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SYSTEMATIC REVIEW

Vitamins for Chronic Disease Prevention: A Systematic Review

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Abstract

Chronic diseases such as cardiovascular disease, type 2 diabetes, cancer, and neurodegenerative disorders are leading contributors to global morbidity and mortality. While genetic and lifestyle factors are known to influence disease risk, emerging evidence highlights the critical role of nutrition, particularly vitamin intake, in the prevention and progression of these diseases. Micronutrients like vitamins B, C, D, E, A, and K are involved in essential physiological functions, including immune response, antioxidant defense, energy metabolism, and cellular repair. Deficiencies in these vitamins have been linked to increased disease risk, yet the evidence regarding the efficacy of supplementation remains inconsistent. This review aims to systematically evaluate current evidence on the preventive potential of vitamin supplementation in reducing the risk of chronic diseases in adults. The focus is to assess both the benefits and limitations across different vitamin types and chronic health conditions. A comprehensive literature search was conducted using PubMed, PubMed Central, and the Directory of Open Access Journals (DOAJ) for studies published between 2018 and 2025. Keywords included "vitamin supplementation," "chronic disease prevention," and specific vitamins (A, B, C, D, E, K, and carotenoids). Studies were selected based on predefined inclusion criteria, such as study design, population (adult humans), and relevance to chronic disease outcomes. Out of 40 initially retrieved articles, 21 met the criteria for detailed review. Data were extracted independently and synthesized based on vitamin type and associated health outcomes. B-Vitamins are effective in lowering homocysteine levels, with potential benefits in reducing the risk of stroke, cardiovascular disease, and cognitive decline. However, evidence for their impact on cancer prevention remains inconclusive. Vitamin E Exhibits antioxidant properties but shows inconsistent results in reducing risks of cardiovascular and prostate cancer outcomes. Lower doses may be more beneficial. Dietary carotenoids may offer protective effects against prostate and lung cancer, though β-carotene supplements increased

lung cancer risk in smokers. Strong evidence supports its role in preventing neural tube defects in women of childbearing age. Overall, the effectiveness of vitamin supplementation appears to vary by dosage, bioavailability, population subgroup, and disease type. Vitamin supplementation shows promising potential in chronic disease prevention, particularly in cardiovascular and cognitive health. However, results vary depending on the type of vitamin, dosage, and population characteristics. The discrepancies in existing studies underline the need for more targeted research and personalized nutrition strategies. These findings are crucial for guiding public health policies and clinical practices in the prevention of chronic diseases.

Keywords: Vitamin supplementation; Chronic disease prevention; B vitamins; Folate; Vitamin D; Vitamin E; Carotenoids; Cardiovascular health; Cognitive decline; Cancer prevention

1 Introduction

Chronic diseases like cardiovascular disease, type 2 diabetes, cancer, and neurodegenerative disorders continue to be among the primary sources of morbidity and mortality worldwide. With global life expectancies increasing yearly, prevalence continues to climb dramatically, placing undue strain on healthcare systems and quality of life.[1] Genetic factors, as well as lifestyle habits like inactivity and tobacco smoking, play an integral part in disease risk factors, yet recent evidence demonstrates nutrition plays a vital part both in terms of development as well as prevention of chronic illnesses, such as cardiovascular disease and type 2 diabetes.[2]

Vitamins, as essential micronutrients, are essential in supporting physiological functioning and metabolic integrity.[3] Vitamin K also serves a variety of biological processes, including immune regulation, antioxidant defense, energy metabolism, and cell repair. Lack of suboptimal levels of certain vitamins has been associated with an increased susceptibility to chronic illnesses.[3] Vitamin D deficiency has been linked with osteoporosis, autoimmune diseases, and cardiovascular events[4]; low folate and B12 levels have also been tied to cognitive decline, as well as elevated homocysteine levels in some studies.[5] Meanwhile, antioxidant vitamins C and E may play a significant role in modulating oxidative stress and inflammation, two mechanisms known to play key roles in chronic disease pathogenesis.[6]

While the results of vitamin supplementation studies are diverse, the potential benefits are significant. Some studies report substantial advantages, while others show limited or no results. These discrepancies underscore the need for a deeper understanding of individual vitamin roles, dosage levels, bioavailability levels, and population responses to supplements.[7] However, the promising outcomes of some studies provide hope for the potential of vitamin supplementation in chronic disease prevention.

This scientific review is a comprehensive appraisal of the current evidence on vitamin use as an intervention strategy against chronic diseases among adults. By synthesizing evidence from epidemiological studies, randomized controlled trials, and mechanistic research studies, it will provide a detailed understanding of the strengths and limitations associated with vitamin-based interventions. These findings will be crucial for shaping future public health strategies targeting chronic disease prevention, making this review an essential read for healthcare professionals, researchers, and public health policymakers.

