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Potential Benefits of Specific Nutrients in the Management of Depression and Anxiety Disorders

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Abstract: Depression and anxiety are widespread mental disorders globally, imposing significant burdens on both individual and societal health. With the continuous advancement of research in the field of mental health, the influence of nutrition on psychological well-being has emerged as an increasingly important area of study. A growing body of evidence suggests that specific nutrients may play a crucial role in the prevention and treatment of depression and anxiety, particularly in the regulation of neurobiological mechanisms. Nutrients such as omega-3 fatty acids, vitamin D, B vitamins, minerals, and antioxidants have been shown to offer potential benefits in modulating brain function, alleviating inflammatory responses, and enhancing neurotransmission. This review consolidates recent research on the relationship between these nutrients and depression/anxiety, exploring the possible mechanisms through which they contribute to neural health improvement. The paper also outlines potential future research directions in this area. By providing this comprehensive overview, this paper aims to offer new insights for future mental health interventions and promote the clinical application of nutritional approaches in psychological care.

Keywords: depression; anxiety disorders; nutrients; mental health

1. Introduction

Depression and anxiety disorders, as the most prevalent mental health conditions globally, not only severely impact the quality of life of affected individuals but also impose significant economic and social burdens on public health systems. According to the World Health Organization (WHO), depression has become the leading cause of disability worldwide, while the prevalence of anxiety disorders continues to rise year by year. Despite the partial effectiveness of traditional pharmacological treatments and psychological interventions in alleviating symptoms, many patients still face challenges such as unstable treatment outcomes and side effects from medications, highlighting the urgent need for alternative adjunctive therapies. In recent years, increasing attention has been given to the relationship between nutrition and mental health, with growing evidence suggesting that specific nutrients may play a positive role in the prevention and intervention of depression and anxiety. Research in this field not only broadens our understanding of mental disorders but also provides potential directions for the development of new therapeutic strategies. This review aims to summarize recent research on specific nutrients, including omega-3 fatty acids, vitamin D, B vitamins, minerals, and antioxidants, in the context of depression and anxiety, exploring the neurobiological mechanisms through which these nutrients may exert their effects and analyzing the challenges and opportunities for future research.

2. Ω-3 Fatty Acids, Depression & Anxiety Disorders

2.1. Physiological Effects of Omega-3 Fatty Acids

Omega-3 fatty acids are a group of polyunsaturated fatty acids, primarily consisting of three major forms: alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) [1]. These fatty acids cannot be synthesized by the body and must be obtained through dietary intake. The main dietary sources of omega-3 fatty acids include oil-rich fish (such as salmon, sardines, mackerel), flaxseed oil, nuts, chia seeds, and other plant oils, as well as algae-based products. Omega-3 fatty acids are essential for maintaining overall human health, particularly for brain function. Their role in the nervous system is prominent, particularly in maintaining brain function, reducing platelet "viscosity", and enhancing vascular elasticity [2]. Omega-3 fatty acids are a key component of brain cell membranes, with DHA playing a critical role in maintaining the fluidity, integrity, and functionality of neuronal cell membranes. Omega-3 fatty acids help maintain membrane fluidity, ensuring smooth neurotransmitter transmission across synapses, which in turn affects cognitive function and emotional regulation. Omega-3 fatty acids are involved in the synthesis and regulation of neurotransmitters. EPA and DHA have been shown to modulate the activity of neurotransmitters such as dopamine, serotonin, and others, which are essential for mood regulation, and the control of anxiety and depressive symptoms. Low levels of omega-3 fatty acids may lead to neurotransmitter imbalances, contributing to mood disorders. Insufficient omega-3 fatty acids can decrease the efficiency of neurotransmitter signaling, thus affecting emotional regulation.

