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REVIEW ARTICLE

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Micronutrient supplementation and cognitive aging in Brazil: evidence, challenges, and policy directions

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Abstract

Introduction: Brazil is undergoing rapid population aging, with individuals aged 60 and above comprising 15.6% of the population in 2023. This demographic shift poses significant publichealth challenges, particularly the rising prevalence of cognitive decline, compounded by widespread micronutrient deficiencies. **Objective:** To synthesize evidence on the relationship between micronutrient status, supplementation, and cognitive decline in older Brazilian population, and to identify barriers to implementing nutritional strategies into public health and clinical practice. **Methods:** A narrative review was conducted using data from national surveys, regional studies, clinical trials and reviews. Literature searches were performed in PubMed, MEDLINE, and Embase using Brazil-specific terms related to micronutrients, cognitive health, and aging. **Results:** Deficiencies in vitamins B-complex, D, E, and minerals such as magnesium, zinc, and selenium are prevalent among older Brazilians, with some inadequacy rates exceeding 60–80%. These deficiencies are mechanistically linked to cognitive decline via oxidative stress, neuroinflammation, and elevated homocysteine levels. Evidence from clinical trials, notably COSMOS, and the 2025 Latin American Consensus Statement supports multivitamin and mineral supplementation (MVMs) as an effective strategy to improve memory and cognition. However, key barriers include lack of age-specific dietary reference values, national supplementation guidelines, and systematic integration of nutrition into geriatric care. **Conclusions:** Addressing micronutrient deficiencies through targeted supplementation and nutrition policy reforms represents a practical, evidence-based approach to promote cognitive resilience and healthy aging in Brazil.

Keywords: Aging. Cognitive Decline. Micronutrients. Multivitamin. Dietary Supplements. Public Health. Brazil.

Introduction

Cognitive decline and dementia are escalating public health challenges worldwide, closely linked to population aging and lifestyle transitions [1]. Brazil is undergoing a rapid demographic transition [2]. According to the Brazilian Institute of Geography and Statistics (IBGE), individuals aged 60 and above comprised 15.6% of the total population in 2023, a proportion projected to rise sharply in the coming decades. This aging trend presents significant public health challenges, particularly in the realm of cognitive health and functional independence [3,4]. Cognitive decline is increasingly prevalent among older Brazilians, exacerbated by widespread micronutrient deficiencies [5-11].

National and regional surveys consistently report inadequacies in B-complex vitamins (especially B12

and folate), as well as vitamin D, vitamin E, and key minerals including magnesium, iron and zinc **[12-25]**. These deficiencies are primarily driven by factors such as food insecurity, limited healthcare access, and persistent socioeconomic disparities affecting both urban and rural populations **[26-33]**. Biologically, micronutrient deficiencies contribute to cognitive deterioration through interrelated pathways involving oxidative stress, neuroinflammation, and elevated homocysteine levels **[34-36]**. These biological disruptions are associated implicated in the pathogenesis of mild cognitive impairment (MCI) **[37,38]** (Figure 1). Adequate intake of vitamins B, D, E, and C, along with trace elements such as zinc and selenium, supports neuronal metabolism, neurotransmitter synthesis, and antioxidant defenses essential for maintaining cognitive resilience **[39]**.

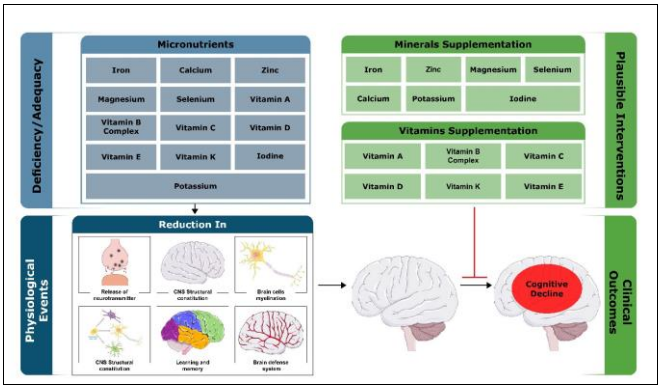

Figure 1. Schematic representation of the relationship between micronutrient deficiency and cognitive decline, and the potential role of supplementation. Biological arts provided by Servier Medical Art (https://smart.servier.com), licensed under CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).

Recent large-scale clinical trials, notably the COSMOS-Mind study and subsequent metaanalyses, have renewed scientific interest in the potential cognitive benefits of daily multivitamin and multimineral supplementation (MVMs). These studies reported significant improvements in episodic memory and global cognition, effectively slowing cognitive aging by approximately two years **[40-42]**. These benefits are particularly relevant for populations with suboptimal dietary intake and limited access to nutrient-rich foods.

