Mimicking diet changes of global travel reveals clues to gut health

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Researchers studied gut motility, measuring in mice the time it takes food to move through the gastrointestinal tract in a way that mimics the dietary effects of world travel. Turmeric, a spice commonly used in curries, was a key ingredient in their investigations. Credit: Robert Boston

When travelers embark on a world tour, they may look forward to encounters with new people, traditions and cultures, including unfamiliar foods. But experienced globetrotters also know that partaking of the local cuisine, while tasty, often changes their bowel habits.

Adding to the growing understanding of the importance of gut bacteria in human health, researchers at Washington University School of Medicine in St. Louis studied gut motility, measuring in mice the time it

takes food to move through the gastrointestinal tract in a way that mimics the dietary effects of world travel.

Beyond simply identifying bacteria present in the guts of individuals who live in different regions of the world and consume culturally distinct diets, the researchers used this unique strategy to identify specific jobs performed by different members of the gut microbial communities, or microbiota. In addition to observing complex interactions between diet and gut bacteria that influenced gut motility, the researchers showed that even a single ingredient—in this case turmeric, a spice commonly used in curries—can alter gut transit time.

The study appears online Sept. 24 in the journal *Cell*.

"Our diets are evolving rapidly with globalization," said senior author Jeffrey I. Gordon, MD, director of Washington University's Center for Genome Sciences & Systems Biology. "During this process, we may lose valuable components of diets that affect health. To help identify these ingredients and understand their health effects, we carried out a series of experiments in mice raised under sterile conditions—they had no microbes in their guts until we deliberately introduced them."

The researchers transplanted into these mice the gut microbial communities of people representing culturally diverse, geographically distinct areas of the world. They fed these mice the native diets of the human donors as well as diets from other regions of the world to simulate effects of travel. These mouse models allowed the researchers to correlate the functions of different members of human gut microbial communities to gut transit times when the microbes were exposed to specific dietary components.

The study showed that transit time through the gut is influenced by many interacting factors, including the types of human microbial communities

present in the gut, how the microbial citizens of these communities process human bile acids involved in digestion and how this processing impacts the body's organs that govern gut motility.

To uncover these relationships, the researchers investigated gut microbe communities sampled from six individuals: three from the United States and one each from Bangladesh, Malawi and Venezuela. Of the three American individuals, two had no restrictions on their diets and one consumed a diet rich in fats and proteins, which is known as a primal diet.

Mice harboring the culturally distinct human gut microbe communities began and ended their simulated travels with their native or "home" diets. In between, the mice were given the same sequence of diets that were foreign to their gut microbes—American primal, American unrestricted, Bangladeshi, Malawian and Venezuelan. In other words, during the travel phase of the experiment, the mice skipped their home diets. The revolving diets were intended to mimic the short-term changes in eating patterns so familiar to travelers.

"Certain diets combined with certain human microbiota produced dramatic differences in gut transit times," Gordon said. "We wanted to understand what might explain these faster or slower times."

The largest contrast in transit times was between Bangladeshi and American diets and gut microbes, according to the study. Mice with the unrestricted American gut microbes had faster transit times when eating a Bangladeshi diet and slower times when eating the American primal diet. Conversely, mice with Bangladeshi gut microbes had faster transit times when eating the American primal diet and slower times when eating their own Bangladeshi diet.

"This large contrast in motility made the Bangladeshi diet and microbes

stand out as something that may be interesting to look at more carefully," said first author Neelendu Dey, MD, instructor in medicine and gastroenterology. "In looking at traditional ingredients in Bangladeshi diets, we found human studies demonstrating that consuming turmeric led the gallbladder to contract and secrete bile acids into the small intestine. So this spice became a tool that we used to test whether bile secretion combined with microbial metabolism of the bile acids would impact gut motility."

The researchers measured levels of several thousand metabolites produced by the different gut microbe communities when exposed to different diets. They found that concentrations of several metabolites produced when gut bacteria process bile acids best explained the range of transit times. Bile acids originate in the liver and are secreted into the intestine.

Using microbes donated by a Bangladeshi individual, the researchers purposefully assembled two artificial gut microbial communities. One produced high levels of an enzyme that processes bile acids, and the other produced low levels of this enzyme.

They transplanted these microbes into two groups of mice and fed the animals Bangladeshi diets with and without turmeric. Feeding turmeric to the mice harboring bacteria that produced a lot of the enzyme—bile salt hydrolase (BSH), which metabolizes bile acids—stimulated bile secretion and processing and resulted in faster gut motility. In mice with microbes that produced little BSH, turmeric still stimulated bile secretion. But without BSH, the bile produced was not metabolized and transit times were slower.

Such data, showing contrasting effects of the same spice, illustrate the importance of understanding the interaction between diet, microbes and specific functions of members of the human gut microbiota.

The researchers also found that returning to the home diet at the end of the simulated journey did not restore transit times to their pre-travel baselines, suggesting long-term effects of temporary diet changes.

"Our evolving diets are interacting with our evolving microbiota," Gordon said. "With such changes, we risk losing traditional culinary wisdom that certain dietary ingredients are associated with health. In this study, for example, we also showed that turmeric affects expression of genes in the gut that are thought to offer defense against parasites. The strategy that we outlined in these mice offers a way to capture this kind of knowledge before these traditional diets disappear."

More information: "Regulators of Gut Motility Revealed by a Gnotobiotic Model of Diet-Microbiome Interactions Related to Travel." DOI: dx.doi.org/10.1016/j.cell.2015.08.059

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