dietary patterns on mild cognitive impairment and dementia incidence among community-dwelling older adults. Frontiers in Nutrition 2022;9:901750. DOI: 10.3389/fnut.2022.901750

49. Lalji C, Pakrashi D, Smyth R. Can eating five fruit and veg a day really keep the doctor away? Economic Modelling 2018;70:320-30. DOI: 10.1016/j.econmod.2017.07.024
50. Jung SE, Shin YH, Kim S, Hermann J, Bice C. Identifying underlying beliefs about fruit and vegetable consumption among low-income older adults: an elicitation study based on the theory of planned behavior. Journal of nutrition education and behavior 2017;49(9):717-23.e1. DOI: 10.1016/j.jneb.2017.05.343
51. Crowe-White KM, Phillips TA, Ellis AC. Lycopene and cognitive function. J Nutr Sci 2019;8:e20. DOI: 10.1017/jns.2019.16
52. Imran M, Ghorat F, Ul-Haq I, Ur-Rehman H, Aslam F, Heydari M, et al. Lycopene as a natural antioxidant used to prevent human health disorders. Antioxidants 2020;9(8):706. DOI: 10.3390/antiox9080706
53. David AVA, Arulmoli R, Parasuraman S. Overviews of biological importance of quercetin: A bioactive flavonoid. Pharmacognosy reviews 2016;10(20):84. DOI: 10.4103/0973-7847.194044
54. Pereira-Netto AB. Tropical fruits as natural, exceptionally rich, sources of bioactive compounds. International Journal of Fruit Science 2018;18(3):231-42. DOI: 10.1080/15538362.2018.1444532
55. Kamchansuppasin A, Sirichakwal P, Bunprakong L, Yamborisut U, Kongkachuichai R, Kriengsinyos W, et al. Glycaemic index and glycaemic load of commonly consumed Thai fruits. International Food Research Journal 2021;28(4). DOI: 10.47836/ifrj.28.4.15
56. Yurko-Mauro K, Alexander DD, Van Elswyk ME. Docosahexaenoic acid and adult memory: a systematic review and meta-analysis. PLoS One 2015;10(3):e0120391. DOI: 10.1371/journal.pone.0120391

57. Phan CW, David P, Naidu M, Wong KH, Sabaratnam V. Therapeutic potential of culinary-medicinal mushrooms for the management of neurodegenerative diseases: diversity, metabolite, and mechanism. Crit Rev Biotechnol 2015;35(3):355-68. DOI: 10.3109/07388551.2014.887649
58. Charoensiddhi S, Lorbeer AJ, Franco CM, Su P, Conlon MA, Zhang W. Process and economic feasibility for the production of functional food from the brown alga Ecklonia radiata. Algal research 2018;29:80-91. DOI: 10.1016/j.algal.2017.11.022
59. Szczerba E, Koch M, Schlesinger S. Soy consumption, cognitive function, and dementia. Curr Opin Lipidol 2022;33(1):68-75. DOI: 10.1097/MOL.0000000000000807
60. Ho S-C, Su M-S. Evaluating the anti-neuroinflammatory capacity of raw and steamed garlic as well as five organosulfur compounds. Molecules 2014;19(11):17697-714. DOI: 10.3390/molecules191117697
61. Sharifi-Rad M, Pezzani R, Redaelli M, Zorzan M, Imran M, Ahmed Khalil A, et al. Preclinical Pharmacological Activities of Epigallocatechin-3-gallate in Signaling Pathways: An Update on Cancer. Molecules 2020;25(3):467. DOI: 10.3390/molecules25030467
62. Zhang H, Li L, Li H, Qu P, Xiao M, Zhang G, et al. Corn embryo ameliorates cognitive dysfunction and anxiety-like behaviors in D-galactose-induced aging rats via attenuating oxidative stress, apoptosis and up-regulating neurotrophic factors. J Chem Neuroanat 2022;121:102088. DOI: 10.1016/j.jchemneu.2022.102088
63. Zhou Y, Zhao W, Lai Y, Zhang B, Zhang D. Edible Plant Oil: Global Status, Health Issues, and Perspectives. Front Plant Sci 2020;11:1315. DOI: 10.3389/fpls.2020.01315
64. Mecocci P, Boccardi V, Cecchetti R, Bastiani P, Scamosci M, Ruggiero C, et al. A long journey into aging, brain aging, and Alzheimer’s disease following the oxidative stress tracks.

Journal of Alzheimer's Disease 2018;62(3):1319-35. DOI: 10.3233/JAD-170732

65. Ros E, Singh A, O'Keefe JH. Nuts: Natural Pleiotropic Nutraceuticals. Nutrients 2021;13(9):3269. DOI: 10.3390/nu13093269.