Despite this promise, Brazil faces several barriers to the systematic implementation of MVMs strategies in older adults. These include inconsistent dietary reference values, limited agespecific nutrition data, and a lack of clinical guidelines tailored to geriatric populations **[43,44]**. Moreover, national health policies have yet to fully integrate cognitive health and nutrition within the framework of healthy aging, despite existing initiatives such as the National Health Policy for the Elderly (PNSPI) **[45,46]**.

Therefore, this review aims to synthesize and critically appraise current evidence on the interplay between micronutrient status, supplementation, and cognitive health among older adults within the Brazilian context. Specifically, it examines (i) the prevalence of micronutrient deficiencies, (ii) biological mechanisms linking these deficiencies to cognitive decline, (iii) the role of MVMs in addressing nutritional inadequacies and (iv) the policy and practice barriers that hinder integration of nutritional strategies into cognitive health promotion. Finally, this review proposes actionable recommendations for policymakers, clinicians, and researchers to strengthen nutrition-based approaches for supporting healthy cognitive aging in Brazil.

Methodology

This review follows a narrative synthesis approach aimed at consolidating evidence from Brazil on micronutrient deficiencies, their implications for cognitive aging, and the potential role of MVM interventions. A comprehensive literature search was conducted across three major databases, PubMed, MEDLINE, and Embase, using predefined set of keywords and Boolean operators related to micronutrients, cognition, aging, and Brazilian populations. The search covered studies published between January 2007 and October 2025, in English or Portuguese, to ensure comprehensive coverage of national and international literature.

Following duplicate removal, titles and abstracts were independently screened for relevance by two reviewers, with disagreements resolved by discussion and consensus. Full-text articles were then assessed against the following inclusion criteria: (1) studies conducted in Brazil or involving Brazilian cohorts, (2) focus on micronutrient status, deficiency or supplementation; and (3) reported relevance to cognitive health, cognitive decline, or aging-related outcomes. Studies were excluded if they were experimental animal models, conference abstracts, or non-peer-reviewed publications.

In total, 56 publications met the inclusion criteria and were incorporated into the final synthesis, comprising observational studies, clinical trials, meta-analyses, and expert consensus statements. Due to heterogeneity in study design, populations, and outcome measures, data were analyzed using a qualitative narrative synthesis framework. Study quality and methodological rigor were appraised qualitatively to contextualize evidence strength.

Results

Micronutrient Deficiencies in Brazilian Older Adults

National and regional studies consistently report a high prevalence of micronutrient inadequacies among older adults in Brazil **[47]**. Deficiencies in vitamins A, B12, D, and E, folate, and essential minerals such as selenium, magnesium, iron, and zinc are particularly common across diverse populations **[12-14,16,17,20,48-58]**. In several cohorts, inadequacy rates for certain micronutrients exceeded 60–80%, especially among individuals with low income, food insecurity, or limited access to healthcare and nutrient-rich diets **[59]**. Table 1 summarizes key findings from national and regional studies, outlining the reported prevalence of deficiencies, associated cognitive outcomes, and proposed biological mechanisms. Collectively, these data reveal that inadequate micronutrient status particularly for vitamins B12 and D, and trace elements such as selenium, magnesium, and zinc is strongly associated with impaired cognitive performance and greater risk of cognitive decline in Brazilian elders.

Table 1. Prevalence of deficiency/Inadequacy, associated cognitive outcomes, and proposed biological mechanisms.

Micronutrients	Deficiency/ Inadequacy (%)	Outcomes	Mechanisms
Vitamin A	26.1% (60) 49.20%-55.17% (61) 83.3% inadequate intake (25)	↑ Cognitive decline (39)	↓ Retinoid-signaling pathway – impaired neurotransmission (62)
Vitamin B12	7.3%-21.2% (49,50,63)	↑ 5 times cognitive deficit (63)	↑ Homocysteine – ↑neurotoxicity, myelin damage, endothelial dysfunction and ↓ nitric oxide activity (64)
Vitamin B9 (Folate)	0.2%-1.76% (12,49,50)	High serum folate – better cognition (49,50,65)	↓ Homocysteine methylation (66)
Vitamin D	Deficiency 22.6-28.16% Insufficiency 39.4%-64.5% (16,54–56) Vit D deficiency and insufficiency were 1.7% and 16% (95% CI) (17)	Higher Vit D – better cognition Inverse link with cognitive decline (54,55)	Modulation of hippocampal BDNF (54)
Magnesium	10.2 to 28.7% (13)	↑ Cognitive decline (5)	↓ Memory and synapse formation (67)
Zinc	3.9% (70 µg/dL-74 µg/dL) (58)	↑ Cognitive deficit (58)	↓ Neurotransmitter activity – ↓ synapse formation (58)
Iron	2.6%-9.01% (61,68)	↓ Hemoglobin levels (a marker of iron deficiency) – ↓ cognitive scores	↑ Accumulation in CNS – ↑ oxidative damage, apoptotic markers, astroglial response, and
		(68,69)	epigenetic alterations – ↑ cognitive decline (70)
Selenium	48.4% (71)	↑ Cognitive decline (57)	↑ Oxidative stress and neuroinflammation ↓ selenoprotein activity – ↑ cognitive decline (72)

