Examining the secrets of the microbiome

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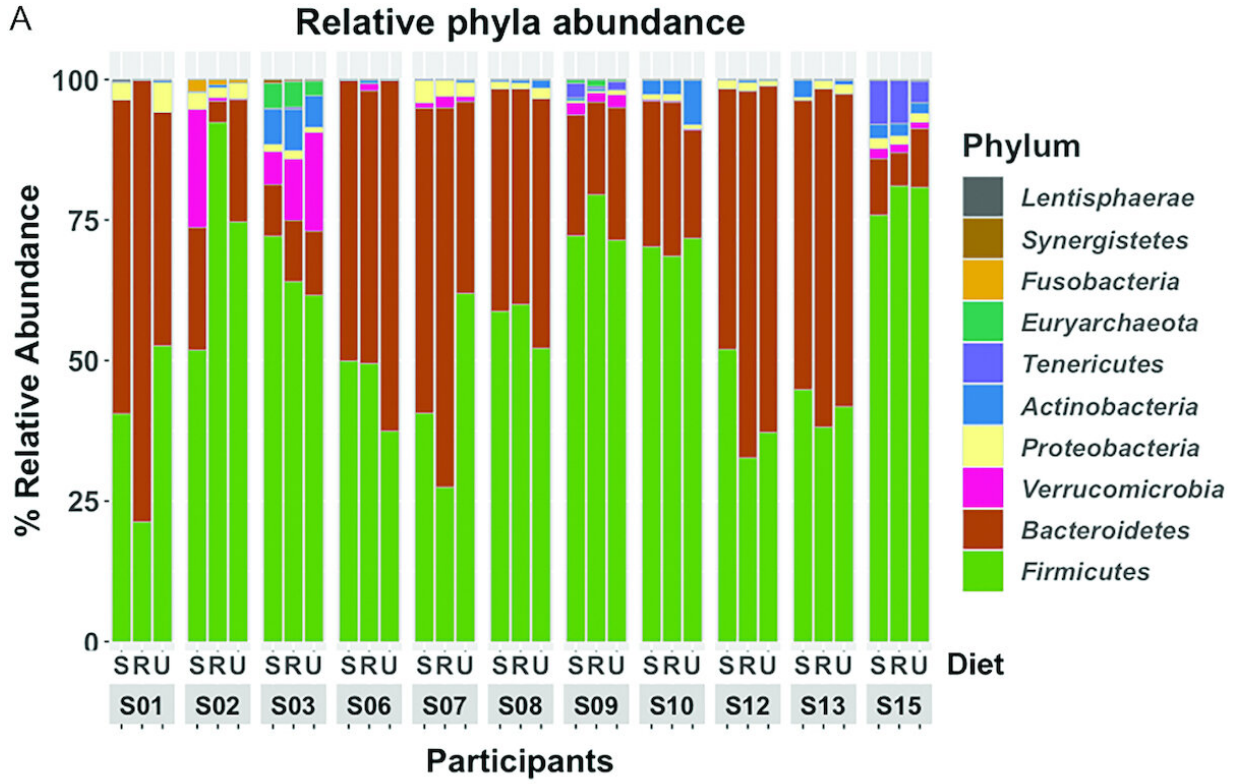
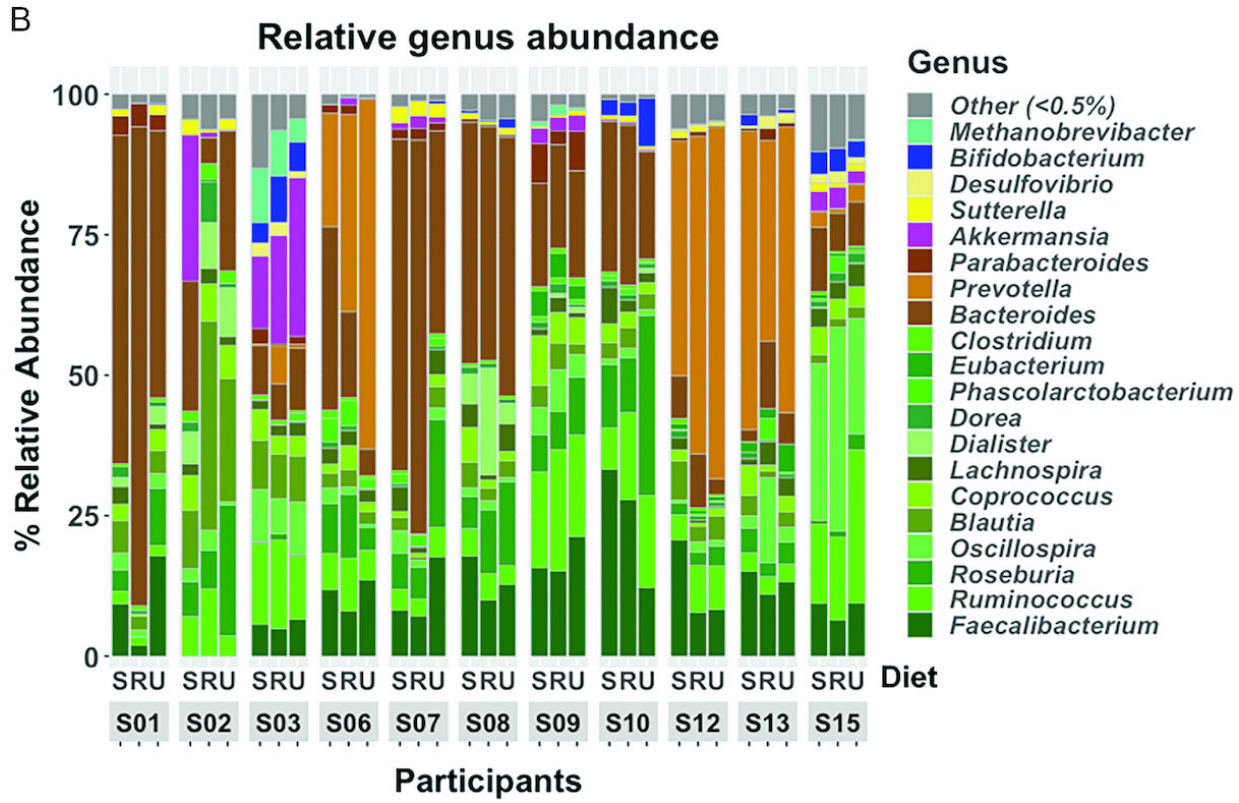