66. Lin W, Zhou X, Liu X. Association of adherence to the Chinese version of the MIND diet with reduced cognitive decline in older Chinese individuals: Analysis of the Chinese Longitudinal Healthy Longevity Survey. J Nutr Health Aging 2024;28(2):100024. DOI: 10.1016/j.jnha.2023.100024

67. Penne T, Goedemé T. Can low-income households afford a healthy diet? Insufficient income as a driver of food insecurity in Europe. Food Policy 2021;99:101978. DOI: 10.1016/j.foodpol.2020.101978

Nutrición Hospitalaria

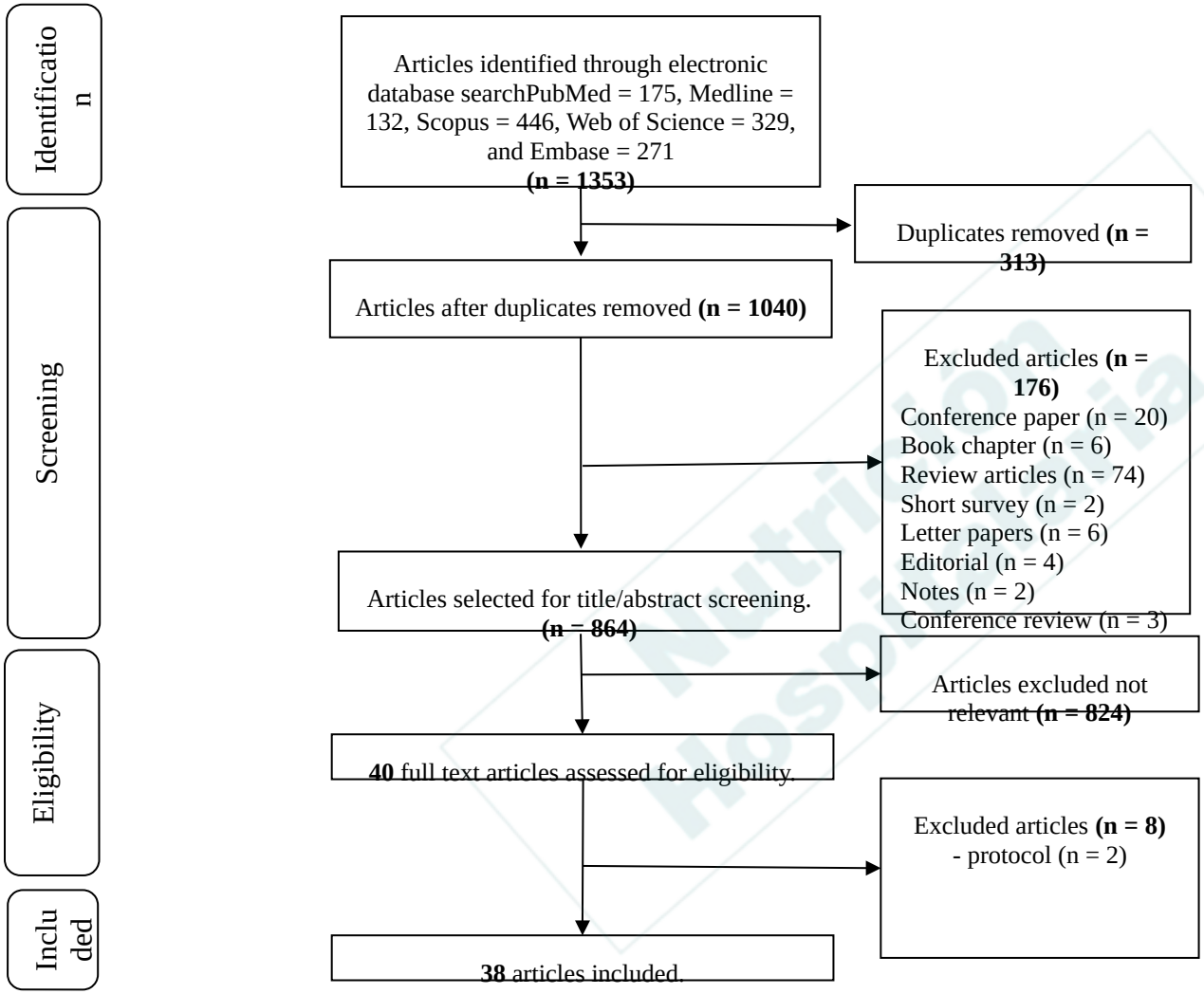
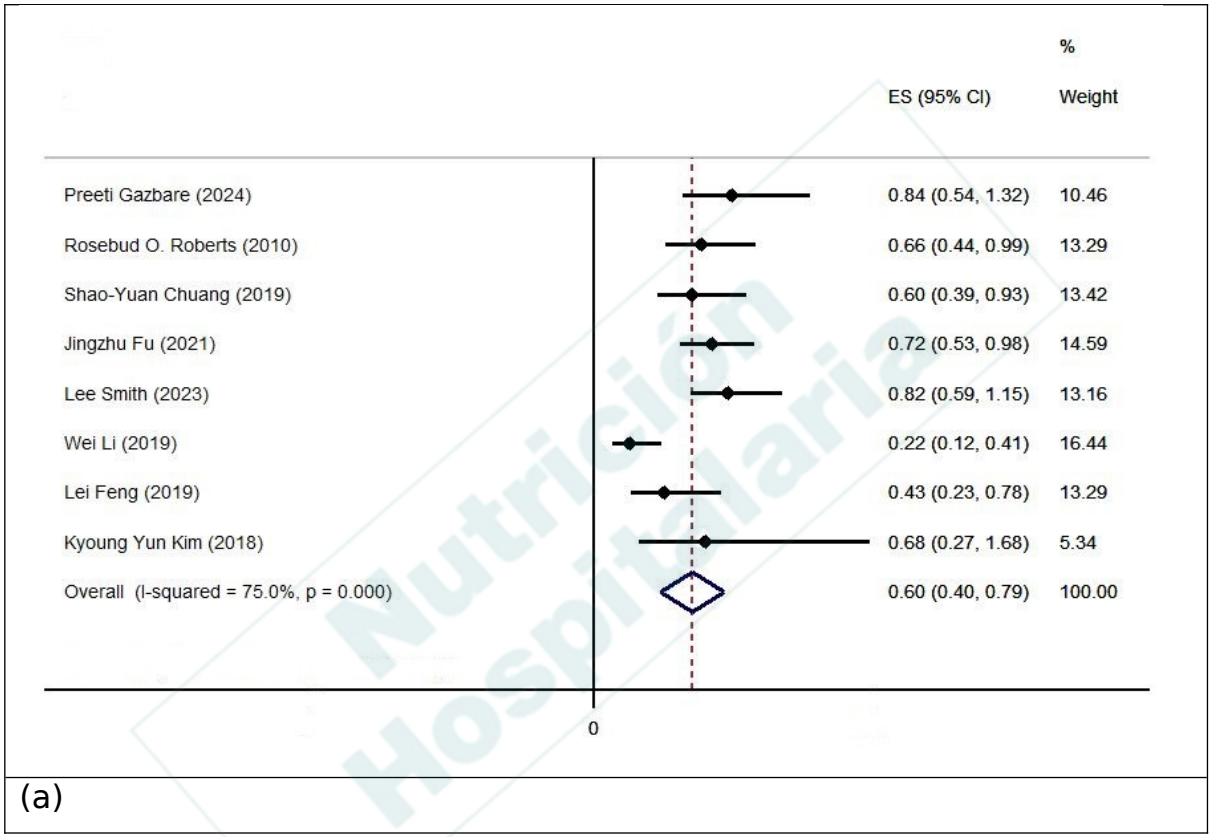