Abbreviations: ↑: Increase, ↓: Reduce/Decrease, BDNF: Brain derived neurotrophic factor, Vit: Vitamin

Source: Own authorship.

Although folate deficiency is relatively uncommon due to mandatory fortification, higher serum folate levels have been positively associated with cognitive performance observed in community-dwelling older adults **[49,50,65]**. In contrast, vitamin B12 deficiency remains prevalent and, when uncorrected for folate status, has been linked to a nearly five-fold increase in cognitive deficit risk **[63]**. Similar associations have been observed for magnesium, zinc, and selenium deficiencies, while excessive iron accumulation has been implicated in oxidative neurotoxicity and worsened cognitive outcomes **[5,57,58,68,69]**.

Socioeconomic determinants play a crucial role in this pattern. A cross-sectional study from Northeast Brazil found that 63.3% of older adults experienced food insecurity, with 59.8% showing measurable cognitive decline and suboptimal micronutrient intake (especially of essential micronutrients), linked to increased risk of cognitive deterioration **[5]**. These findings emphasize that improving micronutrient availability through supplementation, dietary diversification, and food fortification programs represents an essential public-health strategy to preserve cognitive health in Brazil's aging population.

Cognitive Outcomes and Supplementation Evidence

Several studies have demonstrated beneficial effects of micronutrient supplementation on cognitive performance among Brazilian and international older adults. In Brazil, Cardoso et al. (2016) **[73]** reported

improvements in verbal fluency and cognitive scores following increased selenium intake via Brazil nuts consumption, while Matsuo (2022) **[55]** found that vitamin D supplementation reduced the prevalence of cognitive impairment in community-dwelling elderly. Earlier, Miranda et al. (2018) **[48]** evaluated Brazil's national Vitamin A Supplementation Program, highlighting its potential role in addressing micronutrient deficiencies that may contribute to cognitive decline.

These national findings are consistent with results from large-scale international randomized controlled trials, including COSMOS studies (COSMOS-Mind, COSMOS-Web, and COSMOS-Clinic) which collectively demonstrated statistically significant improvements in episodic memory and global cognition among adults aged ≥ 60 years receiving daily MVM supplementation. The observed benefits correspond to an estimated two-year slowing of cognitive aging compared with placebo **[40-42]**.

Further supporting this, a 2025 Latin American expert consensus emphasized the importance of MVMs in promoting cognitive healthy aging, particularly in populations with widespread micronutrient inadequacies like Brazil. The panel recommended regular MVMs use to help older adults meet daily nutrient requirements and reduce the risk of mild cognitive impairment (MCI) **[39]**. Despite these promising findings, supplement use remains limited in Brazil, with only about 16.0% of adults reporting regular intake **[20]**. These findings collectively suggest that while micronutrient interventions especially multivitamin formulations offer promising benefits, broader public adoption and integration into preventive healthcare remain challenges.

Barriers to Implementation in Brazil

Despite growing evidence supporting the role of micronutrient supplementation in promoting cognitive health, systemic and structural barriers continue to limit the translation of research findings into public-health practice **[47,61]**. The major challenges are summarized below.

Lack of Standardized Dietary Reference Values and clinical guidelines for Older Adults

Current recommendations generalize across adult age groups and do not account for agerelated physiological changes, such as decreased vitamin B12 absorption and increased requirements for vitamin D and calcium. This gap complicates both clinical decision-making and public-health planning in geriatric nutrition **[43]**.

