Dr. Mariam Hanna:
Hello, I'm Dr. Mariam Hanna, and this is *The Allergist,* a show that separates myth from medicine, deciphering allergies and understanding the immune system.

You're getting older when you start using the sentence, "Back in my day," or, "When I was growing up, we did or we didn't," and then throw in a comparison and conclude as to whether things were better or worse back then. The pace of progress in different areas of our lives has been rapid in this generation. My grandmother didn't have a remote-controlled TV, much less one that was controlled through her phone.

It's important to understand that our progress in knowledge and consumerism has had far-reaching impacts on other parts of our health. We're first to discuss this in the world of allergy: has our industrialization and advancements been a piece of the puzzle contributing to our changing microbiome and the development of allergies?

I get this question, perhaps not in these exact words, frequently in my clinic, and my best response typically is: maybe, it sounds like an important piece of this puzzle.

It's my distinct pleasure to introduce today's speaker and today's topic on something that I don't think we explore quite enough in our specialty. Dr. Magdalena Zemelka-Wiecek is an associate professor at the Department of Clinical Immunology at Wroclaw Medical University in Poland. She's also the deputy editor of the European Academy of Allergy and Clinical Immunology Knowledge Hub, regularly presenting her findings at major scientific conferences.

Dr. Zemelka-Wiecek, however, is actively engaged in research on the penetration and impact of nanoplastics in the human body, particularly through inhalation, digestion, and skin contact. Her work really focuses on understanding the health implications of nanoplastics, including their potential to trigger immune responses and contribute to allergic diseases.

In addition to her research on nanoplastics, Dr. Zemelka-Wiecek has made significant contributions to the field of allergen-specific immunotherapy, exploring immune tolerance mechanisms and how allergen immunotherapy can be optimized for treating allergic conditions in patients.

If that hasn't gotten you excited enough about this topic, Dr. Zemelka-Wiecek will do that herself. Dr. Zemelka-Wiecek, welcome to the podcast.

Dr. Magdalena Zemelka-Wiecek:
It's my pleasure to be here and to talk with you.

Dr. Mariam Hanna:
So let's start with just what are the main types of plastics that we see?

Dr. Magdalena Zemelka-Wiecek:
So, we have a lot of types of plastics. Usually, they have those really complicated names, and

they have these abbreviations with three or four letters. We have polyethylene, polyvinyl, polypropylene, polycarbonate, and a lot more. So the thing is that because we have so many plastics, we're not sure if all of them react with our body in the same way.

Dr. Mariam Hanna:
So these different types of plastics go to make different plastics that we interact with in our environment. Does it impact how it is that they stay, or how stable they are in our environment, or how they degrade over time.

Dr. Magdalena Zemelka-Wiecek:
This is another thing. The types of plastic usually is some types of plastic. They can be conventional, so they may be produced from the petroleum-based materials, but they might break down or not break down into smaller pieces and biodegrade. Then we have those other plastics that are bio-based made, and they are made from biological sources like plants, for example, from corn or cellulose, and they are bio-based. But it doesn't mean that they are biodegradable. They can also just divide into smaller pieces. And then some of the plastics can be biodegradable, so they're degraded into natural substances like water, carbon dioxide, biomass, and this happens under specific conditions.

This may be because of the temperature, because of the water, the waves of the water, or the wind, or sometimes some bacteria can help the degradation. So, in general, this is very complicated, and we cannot classify that we have some plastic that we use that are biodegradable and the other ones are not, and they are made from petroleum or they're made from plants. So, there's a lot of that. And besides, sometimes they are mixed. So, some products are produced from both types of plastics or even more, and this is getting even more complicated because some parts can degrade, and the other parts cannot.

Dr. Mariam Hanna:
That's very interesting, and I love the explanation of the different words because someone like me that doesn't know a lot about this, I might hear about a bio-based plastic and just think that's better for the environment and then therefore it must be safer or healthier. And it's interesting, that may not necessarily be the case.

Okay. I want to explore one other term that I've heard recently: nanoplastics. Can we talk about the difference between when we talk about the word microplastics versus nanoplastics, what's the difference there?

Dr. Magdalena Zemelka-Wiecek:
So, it's breaking down into smaller pieces. When the pieces are smaller than five millimeters, we call them microplastics, but when the plastic is smaller than one micrometer, which means 1000 nanometers, this is nanoplastics because we called about the nano. One thousand nano is one micrometer.

