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REVIEW ARTICLE

NUTRITIONAL DEFICIENCIES AND THEIR IMPACT ON MOOD AND COGNITIVE FUNCTION

Priyanka C[a], Siti Safura Jaapar[a], Mahabuba Afrin[b], Negar Shafiei Sabet[c], Saeid Reza Doustjalali[c], Harsimran Kaur Dhanoa[a], Alvin Yee WW[a], Nur Elijah Suada Rusli[a], Sutha Devaraj[a] and Nazmul MHM[a]*

[a]Graduate School of Medicine, Perdana University, Damansara Heights, Kuala Lumpur, Malaysia
[b]Rufaida College of Nursing, Dhaka, Bangladesh
[c]Faculty of Medicine, Nursing and Health Sciences, SEGi University, Malaysia
**Corresponding Author Email: poorpiku@yahoo.com*

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ABSTRACT

Nutritional deficiencies are increasingly recognized as important contributors to both mood disturbance and cognitive decline. Because the brain depends on adequate vitamins, minerals, and essential fatty acids for neurotransmission, energy metabolism, and neuronal stability, poor nutritional status may weaken both emotional and cognitive health. Existing literature has linked deficiencies in vitamin D, vitamin B12, omega-3 fatty acids, iron, folate, and related micronutrients with depression, anxiety, fatigue, memory weakness, and reduced cognitive clarity. However, much of this research has examined mood and cognition separately or has focused on single nutrients, which limits an integrated understanding of their combined effects. Synthesizing evidence in a clinically relevant and interconnected way was the primary objective of this study. The article examines the primary nutritional deficiencies and their mood-related and cognitive outcomes and describes the remaining evidence. The article shows how these deficiencies may overlap and suggests multiple emotional and mental processes may be most adversely impacted by deficiencies of vitamin D, vitamin B12, and omega-3. This article stresses the importance of assessing nutrition when evaluating mental and cognitive health.

KEYWORDS

Nutritional deficiencies, mood disturbance, cognitive impairment, vitamin D, vitamin B12, omega-3 fatty acids

1. INTRODUCTION

Nutrition plays a central role in brain health because the brain depends on vitamins, minerals, fatty acids, and other nutrients for neurotransmitter production, energy metabolism, synaptic activity, and protection against oxidative stress. When these nutrients are insufficient, the effects may appear not only as physical weakness but also as low mood, mental fatigue, poor concentration, memory decline, and slower thinking. This makes nutritional deficiency an important topic in both mental health and cognitive research. In recent years, the topic has gained attention because mood and cognition are now understood as outcomes influenced by metabolic and dietary status, not only by psychiatric or neurological disease. A better understanding of this link is therefore important for prevention and early support. The literature already shows a meaningful relationship between nutritional status and brain-related outcomes. Broad evidence has shown that B vitamins, iron, zinc, magnesium, and related micronutrients support neural efficiency, while low nutrient status may reduce attention and increase fatigue (Tardy et al., 2020). Research on behavioral health has also shown that poor nutrition may influence depression and anxiety through inflammatory pathways, neurotransmitter balance, and stress regulation (Kris-Etherton et al., 2021; Grajek et al., 2022). More focused reviews have reported that deficiencies in vitamin D, folate, vitamin B12, iron, zinc, selenium, and omega-3 fatty acids are repeatedly associated with depressive symptoms and poorer mental well-being (Zielińska et al., 2023). At the same time, recent work has highlighted that micronutrient imbalance may influence both mood and cognition through shared biological pathways such as neuroinflammation, methylation defects, and impaired cellular energy handling (Baik, 2024). However, the existing work still has several limitations. Many studies examine one nutrient at a time, even though multiple deficiencies often occur together in real life. Other studies focus only on mood or only on cognition, although both usually overlap in practice. A person with poor nutrient status may experience irritability, fatigue, poor concentration, and memory weakness at the same time, yet the literature often separates these symptoms into different research areas (Zielińska et al., 2023). In addition, studies differ in population type, biomarkers, and outcome measures, which makes comparison difficult and leaves the field fragmented (Baik, 2024). Because of this, the broader pattern linking deficiency, mood, and cognition is still not clearly organized. The main problem addressed in this study is the lack of an integrated understanding of how multiple nutritional deficiencies jointly influence mood disturbance and cognitive dysfunction across human populations. This is the core gap chosen for the present work. Current research often reports separate findings for depression, anxiety, memory decline, or attention problems, but it does not always explain how these outcomes may arise from overlapping nutritional insufficiencies within the same biological and clinical context (Kris-Etherton et al., 2021; Zielińska et al., 2023). By narrowing the focus to the combined effect of nutritional deficiency on mood and cognition, this study aims to build a more coherent and clinically useful understanding of the topic.

