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Diet affects men's and women's gut microbes differently

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The microbes living in the guts of males and females react differently to diet, even when the diets are identical, according to a study by scientists from The University of Texas at Austin and six other institutions published this week in the journal *Nature Communications*. These results suggest that therapies designed to improve human health and treat diseases through nutrition might need to be tailored for each sex.

The researchers studied the gut microbes in two species of fish and in mice, and also conducted an in-depth analysis of data that other researchers collected on humans. They found that in fish and humans diet affected the microbiota of males and females differently. In some cases, different species of microbes would dominate, while in others, the diversity of bacteria would be higher in one sex than the other.

These results suggest that any therapies designed to improve human health through diet should take into account whether the patient is male or female.

Only in recent years has science begun to completely appreciate the importance of the human microbiome, which consists of all the bacteria that live in and on people's bodies. There are hundreds or even thousands of species of microbes in the human digestive system alone, each varying in abundance.

Genetics and diet can affect the variety and number of these microbes in the human gut, which can in turn have a profound influence on human

health. Obesity, diabetes, and inflammatory bowel disease have all been linked to low diversity of bacteria in the human gut.

One concept for treating such diseases is to manipulate the microbes within a person's gut through diet. The idea is gaining in popularity because dietary changes would make for a relatively cheap and simple treatment.

Much has to be learned about which species, or combination of microbial species, is best for human health. In order to accomplish this, research has to illuminate how these microbes react to various combinations of diet, genetics and environment. Unfortunately, to date most such studies only examine one factor at a time and do not take into account how these variables interact.

"Our study asks not just how diet influences the microbiome, but it splits the hosts into males and females and asks, do males show the same diet effects as females?" said Daniel Bolnick, professor in The University of Texas at Austin's College of Natural Sciences and lead author of the study.

While Bolnick's results identify that there is a significant difference in the gut microbiota for males and females, the dietary data used in the analysis are organized in complex clusters of disparate factors and do not easily translate into specific diet tips, such as eating more vegetables or less meat.

"To guide people's behavior, we need to know what microbes are desirable for people," said Bolnick. "Diet and sex do interact to influence the microbes, but we don't yet know what a desirable target for microbes is. Now we can go in with eyes open when we work on therapies for gut microbe problems, as many involve dietary changes. We can walk into those studies looking for something we weren't aware

of before. All along we treated diet as if it works the same for men and women. Now we'll be approaching studies of therapies in a different way."

Why men and women would react differently to changes in diet is unclear, but there are a couple of possibilities. The hormones associated with each sex could potentially influence gut microbes, favoring one strain over another. Also, the sexes often differ in how their immune systems function, which could affect which microbes live and die in the microbiome.

One notable exception in Bolnick's results was in the mice. Although there was a tiny difference between male and female mice, for the most part the microbiota of each sex reacted to diet in the same manner. Because most dietary studies are conducted on mice, this result could have a huge effect on such research, and it raises questions about how well studies of gut microbes in lab mice can be generalized to other species, particularly humans.

"This means that most of the research that's being done on lab mice—we need to treat that with kid gloves," said Bolnick.

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