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The Role of the Gut–Brain Axis in Depression and Anxiety Disorders: A Systematic Literature Review

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Abstract

Depression and anxiety disorders are among the most prevalent mental health conditions worldwide and have a substantial impact on individuals' quality of life. For decades, the pathogenesis of these disorders has primarily been attributed to neurotransmitter imbalances, hypothalamic–pituitary–adrenal (HPA) axis dysfunction, genetic factors, and alterations in neuroplasticity. However, emerging evidence has highlighted the significant role of the gut–brain axis in regulating brain function through bidirectional communication among the central nervous system, enteric nervous system, immune system, endocrine system, and gut microbiota. Disruption of gut microbial homeostasis (gut dysbiosis) has been associated with inflammation, altered neurotransmitter metabolism, and an increased risk of depression and anxiety. Objective of the research to analyze the role of the gut–brain axis in depression and anxiety disorders based on a systematic review of the scientific literature. This study employed a Systematic Literature Review (SLR) methodology. The findings indicate that depression and anxiety disorders are closely associated with alterations in gut microbiota composition, reduced abundance of short-chain fatty acid (SCFA)-producing bacteria, disrupted tryptophan metabolism, increased immune activation, and dysfunction of the HPA axis. The gut–brain axis operates through neuroimmunological, neuroendocrine, and metabolic pathways involving neurotransmitters, inflammatory cytokines, hormones, and microbiota-derived metabolites. Furthermore, numerous studies have demonstrated that microbiota-based interventions, including probiotics, prebiotics, synbiotics, and dietary modifications, have the potential to alleviate symptoms of depression and anxiety, although variations in dosage and intervention duration warrant further investigation. The gut–brain axis plays a crucial role in the pathogenesis of depression and anxiety disorders through complex interactions among the gut microbiota, immune system, endocrine system, and central nervous system. Microbiota-based interventions show promise as adjunctive therapeutic strategies; however, high-quality clinical studies are still needed to determine their optimal efficacy, dosage, and duration.

Introduction

Mental health is part of the definition of health as stipulated in Law No. 36 of 2009 concerning Health. Article 1 states, "Health is a state of well-being, both physically, mentally, spiritually, and socially, that enables everyone to live productively socially and economically." Indonesia already has a specific legal framework regarding mental health, namely Law No. 18 of 2014. Mental health is defined as a condition in which an individual can develop physically, mentally, spiritually, and socially, so that the individual is aware of their own abilities, can cope with stress, can work productively, and is able to contribute to their community (Rahmy & Muslimahayati., 2021).

In the last decade, mental health disorders such as anxiety and depression in children and adolescents have become an increasingly pressing global concern. The rate of depressive

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disorders in children and adolescents is estimated to reach up to 10%. Anxiety is a common mental disorder in children and adolescents. Anxiety is usually characterized by uncontrollable worry, fear, and hyperactivity. Although there are currently numerous tools available to measure anxiety, including the Generalized Anxiety Disorder Scale, the Screen for Child Anxiety-Related Disorders, the Depression, Anxiety, and Stress Scale, among others, depression is also a chronic and recurrent condition common in children and adolescents (Hutasoit., 2025).

For decades, the pathogenesis of depression and anxiety has been primarily explained by neurotransmitter disorders, hypothalamic-pituitary-adrenal (HPA) axis dysfunction, genetic factors, and changes in neuroplasticity. However, advances in microbiology and neuroscience have shown that the gastrointestinal tract and gut microbiota play a crucial role in regulating brain function through a mechanism known as the Gut-Brain Axis. This two-way communication system involves interactions between the central nervous system, the enteric nervous system, the immune system, the endocrine system, and metabolites produced by the gut microbiota (Verma et al., 2024).

The gut-brain axis operates through various communication pathways, including the vagus nerve, hormones, inflammatory cytokines, and microbiota metabolites such as short-chain fatty acids (SCFAs), tryptophan, serotonin, dopamine, and γ-aminobutyric acid (GABA). A balanced gut microbiota plays a role in maintaining the integrity of the intestinal barrier, regulating the immune response, and modulating the production of neurotransmitters that influence cognitive function, emotions, and behavior (Sittipo et al., 2022; Chen et al., 2021). Conversely, an imbalance in the gut microbiota (gut dysbiosis) can trigger systemic inflammation, increase intestinal permeability, disrupt blood-brain barrier function, and contribute to the development of various neuropsychiatric disorders, including depression and anxiety (Verma et al., 2024).

