Podcast Transcript: Understanding Exposures to Microplastics and Nanoplastics

[Theme music]

Ashley Ahearn (AA): You're listening to Environmental Health Chat – a show from the National Institute of Environmental Health Sciences that explores the connections between our health and our world.

I'm Ashley Ahearn.

Plastics are a critical part of modern life – from packaging to clothing to medical supplies, and beyond.

So, it's no surprise that plastic is showing up in some of the remotest parts of the planet – from the bellies of seabirds to the beaches of far-flung islands in the Pacific.

But scientists are just beginning to understand the ways in which plastic particles are getting into our bodies – and what that might mean for human health.

Phoebe Stapleton (PS): They've been found in blood, semen, breast milk, urine, feces, kidney, liver, heart, lung – really, every tissue we've looked at so far.

AA: Dr. Phoebe Stapleton is an associate professor in pharmacology and toxicology at the Ernest Mario School of Pharmacy and a resident scientist at the Environmental and Occupational Science and Health Institute at Rutgers University.

She spends a lot of time thinking about plastic.

PS: So, as you can imagine, since I've gotten into this work, I'm really a lot of fun at parties, and family reunions, and things of that nature.

AA: Dr. Stapleton has a background in inhalation toxicology – basically trying to understand how the pollutants in the air we breathe might affect things like fetal health.

That means studying particles that are often too small for the human eye to detect, known as nanoparticles, that can make their way into our bodies via our lungs, skin, and digestive system.

PS: So, we started looking at that nanosize [particle] thinking that that is an even great health issue because those particles are able to get through the lung. They're able to get to the placenta. They're able to get through the placenta in some cases.

AA: In her research, Dr. Stapleton was initially looking at tiny ultrafine particles of metals to represent common air pollutants. But turns out, she had to consider another material…plastic particles. More specifically, nanoplastic particles, smaller than 2.5 microns.

As plastics age, they break down into smaller and smaller particles. You've probably heard the term microplastics – plastic particles less than 5 millimeters across, which is about the size of a sesame seed. But scientists are now able to detect nanoplastic particles in the same size range as bacteria or viruses, too small to see with the naked eye.

PS: So it's only recently when we've started to use some of the tools that we have scientifically available that we're able to identify them, measure them, and then the next step is quantify them, so we really have an understanding of what people are being exposed to, and if they're being exposed through air, or if they're being exposed through something that we're eating or drinking instead.

AA: Tiny plastic particles can get into the environment in a variety of ways. Plastics in our building materials, household furnishings, clothing, car tires, and other items can break down over the years and end up in landfills or waterways. In many parts of the world, plastic trash is incinerated and ends up in the air. Plastic particles are also found in our food and water.

Dr. Stapleton was part of a team that did groundbreaking research on bottled water with funding from the NIEHS. They found that each liter of water they sampled contained an average of 240,000 plastic particles – about 90% were nanoplastics. That's 10 to 100 times more plastic particles than previously estimated. They were also able to detect the types of plastic present, finding that the water contained all seven of the types of plastic particles they tested for.

The team was able to make this discovery because of a new technique, pioneered by Dr. Stapleton's colleague, Dr. Wei Min, a physicist at Columbia University. He was able to use lasers to stimulate the atoms within a plastic particle and then identify the type of plastic it is – at the nano level.

PS: Many techniques are able to get into that micron size, but not yet into that nano size. And Dr. Min's technique allows us to be in that nano range. And what that does is not only identify particles in that nano range, but it also identifies the chemistry of them. So not only do we get the size, but we also get what kind of particle that is – if it's from a polyamide, or a polyester, or polystyrene.

AA: Dr. Stapleton says this technique will be a gamechanger in her field of research. It will allow scientists to look at the concentration, the chemistry, and the size range of plastic particles present in a sample – and we're not just talking bottled water…

PS: It will also identify what's in human tissues and look at the variation between human tissues as well. So, looking at whether the percentages of plastic chemicals and plastic particles and sizes in the brain is different than that of the liver, for example, or different than that of the heart. If samples from young and old individuals are different, if samples between men and women are different. It'll really open up the ability to look at some of those mixtures and almost individualize the human exposures.

AA: Dr. Stapleton is excited to apply this new technique to her research on rats and nanoplastics. In her lab she has exposed pregnant female rats to nanoplastic particles via inhalation and ingestion.

PS: And so that was our original question, was if we know the nanoparticles are in the maternal blood, are they able to get through the placenta, through the umbilical cord and umbilical vein, and into the fetal tissues?

AA: Sure enough, within 24 hours of maternal exposure, the nanoplastics made it through the placenta and showed up in rat fetal tissues.

PS: We find them in the fetal liver, the fetal heart, kidney, brain, and lung tissues, and that's where we've primarily started to look. And I'm interested in that so that we can start to look at those endpoint tissues. Once we know that they're getting there, we try to understand an amount that's getting there, and then the next step is to figure out what they're doing there.

AA: In her lab, Dr. Stapleton has observed reduced fetal growth in rats that have been exposed to plastic particles in utero. She and her colleagues are now doing studies to see if they detect adverse behavioral or cardiovascular outcomes in the rat offspring.

Studying rats is, of course, not the same as studying humans but Dr. Stapleton's research could provide important clues that will help scientists zero in on health problems in the human population that could be linked with plastic exposure – and that exposure has increased over the years.

A recent study looked at the presence of plastic particles in human placentas from 2006 to 2021. The researchers found that 60% of placental samples from the early 2000s contained plastic particles. But by the early 2020s they were found in all of them.

PS: So, I think that just shows that the body burden is increasing for people. So, we don't have a great "this is how much the average person has in their body," but what we can say is that it seems that those exposures seem to be increasing over time.

AA: Plastics may contain chemical compounds like phthalates, bisphenol A, and others that are known to mimic hormones and have been linked with cancers and other health outcomes. Linking those outcomes with our exposures is of course, always the tricky part in public health research and policy, but Dr. Stapleton says the first steps is to raise awareness.

PS: You can't do anything about something that you don't know. Because once we have that awareness, we can make changes, we can influence policy, we can then make some educated decisions on which plastics are less toxic than others, which plastics might even have better safety regulations. What size range is of a bigger concern? Can we develop plastics and polymers that fit into some more reasonable health outcome bins?

AA: Dr. Stapleton acknowledges that plastic particles may be pervasive in the environment and in our bodies, but that doesn't mean we can't take steps to reduce our exposures – doing things like avoiding bottled water, switching to glass instead of plastic food containers, never microwaving food in plastic, and choosing clothing made of natural fibers like wool and cotton, for example.

Dr. Stapleton says there are many unanswered questions about what the prevalence of plastic particles in our environment and our bodies might mean for human health - and she's eager to continue exploring them through her research.

PS: I think as scientists and as policy makers, we really have to have a strong understanding of the health effects associated with these exposures in order to make some of those policy changes, because it's going to be an uphill battle associated with some of that policy change. And so, in order to do that, we just need to have as much firm, reproducible data as possible to be able to have a really strong case of what plastics should be modified, what plastics should be kind of changed as necessary, or should be eliminated altogether.

[Theme music fades up]

AA: I’m Ashley Ahearn. Thanks for listening to Environmental Health Chat.