2 Methods

2.1 Search Strategy

A comprehensive literature search was performed using the following databases: PubMed, PubMed Central, and the Directory of Open Access Journals (DOAJ). The search covered the time frame from 2018 to 2025, focusing on the most recent and relevant scientific studies. The search was restricted to articles published in English. Commonly used keywords included: "vitamin supplementation," "B vitamins," "folate," "vitamin D," "vitamin E," "vitamin A," "vitamin K," "vitamin C," "chronic disease prevention," "cardiovascular disease," "cancer," "cognitive decline," and "neurodegeneration."

2.2 Study Selection

Inclusion Criteria:

Studies were included if they met the following criteria:

- **Design**: Interventional, observational, cohort, longitudinal, cross-sectional, or systematic reviews and meta-analyses.
- **Scope**: Focused on the association between vitamin intake or status and chronic disease prevention in adult human populations.
- **Content**: Reported on specific outcomes related to chronic diseases such as cardiovascular diseases, cancer, cognitive disorders, or neurodegenerative diseases.
- **Data**: Included quantitative or qualitative outcomes relevant to vitamin efficacy.
- **Accessibility**: Published in open access journals or publicly available scientific repositories.
- **Publication window**: Between 2018 and 2025.

Exclusion Criteria:

Studies were excluded based on the following:

- Non-human (e.g., animal or in vitro) studies.
- Short-duration trials (< 7 days).
- Articles not published in English.
- Studies focusing solely on children or pregnant women, unless indirectly related to adult chronic disease prevention.
- Trials with incomplete methodology or lacking clear outcome reporting.
- Studies based on high-protein diets that included plant sources (irrelevant to vitamin-only effects).
- Unpublished manuscripts and preprints.

2.3 Data Extraction

The initial search yielded a total of 40 articles. After applying the above inclusion and exclusion criteria and conducting relevance screening, 21 articles were selected for detailed review. Data extraction was performed independently by the authors and included:

- Author(s) and Year of Publication
- Study Design
- Type and Dose of Vitamin Studied
- Target Chronic Disease
- Key Findings and Outcomes

These studies were then synthesized to assess the preventive potential of specific vitamins on chronic diseases, especially focusing on B vitamins (B6, B12, folate), Vitamin D, Vitamin E, Vitamin A, Vitamin K, Vitamin C, and carotenoids.

3 Results

This section synthesizes the findings from the selected studies that investigate the impact of vitamin supplementation, particularly vitamins A, B, C, D, E, and carotenoids, on the prevention of chronic diseases such as cardiovascular conditions, cancer, cognitive decline, and metabolic disorders.

3.1 Vitamins and Chronic Disease Prevention

Multiple studies have emphasized the critical roles of B vitamins, especially B6, B12, and folate, in homocysteine metabolism.[8] Elevated homocysteine levels have been strongly associated with an increased risk of cardiovascular and neurodegenerative diseases.[9] In a meta-analysis, folate supplementation significantly lowered homocysteine levels, potentially reducing risks of stroke and cognitive decline in older adults. 10 Additionally, B12 deficiency has been linked with Alzheimer's and Parkinson's disease. Regular intake of B vitamins in older populations was associated with a lower incidence of age-related cognitive impairment and dementia.[10]

The Heart Outcomes Prevention Evaluation 2 (HOPE-2) trial found that folic acid and B vitamin therapy significantly reduced homocysteine levels in cardiovascular contexts.[11] However, no statistically significant reductions in major cardiovascular events were observed. However, a separate dose-response meta-analysis suggested that folic acid supplementation improved endothelial function, contributing to overall cardiovascular health.[12]

A systematic review and meta-analysis revealed that higher folate intake and adequate folate status significantly reduced colorectal cancer risk. In contrast, research on folate's role in breast cancer remains inconclusive. Biomarker analysis from the EPIC cohort study showed no significant association between circulating folate and increased breast cancer risk.[13]

Folate's preventive effects against neural tube defects (NTDs) have been well-documented. A comprehensive review found that mandatory folate fortification during preconception periods substantially lowered the incidence of NTDs.[14] Further research supported the maintenance