Numerous experimental and clinical studies have shown that individuals with depression and anxiety disorders have a different gut microbiota profile than healthy individuals (Xiong et al., 2023; Dong et al., 2021). A decrease in bacteria that produce SCFAs, an increase in pro-inflammatory bacteria, and changes in tryptophan metabolism are known to be associated with increased immune system activation, oxidative stress, and impaired neurotransmitter regulation. Furthermore, research on the use of probiotics, prebiotics, synbiotics, and dietary interventions also shows potential in improving gut microbiota composition, thereby reducing symptoms of depression and anxiety (Verma et al., 2024).

Although numerous studies have revealed a link between gut microbiota and mental health, the biological mechanisms underlying these interactions are still evolving and not fully understood. Available research also shows variation in study design, population characteristics, and types of interventions used, necessitating a more comprehensive synthesis of scientific evidence.

Based on this, this Systematic Literature Review was conducted to identify, analyze, and synthesize the latest scientific evidence regarding the role of the Gut-Brain Axis in depression and anxiety disorders. The results of this study are expected to provide a deeper understanding of the mechanisms of the relationship between gut microbiota and mental health and serve as a basis for developing more effective prevention and treatment strategies for patients with depression and anxiety disorders.

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Method

Literature Search Strategy Design

This study used the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize scientific evidence regarding the role of the Gut-Brain Axis in depression and anxiety disorders. A systematic literature review is a research method conducted systematically, transparently, and structured by following the stages of identification, screening, eligibility assessment, and synthesis of relevant research findings, resulting in comprehensive and accountable scientific evidence.

The literature search was conducted through several electronic databases, namely PubMed (NCBI), Scopus, ScienceDirect (Elsevier), Google Scholar, and SpringerLink. All articles were searched using a combination of keywords and Boolean operators (AND, OR) to obtain literature relevant to the research objectives.

Keywords Used: (1) Gut–Brain Axis; (2) Gut Microbiota; (3) Depression; (4) Anxiety; (5) Dysbiosis; (6) Probiotics

Or, if you prefer, write the search string as follows: ("Gut–Brain Axis" OR "Gut Microbiota") AND ("Depression" OR "Anxiety") AND ("Dysbiosis" OR "Probiotics"). This represents the entire research topic without including redundant terms such as Gut Microbiome, Microbiome, Depressive Disorder, Anxiety Disorder, and Microbiota-Gut-Brain Axis.

Inclusion and Exclusion Criteria

References used in this study must meet several inclusion criteria, namely articles discussing the relationship between the Gut–Brain Axis or gut microbiota with depression and/or anxiety disorders. Selected articles can be original research, systematic reviews, meta-analyses, or clinical trials published in reputable national or international journals. Articles must be available in full text, published within the last five years (2021–2026), and written in Indonesian or English. Furthermore, articles must discuss biological mechanisms, pathophysiology, or gut microbiota-based interventions, such as probiotics, prebiotics, synbiotics, and dietary modifications, related to depression and anxiety disorders.

Articles were excluded from the study if they were not available in full text, did not discuss the relationship between the Gut–Brain Axis and depression and/or anxiety disorders, or were editorials, letters to the editor, commentaries, conference abstracts, or reports that had not undergone peer review. Articles published outside the 2021–2026 period were also excluded. Furthermore, duplicate articles found in more than one database were excluded to avoid data duplication in the analysis.

