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THE INFLUENCE OF GUT MICROBIOTA ON THE CENTRAL NERVOUS SYSTEM

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There exists a bidirectional communication network linking the gastrointestinal tract and the central nervous system known as the Microbiota-Gut-Brain Axis (MGBA). Gut microbiota is increasingly recognized as an important player in the pathophysiology and treatment of neurological and psychiatric disorders, as numerous clinical and preclinical studies have shown alterations in gut microbiota composition in depression, anxiety, autistic spectrum disorders (ASD), schizophrenia, epilepsy, Alzheimer's disease (AD), and Parkinson's disease.

The main aim of this study is to explore the effect of the gut microbiome on the central nervous system circuits and how it is linked with neuropychiatric and neurological disorders.

The vagus nerve is a critical conduit for gut-brain signaling, thus influencing mood, cognition, and stress responses. Gut microbiota regulate neuroendocrine systems such as the hypothalamic-pituitary-adrenal (HPA) axis, modulating stress responses. Other key pathways used are immune signaling by cytokines, tryptophan metabolism, and microbial metabolites such as short-chain fatty acids that are able to cross the blood-brain barrier (BBB), reducing inflammation and supporting neuronal health. Gut bacteria were found to produce neurotransmitters. According to Liu, X. et al. (2024), *Bifidobacterium* and *Lactobacillus* produce GABA, *Escherichia* and *Enterococcus* produce seratonin, *Bacillus* and *Serratia* produce dopamine, and *Lactobacillus* produces acetylcholine. It was found that lack of gut microbiota leads to the increase in the BBB permeability due to reduced tight junction protein expression. Further, dysbiosis (imbalance in gut microbiota) was linked to leaky gut, which allowed bacterial toxins such as lipopolysaccharides (LPS) and amyloids to trigger neuroinflammation. (Megur et al., 2020) Germ-free (GF) mice showed altered synaptic plasticity and reduced brain-derived neurotrophic factor (BDNF). Stress altered the richness of microbiota, reducing *Lactobacillus* and *Bifidobacterium.* Inflammation was linked to depression, schizophrenia, and Parkinson's disease. (Cryan, J.F. et al., 2019).

Socala, K. et al. (2021) demonstrated that GF mice exhibited altered behavior such as decreased anxiety, increased HPA axis reactivity, hyperactivity, and social deficits, suggesting a link between microbiome diversity and depression, anxiety, schizophrenia, and ASD. Increased *Clostridium* and reduced *Bifidobacterium* are linked to GI symptoms and severity of ASD. Gut dysbiosis in AD patients is characterized by lower *Firmicutes* and *Bifidobacterium* and higher *Bacteroidetes*. Patients with schizophrenia showed increased *Lactobacillus* and altered tryptophan metabolism. A ketogenic diet increased *Akkermansia,* reducing seizures via GABA and glutamate balance, thus linking the MGBA to epilepsy. Dysbiosis during migraine due to enrichment with *Clostridium* and reduced *Faecalibacterium* was linked to chronic pain via the tumor necrosis factor alpha (TNF-α). The alpha-synuclein pathology, which may originate in the gut, can spread to the brain via the vagus nerve. Increased *Akkermansia* and decreased *Prevotella* correlate with motor and GI symptoms.

Certain therapeutic methods have been used to restore the gut microbiome and improve neurological symptoms. Probiotics infused with *Lactobacillus* and *Bifidobacterium* strains showed promise for depression, ASD, and Parkinson's disease. (Osadchiy V et al., 2018) Prebiotics such as Bimuno-Galactooligosaccharide (B-GOS) modulated the HPA axis and cognition. Fecal microbiota transplantation (FMT) showed short-term benefits in ASD and depression. Ketogenic diets improved symptoms of epilepsy, whereas omega-3 PUFAs improved symptoms of depression.

In conclusion, the microbiota-based therapies hold promise for treating neurological and psychiatric disorders, as the MGBA is a critical pathway that influences the central nervous system function. Future research in this topic is expected to benefit from improved technologies that offer more sensitivity and resolution in microbiome analysis.