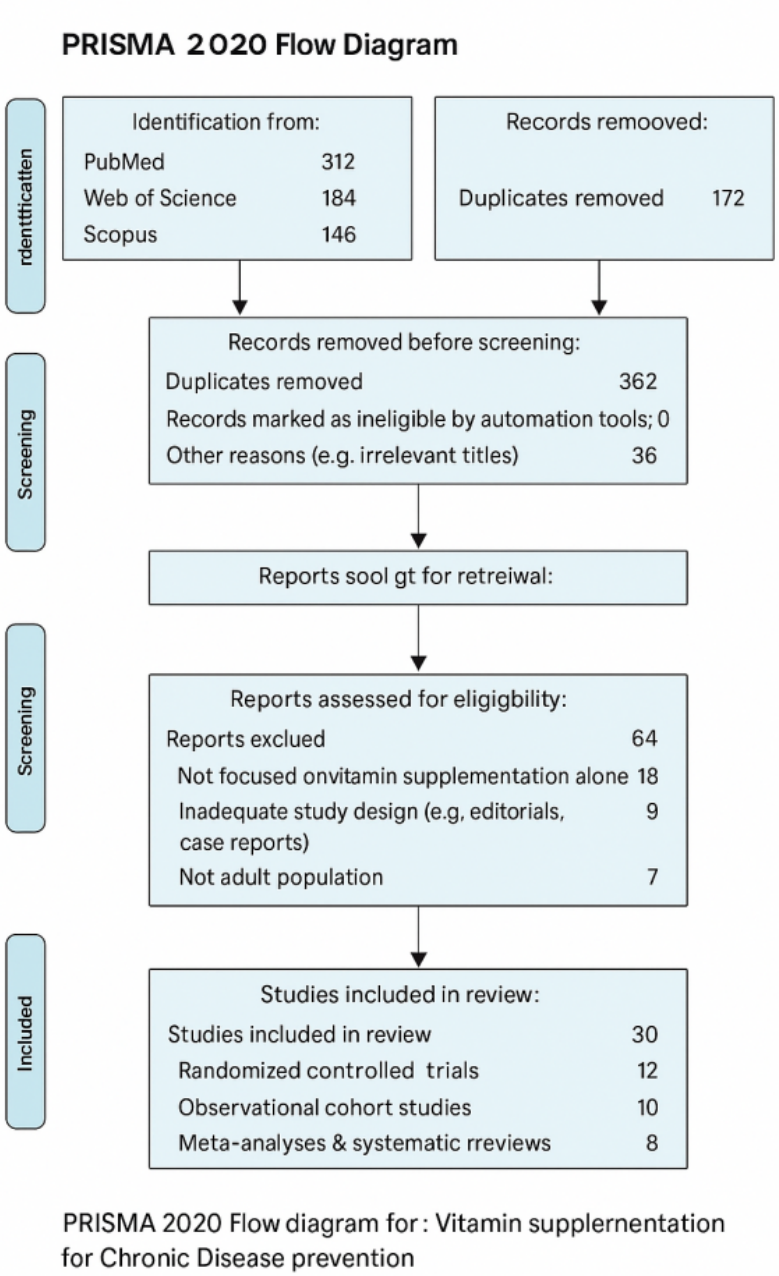

Fig 1.

of adequate red blood cell folate concentrations to protect women of childbearing age.[15]

3.2 Vitamin E and Chronic Disease Outcomes

Due to its antioxidant potential, vitamin E has been extensively studied for its cardiovascular benefits. However, a meta-analysis found no significant reductions in myocardial infarction or stroke risks associated with supplementation.[16] Similarly, vitamin E supplementation had inconsistent outcomes for CHD, with lower doses appearing more favorable than high doses in some subgroups.[17]

In terms of cancer prevention, a 2023 meta-analysis of 32 studies involving over 1.2 million participants found no significant association between vitamin E (dietary or supplemental) and prostate cancer risk.[18] However, subgroup analysis suggested a reduced risk in European populations (RR = 0.81; 95% CI: 0.69–0.97). Prior meta-analyses indicated low

doses ($\leq$400 IU/day) might offer protective effects, though the evidence remains inconsistent.[19]

3.3 Carotenoids and Chronic Disease

Carotenoids, including β-carotene and lycopene, have shown mixed results in disease prevention. A meta-analysis revealed that β-carotene supplementation was associated with an increased risk of lung cancer among smokers and asbestos-exposed individuals (RR = 1.16; 95% CI: 1.06–1.26).[20] In contrast, dietary carotenoids derived from fruits and vegetables were linked to protective effects against lung cancer.[21]

In prostate cancer**,** increased intake of total carotenoids and lycopene was associated with a statistically significant risk reduction (RR = 0.88; 95% CI: 0.81–0.96).[22] Mechanistic studies suggest carotenoids may exert anticarcinogenic effects through apoptosis induction and inhibition of cancer cell proliferation.[23]

Findings regarding colorectal cancer remain inconclusive. Some studies show inverse associations with carotenoid intake, while others do not. Nonetheless, fruit and vegetable consumption rich in carotenoids is generally recognized for its broader health benefits.[24]

For cardiovascular disease, serum β-carotene levels were inversely related to CHD risk. A meta-analysis of 69 prospective studies found that each 25 μg/dL increase in β-carotene corresponded to a 24% reduction in CHD risk (RR = 0.76; 95% CI: 0.62–0.93).[25] However, supplementation studies have not demonstrated consistent cardiovascular benefits and may even pose risks for specific populations such as smokers.