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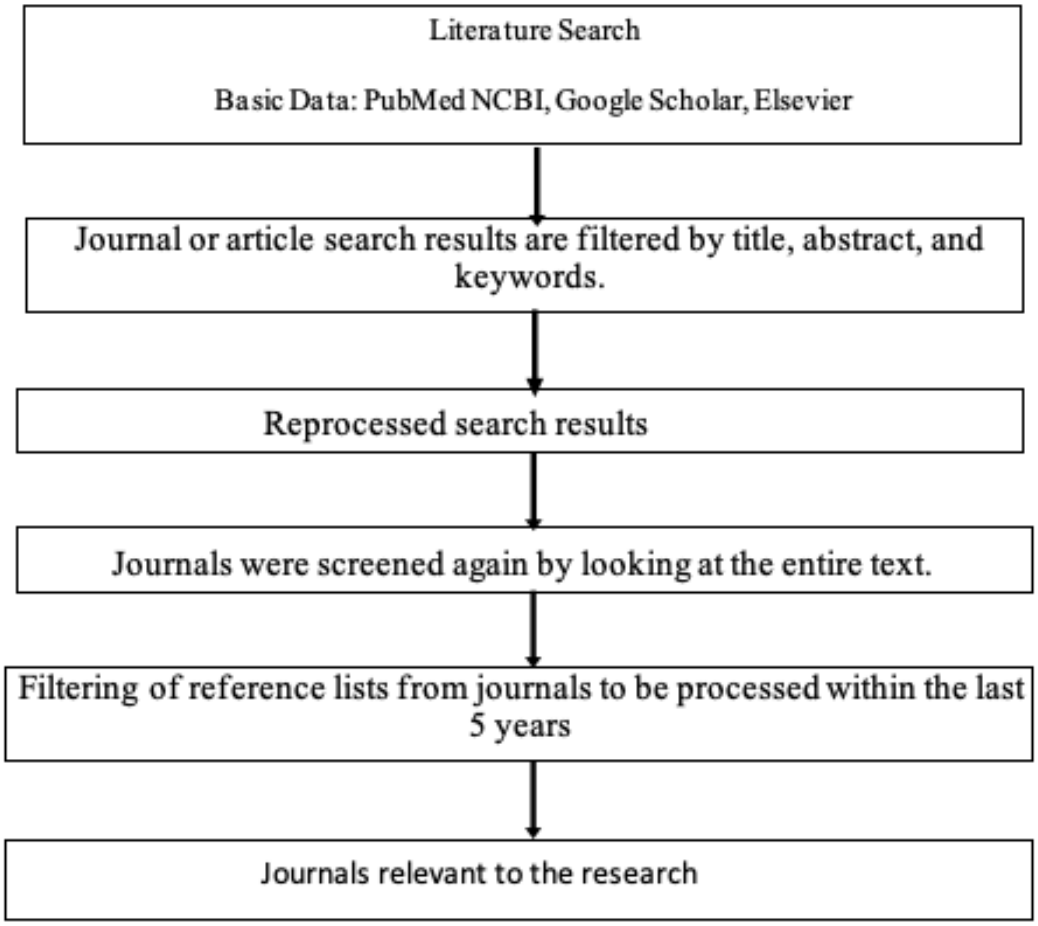
Literature Search Flow



Results and Discussion

This study used the PICOS framework to search for and select articles related to the role of the Gut–Brain Axis in depression and anxiety disorders. Article eligibility was assessed based on five components: Population, Intervention/Exposure, Comparison, Outcomes, and Study Design. The population included individuals experiencing depression, anxiety disorders, or both, from either the general population or clinical groups. The interventions or exposures included changes in gut microbiota composition, the Gut–Brain Axis, gut dysbiosis, and microbiota-based interventions such as probiotics, prebiotics, synbiotics, and dietary modifications. Comparisons included healthy individuals versus patients with depression or anxiety, individuals with normal gut microbiota versus those with gut dysbiosis, and groups receiving microbiota-based interventions versus control or placebo groups.

The main outcomes analyzed were the relationship between the Gut–Brain Axis and depression and anxiety disorders, the biological mechanisms linking the gut microbiota with the central nervous system, changes in gut microbiota composition among patients with depression and anxiety, and the effectiveness of microbiota-based interventions in improving depressive and anxiety symptoms. The eligible study designs included cohort, cross-sectional, case-control, and randomized controlled studies, as well as systematic reviews and meta-analyses.

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Articles were retrieved from PubMed, Scopus, ScienceDirect, and Google Scholar using the keywords “Gut–Brain Axis,” “Gut Microbiota,” “Depression,” “Anxiety,” “Dysbiosis,” and “Probiotics.” A total of 10 references meeting the inclusion criteria were analyzed in relation to the study title, “The Role of the Gut-Brain Axis in Depression and Anxiety Disorders: A Systematic Literature Review.” The characteristics and findings of the included references are presented in tabular form in the following section.

