

A healthy microbiome builds a strong immune system that could help defeat COVID-19

January 25 2021, by Ana Maldonado-Contreras



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You may not know it, but you have an army of microbes living inside of you that are essential for fighting off threats, including the virus that

causes COVID-19.

In the past two decades scientists have learned our bodies are home to more [bacterial cells](#) than human ones. This community of [bacteria](#) that lives in and on us—called the [microbiome](#)—resembles a company, with each microbe species performing specialized jobs but all working to keep us healthy. In the gut, the bacteria balance the immune response against pathogens. These bacteria ensure the immune response is effective but not so violent that it causes collateral damage to the host.

Bacteria in our guts can elicit an effective immune response against viruses that not only infect the gut, such as [norovirus and rotavirus](#), but also those infecting the lungs, such as [the flu virus](#). The beneficial gut microbes do this by ordering specialized immune cells to produce potent antiviral proteins that ultimately eliminate [viral infections](#). And the body of a person lacking these beneficial gut bacteria won't have as strong an immune response to invading viruses. As a result, infections might go unchecked, taking a toll on health.

[I am a microbiologist](#) fascinated by the ways bacteria shape human health. [An important focus of my research](#) is figuring out how the beneficial bacteria populating our guts combat disease and infection. [My most recent work focuses on the link](#) between a particular microbe and the severity of COVID-19 in patients. My ultimate goal is to figure out how to enhance the [gut microbiome](#) with diet to evoke a strong immune response—for not just SARS-CoV-2 but all pathogens.

How do resident bacteria keep you healthy?

Our immune defense is part of a complex biological response against harmful pathogens, such as viruses or bacteria. However, because our bodies are inhabited by trillions of mostly beneficial bacteria, virus and fungi, activation of our immune response is tightly regulated to

distinguish between harmful and helpful microbes.

Our bacteria are spectacular companions diligently helping prime our immune system defenses to combat infections. A seminal study found that mice treated with antibiotics that eliminate bacteria in the gut exhibited an impaired immune response. These animals had low counts of virus-fighting white blood cells, weak antibody responses and poor production of a protein that is vital for [combating viral infection and modulating the immune response](#).

[In another study](#), mice were fed Lactobacillus bacteria, commonly used as probiotic in fermented food. These microbes reduced the severity of influenza infection. The Lactobacillus-treated mice did not lose weight and had only mild lung damage compared with untreated mice. Similarly, others have found that treatment of mice with Lactobacillus protects against different [subtypes of influenza virus](#) and human respiratory syncytial virus—the [major cause of viral bronchiolitis and pneumonia in children](#).

Chronic disease and microbes

Patients with chronic illnesses including Type 2 diabetes, obesity and cardiovascular disease exhibit a hyperactive immune system that fails to recognize a harmless stimulus and is linked to an altered gut microbiome.

In these chronic diseases, the gut microbiome lacks bacteria that activate [immune cells](#) that block the response against harmless bacteria in our guts. Such alteration of the gut microbiome is also observed in [babies delivered by cesarean section](#), individuals consuming a poor [diet](#) and the [elderly](#).

In the U.S., 117 million individuals—about half the adult population –

[suffer from Type 2 diabetes, obesity, cardiovascular disease or a combination of them](#). That suggests that half of American adults carry a faulty microbiome army.

Research in my laboratory focuses on identifying gut bacteria that are critical for creating a balanced immune system, which fights life-threatening bacterial and [viral infections](#), while tolerating the beneficial bacteria in and on us.

Given that diet affects the diversity of bacteria in the gut, [my lab studies show how diet can be used](#) as a therapy for [chronic diseases](#). Using different foods, people can shift their gut microbiome to one that boosts a healthy immune response.

A fraction of patients infected with SARS-CoV-2, the virus that causes COVID-19 disease, develop severe complications that require hospitalization in intensive care units. What do many of those patients have in common? [Old age](#) and chronic diet-related diseases like obesity, Type 2 diabetes and cardiovascular disease.

[Black and Latinx people are disproportionately affected by obesity, Type 2 diabetes and cardiovascular disease](#), all of which are linked to poor nutrition. Thus, it is not a coincidence that [these groups have suffered more deaths from COVID-19](#) compared with whites. This is the case not only in the U.S. but also [in Britain](#).

Discovering microbes that predict COVID-19 severity

The COVID-19 pandemic has inspired me to shift my research and explore the role of the gut microbiome in the overly aggressive immune response against SARS-CoV-2 infection.

My colleagues and I have hypothesized that critically ill SARS-CoV-2

patients with conditions like obesity, Type 2 diabetes and cardiovascular disease exhibit an altered gut microbiome that aggravates acute respiratory distress syndrome.

Acute respiratory distress syndrome, a life-threatening lung injury, in SARS-CoV-2 patients is thought to develop from a [fatal overreaction of the immune response](#) called a cytokine storm [that causes an uncontrolled flood of immune cells into the lungs](#). In these patients, their own uncontrolled inflammatory immune response, rather than the virus itself, causes the [severe lung injury and multiorgan failures](#) that lead to death.

Several studies [described in one recent review](#) have identified an altered gut microbiome in patients with COVID-19. However, identification of specific bacteria within the microbiome that could predict COVID-19 severity is lacking.

To address this question, my colleagues and I recruited COVID-19 hospitalized patients with severe and moderate symptoms. We collected stool and saliva samples to determine whether bacteria within the gut and oral microbiome could predict COVID-19 severity. The identification of microbiome markers that can predict the clinical outcomes of COVID-19 disease is key to help prioritize patients needing urgent treatment.

[We demonstrated](#), in a paper which has not yet been peer reviewed, that the composition of the gut microbiome is the strongest predictor of COVID-19 severity compared to patient's clinical characteristics commonly used to do so. Specifically, we identified that the presence of a bacterium in the stool—called *Enterococcus faecalis*—was a robust predictor of COVID-19 severity. Not surprisingly, *Enterococcus faecalis* has been associated with [chronic inflammation](#).

Enterococcus faecalis collected from feces can be grown outside of the

body in clinical laboratories. Thus, an *E. faecalis* test might be a cost-effective, rapid and relatively easy way to identify patients who are likely to require more supportive care and therapeutic interventions to improve their chances of survival.

But it is not yet clear from our research what is the contribution of the altered microbiome in the [immune response](#) to SARS-CoV-2 infection. A recent study has shown that [SARS-CoV-2 infection triggers an imbalance in immune cells](#) called [T regulatory cells that are critical to immune balance](#).

Bacteria from the gut microbiome are responsible for the [proper activation of those T-regulatory cells](#). Thus, researchers like me need to take repeated patient stool, saliva and blood samples over a longer time frame to learn how the altered microbiome observed in COVID-19 patients can modulate COVID-19 disease severity, perhaps by altering the development of the T-regulatory cells.

As a Latina scientist investigating interactions between diet, microbiome and immunity, I must stress the importance of better policies to improve access to healthy foods, which lead to a healthier microbiome. It is also important to design culturally sensitive dietary interventions for Black and Latinx communities. While a good-quality diet might not prevent SARS-CoV-2 infection, it can treat the underlying conditions related to its severity.

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