3.4 Vitamin D and Disease Risk

Recent randomized controlled trials have questioned the efficacy of vitamin D in cardiovascular disease prevention. A large meta-analysis with over 83,000 participants found no significant association between vitamin D supplementation and reduced risks of myocardial infarction, stroke, or cardiovascular mortality.[26]

For cancer outcomes, while vitamin D supplementation does not appear to reduce cancer incidence significantly, one meta-analysis found a notable reduction in cancer mortality, indicating a potential role in cancer progression rather than prevention.[27]

3.5 Vitamin C and Chronic Disease

Observational studies have shown that higher vitamin C intake reduces CVD mortality (by 21%).[17] However, supplementation trials yielded inconsistent results, with some studies failing to confirm cardiovascular protective effects.

In cancer prevention, meta-analyses demonstrated that each 50 mg/day increase in vitamin C intake was associated with a 13% reduction in esophageal cancer risk.[28] In comparison, 100 mg/day increases were linked with a 26% decrease in gastric cancer risk. High-dose intravenous vitamin C has also been explored as an adjunctive therapy in cancer treatment, with some trials reporting improvements in treatment response and quality of life.[29]

3.6 Vitamin A and Disease Prevention

Vitamin A is essential for immunity, vision, and cellular health. Despite its biological importance, a systematic review involving over 239,000 participants found no significant effect of vitamin A supplementation on all-cause mortality (RR = 0.99; 95% CI: 0.93–1.05).[30]

A meta-analysis investigated Vitamin A's role in inflammation. It revealed reductions in inflammatory markers such as TNF-α and IL-6.[31] However, higher doses were associated with elevated C-reactive protein (CRP) levels, indicating a complex and possibly dose-dependent relationship.

Evidence regarding vitamin A's protective effects against cancer remains inconclusive, with inconsistent findings across studies. While mechanistic data support potential anticarcinogenic effects through cell differentiation and immune modulation, large-scale trials have not consistently validated these benefits.

4 Discussion

Vitamins are vital micronutrients that play a vital role in numerous biochemical and physiological processes, with B vitamins–Folate, B6, and B12 being particularly studied for their roles in neurological health, cardiovascular health, cell metabolic functions, and homocysteine conversion to methionine maintaining optimal homocysteine levels in blood and cognitive decline/neurodegenerative disorders being linked with elevated homocysteine levels[9]; further highlighting their essentiality as health maintenance ingredients.

The present review highlights their crucial function as homocysteine conversion helps maintain optimal homocysteine levels which help to maintain optimal homocysteine levels associated with cardiovascular diseases / vascular / cognitive decline / neurodegenerative disorders / risk, which emphasizes their essentiality as health maintenance agents.[8,9]

Studies have consistently linked deficiencies of folate, B6, and B12 with higher homocysteine concentrations that contribute to increased oxidative stress, leading to potential vascular damage as well as age-related cognitive impairments and stroke risk.[8] A meta-analysis in this review shows the effectiveness of folate supplementation for lowering homocysteine levels, thereby potentially decreasing stroke risks as well as age-related cognitive decline - consistent with research that shows regular intake of B vitamins may protect from dementia, Alzheimer's disease, and other