Figure 1. The flow diagram of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).



(a)

Nutrición Hospitalaria

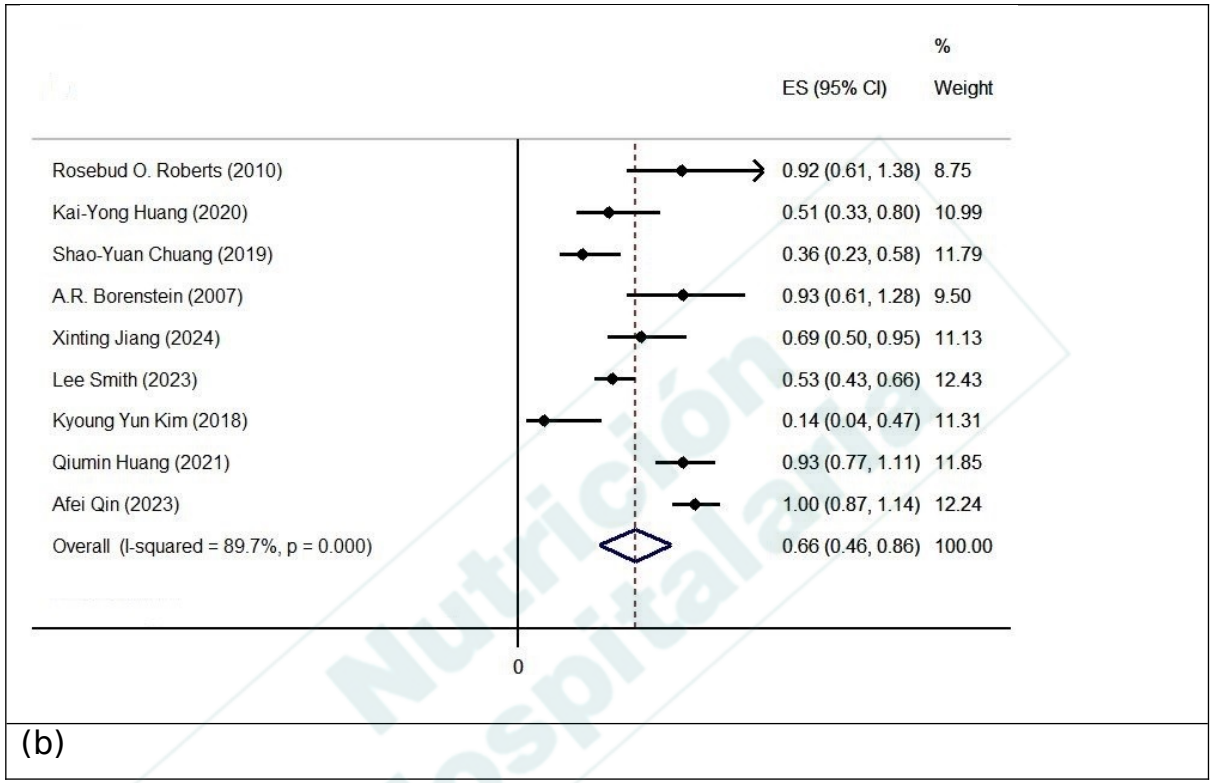


Figure 2. The results of the meta-analysis related to the odds ratio values of the relationship between vegetable intake (A) and fruit consumption (B), and the decreased mild cognitive impairment.

Table I. The total details of the articles encompassed in this systematic review

Author (year)	country	study type	sample size	age	gender	Consumption type (vegetable/fruit/juice)
Y. LU (2021)	Singapore	cohort	2640	66.1	male-female	fruits/vegetables
H. Fangfang (2022)	China	cross-sectional	1461	73.4	male-female	fruits/vegetables
Preeti Gazbare (2024)	India	cross-sectional	605	40-60	male-female	vegetables
Feng Sha (2022)	China	cohort	7422	90	male-female	fruits/vegetables
Rosebud O. Roberts (2010)	USA	cohort	1,233	81.5	male-female	fruits/vegetables
Kai-Yong Huang (2020)	Singapore	cross-sectional	748	68.1	male-female	fruits/vegetables

Nutrición Hospitalaria

K Ritchie (2010)	France	cohort	1433	72.5	male-female	fruits/vegetables
Shao-Yuan Chuang (2019)	Taiwan	cohort	2681	73.5	male-female	fruits/vegetables
A.R. Borenstein (2007)	Micronesia	case-control	cases) 1631 = 50, controls (= 1,581	77.4	male-female	fruit bats
Robert Krikorian (2010)	USA	case-control	cases =) 12 5, controls = (7	2·78	male-female	Concord grape juice
Li Dong (2016)	China	cross-sectional	248	62.9	male-female	fruits/vegetables
Iffa Hafizah (2015)	Malaysia	case-control	cases =) 114 25, controls = (89	case = 65.5-control = 67.5	male-female	fruits/vegetables
Guei-Chiuan Chen (2019)	Taiwan	cross-sectional	985	70.8	male-female	vegetables

Nutrición Hospitalaria

Nurul Fatin Malek Rivan (2022)	Malaysia	cohort	280	67.3	male-female	fruits/vegetables
Angel Gabriel Garrido-Dzib (2024)	Mexico	case-control	cases =) 73 34, controls = (39	case = 73.4-control = 67.2	male-female	fruits/vegetables
Xinting Jiang (2024)	China	case-control	cases =) 599 350, controls (= 249	case = 67.8-control = 64.5	male-female	fruits: berries, grapes, fruit juice
Jingzhu Fu (2021)	China	cohort	4,457	75 ≤-60	male-female	vegetables
Lee Smith (2023)	China, Ghana, India, Mexico, Russia, and South Africa	cohort	32,715	62.1	male-female	fruits/vegetables
CP Chong (2019)	Malaysia	cross-sectional	1,209	68.08	male-female	fruits

Wei Li (2019)	China	case-control	cases =) 507 101, controls (= 406	cases = 72.7, controls = 65.7	male-female	vegetables
Divya Vanoh (2017)	Malaysia	cohort	1,993	68.5	male-female	fruits and fresh fruit juices
S. Pilleron (2015)	Central African Republic, Congo	case-control	cases =) 788 62, controls = (726	cases = 72.7, controls = 65.7	male-female	fruits/vegetables
Kai-Yong Huang (2024)	China	case-control	cases =) 789 131- controls (= 658	cases = 69.6, controls = 69.9	male-female	fruits
Kyoung Yun Kim (2021)	South Korea	cross-sectional	275	75 ≤-50	male-female	vegetables