2.2. Potential Benefits of Omega-3 Fatty Acids for Depression

Depression is a complex mental disorder involving a variety of biological, psychological, and social factors, and the role of omega-3 fatty acids in depression has received increasing attention in recent years. A study by Yu Huan [3] comparing adult female depression patients with healthy individuals found that the total omega-3 fatty acid levels were significantly lower in the depression group, suggesting that low omega-3 fatty acid levels may be an important pathological mechanism of depression. Omega-3 fatty acids may have a positive effect on the alleviation of depression through their anti-inflammatory properties. The development of depression is closely associated with chronic inflammatory responses in the body [4], and the anti-inflammatory action is a key mechanism by which omega-3 fatty acids improve depression.

Omega-3 fatty acids regulate the synthesis and transmission of neurotransmitters, thereby improving depressive symptoms. Neurotransmitters such as serotonin, dopamine, and norepinephrine play a crucial role in mood regulation, and their levels are often lower in individuals with depression. Omega-3 fatty acids, particularly EPA and DHA, promote the synthesis of these neurotransmitters and enhance synaptic signaling, thus improving mood and cognitive function. Long-term intake of omega-3 fatty acids has been shown to significantly increase serotonin levels in depression patients, helping to alleviate depressive symptoms. Additionally, omega-3 fatty acids, especially DHA, can improve brain structure and promote overall brain health. DHA is the most abundant omega-3 fatty acid in the brain, and it helps maintain the fluidity and integrity of neuronal membranes, facilitating communication between nerve cells. A deficiency in DHA can lead to dysfunction in neuronal membranes, affecting neurotransmitter transmission and mood regulation. A study by Kelaiditis CF et al. [5] found that peripheral blood omega-3 fatty acid levels were lower in depression patients, and lower omega-3 fatty acid levels before treatment were associated with poor antidepressant response.

Although the current evidence supports the potential benefits of omega-3 fatty acids for depression, there are still some inconsistent findings, especially regarding the efficacy of omega-3 fatty acids in different types of depression patients. The ratio and dosage of different types of omega-3 fatty acids (such as EPA and DHA) may also influence their effectiveness. Future studies should further explore the optimal supplementation dose and combination of omega-3 fatty acids to optimize their therapeutic effects in depression.

2.3. Potential Benefits of Omega-3 Fatty Acids for Anxiety

While research on the effects of omega-3 fatty acids on anxiety is less extensive than that on depression, existing studies suggest [6] that omega-3 fatty acids may offer potential benefits for individuals with anxiety disorders. Anxiety disorders are common mental conditions characterized by excessive worry, tension, and fear, often linked to imbalances in neurotransmitters and inflammatory responses in the brain. Omega-3 fatty acids may alleviate anxiety symptoms through various mechanisms, particularly by reducing inflammatory responses and regulating neurotransmitter activity. The anti-inflammatory effect of omega-3 fatty acids could positively

influence the improvement of anxiety disorders. In individuals with anxiety disorders, levels of pro-inflammatory cytokines are elevated, and these inflammatory factors can affect neuronal function in the brain, exacerbating anxiety symptoms.

Although preliminary findings indicate potential benefits of omega-3 fatty acids for anxiety, more randomized controlled trials are needed to further validate their efficacy. Different types of anxiety disorders (such as social anxiety, generalized anxiety, and panic disorder) may respond differently to omega-3 fatty acid supplementation. The dosage and duration of omega-3 fatty acid supplementation may also affect its therapeutic outcomes. Future research should explore the optimal application strategies of omega-3 fatty acids in anxiety disorders to provide more treatment options for individuals with anxiety.

3. Vitamin-D, Depression & Anxiety Disorders

3.1. Physiological Functions of Vitamin D

Vitamin D is a fat-soluble vitamin that regulates the absorption and metabolism of calcium and phosphorus, promoting muscle growth and skeletal development [7]. In addition to its essential roles in calcium absorption, bone health, and immune function, recent studies have also highlighted the significance of vitamin D in brain function and mental health [8]. Immunohistochemical methods have confirmed that vitamin D receptors are widely expressed in the brain tissue of adults, including in the cerebral cortex (such as the prefrontal cortex and cingulate cortex), hippocampus, basal forebrain, and striatum [9]. Vitamin D plays a key role in neuroprotection and neurodevelopment [10]. It promotes the synthesis and release of neurotrophic factors, which are crucial for the growth, maintenance, and repair of neurons. These neurotrophic factors support neuronal survival and differentiation, thus helping maintain normal brain function.