A
Relative phyla abundance
% Relative Abundance
100
75
50
25
0
SRU
S01
S02
S03
S06
S07
S08
S09
S10
S12
S13
S15
Diet
Participants
Phylum
Lentisphaerae
Synergistetes
Fusobacteria
Euryarchaeota
Tenericutes
Actinobacteria
Proteobacteria
Verrucomicrobia
Bacteroidetes
Firmicutes


B
Relative genus abundance
% Relative Abundance
100
75
50
25
0
SRU
S01
S02
S03
S06
S07
S08
S09
S10
S12
S13
S15
Diet
Participants
Genus
Other (<0.5%)
Methanobrevibacter
Bifidobacterium
Desulfovibrio
Sutterella
Akkermansia
Parabacteroides
Prevotella
Bacteroides
Clostridium
Eubacterium
Phascolarctobacterium
Dorea
Dialister
Lachnospira
Coprococcus
Blautia
Oscillospira
Roseburia
Ruminococcus
Faecalibacterium

Relative abundance of phyla (A) and the 20 most abundant genera (B), based on 16S rDNA sequencing. Data are depicted as estimated percentage relative abundance grouped by study participant (n = 11), designated S01–S15, and ordered by carbohydrate type, with simple carbohydrate diet labeled "S," refined carbohydrate diet labeled "R," and unrefined carbohydrate diet labeled "U." Phyla and genera were assigned using Qiime2 and based on the Greengenes database. rDNA, ribosomal DNA. Credit: *The American Journal of Clinical Nutrition* (2020). DOI: 10.1093/ajcn/nqaa254

You're more microbe than human, at least by the numbers. The human body has about 37 trillion cells, but it's home to many more microbes—the gut alone has 100 trillion of them. Swimming and squirming inside your tummy are more than 1,000 species of bacteria, as well as a host of fungi and viruses. Together, they make up your gut microbiome, a unique-to-you community of tiny organisms that helps you draw energy from food and keeps your immune system running.

But sometimes our little companions can work against us, with rogue microbiota playing a role in obesity, depression, cancer, diabetes, and other diseases. One potential factor in determining whether they act as friend or foe: our diet.

