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SCIENCE

What 2,000-year-old poo says about our gut bugs

ABC Science / By science reporter Gemma Conroy

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Looking at the microbial DNA in ancient human poo samples — such as this one found at a Viking site in Coppergate in England — can tell us how our gut microbiome has evolved over time. *(Wikimedia Commons: Linda Spashett)*

A lot has changed for humans over the past 2,000 years.

Many of us spend more time sitting than moving, and we are more likely to reach for a highly processed snack than a stick of celery.

And it turns out our poo has also changed.

A new study has found that our gut bugs are vastly different from those that inhabited our hunter-gatherer ancestors, revealing how our switch to a more industrial lifestyle has influenced our microbiome.

An international team of researchers analysed ancient poo samples from rock shelters in the US and Mexico, and compared the microbial make-up to those found in modern samples from Western and developing countries.

The findings have been published today in Nature.

Key points:

- International researchers analysed microbial DNA in 1,000-2,000-year-old human faeces
- They compared these microbial genomes to those found in modern samples from Western and developing countries
- The gut microbes from the present-day non-industrial population were more similar to those in the ancient samples than they were to the urban samples

"There's a theory that the human microbiome has been disappearing in recent times and that this is one of the reasons we're seeing an increase in chronic diseases," said study co-author Aleksandar Kostic, a microbiologist at Harvard Medical School in Boston.

"We're losing our friends."

Hold up ... what is a microbiome?

With estimates ranging from 30 trillion right up to 400 trillion microbes crawling around in the human gut, one thing's for certain: we are far from alone.

Around 90 per cent of these "friendly" microorganisms are bacteria, with the rest being fungi and archaea.

These tiny powerhouses perform an array of important functions that help keep us healthy, such as digesting food, producing vitamins and fending off their more harmful relatives.

But some of the things that come with modern living — such as processed foods, antibiotics, and even cleaner living conditions — can throw our gut's microbial ecosystem out of whack.

Living in cleaner conditions is a double-edged sword, with many household disinfectants wiping out both bad and good bacteria.

But while it's tricky to pinpoint when our microbiome began to change, Dr Kostic said the timing of the emergence of chronic illnesses can give us a clue.

"The incidence of chronic diseases tracks surprisingly well with industrialisation," he said.

"The hypothesis is that the microbiome was changing as our lifestyle changed during that time."