3.2. Potential Benefits of Vitamin D in Depression

Vitamin D exhibits anti-inflammatory and immune-regulatory effects, which are crucial for the regulation of mental disorders such as depression and anxiety. In recent years, an increasing body of evidence has linked depression and anxiety with chronic inflammatory responses. Neurons and glial cells in various regions, including the prefrontal cortex and hippocampus, express vitamin D receptors and 25(OH)D-1α hydroxylase, suggesting that vitamin D may play a role in anxiety and depressive symptoms [9]. By reducing chronic inflammation, vitamin D may help protect the brain from inflammatory damage, thereby improving mood and cognitive function. Vitamin D also regulates the synthesis and release of neurotransmitters, particularly dopamine, which is closely associated with mood regulation [11]. Additionally, vitamin D is involved in the regulation of serotonin, an important monoamine neurotransmitter that plays a significant role in the regulation of anxiety, depression, and other emotional states in the brain [12].

Although the mechanisms through which vitamin D influences brain function have been partially elucidated, its precise mechanisms of action still require further investigation. In recent years, increasing research has focused on the relationship between vitamin D and neuropsychiatric disorders, particularly its role in depression and anxiety.

4. Vitamin-B, Depression & Anxiety Disorders

4.1. Physiological Functions of B Vitamins

B vitamins are a group of water-soluble vitamins, including vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), vitamin B7 (biotin), vitamin B9 (folate), and vitamin B12 (cobalamin) [13]. Each B vitamin has distinct functions in the body, but all play critical roles in energy metabolism, neural function, and DNA synthesis. B vitamins act as coenzymes in the metabolism of carbohydrates, fats, and proteins, helping to convert food into energy. This process is crucial for maintaining normal brain and nervous system function [14]. Vitamins B6, B9 (folate), and B12 are particularly important, as they are directly involved in the functioning of the nervous system, particularly in neurotransmitter synthesis and transmission. Vitamin B6 participates in neurotransmitter synthesis, folate synthesis, heme biosynthesis, and the transfer of one-carbon units, thereby promoting nucleic acid biosynthesis, sphingolipid synthesis, and carbohydrate metabolism [15]. Serotonin, a neurotransmitter closely linked to mood regulation, is often found to be at low levels in individuals with depression. Gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter, helps alleviate anxiety and tension [16]. Dopamine, which is related to the brain's reward system and pleasure, when deficient, may lead to a lack of motivation and depressive feelings.

Folate and vitamin B12 play a key role in methylation reactions. Methylation is an essential biochemical process that affects not only DNA repair and replication but also plays a significant role in neurotransmitter synthesis and metabolism [17]. Folate and vitamin B12 work together in the metabolism of homocysteine, converting it into methionine [18]. Maintaining adequate levels of folate and vitamin B12 helps lower homocysteine levels, thereby supporting normal brain function. B vitamins are essential for brain health, particularly in neurotransmitter synthesis, methylation processes, and energy metabolism, all of which are indispensable for the normal functioning of the nervous system [19]. Deficiencies in B vitamins may lead to imbalances in neurotransmitters and elevated homocysteine levels, contributing to mood disorders such as depression and anxiety [20]. Ensuring sufficient intake of B vitamins through diet is vital for maintaining mental health.

4.2. Potential Benefits of B Vitamins in Depression

Deficiencies in several B vitamins have been significantly linked to the risk of developing depression, with deficiencies in vitamins B6, B12, and folate being particularly closely associated with the onset of depression. B vitamins may exert beneficial effects on depression by regulating neurotransmitters, lowering homocysteine levels, and modulating DNA methylation.