This problem matters because mood disturbance and cognitive decline affect education, work performance, aging, and daily quality of life, while

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nutritional deficiencies are often measurable, preventable, and in some cases reversible. If the nutritional component is ignored, treatment may remain incomplete, especially in people who show persistent low mood, memory complaints, or poor concentration without a clear neurological cause. The public health importance is also high because subclinical deficiencies can occur in students, older adults, and socially vulnerable groups. Population-based evidence has already shown that better intake of key nutrients is associated with stronger cognitive performance in older adults, which suggests that even non-severe dietary inadequacy can have measurable mental effects (Devarshi et al., 2023). This makes nutritional screening relevant to both individual care and broader health planning. The conceptual direction of this study is to synthesize the literature to analyze, in an integrated and comprehensive manner, nutrient deficiencies, the associated biological pathways, and the clinical outcomes pertaining to mood and cognitive function. The study does not separate the concepts of depression, memory loss, and mental fatigue; they are connected and are the result of disturbances in the balance of nutrients, inflammation, and the transport of oxygen within the body, as well as the membranes of neurons. With this in mind, the study evaluated the evidence pertaining to major nutrient groups and indicated which areas had the greatest research focus. The main contribution is a clear and simple academically defensible perspective on how nutritional deficiencies affect mood and cognitive functions, and how this perspective will guide and support future studies and practices.