Limited Integration of Nutrition and Cognitive Health in Public-Health Programs

Policies such as the National Health Policy for the Elderly (PNSPI) acknowledge nutrition as a determinant of healthy aging but rarely incorporate routine micronutrient or cognitive screening within elderly-care services **[4,45,46]**. Nutrition counseling is inconsistently delivered, and regional disparities persist, with the North and Northeast regions showing higher rates of food insecurity and malnutrition **[46]**.

Socioeconomic and Structural Challenges

Deep-rooted socioeconomic inequalities, food insecurity, and limited access to nutriente-rich foods disproportionately affect Brazil's older population. Low-income households experience higher rates of both micronutrient deficiencies and cognitive decline, yet preventive nutrition strategies remain underprioritized in primary-care settings **[26,27]**. Enhancing public awareness, strengthening nutrition education for healthcare providers, and ensuring equitable access to supplements and fortified foods are essential to overcoming these barriers and enabling nationwide implementation of nutrition-based cognitive-health interventions.

Discussion

This review underscores that micronutrient inadequacies remain a major and modifiable determinant of cognitive aging in Brazil. The convergence of biological evidence, regional consensus, and global trial data collectively supports the premise that optimizing micronutrient intake through diet or supplementation can play a meaningful role in preserving cognitive function among older adults. While global evidence such as the COSMOS-Mind and related studies demonstrates the cognitive benefits of daily multivitamin and multimineral (MVM) supplementation, the relevance of these findings for Brazil lies in their applicability to populations characterized by dietary gaps, socioeconomic disparities, and limited healthcare access **[40-42]**.

The recent Latin American Consensus Statement on Micronutrient Supplementation and Cognitive Healthy Aging (2025) reinforces this applicability by contextualizing international evidence for regional realities. Developed using a modified Delphi process, the consensus concluded that MVMs represent a safe, practical, and evidence-based approach to support cognitive health when used within recommended daily allowances. Importantly, it emphasized that MVM supplementation should complement not replace a balanced diet and is particularly valuable where

nutritional inadequacies persist despite fortification efforts [39].

For Brazil, these insights hold clear policy implications. The absence of age-specific dietary reference values, limited integration of nutrition within geriatric care, and the lack of structured national guidelines for micronutrient supplementation represent key barriers to implementation [74]. Strengthening the role of nutrition in primary healthcare and aging-related public programs, alongside routine screening for deficiencies in vitamins B12, D, E, and trace minerals, would enable early intervention and better prevention of cognitive decline. Furthermore, disparities in food security and regional resource allocation necessitate targeted approaches that combine supplementation, fortification, and community-based education. Integrating MVM access into Brazil's existing frameworks such as the PNSPI could enhance equity in nutritional support while leveraging existing healthcare infrastructure.

Future research priorities include the development of Brazil-specific dietary guidelines for older adults, longitudinal studies assessing the long-term cognitive effects of supplementation, and locally designed intervention trials to evaluate feasibility, adherence, and cost-effectiveness in realworld settings [75,76]. Such evidence will be critical for adapting regional recommendations to Brazil's diverse population and ensuring that nutrition-based strategies for cognitive health are both culturally and economically sustainable.

In summary, addressing micronutrient insufficiencies/deficiencies through integrated dietary and MVM supplementation strategies represents a feasible, evidence-informed pathway to promote healthy cognitive aging in Brazil. Collaborative action among policymakers, clinicians, and researchers is essential to translate this growing evidence into equitable, population-level benefits.

Conclusion

Brazil's aging population faces a rising burden of cognitive decline compounded by widespread micronutrient deficiencies and limited access to nutritional care. This review highlights consistent evidence linking B-complex vitamins, vitamin D, magnesium, and zinc to cognitive health and supports MVMs as a feasible strategy to promote healthy cognitive aging. Findings from international trials, notably COSMOS-Mind, together with the 2025 Latin American Consensus Statement, reinforce the relevance of integrating supplementation within Brazil's public-health and clinical frameworks. To translate evidence into impact, Brazil should establish age-specific dietary reference values, develop national guidelines for micronutrient supplementation, and conduct localized intervention trials to validate efficacy in its diverse population. By aligning global evidence with regional consensus and national health priorities, Brazil has a timely opportunity to implement scalable, evidence-based nutritional strategies that enhance cognitive resilience, promote healthy aging, and improve quality of life for its older adults.

CrediT

Author contributions: **Data curation**; **Formal Analysis**; **Investigation**; **Methodology**; **Project administration**; **Supervision**; **Writing - original draft; Writing-review & editing –** All authors.

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Marine Garcia and Lara Mustapic are presently on the payroll of Haleon. Other authors declare no conflicts of interest.

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Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

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