B vitamins play a crucial role in neurotransmitter synthesis [21]. One of the key biological mechanisms underlying depression is the imbalance of neurotransmitters such as serotonin, dopamine, and norepinephrine. Substances such as thiamine, niacin, and pyridoxine in B vitamins can participate in processes such as acetyl-CoA synthesis, tryptophan metabolism, and the synthesis of serotonin, dopamine, and norepinephrine, all of which are essential for maintaining normal biological metabolism and neural function [13]. Homocysteine is an amino acid generated in the metabolism of folate, vitamin B6, and vitamin B12, and elevated levels of homocysteine are associated with depression, cardiovascular diseases, and cognitive decline. Homocysteine levels are often found to be higher in individuals with depression, and supplementation with folate and vitamin B12 can effectively lower homocysteine levels, thereby reducing the risk of depression.

B vitamins also play a role in DNA methylation, a process closely related to the regulation of gene expression. Evidence suggests that epigenetic changes are key mechanisms through which stressors interact with the genome to induce stable alterations in DNA structure, gene expression, and behavior [22]. Folate and vitamin B12 contribute to DNA methylation by providing methyl groups. B vitamins offer significant protective effects in regulating DNA methylation, which may help reduce the risk of depression. Although current evidence suggests that B vitamins may offer potential benefits for depression, more randomized controlled trials are needed to further validate these findings. Future research should focus on evaluating the long-term effects of different dosages of B vitamin supplementation on depression and explore whether B vitamins can serve as an adjunctive intervention in the treatment of depression.

4.3. Potential Benefits of B Vitamins in Anxiety

While research on B vitamins and anxiety is relatively limited, existing evidence suggests that B vitamins may also have potential benefits in anxiety disorders. Anxiety disorders are emotional disturbances that affect both the psychological and physiological states of individuals, with patients often experiencing chronic muscle tension, irritability, fatigue, and difficulty concentrating [23]. B vitamins may help alleviate anxiety by modulating neurotransmitter synthesis and transmission, improving nervous system function, and regulating stress responses. A clinical study by Yang Yuqiong [24] highlighted that B vitamins are essential for the methylation cycle, monoamine oxidase production, DNA synthesis, and the repair and maintenance of phospholipids.

Although current studies suggest potential benefits of B vitamins in anxiety, the mechanisms by which B vitamins influence the treatment of anxiety are still under investigation. More randomized controlled trials are needed to further verify these findings. Future research should explore the specific mechanisms of B vitamins in different types of anxiety disorders (such as generalized anxiety disorder, social anxiety disorder, and panic disorder) and evaluate their effectiveness as adjunctive interventions in the treatment of anxiety.

5. Minerals, Depression & Anxiety Disorders

5.1. Zinc

Zinc is an essential trace element widely involved in various biological processes in the body, with zinc (Zn^{2+}) being present in all organs. It plays a critical role in neurotransmitter synthesis, immune regulation, and other physiological reactions. Zinc is not only vital for overall bodily health but also plays a key role in maintaining the normal function of the brain and nervous system. In recent years, increasing evidence has linked zinc deficiency to a significantly higher risk of mood disorders such as depression and anxiety.

Zinc is closely related to neurotransmitter synthesis. Both increases and decreases in zinc levels can affect the transmission of amino acid neurotransmitters, including serotonin (5-HT), norepinephrine, and dopamine. Zinc influences the stability of membrane structures, inhibits mast cell degranulation and platelet release of serotonin, and also suppresses ATPase activity. Zinc deficiency may cause structural, numerical, and sensitivity alterations in receptor molecules on neuronal membranes in the brain, impairing neurotransmitter secretion and reuptake processes, which leads to dysfunction of monoamine transmission and affects neurotransmitter signaling [25].