Nutrición Hospitalaria

Dayeon Shin (2018)	South Korea	case-control	cases =) 23920, controls = (219	cases = 80.5, controls = 73.4	male-female	fruits/vegetables
Ashley F. Curtis (2024)	USA	case-control	cases =) 3724, controls = (13	cases = 76.3, controls = 76.2	male-female	elderberry Juice
Thanos Chatzikostopoulos (2024)	Greece	case-control	cases =) 8040, controls = (40	cases = 69.8, controls = 69.3	male-female	pomegranate seed oil (PSO)
Robert Krikorian (2012)	USA	case-control	21	case = 78, controls = 75	male-female	Concord grape juice
Lei Feng (2019)	Singapore	case-control	cases =) 66390, controls = (573	case = 69.2, control = 67.4	male-female	mushroom

Robert Krikorian (2010)	USA	case-control	cases =) 169, controls = (7	cases = 76.2, controls = 80.2	male-female	blueberry juice
Erin L Boespflug (2018)	USA	case-control	cases =) 168, controls = (8	cases = 80.4, controls = 75.5	male-female	blueberry juice
Kyoung Yun Kim (2018)	South Korea	case-control	cases =) 27679- controls = (197	50-80	male-female	fruits/vegetables
Jay L. P. Fieldhouse (2020)	Netherlands	case-control	cases =) 22390- controls = (133	cases = 66, controls = 61	male-female	fruits/vegetables
Qiumin Huang (2021)	China	cohort	4,309	68.4	male-female	fruits/vegetables
Afei Qin (2023)	China	cohort	2,454	75.4	male-female	fruits/vegetables

Nutrición Hospitalaria

Shih-Wei Nien (2023)	China	case-control	cases =) 4021, controls = (19	cases = 70.5, controls = 72.4	male-female	fruits/vegetables
Yingjiao Deng (2024)	China	cross-sectional	728	80 ≤-60	male-female	fruits/vegetables
Iman I. Salama (2019)	Egypt	cross-sectional	186	51.3	male-female	vegetables

Nutrición Hospitalaria

Table II. The details of the articles encompassed in this systematic review

Author (year)	Tools	Outcome (MCI)	Findings	Qualit y
Y. Lu (2021)	Mini Nutritional Assessment (MNA) scales and Mini-Mental State Examination (MMSE)	Odds ratio: Few fruits/vegetables daily: [1.77 (95 % CI: 1.14-2.74)]	Individuals with a high nutritional risk score (3 or higher) were more likely to develop mild cognitive impairment (MCI)	Q1
H. Fangfang (2022)	Mini-Mental State Examination (MMSE) and interview	Odds ratio: Non-daily vegetable: [1.27 (95 % CI: 1.006-1.601)] Fruit (< 1 day/week): [1.487 (95 % CI: 1.231-1.797)]	Vegetable consumption on a non-daily basis was linked to an increased probability of mild cognitive impairment (MCI)	Q1

Preeti Gazbare (2024)	Addenbrookes Cognitive examination-III test, International physical activity questionnaire and Simple lifestyle indicator questionnaire, interview	Odds ratio: Consumption of vegetarians: [0.84 (95 % CI: 0.54-1.32)]	The dietary patterns did not show a significant association with mild cognitive impairment (MCI)	Q2
Feng Sha (2022)	Chinese version of Mini-Mental State Examination (CMMSE), food frequency questionnaire (FFQ)	Hazard ratio: Daily consumption of fresh fruits: [1.28 (95 % CI: 1.15-1.42)] Consumption of fresh vegetables: [0.90 (95 % CI: 0.75-1.08)]	Regular intake of fresh fruits was associated with an increased likelihood of reversing mild cognitive impairment (MCI)	Q1
Rosebud O. Roberts (2010)	Food Frequency Questionnaire (FFQ), Chinese Dietary Balance Index, and Mini-Mental State Examination	Odds ratio: vegetabled > 191.0 g/day intake: [0.66 (95 % CI: 0.44-0.99)] Fruits > 276.8 g/day intake: [0.92 (95 % CI: 0.61-1.38)]	The likelihood of developing mild cognitive impairment (MCI) was lower in individuals with a high Mediterranean diet (MeDi) score	Q1

Kai-Yong Huang (2020)	Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), a battery of neuropsychological tests (Block Design, Digit Span, Rey Auditory Verbal Learning Test, Semantic Fluency, and Color Trails Test), structured questionnaires	Odds ratio: Consume fruits (≥ 4 times per week): [0.51 (95 % CI: 0.33-0.80)]	The findings indicated that regular fruit intake (four or more days per week) was inversely related to the incidence of mild cognitive impairment (MCI)	Q3
K. Ritchie (2010)	Modified Peterson's criteria for mild cognitive impairment, standardized interview, Center for Epidemiological Studies depression scale	Hazard ratio: Fruit/vegetables < twice/ day: [1.38 (95 % CI: 1.11-1.70)]	Fruit and vegetable intake has a significant effect on lowering the occurrence of mild cognitive impairment (MCI)	Q1

