The Food Brain Axis and Chemotherapy: a Review of Recent Literature

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Abstract

Research shows microbes are contributing to the development of cancer by 15% in 2023. Common cancer associated microbes such as Helicobacter pylori and Fusobacterium nucleatum contribute to mood disorders such as depression, highlighting the complex interplay between the gut microbiome, mood, and cancer patients. However, limited research has addressed the gut microbiome's influence on mood and cancer in patients undergoing chemotherapy. The findings indicate microbiome imbalances may cause psychological distress to develop, a common issue in cancer patients, therefore further investigation into this area could provide new insights into enhancing psychological wellbeing for cancer patients.

Key words*: Microbes, Helicobacter pylori, Fusobacterium nucleatum, gut microbiome, psychological wellbeing*

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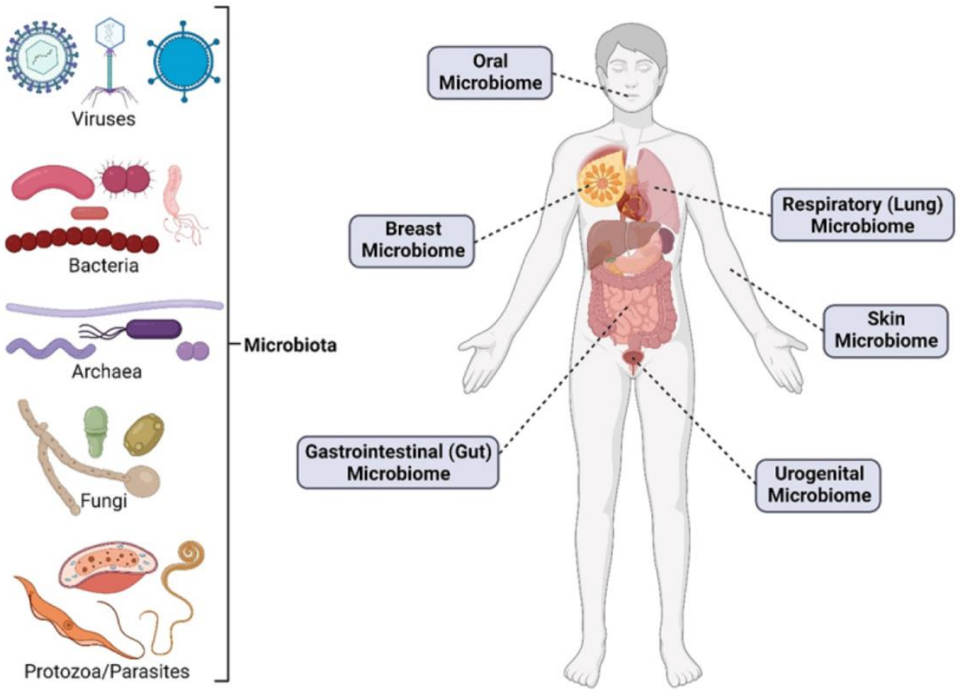
Cancer remains one of the biggest threats to mortality worldwide (Dattani et al., 2023). Characterised by its uncontrolled division of cells with the potential to invade nearby tissues (Hatta et al., 2021), cancer affects an estimated 20 million people on average, with approximately 9.7 million resulting deaths in 2022 (*Global Cancer Burden Growing, amidst Mounting Need for Services*, Retrieved 2024). Statistics shows carcinogenic microbes are contributing to the development of cancer by 15% as of 2023 (Azevedo et al., 2020; Hatta et al., 2021; Humans, 2012). In fact, Kapsetaki et al. (2022) highlighted a noteworthy correlation between cancer and the gut microbiome, identifying several cancers (hepatocellular carcinoma, prostate cancer, breast cancer, gastric adenocarcinoma, lymphoma, and cervical) are linked to the presence of certain microbes such as Helicobacter pylori. Specifically, colorectal cancer has been linked with microbe biomarkers like Escherichia, Citrobacter, Shigella, etc.; Castellarin et al., 2012; Dai et al., 2018; Feng et al., 2015; Yu et al., 2017). Prostate cancer, breast tumors, and hepatocellular carcinoma are associated with intestinal bacteria such as Helicobacter hepaticus (Wong et al., 2019) while Helicobacter pylori has been implicated in the development of gastric, hepatic, and cervical cancers (Martel et al., 2012). Given these connections, extensive research has examined the interactions between the gut microbiome and cancer development (Kandalai et al., 2023; Zhao et al., 2023). Hence, this review will explore the connections between the gut microbiome and cancer, as well as the influence of the gut microbiome on psychological wellbeing.