While most of us know that scarfing down fried chicken and ice cream can put our health on the line, Boston University nutrition scientist Maura E. Walker says researchers aren't quite sure what's actually happening at the body's minutest levels when we eat different foods. Science has shown a connection between diets dripping with saturated fats and poor heart health, but what are all those wings and sundaes actually doing to the molecules in a cell, to individual proteins, and to gut microbiota?

Not knowing puts science at a disadvantage when it comes to fighting

back against cardiometabolic disorders, like diabetes and heart disease, says Walker. Figure out the exact biological changes a diet causes—and why they affect everyone differently—and you can determine who might be at greatest risk, and even come up with earlier detection and prevention tools.

"We're learning more and more about how individuals can respond differently to diet—if I eat something, I may have a different microbial response over time than you," says Walker, a BU College of Health & Rehabilitation Sciences: Sargent College assistant professor of nutrition, whose research combines lab-based biochemical work with epidemiological investigations and data science to detail the journey from dinner to disease.

"Can we harness the microbiome and interactions with diet to explain that?" She says her goal is to decipher the "really rich biological data" that will allow her "to get at what's going on in the body between diet and disease, the mechanisms."

In recent studies, Walker has scrutinized ultraprocessed foods, chemical signatures of healthy dietary patterns, and protein biomarkers of clogged arteries. Her work could help speed the next stage of precision nutrition, allowing clinicians to tailor diets to individual patients and use biomarker tests that spot disease risk decades before any symptoms appear.

"I use both population data and biological data—information about our genes, our microbiome—to help better understand how diet can impact our health throughout adulthood, into older adulthood, and impact healthy aging," she says.

In a study published in the American Journal of Clinical Nutrition, for example, Walker and an international team of researchers looked at how different carb-loaded diets affected gut microbiota and microbial-

derived metabolites, which are molecules generated by digestion. They found a diet rich in whole grains and other unrefined carbohydrates had a positive effect on the gut microbiome, boosting numbers of Roseburia, a handy little organism that can help prevent inflammation.

By contrast, when participants ate a diet with refined grains (like white rice, white bread, and white pasta), their levels of Roseburia and the microbe Anaerostipes—which helps break down dietary fiber—were lower. The whole grain diet—and here things get a little messy, literally—was also associated with lower concentrations of fecal secondary bile acid in stool samples. Secondary bile acids have been tied to colon cancer.

Although previous studies have shown the health benefits of a whole grain diet, Walker's detailed, microscopic approach helps illuminate the why and how. She's analyzing entire diets rather than individual foods and reaching across years rather than days or weeks. As an investigator on the Framingham Heart Study, a BU-led cohort project focused on cardiovascular disease, she's been able to look back at the diets of thousands of people over three decades.

"I can look at how diets are changing over time, how they associate with disease," says Walker, who's also a BU Chobanian & Avedisian School of Medicine assistant professor of health sciences. "An ultimate goal is to identify biological and other factors that interact with diet that we can detect earlier in the disease course and look at prevention even earlier. At the moment, we look at risk factors—blood pressure, blood lipids—that might not pop up until middle, or even older, adulthood."

Expanding the role of dieticians

With trillions of microbes, thousands of people, and decades of diets to look at, there's a lot of data to deal with. Although she was trained in

biology labs, Walker has had to cross disciplines to add data science and epidemiology know-how to her skillset. That's increasingly reflected in her teaching too. The rise of precision nutrition—corralling the data generated by scientists like Walker into diets and advice tailored to individuals and their singular microbiomes—has, she says, "created a whole new job field and sector for dieticians."

"When I'm looking at proteins or metabolites, it's not like there's 10; I'm looking at hundreds, maybe over a thousand," she says. "Data science is something we really need to emphasize to push the field forward and focus on training our nutrition students in."

The expansion of the field is reflected in the expertise of other recent Sargent nutrition program hires (Walker joined the college's faculty in 2020), like Nicola McKeown, an expert on genetics and diet, and Megan McCrory, who studies energy regulation and nutrition.

For now, Walker's focus is adding to the available data—about what Americans eat, their genes, their biological systems. Eventually, that could all plug into artificial intelligence programs that would calculate an individual's chances of getting sick—and suggest a diet that would shift them onto a healthier path.

"If we can collect all this data about you," says Walker, "can we use advanced data science to tell us exactly what you should be eating to achieve a certain goal, whether that's getting off a medication or losing weight?"

Provided by Boston University