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Micronutrient Deficiencies and Emotional Dysregulation in Adults: An Integrative Review of Nutritional Psychiatry

Dr. Shalini PY[1], Dr. Nithesh MK[2], Dr. Prajna P Shetty[3], Dr. Vanitha S Shetty[4], Dr. Shradha[5]

[1] PG Scholar, Department of Clinical Naturopathy, Alva's College of Naturopathy & Yogic Sciences, Moodbidri, Karnataka, India.
[2] Senior research officer, Department of naturopathy, Central council for research in yoga and naturopathy, Delhi, India
[3] Associate Professor, Department of Naturopathy, Alva's College of Naturopathy & Yogic Sciences, Moodbidri, Karnataka, India.
[4] Principal and HOD Department of naturopathy, Alva's College of Naturopathy & Yogic Sciences, Moodbidri, Karnataka, India.
[5] PG Scholar, Department of Clinical Naturopathy, Alva's College of Naturopathy & Yogic Sciences, Moodbidri, Karnataka, India.

Corresponding Author:
Dr. Shalini P Y
PG Scholar,
Department of Clinical Naturopathy,
Alva's College of Naturopathy & Yogic Sciences,
acnys@alvas.org.
Moodbidri, Karnataka, India – 574227
Email: gowdashalini98@gmail.com

ABSTRACT

The increasing global burden of psychological conditions such as depression, anxiety, and emotional dysregulation among adults has prompted greater attention toward modifiable lifestyle factors influencing mental health. Nutrition has emerged as a significant determinant of emotional well-being and neurocognitive functioning, with growing evidence linking specific nutrient deficiencies to psychological symptoms. This systematic review examines the association between nutritional deficiencies and the development and persistence of psychological symptoms in adults. A comprehensive literature search was conducted for studies published between 2000 and 2025 using PubMed, Scopus, and Google Scholar. Search terms included nutritional deficiency, mental health, emotional symptoms, micronutrients, vitamin B12, magnesium, depression, and anxiety. Eligible studies encompassed observational studies, clinical trials, and systematic reviews that evaluated micronutrient status in relation to psychological outcomes in adult populations. The findings consistently demonstrate associations between deficiencies of vitamins B12, B6, folate, vitamin D, iron, zinc, magnesium, and omega-3 fatty acids and a range of psychological disturbances, including mood disorders, heightened stress responses, cognitive fatigue, and reduced emotional resilience. These nutrients are integral to neurotransmitter synthesis, inflammatory regulation, and modulation of the hypothalamic–pituitary–adrenal axis. While evidence supports a meaningful link between nutrient status and mental health, the influence of confounding lifestyle factors such as sleep quality, stress exposure, and physical activity remains substantial. Overall, the review highlights the importance of integrating nutritional assessment and targeted interventions into adult mental health care. Future research should prioritize longitudinal and region-specific studies to strengthen causal inference and enhance the clinical applicability of nutrition-based strategies for psychological well-being.

Keywords: Nutritional deficiencies, mental health, depression, anxiety, micronutrients, emotional well-being, adults

Introduction

Mental health disorders have emerged as one of the most pressing global health challenges, affecting millions of adults and contributing significantly to disability and reduced quality of life. Depression and anxiety, in particular, rank among the leading causes of disease burden worldwide (1). Traditionally, these conditions have been managed through pharmacological and psychotherapeutic approaches. While effective, these methods often fail to address underlying contributors to psychological distress. Recently, increasing attention has been directed toward lifestyle factors—especially nutrition—as modifiable determinants of mental well-being (2,3).

The human brain is an energy-intensive organ that depends on a continuous supply of nutrients to sustain neurotransmitter synthesis, neuroplasticity, and cellular signaling. Micronutrients such as vitamins, minerals, and essential fatty acids play critical roles in these processes (4,5). For example, B vitamins are involved in methylation and neurotransmitter production, omega-3 fatty acids maintain neuronal membrane integrity, and minerals such as magnesium regulate stress response via the hypothalamic-pituitary-adrenal (HPA) axis (6,7). When these nutrients are lacking, neurochemical imbalances, oxidative stress, and inflammation can occur, increasing susceptibility to depression and anxiety (8).