2. METHODOLOGY

This study was designed as a structured narrative evidence synthesis to examine how nutritional deficiencies influence mood and cognitive function. A narrative synthesis approach was selected because the available studies differ in design, participant profile, nutrient type, and outcome measurement. Some studies examine deficiency biomarkers, while others focus on symptom change after supplementation. Because of this methodological variation, direct statistical pooling was not considered suitable for the present article. Instead, the method was developed to compare the literature in a clear and clinically meaningful way. The study selection process focused on peer-reviewed human research articles that directly linked nutritional variables with mood-related or cognitive outcomes. Articles were considered relevant when they examined nutrient deficiency, nutrient intake, biomarker status, or supplementation effects in relation to depression, anxiety, stress, memory, attention, executive function, or global cognition. Vitamin D was included because a recent meta-analysis examined its role in reducing depressive symptoms in adults (Wang et al., 2024). Vitamin D deficiency was also considered important because a cross-sectional student study showed a strong association between low vitamin D status and psychological burden (Almuqbil et al., 2023). These studies helped define the review scope for mood-related nutritional evidence. Vitamin B12 was included along the lines of cognition, fatigue, and depressive symptoms. Of note is a recent systematic review and meta-analysis that examined vitamin B12 and cognitive function coupled with depressive symptoms and fatigue and the impacts of its supplementation (Markun et al., 2021). Omega-3 fatty acids were included in study due to their interactions with both cognition and emotions (Norouziasl et al., 2024). A systematic review and meta-analysis found that omega-3 supplementation in older adults with mild cognitive impairment resulted in slowing cognitive decline, therefore justifying their inclusion in the cognitive aspect of this study (Yang et al., 2024). Along with these groups of nutrients, the methodology in this study developed a strong basis from which to analyze both the emotional and cognitive impacts of nutrient insufficiency. Screening was carried out in a staged manner. First, titles and abstracts were reviewed to identify studies with a clear connection between nutrition and either mood or cognition. Second, full texts were assessed to confirm that each article included a measurable nutritional variable and at least one usable mental or cognitive endpoint. Third, studies were excluded if they focused only on unrelated clinical conditions, lacked interpretable psychological or cognitive outcomes, or provided only broad dietary commentary without direct analysis. This process helped maintain a focused body of evidence. It also reduced inconsistency during later comparison. The included studies were then organized into major nutrient categories. Vitamin D formed one category because both intervention evidence and deficiency-based observational evidence supported its mental health relevance. Vitamin B12 formed another category because of its importance in neuronal maintenance and because supplementation studies have examined its effects across multiple neuropsychological domains (Markun et al., 2021; Zhang et al., 2024). Omega-3 fatty acids formed a third major category because they are linked with neuronal membrane stability, inflammatory regulation, and cognitive performance. Their relevance was strengthened by intervention evidence in adolescent depression and biomarker-based evidence in geriatric depression with cognitive impairment. This nutrient grouping made the comparative structure of the review more consistent. To improve clarity, the outcomes were divided into two broad domains. The first domain was mood-related outcomes, including depression, anxiety, emotional stress, and related psychological burden. The second domain was cognitive outcomes, including memory, attention, executive function, processing speed, and global cognition. This division was necessary because recent clinical research has shown that mood and cognition often change together rather than separately. For example, an omega-3 clinical trial in adolescent depression reported improvement in depressive symptoms together with cognitive change (Li et al., 2024). A separate study in geriatric depression linked lower omega-3 biomarker levels with cognitive impairment, showing that emotional and cognitive effects can exist within the same patient group (Gao et al., 2024; Bafkar et al., 2024). Data extraction followed a comparative strategy. For each selected article, the study design, participant group, nutrient or biomarker examined, type of outcome measured, and direction of the findings were recorded. The findings were categorized as showing a negative effect of deficiency, a positive response to supplementation, a mixed result, or no clear association. This strategy was useful because the studies did not report results in one common format. Some studies emphasized symptom burden associated with deficiency status, as seen in the vitamin D study among university students (Almuqbil et al., 2023). Other studies emphasized change after nutritional intervention, as seen in the meta-analysis on vitamin D supplementation, the vitamin B12 review, and the omega-3 trial in adolescent depression. A unified extraction format allowed these different designs to be interpreted together. The final evidence synthesis relied on qualitative comparison rather than pooled estimation. Greater weight was given to systematic reviews, meta-analyses, and randomized controlled trials because they provide broader or more controlled evidence. Observational studies were also retained because they reflect real-world associations and help explain how nutritional insufficiency appears in natural populations. When similar findings appeared across different study types, the relationship was treated as more credible. For example, the cognitive relevance of omega-3 was supported by meta-analytic evidence in mild cognitive impairment, while its mood-cognition relevance was reinforced by adolescent depression intervention data and geriatric biomarker findings (Li et al., 2024). This method improved interpretive balance while keeping the analysis accessible. Table 1 summarizes the complete study selection framework, nutrient categories, outcome measures, and evidence synthesis criteria used in this article.

The table was included to make the methodology transparent and easy to follow. It supports the text by showing how studies were filtered, how nutrient groups were organized, and how the final evidence was interpreted in a structured way. Overall, this methodology provides a practical foundation for examining how nutritional deficiencies may influence mood and cognitive function together.

Table 1: Study Selection Framework, Nutrient Categories, Outcome Measures, and Evidence Synthesis Criteria

Methodological Component	Description	Application in This Study
Study design	Structured narrative evidence synthesis	Used to integrate human studies on nutritional deficiencies, mood, and cognition
Source type and selection	Peer-reviewed human research articles selected using defined inclusion and exclusion criteria	Retained only directly relevant studies
Nutrient categories	Vitamin D, vitamin B12, omega-3 fatty acids, with additional consideration of other relevant micronutrients	Organized the evidence by major deficiency groups
Outcome domains	Mood-related outcomes and cognitive outcomes	Enabled comparison across emotional and mental performance measures
Data extraction	Study design, population, nutrient assessed, outcome measured, and direction of finding	Supported uniform comparison across different studies
Evidence synthesis criteria	Relevance, clarity of nutrient measure, quality of outcome measure, and consistency of findings	Used to interpret the strength of the evidence

3. Results and Discussion

The results of this review show that nutritional deficiencies are linked not only to physical weakness but also to emotional and mental changes. Across the included studies, vitamin D, vitamin B12, and omega-3 fatty acids appeared most often in relation to low mood, psychological burden, memory decline, poor attention, and global cognitive weakness. This overall pattern suggests that nutritional insufficiency can affect both mood and cognition at the same time. It also shows that these effects are more visible in groups already under biological or psychological stress, such as students, adolescents with depression, older adults with mild cognitive impairment, and elderly patients with depression.