The Gut Microbiome

The human body hosts nearly 40 trillion microorganisms from 3,000 different species, consisting of bacteria, fungi, and viruses, that are predominantly located in the gastrointestinal tract, otherwise known as the gut microbioata (see Figure 1; Adak & Khan, 2019; Martinez-Guryn et al., 2019; Sender et al., 2016).

Figure 1

A Visual Model of the Human Bodie's Microbiome's (Kandalai et al., 2023)



Note. The various microbes presented on the left have been found to make up the different microbiomes on the right.

Disruptions in the balance of the gut microbiome can alter the taxonomic composition, metabolic products and secretory vesicles of the microbiota, all having significant links to cancer (Dejea et al., 2018; Kadosh et al., 2020; Tilg et al., 2018; Yu & Schwabe, 2017). In addition, the intratumoral microbioate within the tumor microenvironment may be a contributor to cancer progression and discrepancies among cancer patients, likely due to its tendency to promote genomic instability and mutations (i.e., a common characteristic seen in cancer cells due to genomic alterations during cell division; Cao et al., 2024; Cogdill et al., 2018; Heymann et al., 2021; Liou et al., 2020; Zhao & Hu, 2020). Zhao et al. (2023) detailed numerous cancer-promoting microbes yet due to word count limitations I will only share a selected few as seen below.

Helicobacter pylori

A bacteria that resides in or beneath the mucus layer of the human stomach, Helicobacter pylori is the most significant indicator of gastric cancer (Martinsen et al., 2019; Stewart et al., 2020; Yang et al., 2021).

Bacteroides fragilis

A microbiota present in the human colon, Bacteroides fragilis has been linked to the development of tumors in the colon (Zamani et al., 2019).

Fusobacterium nucleatum

Residing within the mouth, gram-negative anaerobic bacteria such as Fusobacterium nucleatum has been found within colorectal cancer tissues (Abed et al., 2016; Castellarin et al., 2012; Chen et al., 2022). Studies by Nejman et al. (2020) and Parhi et al. (2020) implied greater abundance of Fusobacterium nucleatum was identified within breast cancer patients.

The Gut Microbiome and Mood

These findings have significant implications for the recent research on the connections between mental health and the gut microbiome, suggesting the common cancer-microbes may also play a role in developing depression and/or anxiety. For instance, a study on 871 participants aged 13 and above found a higher prevalence of depression among those with Helicobacter pylori infection (Soboka et al., 2022). Depression characterized (commonly) as sadness and a lack of interest (Rondón, 2018) while Helicobacter pylori infection refers to a bacteria that infects the stomach. Li et al. (2024) meta-analysis across twelve studies found significant and positive associations between Helicobacter pylori infection and anxiety. A mouse study by Zhang et al.'s (2022) indicated gut microbiota such as Bacteroides fragilis can deplete serotonin, which is commonly known as a happy chemical. Liang et al. (2024) also highlighted the excessive proliferation of, for example, Fusobacterium nucleatum, can consequently trigger pro-inflammatory cytokines (chemical messengers in the immune system) to release across the blood-brain barrier which may exacerbate depressive symptoms.

Limitations

A significant limitation arose however, at the lack of research focused on the gut microbiome's impact on mood and psychological wellbeing in cancer patients undergoing chemotherapy. Findings indicate that microbes associated with cancer, such as Helicobacter pylori, are also connected to depression and anxiety, both components of the psychological distress frequently observed in cancer patients (Negussie et al., 2023). Since psychological distress is known to influence treatment responsiveness and the pain experienced during cancer treatment (Mackie, 2024), future research in this area could be invaluable. Research into how the gut microbiome impacts mood in cancer patients undergoing chemotherapy may reveal insights that could enhance cancer treatment outcomes.

Conclusion

The gut microbiome plays a significant role in mood regulation and cancer development. Evidence has linked common cancer-microbes to mood disorders such as depression, yet the lack of research regarding the interplay between the gut microbiome, cancer patients undergoing chemotherapy, and mood, needs to be remedied. Addressing this gap has the potential to enhance psychological wellbeing in cancer patients, ultimately reducing the risk of developing psychological distress during treatment.

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