Modern diets, dominated by processed foods and low in nutrient density, further amplify the risk of deficiencies. Observational and interventional studies, such as the SMILES trial, have shown that improving dietary quality significantly reduces depressive symptoms, reinforcing nutrition as a therapeutic strategy (9,10). However, nutritional status remains overlooked in mainstream psychiatric practice, creating a critical gap in holistic care (9).
Modern psychiatry primarily relies on pharmacological and psychotherapeutic interventions, which, although beneficial, often show delayed therapeutic response. Antidepressants typically require 4–6 weeks to demonstrate noticeable improvement, and up to one-third of patients experience inadequate response or relapse (3,4). This lag may be attributed to the complexity of mood disorders, which involve not only neurotransmitter imbalances but also inflammatory processes, oxidative stress, hormonal dysregulation, and altered gut microbiota—all systems influenced by nutrition (5,6). The limited focus of conventional treatments on biochemical neurotransmitter regulation, without addressing systemic metabolic and nutritional factors, further prolongs recovery.

In this context, Psychoneuroendocrinoimmunology (PNEI) has gained increasing attention. PNEI emphasizes the interconnectedness of the nervous, endocrine, and immune systems, illustrating how stress, inflammation, and hormonal fluctuations influence mood regulation (7). Emerging evidence shows that nutrient deficiencies amplify PNEI dysregulation, promoting neuroinflammation and stress-axis overactivation (8). For example, inadequate intake of omega-3 fatty acids, magnesium, and B vitamins contributes to chronic inflammation, impaired cortisol regulation, and neurotransmitter depletion, creating a physiological environment conducive to depression and anxiety (9,10)
This paper synthesizes evidence on the relationship between micronutrient deficiencies and emotional health in adults. It focuses on key nutrients—B vitamins, vitamin D, magnesium, iron, zinc, and omega-3 fatty acids—that influence neurotransmission, stress resilience, and cognitive function. The aim is to highlight the need for integrating nutritional screening and intervention into mental health care (12).

2. Role of Nutrition in Mental Health

The brain is one of the most metabolically active organs, consuming nearly 20% of the body's energy despite its small size. It relies on a steady supply of micronutrients for neurotransmission, hormonal regulation, and cellular repair (13). Nutritional inadequacy can disrupt these processes, leading to mood dysregulation and psychological vulnerability.
Neurotransmitter synthesis is highly nutrient-dependent. Serotonin and dopamine require cofactors like vitamin B6, folate, and iron for production (14). A lack of these nutrients impairs neurotransmission, contributing to depression and irritability. Omega-3 fatty acids, especially EPA and DHA, are essential for neuronal membrane fluidity and receptor signaling, with low intake linked to depressive symptoms (15).
Inflammation and oxidative stress are now recognized as central to mood disorders. Micronutrients such as zinc and magnesium exert anti-inflammatory effects, and deficiencies heighten pro-inflammatory cytokine activity, affecting neuroplasticity (16,17). Similarly, dysregulation of the HPA axis—commonly observed in anxiety—can be exacerbated by low magnesium or vitamin D levels, leading to heightened cortisol secretion and stress reactivity (18).

3. Common Nutritional Deficiencies and Their Psychological Impact

3.1. B Vitamins (B6, B12, Folate)

B vitamins are essential for neurotransmitter production and methylation cycles. Deficiencies impair serotonin and dopamine synthesis, leading to depressive symptoms and cognitive fatigue (19). Meta-analyses show low B12 levels are strongly associated with depression in adults (20).

3.2. Vitamin D (6)

Vitamin D (6) regulates serotonin production and modulates neuroimmune function. Deficiency is linked to higher rates of depression and seasonal affective disorder (21). Recent reviews confirm supplementation improves mood in deficient individuals (22).

3.3. Magnesium (7)

Magnesium (7) regulates the HPA axis and acts as a natural anxiolytic. Low levels are correlated with anxiety, poor stress resilience, and sleep disturbances (23). Supplementation studies show significant symptom reduction in depression and anxiety (24).