Table 1. Summary of Vitamin Supplementation and Chronic Disease Prevention

Vitamin	Disease Area	Observed Effect	Strength of Evidence	Notes
B Vitamins (B6, B12, Folate)	Cardiovascular	↓ Homocysteine (but no consistent ↓ in events)	Moderate	HOPE-2: reduced homocysteine; no reduction in events
	Cognitive Decline	↓ Risk of dementia & cognitive decline	Strong	Deficiency linked to Alzheimer's & Parkinson's
	Cancer (Colorectal)	↓ Risk with folate intake	Moderate	Inverse association found in meta-analysis
	Cancer (Breast)	No clear effect	Weak/Inconclusive	Conflicting results in epidemiological studies
	Neural Tube Defects	↓ Risk with folate	Strong	Consistent evidence, basis for fortification
Vitamin E	Cardiovascular	No clear benefit	Moderate	High doses possibly less favorable
	Cancer (Prostate)	No overall effect; ↓ in European subgroups	Moderate	Low-dose (<400 IU/day) may be better
Carotenoids (β-carotene, Lycopene)	Cancer (Lung)	↑ Risk in smokers	Strong	Supplementation harmful in high-risk groups
	Cancer (Prostate)	↓ Risk (especially with lycopene)	Moderate	Dietary intake favored over supplements
	Cancer (Colorectal)	Mixed evidence	Weak/Inconclusive	Some inverse associations
	Cardiovascular	↓ CHD risk with higher serum β-carotene	Moderate	Inverse relationship seen in meta-analyses
Vitamin D	Cardiovascular	No effect	Strong	Based on large RCTs and meta-analyses
	Cancer (Mortality)	↓ Cancer-related mortality	Moderate	Supplementation did not affect incidence
Vitamin C	Cardiovascular	Observational ↓ in mortality, no RCT support	Weak to Moderate	High dietary intake shows more promise
	Cancer (GI tract)	↓ Risk (esophageal, gastric)	Moderate	Risk decreased with each 50–100 mg/day
	Cancer (Adjunct therapy)	Some improvement in QoL & response	Weak	Mainly small trials on IV vitamin C
Vitamin A	All-cause Mortality	No effect	Strong	Based on high-quality meta-analysis
	Inflammation	↓ TNF-α, IL-6; ↑ CRP at high doses	Moderate	Dose-dependent immune effects
	Cancer	Inconclusive	Weak	Mechanistic rationale, but no consistent effect

neurodegenerative conditions.[10]

Folate's role in DNA synthesis and repair further underlines its significance as a cancer preventive supplement. However, the inconclusive results on breast cancer risk highlight the urgent need for more nuanced research on how vitamin intake impacts cancer risk across different populations and genetic backgrounds.[32]

B vitamins, particularly folate, offer immense public health value in preventing neural tube defects (NTDs). According to systematic reviews and policy evaluations, mandatory folate fortification has significantly decreased NTD incidence rates in many countries. Adequate red blood cell folate levels are reliable biomarkers of maternal folate status, confirming its necessity as preconception folate supplementation among women of reproductive age.[14]

This study reviewed B vitamins and fat-soluble ones like vitamins A, D, E, and K as essential to maintaining good health. Fat-soluble vitamins differ from water-soluble ones by being stored within body fat or liver bile; their functions range from immunity, bone health protection, antioxidant defense, blood coagulation, and more.[33]

Vitamin D has long been recognized for its key role in calcium metabolism and bone mineralization. However, emerging evidence also links vitamin D deficiency with cardiovascular risks, insulin resistance, autoimmune conditions, and more. Thus, optimal serum 25(OH) D concentrations must be maintained to support immune functions and minimize inflammation - particularly among aging populations.[34]

Vitamin E, an extremely potent antioxidant, plays an integral part in protecting cell membranes from oxidative damage and may play an integral part in lowering coronary heart disease (CHD) risk by decreasing LDL oxidative modification.[35] Although observational studies and randomized trials indicate cardiovascular benefits from supplementing with Vitamin E, supplementation might prove more advantageous among populations already deficient or with increased levels of oxidative stress stressors.[36]

Vitamin A is essential for vision, immune defense, epithelial integrity, reproduction, and embryonic development. It also plays an essential role in embryonic growth.[37] The potential toxicity of excess intake underscores the importance of maintaining an appropriate daily dosage, making responsible and cautious supplementation vital.

Vitamin K plays an essential part in blood clotting and bone metabolism. Recent research suggests that it may be used to prevent arterial calcification, a condition where calcium builds up in the arteries, and maintain cardiovascular health, though further investigations are needed to fully test this theory across populations.[38]

This review highlights water and fat-soluble vitamins' multidimensional role in supporting physiological, neurological, cardiovascular, and reproductive health. While some forms of supplementation, such as folate during gestation or vitamin D in populations with limited sun exposure, have proven helpful, routine intake should be approached cautiously as over-supplementation with fat-soluble vitamins may result in overeating and even lead to toxic side effects due to long-term storage in our bodies.

In summary, adequate levels of both water-soluble B vitamins and fat-soluble vitamins are necessary to promote overall wellness and avoid chronic disease. Their impact can differ based on genetics, age, lifestyle, and coexisting medical conditions, so adequate consumption should not only benefit but also prevent them. Future studies should explore optimal dosage, bioavailability, and long-term health outcomes associated with both deficiency and excess. Tailored nutritional interventions tailored to an individual's specific needs and risk profiles promise to optimize benefits while minimizing potential risks. Public health strategies must focus on education and guidance for creating diets rich with essential nutrients and informed supplement use throughout life.

