# The Gut Microbiome in Chronic Diseases

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## Introduction

The development of the gut microbiome begins at birth and is heavily influenced by environmental exposures such as diet, mode of delivery, antimicrobials, and animal exposure.[1] Due to the vast number of bacteria that inhabit the gut microbiome, there is a large possibility of dysbiosis with the opportunity to contribute to disease. Different microbial agents have a variety of health benefits including suppression of chronic inflammation, improvement of insulin sensitivity, maintenance of host-microbe homeostasis, and modulation of host metabolism.[1] Due to the different factors that influence the gut microbiome, the gut microbiome has become associated with the development of disease, and therefore, has been a target for the treatment of chronic disease.[2]

## Chronic Diseases

**Cardiovascular Disease**

Cardiovascular disease is the leading cause of morbidity and mortality worldwide, specifically, 31% of all deaths.[3,4] General risk factors for cardiovascular disease include atherosclerosis, diabetes, mental illness, and obesity.[3] Specific microbiota have been shown to be decreased in persons with heart failure, as compared to the gut microbiota of healthy individuals.[4] Examples include Coriobacteriacae, *Erysipelotrichaecae*, *Dorealongicatena*, *Faecalibacterium*, and *Prausnitzii*.[4] These bacteria are responsible for producing the short-chain fatty acid, butyrate.

**Chronic Kidney Disease**

Approximately 9% of people in the world suffer from CKD.[3] An increase in bacteria species including *P. gingivalis*, *T. denticola*, *S. noxia*, *A actinomycetemcomitans*, and *V. parvula* have been shown to be detrimental to kidney function as they increase the levels of IgG.[3] Additionally, a decrease in colonization of *Bifidobacterium sp*, *Lactobacillaceae*, *Bacteriodaceae*, *Akkermansia*, and *Prevotellaceae* genera have been demonstrated in patients with CKD, as well.[7]

**Type I Diabetes Mellitus**

Type I diabetes is an autoimmune disease which the immune system destroys the insulin producing cells in the pancreas leading to a high amount of glucose in the blood.[3] Decreased levels of short-chain fatty acid butyrate-producing bacteria were found in these patients, as well.[7] Additionally, *R. faecis*, *F. praunitzii*, and *Intestimonas* were all decreased in type I diabetics.[7]

**Type II Diabetes Mellitus**

Type II diabetes is a disease in which the body is unable to produce or utilize insulin.[3] Similarly to Type I diabetics, patients with Type II diabetics have decreased levels of short-chain fatty acid producing bacteria, *Facalibacterum* and *Roseburia*.[3] Type II diabetes is associated with increased levels of lipopolysaccharide, a pro-inflammatory molecule.[3]

**Inflammatory Bowel Disease**

Inflammatory Bowel Disease (IBD) is a chronic inflammatory disease that has two main subtypes: ulcerative colitis and Crohn's disease.[9] Expansion of *Enterobacteriaceae* is associated with the onset of Crohn's disease and depletion of this species has been shown to decrease inflammation when tested in mice.[10] Additionally, the loss of *Faecalibacterium prausnitzii* has been related to the recurrence of Crohn's disease.[10] During the investigation of microbiota in patients with ulcerative colitis, it was found that severely ill patients exhibited an increase in *Bacteroides candida*.

**Mental Health Disorders**

There is a two-way communication between our central nervous system and the gut microbiome termed the "gut-brain axis".[12] It was found that there was a relative abundance of Actinobacteria and Lentisphraerae, and decreased levels of Verfucomicrobia phyla in the 18 individuals who suffer from PTSD.[11] Studies have shown that the oropharyngeal microbiome has increased levels of lactic acid bacteria and increased levels of Lactobacillius phage.[11] Other studies have also shown that the abundance of Lactobacillus has an effect on the severity of psychosis that a patient with schizophrenia will develop.[11]

