NEWS

Microplastics measured in human blood and mouse brains

First human biomonitoring study encounters plastic particles of four different polymer types in human blood; *in vivo* study reports polystyrene nanoparticles pass blood-brain barrier and induce neurotoxicity in mice; review summarizes plastic particle and titanium dioxide impacts on human gut epithelial integrity, gut homeostasis, and intestinal inflammation

April 6, 2022 Lisa Zimmermann Reading time: 4 minutes

In an article (https://www.sciencedirect.com/science/article/pii/S0160412022001258?via%3Dihub) published on March 24, 2022, in the journal *Environment International,* Heather A. Leslie from *Vrije Universiteit Amsterdam*, the Netherlands, and co-authors investigated plastic particles in human blood. The scientists analyzed whole blood samples from 22 non-fasting, healthy adults for the presence of the five high production polymers polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP), polymers of styrene (such as polystyrene, PS) and poly(methyl methacrylate) (PMMA). Except of PP, the researchers detected all polymers above the limits of quantification in the samples with the mean of the sum concentrations for each donor at a value of 1.6 µg total plastic particles/ml blood. This is the first research published to show that microplastics are present in human blood.

While PMMA has several applications inside the human body directly, such as in dental works, three of the polymers, Leslie et al. detected in blood, PET, PS, and PE, are commonly used to produce food contact materials. To assess the mass concentrations of the polymers in the blood samples, Leslie and co-authors developed and validated a semi-quantitative technique that targets thermal degradation products of plastics (double shot pyrolysis – gas chromatography/ mass spectrometry, Pyr-GC/MS).

These findings demonstrate "that human exposure to plastic particles results in absorption of particles into the bloodstream" and that their elimination (e.g., via the biliary tracts) and desorption by organs is slower than their absorption into the blood. How long the particles stay in the bloodstream as well as their fate in the human body is still unknown. However, previous research has shown that small plastic particles can transfer into organs such as the human placenta (FPF reported (https://www.foodpackagingforum.org/news/microplastics-found-in-human-placenta) and here (https://www.foodpackagingforum.org/news/second-study-finds-microplastics-in-human-placenta)). Five Horizon 2020 research projects are now working to better understand micro- and nanoplastics impacts on human health (FPF reported (https://www.foodpackagingforum.org/news/new-horizon-2020-projects-to-research-impacts-of-micro-and-nanoplastics)). One of the projects (AURORA (https://auroraresearch.eu/)) is specifically focusing on the assessment of microplastics' effects on the placenta and the developing fetus.

Whether small plastic particles can pass through the blood-brain barrier, and how, was analyzed by Shan Shan and co-authors from Shandong University, Jinan, China, using mice. Their research (https://www.sciencedirect.com/science/article/pii/S0045653522007548?

casa_token=dylj4JmbJR0AAAAA:6CEXRUc8Uj3hXHV88Z1XCmY8-b3qy7kJn7Fe0KqfoD4JA0JflUxryLBaa6eoKcw3iHpNU3JcVVv1) was published on March 14, 2022, in the journal *Chemosphere*. The scientists fed mice with four different doses (0.5, 2.5, 10, and 50 mg/kg body weight) of fluorescent PS nanoparticles with a mean diameter of 42 nm for seven days before using immunofluorescence and immunohistochemistry to investigate whether particles had passed into the brain and in which amounts. Shan and co-authors found that PS nanoparticles "significantly induced the increase of permeability of [the] blood-brain barrier and dose-dependently accumulated in the brain of mice."

The three lower doses (0.5, 2.5, and 10 mg/kg body weight) fall within the estimated mass range of which humans ingest nanoplastics. They further reported particle-related neuron damage, as well as the presence in and activation of microglia which are responsible for the immune defense of the central nervous system. The authors hypothesized that this activation led to the observed neurotoxicity. Internalization into brain cells and consequences hereof were also analyzed by *in vitro* studies with three different cell types. PS nanoparticles were found to accumulate in the cells, induce the production of reactive oxygen species, activate murine microglia, and damage murine neuron cells amongst others.

When micro- and nanoplastics are orally ingested and pass through the body, the intestinal epithelial layer serves as a barrier against these particles as it does for other exogenous factors. Disturbances of this barrier contribute to the development of inflammatory bowel disease (IBD), a chronic disorder. Due to the increased permeability of the intestinal barrier associated with that disease, micro- and nanoplastics translocation might be increased in IBD patients. This is hypothesized by Marlene Schwarzfischer and Gerhard Rogler from the *University Hospital Zurich*, Switzerland, in their review article (https://www.mdpi.com/2218-1989/12/3/223) published on March 2, 2022, in the journal *Metabolites*. The two authors summarized the potential impacts of micro- and nanoplastics present in food, as well as of the food-coloring agent titanium dioxide (TiO_2), on epithelial integrity, gut homeostasis, and intestinal inflammation, with a specific focus on IBD. Schwarzfischer and Rogler reported that available scientific literature shows that TiO_2 nanoparticles have an inflammatory potential, negatively affecting the intestinal barrier and the gut microbiome. However, they come to the conclusion that the intestinal impacts of micro- and nanoplastics are still controversial, and studies on the topic are limited. While literature suggests that the small particles follow the same uptake route as TiO_2 and penetrate the intestinal epithelium, not all studies reported alteration of gut homeostasis using mouse models (FPF reported (https://www.foodpackagingforum.org/news/microplastics-may-affect-the-human-microbiome) and here (https://www.foodpackagingforum.org/news/research-on-microplastics-a-changed-gut-microbiome-and-autism-spectrum-disorder)). Overall, the authors conclude that the topic requires further research to fully understand the small particles' intestinal impacts.

In January 2022, the EU banned the use of TiO_2 as a food additive since genotoxicity could not be ruled out. However, it can still be used in food contact materials, cosmetics (e.g., toothpaste), and pharmacological preparations (FPF reported (https://www.foodpackagingforum.org/news/efsa-determines-titanium-dioxide-not-safe-as-food-additive)).

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Anthony King (April 20, 2022). "Discovery of microplastics in people raises concerns about health implications (https://www.chemistryworld.com/news/discovery-of-microplastics-in-people-raises-difficult-questions-about-health-implications/4015516.article)." *Chemistry World*

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