5 Conclusion

This evidence review highlights vitamins' complex and multidimensional role in chronic disease prevention. While certain B vitamins—particularly folate, B6, and B12—show promising effects in lowering homocysteine levels and potentially decreasing risks of cardiovascular and neurodegenerative conditions, evidence from larger clinical trials remains mixed. Similarly, vitamin D does have biological plausibility with improved cardiometabolic and skeletal outcomes, but it hasn't demonstrated consistent preventive benefits in random controlled trials.

Fat-soluble vitamins like vitamins A, D, E, and K and carotenoids play an essential role in modulating immune responses, oxidative stress levels, and cell signaling pathways. Their supplementation outcomes vary based on dose, population characteristics, and baseline nutritional status; vitamin E's antioxidant benefits have not consistently translated to decreased cardiovascular or cancer risks when studied clinically while supplementing with beta carotene may cause harm among smokers; by contrast, consuming whole fruits and vegetables may confer additional protective benefits through synergistic interactions with bioactive compounds that act together on bioactive compounds within them thereby creating synergies which enhance their effects when taken orally dietary sources seem more protective benefits due to synergies with bioactive compounds present.

Overall, this review illuminates that while vitamin supplementation may provide targeted benefits in populations with confirmed deficiencies or elevated risk profiles, an indiscriminate one-size-fits-all approach does not support current evidence. Instead, more tailored, evidence-based strategies that emphasize balanced nutrition-rich diets over high-dose supplementation should be implemented. Furthermore, long-

term clinical trials need to take place with diverse populations across chronic disease endpoints to more fully establish individual vitamins' preventive potential and effect.

