Human brain samples contain an entire spoon's worth of nanoplastics, study says

By Sandee LaMotte, CNN
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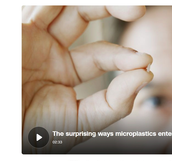

[CNN] — Cognitively normal human brain samples collected at autopsy in early 2024 contained more tiny shards of plastic than samples collected eight years prior, according to a new study.

Overall, cadaver brain samples contained seven to 30 times more tiny shards of plastic than their kidneys and liver, said co-lead study author Matthew Campen, Regents' Professor and professor of pharmaceutical sciences at the University of New Mexico in Albuquerque.

"The concentrations we saw in the brain tissue of normal individuals, who had an average age of around 45 or 50 years old, were 4,800 micrograms per gram, or 0.48% by weight," Campen said.

That's the equivalent of an entire standard plastic spoon, Campen said.

"Compared to autopsy brain samples from 2016, that's about 50% higher," he said. "That would mean that our brains today are 99.5% brain and the rest is plastic."

It is possible, however, that current methods of measuring plastics may have over- or underestimated their levels in the body, Campen said. "We're working hard to get to a very precise estimate, which should I think we will have within the next year."

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Researchers also found an additional three to five times of shard-like plastic fragments in the brains of 12 people who had been diagnosed with dementia before their death, compared to healthy brains. Those shards, smaller than the eye can see, were concentrated in the walls of arteries and veins of brain as well as in the brain's immune cells.

"It's a little bit alarming, but remember that dementia is a disease where the blood brain barrier and clearance mechanisms are impaired," Campen said.

In addition, there are inflammatory cells and atrophy of brain tissue with dementia, which may create "a sort of sink for plastics to go," he said.

"We want to we want to be very cautious in interpreting these results as as the microplastics are very likely elevated because of the disease [dementia], and we do not currently suggest that microplastics could cause the disease," Campen said.

Finding plastic deposits in the brain does not prove they cause damage, said Phoebe Stapleton, an associate professor of pharmacology and toxicology at Rutgers University in Piscataway, New Jersey. She was not involved in the new study.

"It is unclear if, in life, these particles are fluid, entering and leaving the brain, or if they collect in neurological tissues and promote disease," she said in an email. "Further research is needed to understand how the particles may be interacting with the cells and if this has a toxicological consequence."

In fact, researchers did see signs that the body's liver and kidneys may be capable of flushing some plastics from the body, Campen said. Whether that can happen in the brain, he said, is unknown.

Potential health harms

Finding higher levels of microplastics in human tissues today "makes sense" because plastic manufacture, plastic pollution and human exposure to plastics have all been increasing rapidly, said pediatrician and biology professor Dr. Philip Landrigan, director of the Program for Global Public Health and the Common Good and the Global Observatory on Planetary Health at Boston College.

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"More than half of all plastic ever made has been made since 2002 and production is on track to double by 2040," said Landrigan, who was not involved in the new study.

Landrigan is the lead author of a March 2023 report from the Minderoo – Monaco Commission on Plastics and Human Health, a global consortium of scientists, health-care workers and policy analysts charged with following plastics from creation to final product.

In the 2023 report, the consortium determined plastics are associated with harms to human health at every single stage of the plastic lifecycle.

"Studies have found these plastics in the human heart, the great blood vessels, the lungs, the liver, the testes, the gastrointestinal tract and the placenta," Landrigan said.

"The biggest question is, 'OK, what are these particles doing to us?' Honestly there's a lot we still don't know," he said. "What we do know with real certainty is that these microplastic particles are like Trojan horses — they carry with them all the thousands of chemicals that are in plastics and some of these chemicals are very bad actors."

By invading individual cells and tissues in major organs, nanoplastics can potentially interrupt cellular processes and deposit endocrine-disrupting chemicals such as bisphenols, phthalates, flame retardants, heavy metals and per- and polyfluorinated substances, or PFAS.

Endocrine disruptors interfere with the human reproductive system, leading to genital and reproductive malformations as well as female infertility and a decline in sperm count, according to the Endocrine Society.

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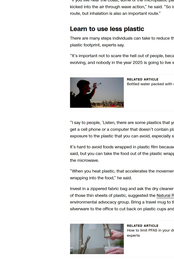
"We have some pretty good indications that microplastics and nanoplastics cause harm, even though we are a long way from knowing the full extent of that harm," Landrigan said. "I would say we have enough information here that we need to start taking protective action."

The American Chemistry Council, an industry association, told CNN the FDA says current scientific evidence doesn't show that microplastics or nanoplastics detected in foods pose a risk to human health.