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No	Year	Title	Methods	Author	Result	Conclusion
1.	2025	*The Gut–Brain–Circadian Axis in Anxiety and Depression: A Critical Review*	Critical review (literature review)	Jhommara Bautista, Camila Hidalgo-Tinoco, Miranda Di Capua Delgado, Juliana Viteri-Recalde, Antonio Guerra-Guerrero, Andrés López-Cortés	Studies show that bidirectional communication between the gut and the brain via neural, endocrine, immune, metabolic, and circadian rhythm pathways plays a key role in the pathogenesis of depression and anxiety. Microbial dysbiosis and circadian rhythm disruption increase inflammation, HPA axis activation, and impaired emotion regulation.	Gangguan Depression and anxiety are systemic conditions influenced by the interaction of the gut-brain axis and circadian rhythms. Interventions such as psychobiotics, diet, fecal microbiota transplantation, and chrononutrition have the potential to become personalized therapies.
2.	2025	*The Influence of the Gut-Brain Axis on Anxiety and Depression: A Review of the Literature on the Use of Probiotics*	Literature review	Sara Ferrari, Simone Mulè, Francesca Parini, Rebecca Galla, Sara Ruga, Giorgia Rosso, Arianna Brovero, Claudio Molinari,	Various studies have shown that probiotic supplementation can improve symptoms of anxiety and depression by modulating the composition of the gut microbiota, reducing inflammation, and improving gut-brain axis communication	Probiotics and postbiotics have the potential to be safe and effective companion therapies to improve mental health through gut–brain axis regulation.

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				Francesca Uberti	without significant side effects.	
3.	2025	*The Gut–Brain Axis in Depression, Anxiety, and Schizophrenia: A Scoping Review of Mechanisms, Biomarkers, and Therapeutic Implications*	Scoping review	Kirolos Eskandar	Consistent patterns of microbial dysbiosis, impaired short-chain fatty acid (SCFA) production, alterations in the kynurenine pathway, and immune activation have been found in depression and anxiety disorders. Microbiota-based interventions have shown improvement in symptoms, although clinical evidence is limited.	The gut–brain axis is a promising therapeutic target in psychiatric disorders, but research with more uniform methodology and high-quality clinical trials is still needed.
4.	2024	*Stress-Resilience Impacts Psychological Wellbeing: Evidence from Brain-Gut Microbiome Interactions*	Observational study with multi-omics analysis	Eric An, Desiree R. Delgadillo, Jennifer Yang, Rishabh Agarwal, Jennifer S. Labus, Shrey Pawar, Madeline Lietman, Lisa A. Kilpatrick, Ravi R. Bhatt, Priten Vora, Allison Vaughan, Tien S. Dong,	Individuals with high levels of resilience have lower symptoms of depression and anxiety, a healthier microbiota composition, higher levels of anti-inflammatory metabolites, and better brain connectivity in emotion regulation..	Brain-gut-microbiome interactions play a crucial role in developing psychological resilience. Microbiota modulation has the potential to be a strategy for improving mental health and preventing depression and anxiety.

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				Arpana Gupta		
5.	2022	*Metabolomics Changes in Brain-Gut Axis After Unpredictable Chronic Mild Stress*	Experimental research	Qiuyue Xu, Mingchen Jiang, Simeng Gu, Xunle Zhang, Guangkui Feng, Xianjun Ma, Shijun Xu, Erxi Wu, Jason H. Huang, Fushun Wang	Chronic stress causes changes in key metabolites in the hippocampus and gut, such as L-glutamine, L-tyrosine, hydroxylamine, and 3-phosphoglyceric acid. These changes are associated with impaired neural plasticity and the emergence of depressive- and anxiety-like behaviors.	Metabolic changes in the brain and gut support a role for the gut-brain axis in the pathogenesis of depression. Certain metabolites have the potential to serve as biomarkers and therapeutic targets for depression and anxiety disorders.
6.	2024	*High-fat Diet, Microbiome-Gut-Brain Axis Signaling, and Anxiety-like Behavior in Male Rats*	Experimental research	Sylvana I. S. Rendeiro de Noronha, Lauro Angelo Gonçalves de Moraes, James E. Hassell Jr., Christopher E. Stamper, Mathew R. Arnold, Jared D. Heinze, Christine L. Foxx, Margaret M. Lieb, Kristin E. Cler, Bree L. Karns, Sophia Jaekel, Kelsey M.	High-fat diet decreases gut microbiota diversity, increases Firmicutes/Bacteroidetes ratio, increases expression of serotonergic genes tph2, htr1a, and slc6a4 in the dorsal raphe nucleus, and increases anxiety-related defensive behavior.	Obesity caused by a high-fat diet alters microbiome–gut–serotonergic brain axis signaling, increasing anxiety-like behaviors. Gut microbiota plays a key role in regulating the brain's serotonergic system and stress response.