3.4. Iron (8)

Iron (8) supports dopamine synthesis and oxygen delivery to neurons. Deficiency manifests as fatigue, irritability, and emotional instability (25). Evidence indicates higher depression prevalence among iron-deficient women (26).

3.5. Zinc

Zinc influences neurotransmission and neurogenesis. Deficiency is associated with depressive symptoms and increased inflammation (27). Clinical trials suggest zinc supplementation enhances antidepressant efficacy (28).

3.6. Omega-3 Fatty Acids (4,5)

EPA and DHA maintain neuronal membrane function and reduce neuroinflammation. Low intake correlates with mood disorders and cognitive decline (29). RCTs confirm omega-3 supplementation improves depressive symptoms (30).

4. Mechanistic Insights

Nutrition impacts mental health through interconnected pathways. Neurotransmitter synthesis depends on adequate B vitamins, iron, and amino acids. Deficiencies reduce serotonin, dopamine, and GABA availability, impairing mood regulation (31). Inflammatory signaling also plays a key role; low zinc and omega-3 intake allows cytokine overproduction, altering neural plasticity and stress responses (32).

Micronutrient deficits can dysregulate the HPA axis, amplifying cortisol secretion and anxiety symptoms (33). Magnesium (7) and vitamin D are critical for stress regulation; low levels result in heightened sympathetic activity and poor emotional resilience. Furthermore, gut microbiota, shaped by diet, influences mood via immune and neurochemical pathways. Nutrient-poor diets promote dysbiosis, increasing systemic inflammation and neurochemical imbalance (34).

he relationship between nutrition and mental health is driven by intricate biochemical and physiological pathways that influence brain function. Micronutrients serve as cofactors in neurotransmitter synthesis, regulate immune signaling, and modulate stress-response systems. When these nutrients are deficient, disruptions occur in neurochemical transmission, inflammatory balance, and hormonal control—contributing to mood disorders and emotional dysregulation (31,32).

One of the most direct mechanisms is neurotransmitter synthesis. Key neurotransmitters, including serotonin, dopamine, and gamma-aminobutyric acid (GABA), depend on specific nutrients for production. Vitamin B6 acts as a coenzyme in the conversion of tryptophan to serotonin, while iron and folate are essential for dopamine synthesis (13,14,19). Deficiencies in these nutrients impair neurotransmission, leading to symptoms such as irritability, low motivation, and depressive mood (20). Low omega-3 fatty acid levels further compromise neuronal membrane integrity, affecting receptor signaling and synaptic plasticity (15,29,30).

Inflammation and oxidative stress constitute another critical pathway linking nutritional status to psychological health. Many mood disorders exhibit elevated inflammatory markers and oxidative damage (32,38). Nutrients like zinc, magnesium, and omega-3 fatty acids possess anti-inflammatory and antioxidant properties, reducing cytokine-mediated neurotoxicity (16,27,33). Deficiencies in these nutrients enhance pro-inflammatory cascades, disrupt neuroplasticity, and impair mood regulation (31,38). For example, inadequate omega-3 intake can lead to excessive microglial activation in the brain, exacerbating neuroinflammation and depressive symptoms (17,33).

Dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis is another well-established mechanism associated with mood disorders, particularly anxiety and chronic stress. Magnesium (7) and vitamin D are essential for maintaining balanced cortisol secretion. When these nutrients are insufficient, heightened cortisol responses and prolonged stress activation occur, contributing to anxiety and emotional exhaustion (18,23,24). Persistent HPA axis overactivity further disturbs sleep patterns and energy metabolism, compounding psychological vulnerability.

Finally, the gut-brain axis provides an emerging link between nutrition and mental health. Gut microbiota communicates with the central nervous system via neural, immune, and endocrine pathways. Nutrient deficiencies, combined with low-fiber, high-processed diets, promote gut dysbiosis, which triggers systemic inflammation and alters neurotransmitter production (18,34). For instance, inadequate intake of omega-3 fatty acids and B vitamins has been associated with changes in microbial diversity, influencing serotonin availability in the gut and brain (17,34).