Nutrición Hospitalaria

Shao-Yuan Chuang (2019)	Food-frequency questionnaire, Mini-Mental State Examination score (MMSE)	Odds ratio: Fresh vegetables ≥ 21 times/week: [0.60 (95 % CI: 0.39-0.93)] Fresh fruits ≥ 7 times/week: [0.36 (95 % CI: 0.23-0.58)]	The dietary pattern score has an inverse association with the presence of mild cognitive impairment	Q1
A. R. Borenstein (2007)	Cognitive Abilities Screening Instrument (CASI) score	Odds ratio: Eat fruit bat as a child: [0.91 (95 % CI: 0.67-1.23)] Eat fruit bat as a young adult: [1.35 (95 % CI: 0.93-1.97)] Eat fruit bat as an adult: [0.55 (95 % CI: 0.25-1.24])	Dietary habits may play a role in the development of mild cognitive impairment	Q1
Robert Krikorian (2010)	Academic and Medical History Questionnaire, California Verbal Learning Test, Spatial Paired Associate Learning Test, Geriatric Depression Scale	-	The results indicate that Concord grape juice consumption could potentially improve cognitive abilities in patients	Q1

Li Dong (2016)	Montreal Cognitive Assessment (MoCA) test, semi-quantified food-frequency questionnaire (FFQ)	-	A diet with abundant vegetables and fruits may reduce the likelihood of cognitive decline	Q1
Iffa Hafizah (2015)	Mini-Mental State Examination score (MMSE), Geriatric Depression Scale, neurocognitive testing scales (Rey auditory verbal learning test (RAVLT), clock drawing test (CDT), digit span)	-	Individuals without mild cognitive impairment (MCI) consumed notably more fruits and vegetables (281.6 ± 77.2 g/day) in contrast to those diagnosed with MCI (250.4 ± 51.3 g/day)	Q3
Guei-Chiuan Chen (2019)	Test of memory, orientation, judgment, and function	-	A vegetarian diet could potentially lead to a reduced occurrence of mild cognitive impairment	Q1

Nutrición Hospitalaria

Nurul Fatin Malek Rivan (2022)	Petersen criteria, Rey Auditory Verbal Learning Test (RAVLT), Geriatric Depression Scale-15 (GDS-15), Malay version Mini-Mental State Examination (M-MMSE), dietary history questionnaire (DHQ)	-	Dietary habits may offer protection against the onset of mild cognitive impairment	Q1
Angel Gabriel Garrido-Dzib (2024)	Food-frequency questionnaire (FFQ), Partial Least-Squares Discriminant Analysis (PLS-DA)	-	Consumption of sufficient amounts of fruits and vegetables may enhance the quality of life among individuals with mild cognitive impairment (MCI)	Q1

Nutrición Hospitalaria

Xinting Jiang (2024)	Dietary habit questionnaire, medical history inquiry, physical examination, neuropsychological test, laboratory examination (genetic detection such as APOE), imaging examination (brain MRI, Amyloid β-PET)	Odds ratio: Berries: [0.685 (95 % CI: 0.502-0.935)] Grapes: [0.702 (95 % CI: 0.509-0.969)]	The research indicated that the intake of berries and grapes may safeguard cognitive abilities	Q1
Jingzhu Fu (2021)	Food frequency questionnaire, Petersen criteria, Mini-Mental State Examination (MMSE)	Odds ratio: Vegetarian pattern: [0.72 (95 % CI: 0.53-0.98)]	The findings indicate a notable relationship between a vegetarian diet and the incidence of mild cognitive impairment (MCI)	Q1
Lee Smith (2023)	Aging-Alzheimer's Association criteria, questionnaire	Odds ratio: Fruit consumption: [0.53 (95 % CI: 0.43-0.66)] Vegetable consumption: [0.82 (95 % CI: 0.59-1.15)]	Increased intake of fruits and vegetables was linked to reduced likelihood of mild cognitive impairment	Q1

Nutrición Hospitalaria

C. P. Chong (2019)	Dietary history questionnaire (DHQ), digit span, Rey Auditory Verbal Learning Test (RAVLT), Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), digit symbol, VR	-	Fruit intake was notably correlated with improved scores on the mini-mental state examination (MMSE)	Q1
Wei Li (2019)	Food frequency questionnaire (FFQ), Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA)	Odds ratio: Green vegetables everyday consumption: [0.218 (95 % CI: 0.116-0.411)]	Individuals who consumed green vegetables daily exhibited a notably reduced risk of mild cognitive impairment compared to those who did not use green vegetables in their daily diet	Q1