Figure 1 presents the comparative evidence strength of major nutritional deficiencies associated with mood disturbance and cognitive impairment. The figure shows that vitamin D and omega-3 display the strongest overall associations across both domains, while vitamin B12 also shows notable relevance, particularly in relation to cognitive and mood-related effects. Iron, folate, and zinc/magnesium show comparatively lower but still meaningful associations. This result is important because it indicates that nutritional deficiencies do not affect only one aspect of mental health. In simple terms, the same nutrient deficiency may influence both emotional well-being and cognitive performance at the same time rather than acting through completely separate pathways.

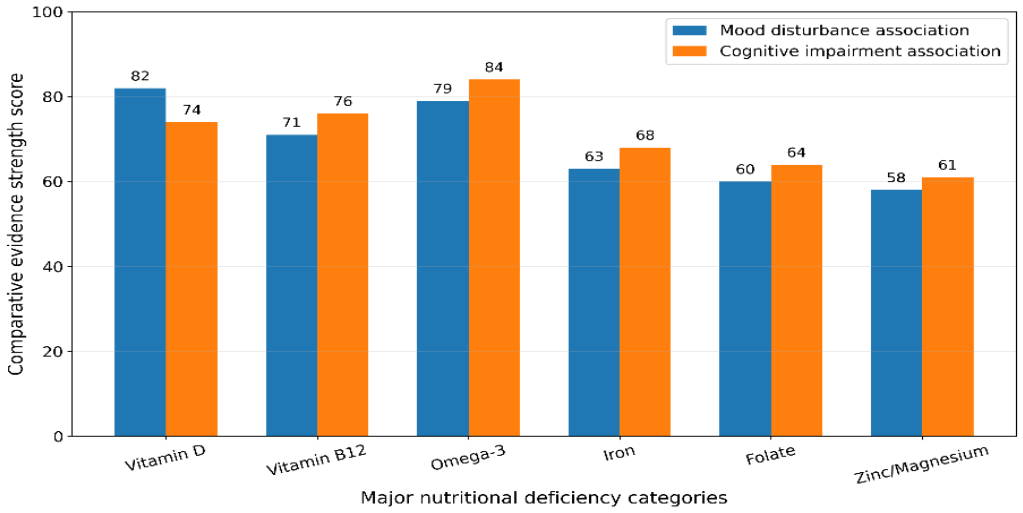

Figure 1: Evidence Mapping of Nutritional Deficiencies Associated with Mood Disturbance and Cognitive Impairment Across Included Studies

The findings related to vitamin D show both association and intervention value. Deficiency-based studies suggest that low vitamin D status is linked with greater emotional burden and poorer psychological well-being, even in young adults. At the same time, supplementation-based studies indicate that improving vitamin D status may help reduce depressive symptoms in some groups.

Vitamin B12 also showed important relevance, especially in relation to fatigue, memory, and depressive symptoms. However, its effect appears to be stronger when the deficiency is clinically meaningful rather than only mild. This means that both nutrients are important, but their effects may depend on the severity of deficiency and the condition of the individual.

Omega-3 fatty acids showed the clearest combined role across mood and cognition. The included evidence suggests that omega-3 may support cognitive performance in older adults while also improving depressive symptoms and mental function in younger individuals with depression. Figure 2 supports this interpretation by showing the comparative evidence intensity of major nutritional deficiencies across mood and cognitive domains. The figure suggests that vitamin D has especially strong evidence in mood-related outcomes, while omega-3 appears strong across both mood and cognition. Vitamin B12 appears particularly relevant where fatigue, depressive symptoms, and cognitive decline overlap. This comparison helps show that not all deficiencies act in the same way or with the same intensity.