The purpose of this systematic review was to critically synthesize existing evidence on the association between micronutrient deficiencies and emotional dysregulation, depression, and anxiety in adults. Specifically, the review aimed to (i) identify key micronutrients consistently linked to psychological outcomes, (ii) examine proposed biological mechanisms underlying these associations, and (iii) evaluate the strength and limitations of current evidence within the emerging field of nutritional psychiatry. By integrating epidemiological, clinical, and mechanistic findings, this review sought to clarify the role of nutrition as a modifiable factor in adult mental health and to inform future research and clinical practice.

Materials and Methods

Study Design

This review was designed as a **systematic review** to examine the relationship between micronutrient deficiencies and emotional dysregulation in adults. The review was conducted and reported following the **PRISMA 2020 guidelines**, which provide a standardized framework for transparent and reproducible systematic reviews.

Literature Search

A comprehensive search of the literature was undertaken using **PubMed**, **Scopus**, and **Google Scholar**. These databases were chosen to capture a wide range of studies from nutrition, psychology, psychiatry, and public health. Articles published between **January 2000 and March 2025** were considered. Search terms were combined using Boolean operators and included keywords related to nutrition and mental health, such as *micronutrient deficiency*, *emotional dysregulation*, *depression*, *anxiety*, *psychological wellbeing*, *vitamin B12*, *vitamin D*, *folate*, *zinc*, *magnesium*, *iron*, and *omega-3 fatty acids*. In addition, reference lists of relevant articles were manually screened to identify any studies that may have been missed during the database search.

Eligibility Criteria

Studies were included if they involved **adult participants (18 years or older)** and examined the association between **micronutrient status or supplementation** and **psychological or emotional outcomes**, such as depression, anxiety, stress, or emotional regulation. Eligible study designs included

observational studies, randomized controlled trials, systematic reviews, and meta-analyses published in peer-reviewed journals and available in English. Studies were excluded if they focused solely on children or adolescents, were animal or laboratory-based without direct clinical relevance, or consisted of editorials, commentaries, or conference abstracts without full-text data.

Study Selection

All identified articles were imported into a reference management system, and duplicate records were removed. Titles and abstracts were screened for relevance, followed by a full-text review of potentially eligible studies. Any disagreements regarding study inclusion were resolved through discussion. The selection process followed the standard PRISMA stages of identification, screening, eligibility, and inclusion.

Data Extraction

Key information was extracted from each included study, including authorship, year of publication, study design, population characteristics, micronutrients assessed, psychological outcomes measured, and main findings. Particular attention was given to results related to emotional dysregulation, mood disturbances, and underlying biological mechanisms.

Data Synthesis

Given the heterogeneity of study designs and outcome measures, a **qualitative synthesis** was performed. Findings were grouped according to specific micronutrients and their reported effects on emotional and psychological functioning. Biological mechanisms, such as neurotransmitter synthesis, inflammatory modulation, oxidative stress, and regulation of the hypothalamic–pituitary–adrenal axis, were considered when interpreting results.

Ethical Considerations

As this review was based exclusively on previously published studies, **ethical approval was not required**.

RESULT

Across the included studies, consistent associations were observed between poor diet quality, micronutrient deficiencies, and adverse emotional outcomes. Observational studies and meta-analyses demonstrated that dietary patterns low in fruits, vegetables, whole grains, and essential fatty acids were associated with an increased risk of depression and anxiety, whereas higher-quality, nutrient-dense diets showed protective effects. Deficiencies in zinc, magnesium, vitamin D, B-complex vitamins, iron, and omega-3 fatty acids were repeatedly linked to mood disturbances, emotional instability, cognitive fatigue, and reduced stress resilience.