Nutrición Hospitalaria

Divya Vanoh (2017)	Dietary History Questionnaire (DHQ), digit span, Rey Auditory Verbal Learning Test (RAVLT), Mini-Mental State Examination (MMSE)	-	The findings suggested that consumption of fruits and fresh fruit juices was associated with lower cognitive functioning	Q1
S. Pilleron (2015)	Petersen criteria, Free and Cued Selective Reminding Test, Zazzo's cancellation task, Isaac's Set Test of verbal fluency, food frequency questionnaire	Odds ratio: Consumption of fruits: [1.82 (95 % CI: 0.88-3.77)] Consumption of vegetables: [2.52 (95 % CI: 1.21-5.23)]	The research shows the relationship between dietary patterns and cognitive impairments	Q1
Kai-Yong Huang (2024)	Mini-Mental State Examination (MMSE)	Odds ratio: Constipation and infrequent fruit consumption: [1.51 (95 % CI: 1.277-1.797)]	The occurrence of mild cognitive impairment (MCI) has been associated with factors such as constipation and low intake of fruits	Q2

Kyoung Yun Kim (2021)	Mini-Mental State Examination (MMSE), food frequency questionnaire	-	The consumption pattern of legumes and vegetables did not show a significant relationship with the incidence of mild cognitive impairment (MCI)	Q2

Nutrición Hospitalaria

Dayeon Shin (2018)	Korean-Mini Mental State Examination (K-MMSE), food frequency questionnaire	Odds ratio: Seafood and vegetable patterns: [0.45 (95 % CI: 0.04-5.63)]	Older adults who followed a dietary pattern rich in seafood, vegetables, fruits, bread, snacks, soy products, beans, chicken, pork, ham, eggs, and milk exhibited a lower risk of mild cognitive impairment compared to their counterparts who did not adhere to this diet	Q1

Nutrición Hospitalaria

Ashley F. Curtis (2024)	Clinical Dementia Rating (CDR) scale, Mini-Mental State Exam (MMSE), Hopkins Verbal Learning Test (HVLT), Boston Naming Test (BNT), Rey-Osterrieth Complex Figure Test (Rey CFT), Anagram problem-solving tasks, Visuospatial Problem Solving (VPS)	-	Regular intake of elderberry juice could potentially enhance visuospatial cognitive flexibility in individuals with mild cognitive impairment (MCI)	Q1

Nutrición Hospitalaria

Thanos Chatzikostopoulos (2024)	Alzheimer's Disease Assessment Scale-Cognitive Subscale (ADAS-cog), Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Rivermead BehavioralVerbal Learning Test, Rey Auditory Verbal Learning Test (RAVLT), Rey-Osterrieth Complex Figure Test, Trail Making Test Part B (TMT B), Functional Cognitive Assessment Scale (FUCAS).	-	The findings indicated that individuals who consumed pomegranate seed oil demonstrated a statistically significant improvement in overall cognitive abilities, verbal episodic memory, and both processing and executive functions compared to those who did not consume the oil	Q1

Nutrición Hospitalaria

Robert Krikorian (2012)	Structured interview, Clinical Dementia Rating (CDR), Montreal Cognitive Assessment (MOCA), Rey Auditory Verbal Learning Test (RAVLT), Geriatric Depression Scale (GDS)	-	Individuals with grape juice consumption exhibited a decreasing semantic interference during memory assessments. Functional magnetic resonance imaging revealed comparatively higher activation in the anterior and posterior areas of the right hemisphere in these subjects	Q1

Nutrición Hospitalaria

Lei Feng (2019)	Singapore modified Mini-Mental State Examination (SM-MMSE), Clinical Dementia Rating (CDR), Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV), 6-item mushroom consumption questionnaire	Odds ratio: Mushroom consumption (> 2 portions per week): [0.43 (95 % CI: 0.23-0.78)]	People who consumed more than two portions per week compared to ones who ate mushrooms less than once per week exhibited a lower likelihood of developing mild cognitive impairment (MCI)	Q1
Robert Krikorian (2010)	Verbal Paired Associate Learning Test (V-PAL), California Verbal Learning Test (CVLT), Geriatric Depression Scale (GDS)	-	Enhanced performance was noted in paired associate learning and the recall of word lists	Q1

Nutrición Hospitalaria

Erin L. Boespflug (2018)	Functional magnetic resonance imaging, Academic and Medical History Questionnaire, modified Clinical Dementia Rating (mCDR), Montreal Cognitive Assessment (MoCA), California Verbal Learning Task (CVLT), Geriatric Depression Scale (GDS)	-	Participants with blueberry consumption demonstrated increasing activation in the left pre-central gyrus, left middle frontal gyrus, and left inferior parietal lobe, as measured by blood oxygen level-dependent (BOLD) signaling, under conditions of working memory load	Q1

