



Gut-Brain Axis (GBA) and Irritable Bowel Syndrome (IBS)



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Irritable Bowel Syndrome (IBS)

For most people, IBS is best understood as a long-term or chronic condition in which they experience reoccurring issues with abdominal pain or discomfort associated in some way with their bowel movements. Some patients with IBS, particularly those whose problems started after food poisoning or traveler’s diarrhea (post-infectious IBS) can gradually get better over time. Others may have IBS for their entire lives.

In IBS, the digestive system appears normal on routine tests. For this reason, it has been referred to as a *functional gastrointestinal (GI) disorder*. However, there is increasing evidence that the GI symptoms experienced in IBS may be caused by one of more of the following:

- Abnormalities in gut *motility*
- Improper functioning of the immune system (over- or under-active)
- Abnormal amounts of bacteria and other organisms (like viruses and fungi) in the gut (microbiota)
- The *central nervous system’s* misreading all pain signals as extreme pain.

Motility is movement in the body (in this context, usually movement of food through the GI tract).

The **central nervous system (CNS)** is the part of the nervous system consisting primarily of the brain and spinal cord.

Gut-Brain Axis

The Gut-Brain Axis (GBA) is a communication system between the *digestive tract* and the brain. This pathway is bi-directional, meaning the brain communicates with the gut, and the gut also communicates information to the brain.

Digestive tract is a group of hollow organs that forms a long, twisting tube extending from the mouth to the anus through which food is ingested, digested, and expelled.

The GBA involves communication between several systems in the body:

- Nervous System – Playing a role in nearly every aspect of our health, the nervous system is involved

in automatic activities such as breathing, and in complex processes such as thinking, reading, remembering, and feeling emotions.

- Endocrine System – Consisting of all the body’s different hormones, the endocrine system regulates all biological processes in the body.
- Immune System – This network of biological processes protects your body from diseases.

The GBA also communicates with the *gut microbiome*, which includes all the bacteria in the intestines. Many bacterium are necessary for healthy digestion.

The role of the nervous system: The Autonomic Nervous System (ANS) is responsible for bodily functions that are not consciously controlled. This includes a person’s blood pressure, heart rate, respiratory rate, and digestion. The ANS is divided into the sympathetic and parasympathetic (vagal) nervous system, described below.

- The *sympathetic nervous system (SNS)* is associated with the “fight, flight, or freeze” response, also known as the “stress” response. It is often compared to the gas pedal of a car: when the brain detects a stressful event, the SNS sends signals to the body by releasing adrenaline from the adrenal glands. This can cause increased heart rate and blood pressure, rapid breathing for increased oxygen intake (to increase alertness) and release of glucose to supply additional energy. While energy is being directed to the heart, lungs, muscle, and brain during the sympathetic response, blood flow is directed away from the digestive tract, leading to delayed digestion and decreased oxygen to the GI tract. This can result in abdominal symptoms such as indigestion or nausea. The stress response can also result in stimulation of the large bowel, which may contribute to increased need to have a bowel movement (also known as *urgency*).
- The *parasympathetic (vagal) nervous system (PSNS)*: While the SNS response works like a gas pedal, the parasympathetic response acts like a brake. Known

as the “rest-and-digest process,” the PSNS helps the body recover the energy expended during stressful periods and promotes relaxation and healthy digestion. The vagal nerves that communicate between the brain and gut are part of the PSNS. Heart rate, blood pressure, and breathing patterns return to healthy levels, muscles relax, and the blood flow and oxygen are returned to the digestive tract. Production of saliva resumes, as does the release of digestive enzymes, and motility increases.

The endocrine system: The *hypothalamic-pituitary-adrenal axis (HPA axis)* is the neuroendocrine system involved in the response to stress. The hypothalamus and pituitary glands are located in the brain, and the adrenal glands are located on top of the kidneys. The hypothalamus, pituitary glands, and adrenal glands interact by releasing stress hormones. The adrenal gland releases cortisol, which has a fluctuating, cyclical pattern. Higher amounts of cortisol are typically released upon awakening to supply energy, but this level decreases throughout the day. When a person experiences increased stress, higher cortisol levels can provide the energy needed to respond to the crisis. Cortisol levels return to normal after the stressor resolves. However, chronic stress can result in improper function of the HPA axis and has been associated with poorer mental health, increased inflammation, sleep disorders, metabolic problems, and GI conditions such as IBS.

The immune system: Some research shows that altered immune function may play a role in IBS. Studies show that there can be elevated levels of immune cells in the intestinal lining of some people with IBS. There also can be an increase in the presence of other inflammatory markers in their blood. The role of the immune system in IBS is best illustrated by post-infectious IBS where individuals develop new onset IBS symptoms after getting a *gastroenteritis*, such as food poisoning.

Gastroenteritis is an infection in the stomach and/or intestines typically caused by contaminated food or water. This infection can cause inflammation, vomiting and diarrhea.

Gut Microbiome: The *gut microbiome* is the diverse combination of microorganisms such as bacteria, viruses, and protozoa that are found in a person’s digestive tract. Increasing research has found that patients with IBS have changes in the gut microbiome, which can influence intestinal inflammation, pain, and changes to the HPA axis. The microbiome can also be affected by diet, which can be altered in some patients with IBS.