Intervention studies yielded mixed but informative findings. Magnesium and zinc supplementation demonstrated comparatively stronger and more consistent benefits in reducing depressive symptoms, while omega-3 fatty acid and vitamin D supplementation produced heterogeneous outcomes. This variability appears to be influenced by differences in baseline nutrient status, dosage, formulation, duration of intervention, and study design. Collectively, these findings suggest that emotional dysregulation in adults is more strongly associated with cumulative nutritional inadequacy than with isolated nutrient deficiencies. The implicated biological pathways include impaired neurotransmitter synthesis, chronic low-grade inflammation, oxidative stress, dysregulation of the hypothalamic–pituitary–adrenal axis, and altered neuroplasticity.

An important emerging theme across the literature is the relevance of **functional and integrative medicine frameworks** in addressing emotional dysregulation. Rather than focusing solely on symptom management or single-nutrient supplementation, functional medicine approaches emphasize identification of **root causes**, including dietary quality, micronutrient imbalances, gut–brain axis dysfunction, inflammatory burden, and lifestyle-related stressors. Several studies implicitly support this paradigm by demonstrating that targeted nutritional repletion, combined with dietary pattern modification, may restore metabolic and neurochemical balance and improve emotional regulation. These findings align with a systems-based approach that views mental health as an outcome of interconnected biological and lifestyle factors, highlighting the potential role of personalized nutritional strategies in restoring emotional and psychological equilibrium.

DISCUSSION

This systematic review consolidates current evidence demonstrating that micronutrient inadequacies are closely associated with emotional dysregulation, depression, and anxiety in adult populations, reinforcing the role of nutrition as a modifiable determinant of psychological health. Findings drawn from epidemiological studies, clinical trials, and mechanistic research consistently indicate that deficiencies in B-complex vitamins, vitamin D, iron, zinc, magnesium, and omega-3 fatty acids are linked to adverse emotional and cognitive outcomes [25–33].

Overall diet quality emerged as a central factor influencing emotional regulation. Diets high in saturated fats and low in fruits, vegetables, and omega-3 fatty acids were repeatedly associated with impaired cognitive performance, heightened stress sensitivity, and increased susceptibility to mood disorders [25,26]. These patterns suggest that prolonged exposure to poor-quality diets may alter brain plasticity and emotional resilience through inflammatory activation, oxidative stress, and neuroendocrine dysregulation [26,27]. In contrast, nutrient-dense dietary patterns rich in polyphenols and essential fatty acids appear to confer protective effects against emotional instability and depressive symptoms [25,26].

Among individual micronutrients, zinc demonstrated one of the most consistent associations with anxiety and mood disturbances. Clinical and observational studies indicate that individuals with anxiety or depression frequently exhibit reduced zinc status, which may disrupt glutamatergic neurotransmission and synaptic plasticity [36,37]. Zinc supplementation has been shown to enhance antidepressant response in treatment-resistant depression, although variability in study designs limits firm conclusions regarding its independent efficacy [36]. These findings highlight the importance of assessing trace-element balance rather than isolated deficiencies.

Omega-3 fatty acids were also strongly associated with emotional wellbeing in population-based studies, with low intake linked to higher rates of depression and anxiety [25,26]. Proposed mechanisms include anti-inflammatory effects, modulation of neuronal membrane fluidity, and neuroprotective actions [26,38]. However, randomized controlled trials and meta-analyses have produced mixed outcomes, likely reflecting heterogeneity in dosage, EPA/DHA composition, baseline nutritional status, and participant characteristics [38,39]. This suggests that omega-3 supplementation may be most effective when personalized rather than universally applied.

Vitamin D deficiency was consistently associated with greater severity of depressive and anxiety symptoms across observational studies [30]. Biological plausibility is supported by vitamin D's involvement in neuroimmune regulation, serotonin synthesis, and inflammatory control. Nevertheless, intervention trials remain inconclusive, emphasizing the need for rigorously designed studies to clarify causality and therapeutic relevance [31].

Magnesium showed comparatively stronger clinical support among micronutrients. Meta-analytic and observational evidence suggests that magnesium intake or supplementation is associated with reduced depressive symptoms, potentially mediated through NMDA receptor modulation, HPA-axis regulation, and enhanced neuroplasticity [32,33]. Although the number of high-quality trials remains limited, the consistency of findings positions magnesium as a promising adjunctive strategy in mood disorder management.