Zinc also possesses significant antioxidant and anti-inflammatory properties. One of the pathological mechanisms of depression and anxiety is the excessive activation of oxidative stress and inflammatory responses. As a potent antioxidant, zinc neutralizes free radicals, reducing oxidative stress-induced damage to the nervous system. Additionally, zinc can mitigate brain inflammation by inhibiting the production of pro-inflammatory cytokines, thus alleviating symptoms of depression and anxiety. Zinc supplementation has been shown to significantly improve symptoms in patients with depression. Studies indicate that most antidepressants rapidly increase synaptic levels of norepinephrine and/or serotonin. Long-term use of non-selective antidepressants like imipramine, norepinephrine-selective reuptake inhibitors like desipramine, or serotonin-selective reuptake inhibitors like fluoxetine may decrease the expression of p21, with a common mechanism being the enhancement of hippocampal neurogenesis [26]. Some clinical trials suggest that antidepressants can elevate serum zinc levels, thereby improving depressive symptoms. Although current research shows potential benefits of zinc in treating depression and anxiety, further randomized controlled trials are needed to validate its effectiveness. As individuals may have varying zinc requirements, future studies should explore personalized zinc supplementation strategies and assess the long-term safety and efficacy of such interventions.

5.2. Magnesium

Magnesium is another essential mineral for brain and nervous system health. It plays a vital role in neurotransmitter synthesis, neural plasticity, and the regulation of stress responses. In recent years, magnesium deficiency has been increasingly linked to a significantly higher risk of depression and anxiety. Valproate magnesium, a widely used anticonvulsant, serves as a mood stabilizer by enhancing GABAergic neurotransmission in the brain while altering norepinephrine levels, thereby increasing serotonin concentrations in the striatum-limbic system [27]. Magnesium helps maintain normal brain function by regulating neurotransmitter synthesis and transmission. It is involved in the metabolism of neurotransmitters such as glutamate, GABA, and norepinephrine, which play crucial roles in regulating mood, anxiety, and stress responses. Magnesium deficiency may lead to an imbalance of these neurotransmitters, thereby contributing to mood disorders like depression and anxiety.

The regulation of NMDA receptors by magnesium is especially important. NMDA receptors influence neural plasticity and signal transmission by modulating glutamate activity. Magnesium protects neurons from damage by inhibiting excessive NMDA receptor activation, thereby reducing the neurotoxic effects of glutamate.

Although current research indicates that magnesium may offer potential benefits for depression and anxiety, further randomized controlled trials are necessary to confirm its effects. In particular, optimal dosages of magnesium supplementation, its long-term safety, and its specific impact on different types of depression and anxiety still require further investigation. Future research should focus on exploring the best application strategies for magnesium in mental health interventions, providing additional treatment options for depression and anxiety.

6. Antioxidants and Depression, Anxiety Disorders

Depression and anxiety are closely associated with oxidative stress. Oxidative stress refers to a state in which an excessive amount of free radicals, such as reactive oxygen species (ROS) and reactive nitrogen species

(RNS), are produced, overwhelming the body's antioxidant defense mechanisms, leading to oxidative damage of biomolecules such as DNA, proteins, and lipids. Free radicals are highly reactive molecules that are generated during normal metabolic processes, but when their levels become excessive or when antioxidant mechanisms are impaired, they can cause cellular damage, particularly to the nervous system, which is highly dependent on energy metabolism and oxygen. In the brain, oxidative stress leads to neuronal damage, affecting normal brain function. The neuronal cell membranes contain large amounts of polyunsaturated fatty acids, making them susceptible to attack by free radicals. Oxidative stress can disrupt these fatty acids, resulting in damage to cell membranes, which in turn impairs neural signaling [28]. Oxidative stress can also cause mitochondrial dysfunction, reducing the energy production capacity of nerve cells, ultimately affecting their survival and function. Studies have confirmed that oxidative stress is closely linked to biological processes such as neuroinflammation, neurotransmitter imbalance, and decreased neuroplasticity, which are considered key pathological mechanisms underlying depression and anxiety.