References

1) Hacker K. The Burden of Chronic Disease. *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*. 2024;8(1):112–119. Available from: https://dx.doi.org/10.1016/j.mayocpiqo.2023.08.005.
2) Balwan WK, Kour S. Lifestyle Diseases: The Link between Modern Lifestyle and Threat to Public Health. *Saudi Journal of Medical and Pharmaceutical Sciences*. 2021;7(4):179–184. Available from: https://dx.doi.org/10.36348/sjmps.2021.v07i04.003.
3) Godswill AG, Somtochukwu IV, Ikechukwu AO, Kate EC. Health Benefits of Micronutrients (Vitamins and Minerals) and their Associated Deficiency Diseases: A Systematic Review. *International Journal of Food Sciences*. 2020;3(1):1–32. Available from: https://dx.doi.org/10.47604/ijf.1024.
4) De Martinis M, Allegra A, Sirufo MM, Tonacci A, Pioggia G, Raggiunti M, et al. Vitamin D Deficiency, Osteoporosis and Effect on Autoimmune Diseases and Hematopoiesis: A Review. *International Journal of Molecular Sciences*. 2021;22(16):1–22. Available from: https://dx.doi.org/10.3390/ijms22168855.
5) Baroni L, Bonetto C, Rizzo G, Bertola C, Caberlotto L, Bazzerla G. Association Between Cognitive Impairment and Vitamin B12, Folate, and Homocysteine Status in Elderly Adults: A Retrospective Study. *Journal of Alzheimer's Disease*. 2019;70(2):443–453. Available from: https://dx.doi.org/10.3233/jad-190249.
6) Moritz B, Schmitz AE, Rodrigues ALS, Dafre AL, Cunha MP. The role of vitamin C in stress-related disorders. *The Journal of Nutritional Biochemistry*. 2020;85:1–18. Available from: https://dx.doi.org/10.1016/j.jnutbio.2020.108459.
7) Fekete M, Lehoczki A, Tarantini S, Fazekas-Pongor V, Csípő T, Csizmadia Z, et al. Improving Cognitive Function with Nutritional Supplements in Aging: A Comprehensive Narrative Review of Clinical Studies Investigating the Effects of Vitamins, Minerals, Antioxidants, and Other Dietary Supplements. *Nutrients*. 2023;15(24):1–32. Available from: https://dx.doi.org/10.3390/nu15245116.
8) Calderón-Ospina CA, Nava-Mesa MO. B Vitamins in the nervous system: Current knowledge of the biochemical modes of action and synergies of thiamine, pyridoxine, and cobalamin. *CNS Neuroscience & Therapeutics*. 2020;26(1):5–13. Available from: https://dx.doi.org/10.1111/cns.13207.
9) Zaric BL, Obradovic M, Bajic V, Haidara MA, Jovanovic M, Isenovic ER. Homocysteine and Hyperhomocysteinaemia. *Current Medicinal Chemistry*. 2019;26(16):2948–2961. Available from: https://dx.doi.org/10.2174/0929867325666180313105949.
10) Kumar RR, Singh L, Thakur A, Singh S, Kumar B. Role of Vitamins in Neurodegenerative Diseases: A Review. *CNS & Neurological Disorders - Drug Targets*. 2022;21(9):766–773. Available from: https://dx.doi.org/10.2174/1871527320666211119122150.
11) Li S, Guo Y, Men J, Fu H, Xu T. The preventive efficacy of vitamin B supplements on the cognitive decline of elderly adults: a systematic review and meta-analysis. *BMC Geriatrics*. 2021;21(1):1–14. Available from: https://dx.doi.org/10.1186/s12877-021-02253-3.
12) Zamani M, Rezaiian F, Saadati S, Naseri K, Ashtary-Larky D, Yousefi M, et al. The effects of folic acid supplementation on endothelial function in adults: a systematic review and dose-response meta-analysis of randomized controlled trials. *Nutrition Journal*. 2023;22(1):1–14. Available from: https://dx.doi.org/10.1186/s12937-023-00843-y.
13) Moazzen S, Dolatkhah R, Tabrizi JS, Shaarbafi J, Alizadeh BZ, de Bock GH, et al. Folic acid intake and folate status and colorectal cancer risk: A systematic review and meta-analysis. *Clinical Nutrition*. 2018;37(6):1926–1934. Available from: https://dx.doi.org/10.1016/j.clnu.2017.10.010.
14) Shlobin NA, LoPresti MA, Du RY, Lam S. Folate fortification and supplementation in prevention of folate-sensitive neural tube defects: a systematic review of policy. *Journal of Neurosurgery: Pediatrics*. 2021;27(3):294–310. Available from: https://dx.doi.org/10.3171/2020.7.peds20442.
15) Gebremichael B, Roba HS, Getachew A, Tesfaye D, Asmerom H. Folate deficiency among women of reproductive age in Ethiopia: A systematic review and meta-analysis. *PLOS ONE*. 2023;18(5):1–22. Available from: https://dx.doi.org/10.1371/journal.pone.0285281.
16) Hu Y, Hu FB, Manson JE. Marine Omega-3 Supplementation and Cardiovascular Disease: An Updated Meta-Analysis of 13 Randomized Controlled Trials Involving 127 477 Participants. *Journal of the American Heart Association*. 2019;8(19):1–32. Available from: https://dx.doi.org/10.1161/jaha.119.013543.
17) Jayedi A, Rashidy-Pour A, Parohan M, Zargar MS, Shab-Bidar S. Dietary and circulating vitamin C, vitamin E, β-carotene and risk of total cardiovascular mortality: a systematic review and dose–response meta-analysis of prospective observational studies. *Public Health Nutrition*. 2019;22(10):1872–1887. Available from: https://dx.doi.org/10.1017/s1368980018003725.
18) Qi LW. Micronutrients and Prostate Cancer Risk. 2022. Available from: https://www.proquest.com/openview/82c21dcad64a8df5c4395f9883603aa4/1?pq-origsite=gscholar&cbl=2026366&diss=y.
19) Loh WQ, Youn J, Seow WJ. Vitamin E Intake and Risk of Prostate Cancer: A Meta-Analysis. *Nutrients*. 2022;15(1):1–23. Available from: https://dx.doi.org/10.3390/nu15010014.
20) Sun Y. The associations of carotenoids and vitamin A with lung cancer risk. 2022. Available from: https://ir.vanderbilt.edu/bitstreams/cdf43e54-131b-4ea6-af4c-7c72cea25d1c/download.
21) Varghese R, Efferth T, Ramamoorthy S. Carotenoids for lung cancer chemoprevention and chemotherapy: Promises and controversies. *Phytomedicine*. 2023;116:154850. Available from: https://doi.org/10.1016/j.phymed.2023.154850.
22) Benkhadda H, Bouchentouf M, Herrag SEE. Association between carotenoids and prostate cancer risk: A Meta-Analysis. *The North African Journal of Food and Nutrition Research*. 2019;3(5):131–139. Available from: https://dx.doi.org/10.51745/najfnr.3.5.131-139.
23) Koklesova L, Liskova A, Samec M, Buhrmann C, Samuel SM, Varghese E, et al. Carotenoids in Cancer Apoptosis—The Road from Bench to Bedside and Back. *Cancers*. 2020;12(9):1–40. Available from: https://dx.doi.org/10.3390/cancers12092425.
24) Black HS, Boehm F, Edge R, Truscott TG. The Benefits and Risks of Certain Dietary Carotenoids that Exhibit both Anti- and Pro-Oxidative Mechanisms—A Comprehensive Review. *Antioxidants*. 2020;9(3):1–31. Available from: https://dx.doi.org/10.3390/antiox9030264.
25) Liu S, Wu Q, Wang S, He Y. Causal associations between circulation β-carotene and cardiovascular disease: A Mendelian randomization study. *Medicine*. 2023;102(48):1–5. Available from: https://dx.doi.org/10.1097/md.0000000000036432.
26) Nudy M, Krakowski G, Ghahramani M, Ruzieh M, Foy AJ. Vitamin D supplementation, cardiac events and stroke: A systematic review and meta-regression analysis. *IJC Heart & Vasculature*. 2020;28:1–10. Available from: https://dx.doi.org/10.1016/j.ijcha.2020.100537.
27) Zhang YB, Pan XF, Chen J, Cao A, Zhang YG, Xia L, et al. Combined lifestyle factors, incident cancer, and cancer mortality: a systematic review and meta-analysis of prospective cohort studies. *British Journal of Cancer*. 2020;122(7):1085–1093. Available from: https://dx.doi.org/10.1038/s41416-020-0741-x.
28) Jia C, Lv X, Liu T, Yang L, Chen H. The Association between Dietary Vitamin C Intake and the Risk of Esophageal Cancer: An Updated Dose–Response Meta-Analysis. *Nutrition and Cancer*. 2022;74(10):3479–3491. Available from: https://dx.doi.org/10.1080/01635581.2022.2088813.
29) Thrift AP, Wenker TN, El-Serag HB. Global burden of gastric cancer: epidemiological trends, risk factors, screening and prevention. *Nature Reviews Clinical Oncology*. 2023;20(5):338–349. Available from: https://doi.org/10.1038/s41571-023-00747-0.