"Research underway not only helps address current data gaps in our understanding of exposure to microplastics but it also aims to develop improved tools to measure the toxicity of microplastics to humans, said Kimberly Wise White, the council's vice president of regulatory and scientific affairs.

"This work is important given the unvalidated methods often applied by researchers which can lead to unreliable or misleading outcomes, the complex nature of microplastics, and the many variables that can affect human health," she said.



This pieces of plastic have been discovered in the human placenta, breastmilk, testes, liver, kidneys, carotid arteries and the brain. Douglas Sacha/Moment RF/Getty Images/Flat

Nanoplastics 'hijack' their way into the brain

For the study, published Monday in the journal Nature Medicine, researchers examined brain, kidney and liver tissues harvested from people who underwent a forensic autopsy in 2016 and 2024. For comparison, researchers also looked at brains from people who died between 1997 and 2013.

Brain tissue samples were gathered from the frontal cortex, the area of the brain associated with thinking and reasoning. It's the part of the brain which is most affected by frontotemporal dementia (FTD) and later stages of Alzheimer's disease.

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whereas some of the larger particles that are a micrometer to five micrometers go into the liver and kidneys."

Microplastics are fragments that can range from less than 0.2 inch (5 millimeters) or about the size of a pencil eraser, to 1 nanometer. A strand of human hair is about 80,000 nanometers wide, according to the US Environmental Protection Agency. Anything smaller is a nanoplastic that must be measured in billionths of a meter.

"Based on our observations, we think the brain is pulling in the very smallest nanostructures, like 200 to 250 nanometers in length. These are roughly the size of two COVID viruses side by side," said Campen, who is also the director of the New Mexico Center for Metals in Biology and Medicine.

Nanoplastics are the most worrisome plastics for human health, experts say, because the minuscule pieces can take up residence inside individual cells.

"Somehow these nanoplastics hijack their way through the body and get to the brain, crossing the blood-brain barrier," Campen said. "Plastics love fats, or lipids, so one theory is that plastics are hijacking their way with the fats we eat which are then delivered to the organs that really like lipids — the brain is top among those."

The human brain is about 60% fat by weight, far more than any other organ. Essential fatty acids, such as omega 3s, are key to the strength and performance of the brain's cells. Since the human body can't produce essential fatty acids on its own, they must come from food or supplements.

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Diet is the main route of exposure for micro- and nanoplastics, Landrigan said, however some are also airborne. "When people are driving down the highway and their tires are abrading on the surface of the highway, a certain amount of microplastic particles are thrown into the air.

"If you live near the coast, some of the microplastic particles that are in the ocean get kicked into the air through wave action," he said. "So ingestion is probably the dominant route, but inhalation is also an important route."

Learn to use less plastic

There are many steps individuals can take to reduce their exposure to plastics and their plastic footprint, experts say.

"It's important not to scare the hell out of people, because the science in this space is still evolving, and nobody in the year 2025 is going to be without plastic," Landrigan said.

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"I say to people, 'Listen, there are some plastics that you can't escape. You're not going to get a cell phone or a computer that doesn't contain plastic.' But do try to minimize your exposure to the plastic that you can avoid, especially single-use plastics."

It's hard to avoid foods wrapped in plastic film because they are ubiquitous, Landrigan said, but you can take the food out of the plastic wrapping before you cook it or put it in the microwave.

"When you heat plastic, that accelerates the movement of the microplastics out of the wrapping into the food," he said.

Invest in a zippered fabric bag and ask the dry cleaner to return your clothes in that instead of those thin sheets of plastic, suggested the Natural Resources Defense Council, an environmental advocacy group. Bring a travel mug to the local coffee store for takeout and silverware to the office to cut back on plastic cups and utensils.

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"Don't use plastic bags when you go shopping. Use a cloth bag or a paper bag or a recycle bag. Try to avoid plastic water bottles, if you can possibly do so," Landrigan said.

A March 2024 study found 3 liter of bottled water — the equivalent of two standard-size bottled waters typically purchased by consumers — contained an average of 240,000 plastic particles from seven types of plastics. Some 90% of those were nanoplastics.

"Use a metal or glass drinking cup instead of a plastic cup. Store your food in glass containers instead of in plastic ones," Landrigan said. "Work in your local community to ban plastic bags, as many communities around the United States have now done. There is a lot you can do.

"And at a societal level, you can join forces with other people who care about children's health to push for restrictions on plastic manufacture and for the use of safer chemicals in plastics," he said. "Just because we don't know everything there is to know about every chemical in plastics does not mean we should not take action against the plastic chemicals we know are bad actors."

Editor's Note: This story was originally written in August 2024 based on a preprint, which is an early copy of a paper that had not yet been peer-reviewed. It has been updated to reflect the final peer-reviewed and published paper in Nature.

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