Antioxidants can neutralize free radicals and reduce oxidative stress, thereby protecting neurons from damage. Antioxidants exert their effects through various mechanisms, including scavenging oxygen free radicals, regulating cellular metabolic activity, preventing DNA damage, and modulating gene expression and signal transduction pathways [29]. By reducing the damage caused by free radicals to neurons, antioxidants hold promise for improving mood disorders, particularly in conditions of significantly elevated oxidative stress. Oxidative stress also triggers neuroinflammatory responses, further exacerbating neuronal damage [30]. Free radicals promote the production of pro-inflammatory cytokines, such as tumor necrosis factor α (TNF-α) and interleukin-6 (IL-6), leading to a chronic inflammatory state in the nervous system. Antioxidants help alleviate depression and anxiety symptoms by reducing the occurrence of oxidative stress and inhibiting the release of pro-inflammatory factors. Overall, antioxidants not only protect neurons from oxidative damage but also reduce inflammation, promoting the healthy functioning of the nervous system, thus playing an active role in the prevention and treatment of mood disorders.

Antioxidants such as glutathione, coenzyme Q10, and polyphenolic compounds are also considered to have potential benefits for depression and anxiety. These antioxidants reduce oxidative stress in the brain through different mechanisms, protecting neurons from damage and thereby improving mood and cognitive function. Glutathione is widely present in various cells [31]. It not only directly neutralizes free radicals but also enhances the activity of other antioxidants, exerting a powerful antioxidative effect [32]. In patients with depression and anxiety, glutathione levels are often lower, particularly in those with chronic inflammation and oxidative stress [33]. Supplementing glutathione or promoting its endogenous synthesis may help reduce oxidative stress-induced damage to the nervous system, thereby improving symptoms of depression and anxiety.

Coenzyme Q10 is another important antioxidant. It participates in cellular energy metabolism and protects neurons from free radical damage. Coenzyme Q10 plays a critical role in mitochondria, helping neurons generate energy. Mitochondrial dysfunction is common in depression, and supplementation with coenzyme Q10 has been shown to improve mitochondrial function [34], thereby enhancing neuronal energy supply and contributing to alleviating symptoms of depression and anxiety. Polyphenolic compounds are a group of natural antioxidants found in plants, including flavonoids, catechins, and resveratrol. These compounds possess potent antioxidant properties and exhibit various biological activities, including anti-inflammatory, anticancer, and neuroprotective effects. Certain polyphenol-rich foods, such as green tea, blueberries, grapes, and red wine, are considered to have mood-enhancing effects. Polyphenolic compounds protect neurons from damage by reducing oxidative stress and inflammation, thereby helping to regulate mood and cognitive function [35].

Although existing studies indicate that antioxidants like glutathione, coenzyme Q10, and polyphenolic compounds may offer potential benefits for depression and anxiety, more clinical trials are needed to validate their effectiveness. Future research should further explore the optimal dosages and methods of administration for these antioxidants, especially their combined use with other nutrients or drugs, in order to provide a more comprehensive treatment strategy for individuals with mood disorders.

7. Future Work

Although the potential benefits of specific nutrients for depression and anxiety have been recognized, many issues remain unresolved. Future research could be conducted in the following areas to further elucidate the specific roles of nutrients in mood disorders and optimize their clinical application.