## Relationship Between Gut Microbiota and Disease

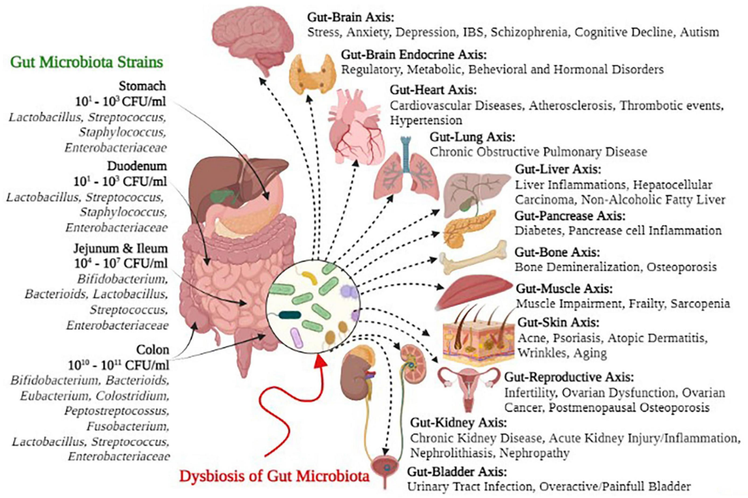


Figure 1: This image shows the relationship of bacteria that occurs with dysbiosis of different organs.

Afzaal M, Saeed F, Shah YA, et al. Human gut microbiota in health and disease: Unveiling the relationship. *Front Microbiol*. 2022;13. doi:10.3389/fmicb.2022.999001

## Correlation between Gut Microbiome and Chronic Diseases

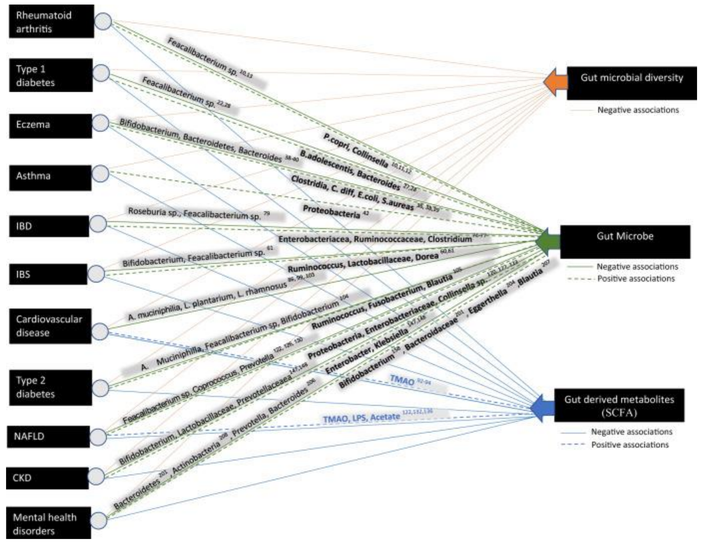


Figure 2: Composition of the gut microbiome and the association between gut-derived metabolites and chronic diseases

Vijay A, Valdes AM. Role of the gut microbiome in chronic diseases: a narrative review.*Eur J Clin Nutr*. 2022;76(4):489-501. doi:10.1038/s41430-021-00991-6

## Discussion & Future Directions

The gut microbiome alterations found in these diseases and conditions create an opportunity for focused treatment to limit their pathogenesis. For example, the Mediterranean diet focuses on the consumption of plant-based foods, healthy fats, and whole grains.[17] This diet has been shown to lower levels of TMAO which may decrease one's risk of developing cardiovascular disease.[18] Butyrate supplements have been shown to reduce blood pressure, atherosclerosis, abdominal pain in patients with IBD, and lower insulin resistance.[19] Butyrate may also be increased by increasing the amount of butyrate-producing bacteria in the gut by consuming a high-fiber diet.[4] Currently, clinical trials are focusing on fetal microbiota transplantation and probiotic therapy as possible options to reduce dysbiosis.[3]

Additionally, further research to solidify the differences between male and female gut microbiomes can provide an opportunity for unique and personal treatment or prevention plans for patients that have or are predisposed to chronic disease.

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