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				Loupy, Fernanda C. S. Silva, Deoclécio Alves Chianca-Jr., Christopher A. Lowry, Rodrigo Cunha de Menezes.		
7.	2024	*Microbiome Composition and Central Serotonergic Activity in Patients with Depression and Type 1 Diabetes*	Observational study	Vera Flasbeck, Julia Hirsch, Frank Petrak, Juris J. Meier, Stephan Herpertz, Sören Gaterman n, Georg Juckel.	High gut microbiota diversity is associated with lower central serotonergic activity in diabetic patients with depression. Bacteroidetes, Proteobacteria, and Firmicutes bacterial groups are associated with altered serotonergic neurotransmission .	Gut microbiota composition plays a role in regulating brain serotonergic activity in depression. These findings strengthen the concept that the gut-brain axis influences central neurotransmissi on and depressive symptoms.
8.	2022	*Gut Microbiome-Linked Metabolites in the Pathobiology of Major Depression With or Without Anxiety—A Role for Bile Acids*	Observational study	Siamak MahmoudianDehkordi, Sudeepa Bhattacharyya, Christopher R. Brydges, Wei Jia, Oliver Fiehn, A. John Rush, Boadie W. Dunlop, Rima	Levels of the primary bile acid chenodeoxycholic acid (CDCA) are lower in patients with severe depression and anxiety, while secondary bile acids produced by gut bacterial metabolism are higher in patients with severe anxiety. Certain bile acid profiles are also associated	Gut microbiota-associated metabolites, particularly bile acids, are closely associated with the severity of anxiety and depression and response to therapy. The gut–brain axis is a potential target for microbiota-modulation-based treatments.

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				Kaddurah-Daouk.	with initial therapy failure.	
9.	2021	*Gut Microbiome: A Potential Indicator for Differential Diagnosis of Major Depressive Disorder and General Anxiety Disorder*	Observational case-control study	Zaiquan Dong, Xiaoling Shen, Yanni Hao, Jin Li, Haoran Li, Haizheng Xu, Li Yin, Weihong Kuang.	Significant differences were found in the diversity and composition of gut microbiota between MDD, GAD patients, and healthy groups. The genera Sutterella, Fusicatenibacter, Christensenellaceae_R7_group, and Faecalibacterium show different patterns in each group. Some bacteria also correlate with the severity of depression and anxiety.	MDD and GAD have different gut microbiota profiles, so the microbiota composition has the potential to be a biomarker to help differential diagnosis and support the development of gut–brain axis-based therapies.
10.	2024	*Alterations in Gut Microbiota Caused by Major Depressive Disorder or a Low FODMAP Diet and Where They Overlap*	Systematic review.	Simone O'Neill, Michelle Minehan, Catherine R. Knight-Agarwal, David B. Pyne.	Individuals with MDD showed decreases in Bacteroidetes, Bacteroidaceae, and Bacteroides, while the low-FODMAP diet increased the abundance of these bacteria. Both the MDD and low-FODMAP diet groups showed changes in Ruminococcaceae and Bilophila, which are associated with gut–brain axis regulation.	Modifying the gut microbiota through a low-FODMAP diet has the potential to improve the disturbed microbiota composition in depressed patients. Nutritional intervention is a promising approach to treating depression through the gut-brain axis.

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Gut–Brain Axis Mechanisms in Depression and Anxiety Disorders

Depression and anxiety disorders are among the most common mental disorders worldwide and are leading causes of reduced quality of life. These disorders are no longer viewed solely as consequences of central nervous system dysfunction but as multifactorial conditions involving interactions among the nervous, immune, endocrine, and metabolic systems and the gut microbiota. These interactions occur through the gut–brain axis, a bidirectional communication network connecting the brain and gastrointestinal tract through neural pathways, particularly the vagus nerve, the hypothalamic–pituitary–adrenal (HPA) axis, immune responses, hormones, and microbial metabolites. Alterations in gut microbiota composition, commonly referred to as dysbiosis, may disrupt neurotransmitter regulation, inflammatory processes, stress responses, and cognitive function, thereby contributing to depression and anxiety.