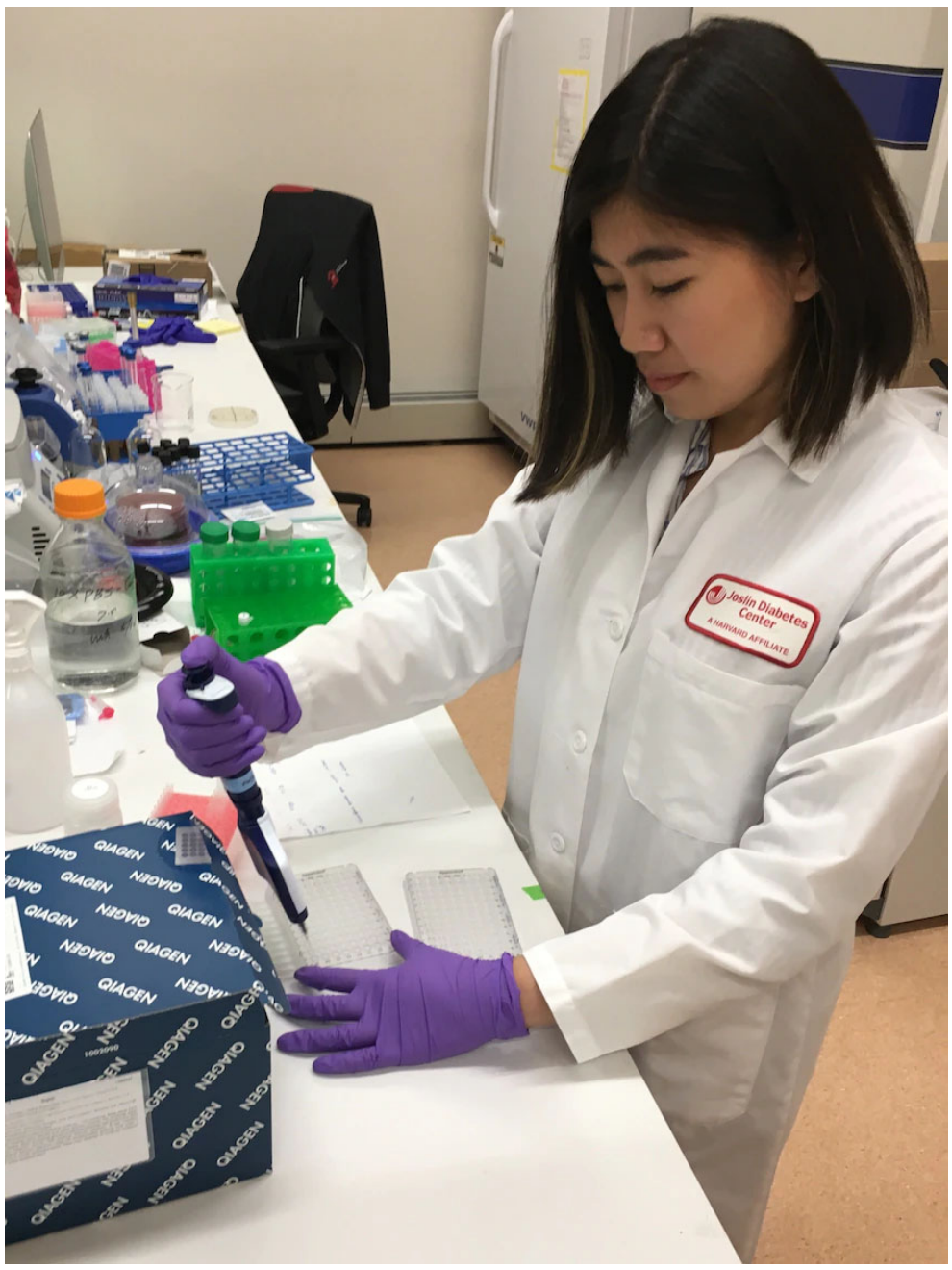
Digging into our ancestors' poo

While research on the human microbiome has exploded over the last decade, not much is known about the microbiomes of our ancestors.

Dr Kostic and colleagues analysed eight samples of palaeofaeces — or ancient poo — that had been collected from rock shelters in the south-west US and north-west Mexico.

Radiocarbon dating revealed the faeces samples were between 1,000 and 2,000 years old.

To identify the bacteria that inhabited our ancestors' guts, the researchers used the DNA present in the faeces to reconstruct 498 microbial genomes.



Study co-author Marsha Wibowo analyses samples in a lab at the Joslin Diabetes Center, Boston. *(Supplied: Joslin Diabetes Center)*

Of those 498 genomes, they concluded that 181 had originated in the guts of our ancestors.

The team compared these microbial genomes to those present in 789 poo samples from people living today.

Roughly half of these samples were from people living in the US, Denmark and Spain who ate a Western diet, used antibiotics frequently, and lived a largely sedentary lifestyle.

The other 371 samples were from populations in Tanzania, Fiji, Peru, Madagascar and Mexico.

This group lived a "non-industrialised" lifestyle, relying on a diet of unprocessed, home-prepared food.

They also rarely used antibiotics and engaged in more physical activity than the group living in Western countries.

Diverging microbiomes

A total of 61 microbial genomes in the ancient samples had not been described previously, indicating that our ancestors' gut flora differed from our own.

The team found that the gut microbiomes of people living in non-industrialised countries had more in common with those detected in the ancient poo samples than their more urbanised counterparts.

Both the ancient and non-Western samples contained *Treponema succinifaciens*, a spiral-shaped bacterium that has been labelled as a pathogen.

But it was virtually absent in the samples from Europe and North America, suggesting that it had been largely wiped out by antibiotics.

This isn't necessarily good news, Dr Kostic said.

"It was present in every single one of our ancient samples, which suggests that it's a human-associated microbe."

"It's reasonable to suspect that it's performing important functions in keeping us healthy, and that its disappearance is, on average, not good for us."