Other micronutrients, including iron, iodine, vitamin B12, and selenium, were also implicated in emotional and cognitive functioning. Iron deficiency was associated with depressive symptoms and cognitive fatigue, while iron repletion improved cognitive performance in women [34,35]. Vitamin B12 deficiency was linked to depressive symptoms and cognitive decline in adults [28,29]. Iodine deficiency demonstrated the strongest association with irreversible cognitive impairment, particularly during critical developmental periods, and selenium appeared to support mood regulation through antioxidant mechanisms, although direct human evidence remains limited [28].

Collectively, these findings suggest that emotional dysregulation in adults is more strongly influenced by cumulative nutritional inadequacy than by single nutrient deficits. Lifestyle factors, chronic stress, and socioeconomic conditions likely interact with nutritional status to amplify psychological vulnerability [25,27]. The evidence supports an integrative nutritional psychiatry framework that incorporates dietary assessment and targeted micronutrient strategies within comprehensive mental health care. However, heterogeneity across study designs and outcomes underscores the need for high-quality longitudinal and interventional research to establish causality and inform personalized nutritional interventions [31,38,39].

Strengths of the Review

A key strength of this review lies in its **systematic approach**, guided by PRISMA principles, which allowed for transparent identification, selection, and synthesis of relevant literature. The review integrated evidence from **multiple study designs**, including prospective cohorts, randomized controlled trials, and meta-analyses, providing a comprehensive perspective on nutritional influences on emotional health. Additionally, the focus on **biological mechanisms** strengthened the interpretive depth and clinical relevance of the findings. By examining multiple micronutrients simultaneously, the review reflects the multifactorial nature of emotional dysregulation and aligns with integrative models of mental health.

Limitations

Several limitations should be acknowledged. First, substantial **heterogeneity across study designs, outcome measures, and supplementation protocols** limited direct comparison and precluded quantitative meta-analysis within this review. Second, many included studies were observational, restricting causal inference. Third, micronutrient status was often inferred from dietary intake rather than biochemical assessment, increasing the potential for measurement bias. Fourth, confounding factors such as physical activity, sleep quality, socioeconomic status, and comorbid medical conditions were inconsistently controlled across studies. Finally, publication bias and restriction to English-language studies may have limited the inclusion of relevant evidence.

CONCLUSION

This systematic review reinforces the growing recognition of nutrition as a central pillar in mental health, particularly within the emerging field of **nutritional psychiatry**. The collective evidence indicates that poor diet quality and cumulative micronutrient deficiencies contribute meaningfully to emotional dysregulation, depression, and anxiety in adults. Rather than isolated nutrient shortages, it is the broader pattern of nutritional imbalance—interacting with inflammation, neuroendocrine dysregulation, oxidative stress, and impaired neurotransmitter synthesis—that appears to underlie psychological vulnerability.

Findings from observational, interventional, and mechanistic studies suggest that optimizing dietary quality and restoring micronutrient sufficiency may enhance emotional resilience and cognitive functioning. Nutrients such as magnesium, zinc, B-complex vitamins, vitamin D, iron, and omega-3 fatty acids play integral roles in neurochemical balance and stress regulation, supporting their relevance in mental health prevention and adjunctive treatment strategies. However, variability in supplementation outcomes highlights the limitations of a one-size-fits-all approach.

From a nutritional psychiatry and functional medicine standpoint, these results underscore the importance of **root-cause–oriented, personalized interventions** that address diet quality, micronutrient status, gut–brain axis function, lifestyle stressors, and metabolic health. Integrating nutritional assessment into routine mental health care offers a promising, low-risk, and potentially cost-effective avenue to complement conventional psychological and pharmacological therapies.

In conclusion, nutritional psychiatry provides a valuable framework for understanding and managing emotional dysregulation by bridging biological, psychological, and lifestyle factors. While current evidence is compelling, further high-quality longitudinal and randomized controlled studies are needed to establish causality, refine individualized treatment protocols, and translate nutritional psychiatry into standardized clinical practice for adult mental health care.

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