Some guts are better than others at harvesting energy, study shows

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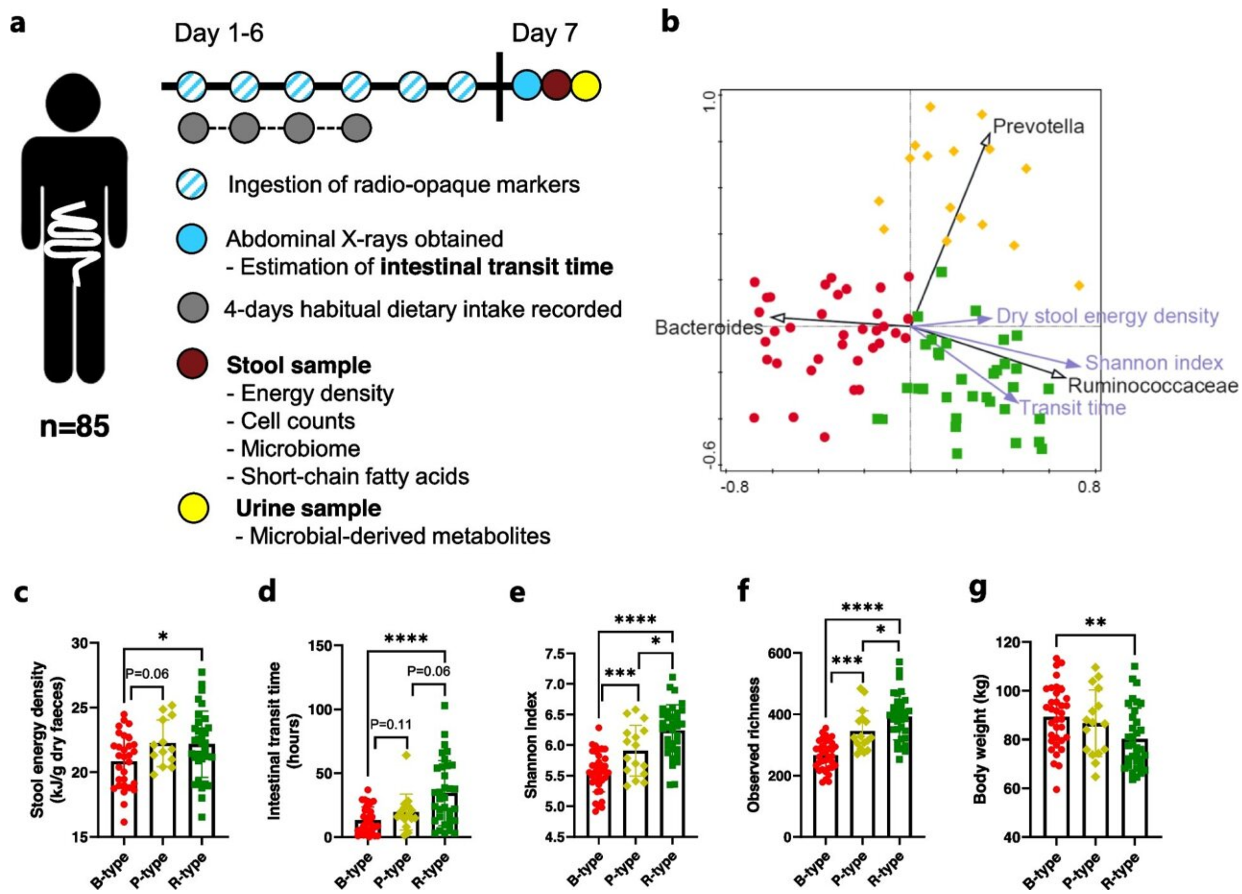

Enterotypes differ in stool energy density, intestinal transit time, microbial alpha-diversity, and body weight. **a** The study included baseline measurements of 85 overweight subjects. Prior to collection of the stool and urine samples used in the study, habitual dietary intake was estimated based on 4-day dietary registrations and intestinal transit time was estimated using radio-opaque markers from day 1 to 6 where participants maintained their habitual diet and lifestyle. The collected stool sample was used to estimate dry stool energy density as a measure of gut microbial energy extraction, bacterial cell counts, the gut microbiome community structure, and short-chain fatty acids. Microbial-derived metabolites were measured in the urine samples. **b** Principal coordinate analysis plot using Bray-Curtis distance of bacterial relative abundance on the genus level as distance metric. Symbols are samples, with shape/color indicating assigned enterotype (red circles: Bacteroides (B-type), n = 35; yellow diamonds: Prevotella (P-type), n = 16; green squares: Ruminococcaceae (R-type), n = 34). Relative abundance of the taxa used for enterotype assignment (black arrows) and values for dry energy, Shannon index and transit time (purple arrows) were plotted supplementary (i.e. projected after ordination). Horizontal and vertical axis explain 20% and 12% of variation, respectively. Subjects stratified into three enterotypes differed in **c** stool energy density (n = 77), **d** intestinal transit time (n = 85), microbiome alpha-diversity as reflected by **e** Shannon Index and f observed richness (n = 85), as well (g) body weight (n = 85). Differences between enterotypes were detected using the Mann-Whitney U test. *p Microbiome (2022). DOI: 10.1186/s40168-022-01418-5

New research from the University of Copenhagen suggests that a portion of the Danish population has a composition of gut microbes that, on average, extracts more energy from food than do the microbes in the guts of their fellow Danes. The research is a step towards understanding why some people gain more weight than others, even when they eat the same.