7.1. Deepening Mechanistic Research

Existing studies have preliminarily revealed that specific nutrients contribute to the improvement of mood disorders through pathways such as regulating neurotransmitters, reducing inflammatory responses, and promoting neuroplasticity. However, these mechanisms require further exploration. Future research should utilize multi-level experimental designs to investigate how specific nutrients precisely regulate the synthesis, release, and metabolism of neurotransmitters, thereby affecting the occurrence and development of depression and anxiety at the pathophysiological level. Additionally, in-depth research on the impact of these nutrients on neuroplasticity and neuroinflammation is critical to understanding their specific mechanisms in improving brain function and supporting neural recovery processes. For example, future studies could combine animal experiments and human clinical research to clarify how nutrients improve mood states by influencing synaptic plasticity between neural cells. By uncovering these complex biological processes, researchers will be able to provide solid scientific evidence for the design of more targeted nutritional intervention strategies. Moreover, the role of nutrients in the immune system is another key focus for future research. Investigating how specific nutrients modulate the immune system and alleviate inflammation to influence mental health may provide new therapeutic targets for mood disorders. The development of multi-omics technologies, such as transcriptomics, proteomics, and metabolomics, will offer novel tools to explore these mechanisms, aiding in the comprehensive understanding of how nutrients affect the nervous system.

7.2. Promoting High-Quality Clinical Trials

Currently, most studies rely on observational research or small-scale clinical trials. While these studies provide preliminary evidence for the potential benefits of nutrients, the reliability and generalizability of their conclusions are still limited due to small sample sizes, short follow-up periods, and design flaws. Therefore, future efforts should focus on conducting large-scale, long-duration randomized controlled trials (RCTs) to further validate the efficacy of specific nutrients in depression and anxiety. These trials should not only assess the short-term effects of nutrients but also investigate their long-term safety and efficacy. Furthermore, future clinical studies should emphasize the standardization of trial designs and transparency of data to enhance the reproducibility and credibility of results. For example, unified trial standards should be established, including criteria for sample selection, nutrient dosage, and duration of intervention. In addition, the integration of big data and artificial intelligence tools holds promise for uncovering more nuanced relationships between nutrients and mental health, thereby optimizing intervention strategies. Research should also focus on determining the optimal dosage, timing, and administration methods of nutrients to optimize treatment plans for different patient populations, ensuring both safety and effectiveness.

7.3. Personalized Nutritional Interventions

There are significant individual differences in nutrient requirements and responses, which may be influenced by factors such as genetic background, gut microbiota, metabolic characteristics, and lifestyle. Future research should focus on how to develop personalized nutritional intervention strategies based on individual characteristics, utilizing precision medicine to improve intervention outcomes. For instance, studies should explore the relationship between genetic polymorphisms and nutritional responses, as well as how gut microbiota affects the absorption and metabolism of specific nutrients. Based on this information, future research could integrate multidimensional data, such as genomic data, gut microbiome features, and metabolic biomarkers, to develop personalized nutritional intervention models, thereby achieving precision in nutritional therapies. Additionally, the role of the gut-brain axis in mood disorders has gained attention, and future research should further explore how nutrients regulate the central nervous system by influencing gut microbiota and its metabolic products.

8. Conclusion

Depression and anxiety are significant global public health issues, with their complex etiologies and high prevalence posing a substantial burden on both individuals and society. Although traditional pharmacological treatments and psychological interventions are the main therapeutic approaches, they are not suitable for all patients and are often accompanied by side effects and unstable efficacy. In recent years, an increasing body of research has demonstrated the significant potential of specific nutrients, such as Ω-3 fatty acids, vitamin D, B vitamins, minerals, and antioxidants, in preventing and treating these mental disorders. These nutrients may

modulate brain function through various mechanisms, including the synthesis and regulation of neurotransmitters, alleviation of inflammatory responses, and enhancement of neuroplasticity, thereby alleviating symptoms of depression and anxiety to some extent.

Despite the strong preliminary evidence supporting the role of nutrients, more high-quality studies are needed to validate their effects and explore the underlying mechanisms. A deeper understanding of the biological effects of these nutrients and how to apply them individually in clinical settings will help develop more effective and safe adjunctive therapies, providing new perspectives and approaches for mental health interventions. Future research should focus on mechanism analysis, large-scale clinical validation, and the exploration of personalized intervention strategies, fostering the integration of nutritional science and mental health. Ultimately, this will contribute to the development of innovative solutions for the treatment of depression and anxiety.

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