The Body’s Second Brain

Information received from the brain and spinal cord, the autonomic nervous system (ANS), immune system, and endocrine system all come together in what is known as the Enteric Nervous System (ENS)—a large and complex system that organizes gastrointestinal (GI) activity. In fact, while the ENS receives input from the brain or spinal cord, it can function independently, leading some healthcare providers to refer to it as the body’s “second brain.” The ENS contains more than 100 million nerve cells lining the digestive tract from mouth to rectum. Neurotransmitters or neurochemicals such as serotonin (a mood stabilizer) and dopamine (involved in pleasurable experiences) are responsible for communication between the brain and the gut. In fact, the gut contains greater than 90% of the body’s serotonin and half of the body’s dopamine. The large presence of these neurotransmitters in the digestive tract and the brain play a significant role in the use of certain medications that work as neuromodulators that act with and enhance the role of neurotransmitters in IBS.

Gut-Brain Dysfunction

When the Gut-Brain Axis (GBA) is out of balance, normal sensations—such as food moving through the digestive tract—that would typically not be noticed or considered bothersome, can be experienced as unpleasant symptoms. In other words, the gut can be more sensitive than normal. A number of factors that can influence Gut-Brain dysfunction:

- **Stress** – As noted above, stressful events, as well as long-lasting or recurring stress, can lead to dysregulation of the Gut-Brain Axis, including activation of the autonomic nervous system (ANS) and hypothalamic-pituitary-adrenal axis (HPA axis), which can worsen GI symptoms. Stress can also result in changes in gut motility and permeability.
- **Early Life Stress and Traumatic Experiences** – Patients with IBS report higher rates of physical, emotional, or sexual abuse and general early life trauma than non-IBS patients. Early life stress is associated with more severe and difficult-to-treat GI symptoms. The impact of early life stress is also associated with IBS patients’ increased stress (cortisol) response and decreased resilience or ability to bounce back or recover from stress. As a result, in addition to increasing their likelihood of developing IBS, untreated early life stress can make it harder for

Permeability is the measure of how liquids or gases or specific chemicals pass through a material. In the digestive system, permeability refers to bacteria and toxins that pass through the intestinal wall.

patients to cope with their IBS symptoms once they appear.

- **Anxiety and Depression** – Patients with IBS report higher than normal rates of anxiety and depression. IBS patients also report higher rates of *somatization*, which is a tendency to experience stress through physical symptoms. The presence of anxiety or depression is associated with increased GI-symptom severity and poorer mental health outcomes, which lead to a higher level of interference in a patient’s quality of life.
- **GI Symptom-related Anxiety, Hypervigilance/Attentional Bias** – Some IBS patients who do not have general anxiety may still experience anxiety triggered by their GI symptoms. Bothersome GI symptoms can lead to *anticipatory anxiety*, the worry that even the faintest symptom may be merely the first sign that a serious IBS incident is about to strike, bringing with it discomfort, urgency, and (possibly) embarrassment. While this concern is completely understandable, it can unfortunately lead some patients to become very focused on their physical symptoms. They may begin to notice (and suffer stress) over mild, transitory symptoms that might otherwise have come and gone undetected in the bustle of everyday life. This chronic stress can then cause more, and stronger, IBS symptoms, which will, in turn, cause the patient to become even more focused than before.

Many patients report that in practical terms, this ever-present concern leads to an avoidance mindset that disrupts daily activities—such as cancelling dinner plans out of fear that eating will trigger GI symptoms or avoiding taking longer trips out of concerns about bathroom accessibility.

- **Visceral Hypersensitivity** – Many patients with IBS report a tendency to experience discomfort or pain in response to normal bowel functions. This is known as *visceral hypersensitivity*. It is believed that in IBS patients, the ENS nerves send stronger pain signals to the brain in response to activity within the GI tract. Muscle contractions moving food through the GI tract, or normal gas patterns, are now perceived as discomfort or pain. Brain-imaging studies demonstrate alterations in the way the brain responds to gut sensations and is associated with increased sensitivity.
- **Sleep** – Many IBS patients also report sleep disturbances. Sleep disruption, including frequent sleep awakenings and poor sleep quality are

associated with increased abdominal pain and GI distress, as well as non-GI pain such as headache and backache. Shift work, especially rotating shift work, is also associated with increased abdominal pain, most likely due to its impact on sleep quality.

Conclusion

IBS symptoms are very real and quite common. As described in this fact sheet, there are often numerous factors that may play a role in the development of and the experience of GI symptoms. The way the brain responds to signals from the gastrointestinal tract is altered in those with IBS, but these are real, physiologic changes. The gut in an IBS patient also does not function normally and results in GI symptoms such as abdominal pain, diarrhea, and constipation. Because there are numerous factors that may contribute to a patient’s symptom experience, treatment plans need to be personalized and tailored to that patient’s needs. For some patients, simple diet and lifestyle modifications may be all that is required to relieve symptoms. For patients with severe symptoms, a more comprehensive, integrated approach (formulated in collaboration with your gastroenterologist, dietitian, and GI health psychologist) is often the most effective treatment approach.

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