Unfair as it, some of us seem to put on weight just by looking at a plate of Christmas cookies, while others can munch away with abandon and not gain a gram. Part of the explanation could be related to the composition of our gut microbes. This is according to new research conducted at the University of Copenhagen's Department of Nutrition, Exercise and Sports.

The research is published in the journal *Microbiome*.

Researchers studied the residual energy in the feces of 85 Danes to estimate how effective their gut microbes are at extracting energy from food. At the same time, they mapped the composition of gut microbes for each participant.

The results show that roughly 40% of the participants belong to a group that, on average, extracts more energy from food compared to the other 60%. The researchers also observed that those who extracted the most energy from food also weighed 10% more on average, amounting to an extra nine kilograms.

"We may have found a key to understanding why some people gain more weight than others, even when they don't eat more or any differently. But this needs to be investigated further," says Associate Professor Henrik Roager of the University of Copenhagen's Department of Nutrition, Exercise and Sports.

May increase the risk of obesity

The results indicate that being overweight might not just be related to how healthily one eats or the amount of exercise one gets. It may also have something to do with the composition of a person's gut microbes.

Participants were divided into three groups, based on the composition of their gut microbes. The so-called B-type composition (dominated by Bacteroides bacteria) is more effective at extracting nutrients from food and was observed in 40% of the participants.

Following the study, the researchers suspect that a portion of the population may be disadvantaged by having gut bacteria that are a bit too effective at extracting energy. This effectiveness may result in more calories being available for the human host from the same amount of food.

"The fact that our gut bacteria are great at extracting energy from food is basically a good thing, as the bacteria's metabolism of food provides extra energy in the form of, for example, short-chain fatty acids , which are molecules that our body can use as energy-supplying fuel. But if we consume more than we burn, the extra energy provided by the intestinal bacteria may increase the risk of obesity over time," says Henrik Roager.

Short travel time in the gut surprises

From mouth to esophagus, stomach, duodenum and small intestine, large intestine and finally to rectum, the food we eat takes a 12-to-36-hour journey, passing several stations along the way, before the body has extracted all the food's nutrients.

The researchers also studied the length of this journey for each participant, all of whom had similar dietary patterns. Here, the researchers hypothesized that those with long digestive travel times would be the ones who harvested the most nutrition from their food. But the study found the exact opposite.

"We thought that there would be a long digestive travel time would allow more energy to be extracted. But here, we see that participants with the B-type gut bacteria that extract the most energy, also have the fastest passage through the gastrointestinal system, which has given us something to think about," says Henrik Roager.

Confirms previous study in mice

The new study in humans confirms earlier studies in mice. In these studies, it was found that germ-free mice that received gut microbes from obese donors gained more weight compared to mice that received gut microbes from lean donors, despite being fed the same diet.

Even then, the researchers proposed that the differences in weight gain could be attributable to the fact that the gut bacteria from obese people were more efficient at extracting energy from food. This is the theory now being confirmed in the new study by the Department of Nutrition, Exercise and Sports.

"It is very interesting that the group of people who have less energy left in their stool also weigh more on average. However, this study doesn't provide proof that the two factors are directly related. We hope to explore this more in the future," says Henrik Roager.

About gut bacteria:

- Everyone has a unique composition of gut bacteria—shaped by genetics, environment, lifestyle and diet.
- The collection of gut bacteria, called the gut microbiota, is like an entire galaxy in our gut, with a staggering 100 billion of them per gram of stool.
- Gut bacteria in the colon serve to break down food parts that our body's digestive enzymes can't, e.g., dietary fiber.
- Humans can be divided into three groups based on the presence and abundance of three main groups of bacteria that most of us have: B-type (Bacteroides), R-type (Ruminococcaceae) and P-type (Prevotella).

About the study:

- The energy content of stool specimens from 85 overweight Danish women and men was examined.
- Participants included men and women from 22 to 66 years old.
- 40% of participants fell into a special group, characterized by having a lower diversity of gut bacteria and faster travel time for food through their digestive tracts.

- This group was also found to have less residual energy in their stool compared to the other two groups, which could not be explained by differences in habitual diet.
- The researchers also observed that the group with less energy in their stool also weighed more than the other groups.

More information: Jos Boekhorst et al, Stool energy density is positively correlated to intestinal transit time and related to microbial enterotypes, *Microbiome* (2022). DOI: 10.1186/s40168-022-01418-5

Provided by University of Copenhagen