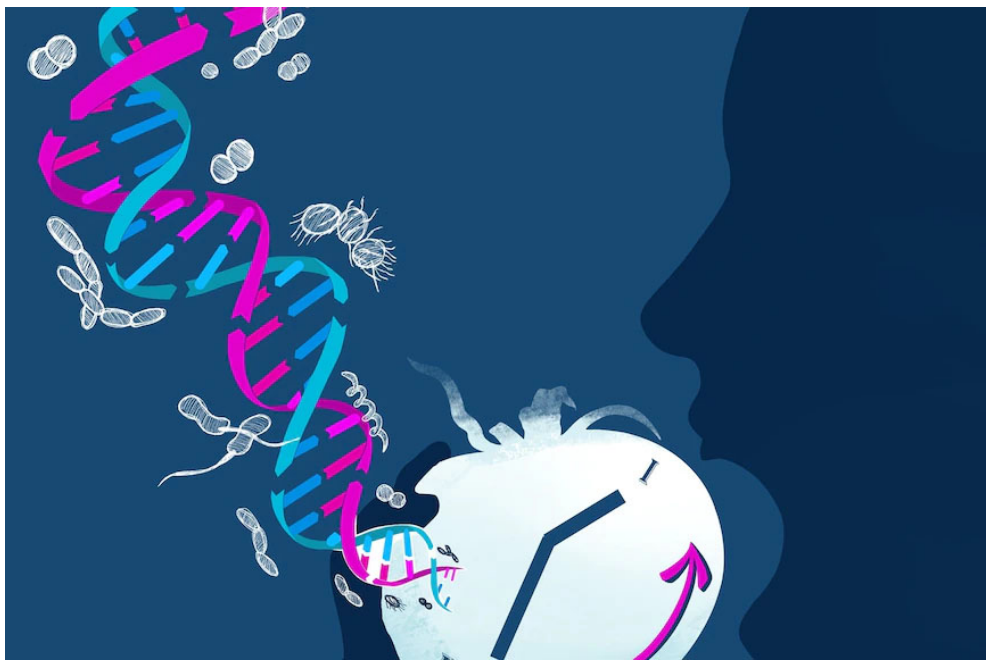
While the samples from industrialised countries lacked some of the bacteria present in the ancient poo, they contained a higher concentration of other types.

For instance, samples from Europe and North America contained *Akkermansia muciniphila,* a species that produces mucous in the intestines.

The presence of this bacterium has been linked to conditions such as inflammation, obesity and diabetes.

On the other hand, this mucous-producer was very rare in the non-Western samples and totally absent in the ancient poo.

All in the genes



It's estimated anywhere between 30 trillion and 400 trillion microbes are crawling around in the human gut. *(Supplied: Valentino Sudaryo & Cindy Lin)*

When the researchers looked at the functions of the genes in the three sample types, they found that the ancient and non-industrial groups contained a diverse array of genes linked with the breakdown of starches.

This indicates that the diets of the ancient and non-industrialised populations were high in complex carbohydrates, like vegetables and grains.

Under the microscope, the team found traces of pollen, mushrooms, insects, and *Ustilago maydis* — a corn fungus that is behind the Mexican delicacy huitlacoche — in the ancient faeces.

While the fossilised poo contained no antibiotic-resistant genes, they were present in all modern-day samples.

A diverse, plant-rich diet and a lack of antibiotics allowed our ancestors' gut bugs to flourish, Dr Kostic said.

"They ate everything that was available in order to get enough calories and we think that contributed to a more complex microbiome," he said.

Keep your friends close

Samuel Forster, a microbiologist at the Hudson Institute of Medical Research in Melbourne, says looking into the past can help us better understand how our changing lifestyles can influence the microbial communities that live inside us.

"While this work is based on only a small number of individuals, it provides an important snapshot into the types of bacteria that may have been carried by our ancestors," said Dr Forster, who was not involved in the study.

"It is certainly possible that some of the species identified through this work have already been lost, or are being lost now."

Dr Forster and his team are currently working on growing and preserving bacteria from the Australian population to help maintain these species for future generations.

Dr Kostic and his colleagues are planning to look at the microbial composition of poo samples from people from other parts of the world and implant some of those beneficial bugs into mice to study their impact on chronic diseases.

One day, these species could be stored at a biobank, where clinicians can grab them off the shelf to treat patients, Dr Kostic said.

"Once these microbes are gone, there's no bringing them back.

"Luckily, they do exist in other parts of the world and there are efforts to create a 'conservancy' of the microbiome."

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