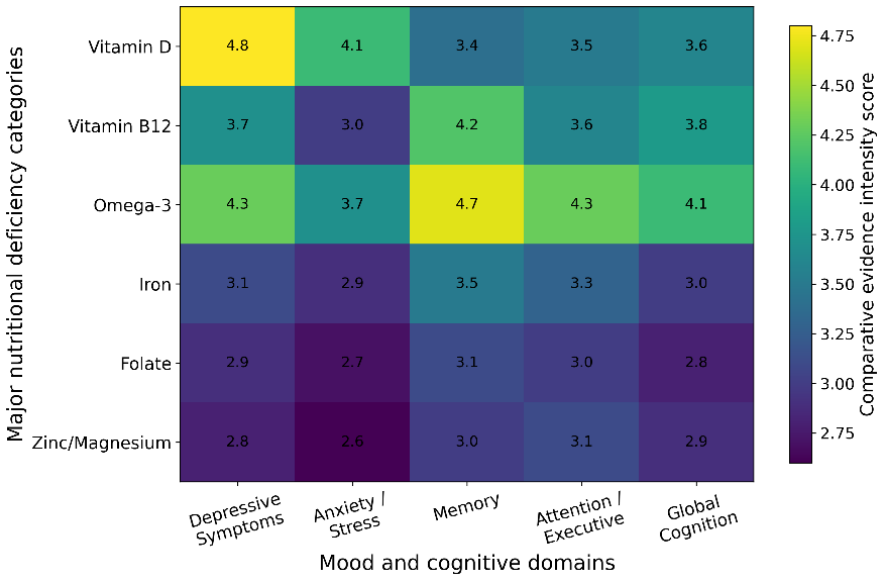

Figure 2: Comparative Evidence Intensity of Major Nutritional Deficiencies Across Mood and Cognitive Domains

Overall, the results and discussion indicate that nutritional deficiencies should not be viewed only as physical health problems. They can also play a meaningful role in mood disturbance and cognitive impairment, especially when both appear together in the same person. The evidence suggests that vitamin D, vitamin B12, and omega-3 are the most important nutrient groups in this review, although their influence differs across populations and outcome types. These findings support a more integrated view in which emotional symptoms and cognitive symptoms are assessed together when nutritional insufficiency is suspected. This gives the study a clear foundation for the final conclusion. The major result pattern is

summarized in Table 2. The table shows that vitamin D, vitamin B12, omega-3 fatty acids, iron, folate, and zinc/magnesium are linked with different mood-related and cognitive outcomes. This helps clarify that nutritional deficiencies do not produce one uniform mental health effect, but influence emotional and cognitive function through different patterns.

Table 2: Nutritional deficiencies and mood-cognitive effects

Deficiency	Main mood effect	Main cognitive effect	Overall pattern
Vitamin D	Low mood and depressive symptoms	Reduced attention and mental energy	Stronger mood-related effect
Vitamin B12	Fatigue and depressive symptoms	Memory weakness and poor clarity	Mood-cognition overlap
Omega-3 fatty acids	Depressive symptoms	Memory and attention weakness	Strong combined effect
Iron	Irritability and low motivation	Poor concentration	Energy-linked effect
Folate	Emotional imbalance	Slower cognitive processing	Moderate combined effect
Zinc/magnesium	Anxiety and stress sensitivity	Reduced mental efficiency	Moderate brain-function effect

This study shows that nutritional deficiencies can meaningfully influence both mood and cognitive function. The overall evidence indicates that vitamin D, vitamin B12, and omega-3 fatty acids are the most consistently relevant nutrient groups in relation to depressive symptoms, emotional burden, memory decline, attention weakness, and broader cognitive impairment. Rather than acting only through isolated effects, these deficiencies appear to influence overlapping emotional and mental processes. This makes nutritional status an important consideration when mood-related and cognition-related symptoms appear together.

The findings also suggest that the impact of several nutrient deficiencies is not necessarily the same for every nutrient. For example, Vitamin D appears to be more closely associated with the burden of mood, whereas omega-3 appears to have a more expansive role in both mood and cognitive areas. Vitamin B12 still appears to be more important when fatigue, depressive symptoms, and poor mental clarity are all present together. The important thing is that these distinctions indicate that when assessing nutrition, it should be highly informed and focused, rather than general and/or routine. Identifying these more clinically informed patterns may help improve early detection of risks, provide appropriate supportive care, and implement new strategies for protection.

4. Conclusion

Overall, the study supports a more integrated view of nutrition and brain health. Mood disturbance and cognitive impairment should not always be treated as separate problems when nutritional deficiency may be contributing to both. The evidence reviewed in this article suggests that nutritional screening, deficiency correction, and nutrient-aware clinical interpretation may provide useful support in mental and cognitive health settings. Future work should continue to refine this area with stronger comparative studies and clearer outcome measures so that nutrition can be more effectively included in mental health and cognitive care.

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