The studies included in this review consistently demonstrate the involvement of gut–brain axis disturbances in the pathogenesis of depression and anxiety. Bautista et al. (2025) explained that bidirectional communication between the gut and brain involves neural, endocrine, immune, metabolic, and circadian mechanisms. Circadian disruption caused by sleep deprivation, irregular eating patterns, and shift work may alter gut microbiota composition, increase HPA-axis activation and pro-inflammatory cytokine production, and exacerbate emotional dysregulation (Yang et al., 2023). These findings indicate that depression and anxiety are systemic disorders influenced by complex interactions among the gut microbiota, immune system, metabolism, and biological rhythms.

Eskandar (2025), through a scoping review of 145 studies, similarly identified consistent patterns of gut dysbiosis, impaired production of short-chain fatty acids (SCFAs), alterations in the kynurenine pathway, and immune-system activation among individuals with depression and anxiety. These mechanisms demonstrate that disturbances in microbial composition can influence psychiatric symptoms through inflammatory, metabolic, and neuroendocrine pathways.

The relationship between the gut microbiota and psychological resilience was further demonstrated by An et al. (2024). Individuals with greater psychological resilience exhibited fewer symptoms of depression and anxiety, healthier microbiota composition, increased anti-inflammatory metabolites, and better connectivity in brain regions responsible for emotional regulation. Multi-omics analysis showed that microbiota function was the strongest factor differentiating individuals with high and low resilience (Tian et al., 2026; Hou et al., 2025). These findings suggest that the gut microbiota may contribute not only to the development of mental disorders but also to maintaining psychological resilience against stress.

Experimental findings also clarify the metabolic pathways involved in gut–brain communication. Using an unpredictable chronic mild stress model in mice, Xu et al. (2022) identified alterations in important metabolites in the hippocampus and gastrointestinal tract, including L-glutamine, L-tyrosine, hydroxylamine, and 3-phosphoglyceric acid. These metabolic changes were associated with impaired neuronal plasticity and the development of depressive- and anxiety-like behaviours. The simultaneous occurrence of metabolic alterations in the brain and gastrointestinal tract provides further evidence of bidirectional communication through the gut–brain axis.

Lifestyle factors, particularly dietary patterns, may also affect gut–brain axis function. de Noronha et al. (2024) found that consuming a high-fat diet for nine weeks reduced gut microbial diversity, increased the Firmicutes/Bacteroidetes ratio, altered the expression of

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serotonergic genes such as *tph2*, *htr1a*, and *slc6a4* in the dorsal raphe nucleus, and increased anxiety-like behaviour in male rats. These results demonstrate that a high-fat diet can disrupt microbiome gut–serotonergic brain signalling and increase anxiety responses. Therefore, dietary patterns represent an important modifiable factor affecting mental health through changes in gut microbiota composition.

The serotonergic mechanism was also supported by Flasbeck et al. (2024), who examined patients with type 1 diabetes and depression. Gut microbial diversity was associated with central serotonergic activity measured using the Loudness Dependence of Auditory Evoked Potentials. Bacteria belonging to Bacteroidetes, Proteobacteria, and Firmicutes were associated with serotonin neurotransmission in the brain. These findings support the proposition that the gut microbiota may participate in regulating serotonin synthesis and activity, which are essential to mood regulation and the pathophysiology of depression and anxiety.

Microbial metabolites may also provide important information regarding disease severity and treatment response (Recharla et al., 2023). MahmoudianDehkordi et al. (2022) found that patients with severe depression and anxiety had lower levels of chenodeoxycholic acid but higher levels of lithocholic acid and other secondary bile acids produced by gut bacteria. This bile-acid profile was also associated with failure to respond to first-line antidepressant treatment. Microbial metabolites, particularly bile acids, may therefore have potential as biomarkers of disease severity and predictors of therapeutic response.

Moreover, Dong et al. (2021) demonstrated that patients with major depressive disorder and generalized anxiety disorder have distinct gut microbiota profiles. The genera *Sutterella*, *Fusicatenibacter*, *Christensenellaceae_R7_group*, and *Faecalibacterium* exhibited characteristic alterations across the clinical groups, and some were associated with the severity of depression and anxiety symptoms. These findings indicate that gut microbiota composition may have potential as a biomarker for differentiating major depressive disorder from generalized anxiety disorder and as a target for microbiota-based treatment.