Nutrición Hospitalaria

Kyoung Yun Kim (2018)	Semi-quantitative food frequency questionnaire (SQ-FFQ), mini-mental state examination (MMSE)	Odds ratio: Vegetables: [0.678 (95 % CI: 0.274-1.681)] Fruits: [0.144 (95 % CI: 0.044-0.468)]	Consumption of fruits was observed to substantially reduce the odds ratio related to the risk of mild cognitive impairment (MCI)	Q1
Jay L. P. Fieldhouse (2020)	Visual Association Test (VAT), Rey Auditory Verbal Learning Task, visual object and space perception battery, trail making test (TMT), frontal assessment battery, the backward condition of digit span, the color-word subtest of the Stroop test, letter fluency, Dutch Healthy Diet-Food Frequency Questionnaire (DHD-FFQ)	-	The studies indicated that reduced consumption of vegetables is linked with diminished overall cognitive abilities, including aspects of visuospatial skills, attention, and executive functions	Q1

Nutrición Hospitalaria

Qiumin Huang (2021)	Semi-quantitative food frequency questionnaire, Montreal Cognitive Assessment (MoCA)	Odds ratio: Consumption of fresh vegetables: [1.03 (95 % CI: 0.86-1.23)] Fresh fruit: [0.93 (95 % CI 0.77-1.11)]	Individuals who consumed more fresh vegetables and fruits generally exhibited better overall cognitive function and specific cognitive domains and were less likely to have mild cognitive impairment (MCI)	Q1
Afei Qin (2023)	Mini-mental State Examination (MMSE), PhenX (consensus measurements for phenotypes and exposures) Toolkit, Psychological Well-Being (PWB) scale, interview	Odds ratio: Vegetable intake: [1.075 (95 % CI: 1.038-1.114)] Fruit intake: [0.995 (95 % CI: 0.869-1.14)]	Elderly individuals with regular consumption of fruits and vegetables in their diet showed a lower risk of mild cognitive impairment (MCI)	Q1

Shih-Wei Nien (2023)	Clinical dementia rating (CDR), mini-mental state examination (MMSE), dietary records	Odds ratio: MIND diet (plant-based foods): [0.20 (95 % CI: 0.04-0.99)]	Consumption of fruit has a positive relationship with the Mini-Mental State Examination (MMSE) scores	Q1
Yingjiao Deng (2024)	Montreal Cognitive Assessment-Basic (MoCA-B) scale, Simple Food Frequency Counting Survey Scale	-	Consumption of fruits and root vegetables was associated with a reduced risk of mild cognitive impairment (MCI)	Q1
Iman I. Salama (2019)	Montreal Cognitive Assessment test (MoCA), Addenbrooke's Cognitive Examination III (ACE III), The Quick Mild Cognitive Impairment (Quick MCI)	Odds ratio: Vegetables: [1.2 (95 % CI: 1.04-1.43)]	A low monthly consumption of vegetables was identified as a predictive factor for mild cognitive impairment (MCI)	Q3

Nutrición Hospitalaria

Table III. Results of subgroup analysis for the vegetable consumption and MCI risk

Type	**Subgroup analysis**					
	Subgroup	**Category (number of studies)**	**OR [95 % CI]**	**I^2 (%)**	**Q statistic (df)**	***p*** **of heterogeneity**
Vegetable consumption	Income level	High income (3)	0.55 [0.36, 0.74]	0.0	2	0.479
		LMICs (5)	0.62 [0.34, 0.90]	84.7	4	< 0.001
	Region	Europe (-)	-	-	-	-
		East /southeast Asia/Oceania (6)	0.54 [0.32, 0.77]	75.6	5	0.001
		Middle East (-)	-	-	-	-
		Americas (1)	0.66 [0.38, 0.93]	-	0	-
		Africa (-)	-	-	-	-
	Study date	In or before 2015 (1)	0.66 [0.38, 0.93]	-	0	-
		After 2015 (7)	0.59 [0.37, 0.81]	77.4	6	< 0.001
Fruit consumptio	Income level	High income (3)	0.49 [0.09, 0.89]	85.1	2	0.001
		LMICs (6)	0.73 [0.51, 0.95]	90.0	5	< 0.001
	Region	Europe (-)	-	-	-	-
		East /southeast Asia/Oceania (7)	0.65 [0.39, 0.90]	91.5	6	< 0.001

Nutrición Hospitalaria

n		Middle East (-) Americas (1) Africa (-)	- 0.92 [0.53, 1.30] -	- -	- 0 -	- - -
	Study date	In or before 2015 (2) After 2015 (7)	0.92 [0.67, 1.17] 0.59 [0.37, 0.82]	0.0 91.8	1 6	0.969 < 0.001

Nutrición Hospitalaria