30) Corbi G, Ali S, Intrieri M, Modaferri S, Calabrese V, Davinelli S, et al. Association Between Beta-Carotene Supplementation and Mortality: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Frontiers in Medicine*. 2022;9:1–14. Available from: https://dx.doi.org/10.3389/fmed.2022.872310.
31) Gouveia HJCB, da Silva MM, de Castro RM, da Silva LKTM, da Silva Calado CMS, da Silva Araújo ER, et al. Vitamin D supplementation does not alter inflammatory markers in overweight and obese individuals: A systematic review and meta-analysis of randomized controlled trials. *Nutrition Research*. 2024;128:24–37. Available from: https://dx.doi.org/10.1016/j.nutres.2024.06.005.
32) Scafuri L, Buonerba C, Strianese O, de Azambuja E, Palleschi M, Riccio V, et al. Impact of Dietary Supplements on Clinical Outcomes and Quality of Life in Patients with Breast Cancer: A Systematic Review. *Nutrients*. 2025;17(6):1–19. Available from: https://dx.doi.org/10.3390/nu17060981.
33) Rafeeq H, Ahmad S, Tareen MBK, Shahzad KA, Bashir A, Jabeen R, et al. Biochemistry of Fat Soluble Vitamins, Sources, Biochemical Functions and Toxicity. *Haya: The Saudi Journal of Life Sciences*. 2020;5(9):188–196. Available from: https://dx.doi.org/10.36348/sjls.2020.v05i09.007.
34) Argano C, Mirarchi L, Amodeo S, Orlando V, Torres A, Corrao S. The Role of Vitamin D and Its Molecular Bases in Insulin Resistance, Diabetes, Metabolic Syndrome, and Cardiovascular Disease: State of the Art. *International Journal of Molecular Sciences*. 2023;24(20):1–26. Available from: https://dx.doi.org/10.3390/ijms242015485.
35) Fatima G, Dzupina A, Mahdi AA, Fedacko J, Magomedova A, Yousif NG. Role of Vitamin-E as a Vital Nutrient in Health and Diseases. *Indian Journal of Clinical Biochemistry*. 2025;p. 1–14. Available from: https://dx.doi.org/10.1007/s12291-025-01309-0.
36) Meulmeester FL, Luo J, Martens LG, Mills K, van Heemst D, Noordam R. Antioxidant Supplementation in Oxidative Stress-Related Diseases: What Have We Learned from Studies on Alpha-Tocopherol? *Antioxidants*. 2022;11(12):1–17. Available from: https://dx.doi.org/10.3390/antiox11122322.
37) Roy S, Awasthi A. Vitamin A and the Immune System. *Nutrition and Immunity*. 2019;p. 53–73. Available from: http://dx.doi.org/10.1007/978-3-030-16073-9_3.
38) Tsugawa N, Shiraki M. Vitamin K Nutrition and Bone Health. *Nutrients*. 1909;12(7):1–16. Available from: https://doi.org/10.3390/nu12071909.