Microbiota-Based Interventions and Future Therapeutic Directions

The findings of the reviewed studies indicate that modulation of the gut microbiota may provide a complementary therapeutic strategy for depression and anxiety disorders. Ferrari et al. (2024) reported that probiotic supplementation may improve depressive and anxiety symptoms by modifying gut microbiota composition, reducing systemic inflammation, and improving communication through the gut–brain axis. Postbiotics have also demonstrated potential mental-health benefits without producing significant adverse effects. These findings suggest that microbiota modulation may represent a promising non-pharmacological approach to managing psychiatric disorders.

Other microbiota-based interventions, including prebiotics, synbiotics, and faecal microbiota transplantation, have also produced potentially beneficial outcomes. Eskandar (2025), however, emphasized that evidence supporting these interventions still requires validation through clinical trials with stronger methodologies, larger samples, appropriate control groups, and standardized intervention protocols. Therefore, although microbiota-based treatments are promising, the available evidence is not yet sufficient to support their routine application in clinical practice.

Nutritional modification is another potentially useful intervention. O'Neill et al. (2024) reported that individuals with major depressive disorder had reduced abundances of Bacteroidetes, Bacteroidaceae, and *Bacteroides*, whereas a low-FODMAP diet increased the abundance of these microbial groups. Overlapping changes were also identified in

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Ruminococcaceae and *Bilophila*, which may participate in gut–brain axis regulation. These findings suggest that dietary modification may improve gut microbiota composition and potentially contribute to reducing depressive symptoms. Nevertheless, direct evidence regarding the clinical effectiveness of a low-FODMAP diet for treating depression remains limited, and controlled intervention studies are required.

Lifestyle approaches that support circadian regularity may also contribute to maintaining gut–brain axis function. Regular sleep, consistent eating schedules, physical activity, and balanced dietary intake may help maintain microbial diversity and reduce HPA-axis hyperactivation and systemic inflammation. However, the effects of lifestyle modification should be evaluated alongside other clinical factors because depression and anxiety are multifactorial disorders that cannot be explained or treated solely through gut microbiota modification.

The 10 studies consistently demonstrate that depression and anxiety disorders are associated with changes in gut microbiota composition, immune-system activation, microbial metabolite disturbances, altered serotonin neurotransmission, circadian disruption, and HPA-axis dysregulation. Despite differences in study design from experimental animal studies and observational human research to systematic and scoping reviews the findings collectively identify the gut–brain axis as an important component in the pathogenesis of depression and anxiety.

Modulation of the gut–brain axis through probiotics, prebiotics, postbiotics, synbiotics, faecal microbiota transplantation, dietary modification, and lifestyle interventions may therefore provide useful complementary strategies. Nevertheless, these approaches should not yet be considered substitutes for established psychological and pharmacological treatments. Large-scale randomized clinical trials, longitudinal studies, standardized microbiota-analysis methods, and integrated multi-omics research are required to determine their effectiveness, safety, appropriate dosage, duration, and clinical applicability.

Conclusion

Based on literature studies, there is a close relationship between gut microbiota and depressive disorders. Gut microbiota dysbiosis causes changes in metabolite production, increased inflammation, and neurotransmitter disturbances that contribute to depression. The gut-brain axis plays a crucial role in the pathogenesis of anxiety disorders through bidirectional communication between the gut and the brain. Disruptions in the gut microbiota can activate the HPA axis, increase inflammation, and disrupt the serotonergic system, thereby exacerbating anxiety symptoms. The biological mechanisms of the gut-brain axis involve neuroimmunological, neuroendocrine, and metabolic pathways through inflammatory cytokines, the HPA axis, and microbiota metabolites such as short-chain fatty acids (SCFAs), tryptophan, serotonin, and bile acids, which play a role in regulating brain function and emotions. Probiotic interventions have shown potential in improving symptoms of depression and anxiety through modulation of the gut microbiota. However, variations in strains, doses, and duration of administration across studies have prevented the determination of optimal therapy protocols. Microbiota-based interventions, such as probiotics, prebiotics, and dietary modifications, have the potential to be complementary therapies for depression and anxiety, although further clinical research is needed to confirm their effectiveness.

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