So, microplastics and nanoplastics, this is just the size of plastic, and probably, we don't know that for sure, the nanoplastic is more because the cells can get it much easier than the

microplastic because microplastic is quite big compared to cell size, and that's why probably it's not that harmful for cells. We don't know what about organs, but just for cells.

Dr. Mariam Hanna:
Interesting. And what's the main routes that we're seeing that we're getting this into our body?

Dr. Magdalena Zemelka-Wiecek:
So, in general, we have three routes. I think that the most common one, the one that people know, is through the digestive tract. So, we eat the plastic with fish, with beer, with honey, with sugar, with water. There's a lot of plastic in water. Also, in bottled water, which is in plastic bottles, which is obvious, but also in tap water, there's also plastic. I mean, there is less, but we still have plastic.

But then we get the plastic through inhalation, and this is the route which is maybe not that obvious because if we have, for example, I dunno, house dust mite at home, it's mixed with the plastic particles, and we can inhale it. Also, there's a lot of clothes which are made with plastic additives. The companies are sometimes advertising, "We use plastics for our clothes," and this is, for them, it's an advantage because they use the plastics, so they use the waste. But in reality, it's so close to your mouth, to your nose, that you can inhale it.

And then the third route, which we think is the less important one, is the skin. Because the skin, when we have healthy skin, the skin is a very good barrier, and there is a limited number of studies about the penetration of plastic through the skin. And most of the studies say that the penetration is not really high.

Dr. Mariam Hanna:
So oral and inhalation are ways to get plastics into our body. Do we have studies that talk about what ways nano or microplastics impact the cells in our body at that molecular level that causes concern?

Dr. Magdalena Zemelka-Wiecek:
So, if you look at the literature, there's quite a lot of studies about that. But first of all, they don't reflect the organism because those are just studies on cells. So, they have some bias. Then we have different types of plastics, also different concentrations, because this is the biggest, the toughest part—the concentration—because we're not sure what the concentration should be.

There are no clear research about how much plastic is in our body, and different cells will be exposed to different concentrations. Like when we have the cells in our lungs, they will be exposed more than, for example, blood cells, right? Because first, we inhale the plastic, and then just some of the particles go to the blood. So, we don't know what the concentration should be. Is it toxic, or is it just the concentration that is occurring naturally?

So, all these different types and all these different times and everything make the research, of course, very important, but very hard to compare. And this is something that is missing in the whole research of plastic, I guess.

Dr. Mariam Hanna:
One of the challenges we often face as clinicians when we hear about in vitro studies is that we're often thinking, "What is the clinical implication of this knowledge right now?"

Dr. Magdalena Zemelka-Wiecek:
Right now, we have a very recent study that was published in the *New England Journal of Medicine,* so one of the best journals in the world, and they had 304 patients, and those patients had carotid artery plaques. And so they removed the plaques, and they checked if there were microplastics inside.

And they found that half of the patients, 150 patients, had micro and nanoplastics inside. And this study was taking 34 months. And after 34 months, they noticed that patients—half of the patients of this population of 150 patients—had actually detected, in their atheroma, micro and nanoplastics.

And they had a higher risk of myocardial infarction, stroke, and death from any cause. And the hazard ratio was 4.53. So, that means that they had 4.53 times more chances to get this myocardial infarction, stroke, or death because they had this micro and nanoplastic inside the atheroma.

Dr. Mariam Hanna:
That's a really concerning number. Dr. Zemelka-Wiecek, can you clarify, would these patients have had higher than normal levels of exposure because of the workplace?

Dr. Magdalena Zemelka-Wiecek:
No, no, no. They were just regular patients of the cardiologists. And that's why they were, because they were removing the plaque, and they analyzed the plaque. So, they were cardiac patients, not the patients that were exposed to plastic.

Dr. Mariam Hanna:
Okay. Can we speak a little bit to how plastic exposure correlates with GI disorders and more overall with the gut microbiome?

Dr. Magdalena Zemelka-Wiecek:
So, there is also a really nice study, a really recent study, that correlated the plastic they found in fecal samples and inflammatory bowel diseases. So, they found a positive correlation between the concentration of fecal microplastic and the severity of inflammatory bowel disease.

So, in general, they had two groups. They had one group, there were about 50 patients, and they were healthy. And then they had another group, which was also 50 patients, and they had bowel disease. And they compared the number of plastics that they had in the fecal samples, and they found the correlation: more plastic, the severity of the disease was higher.

So, this was on humans. We also have a lot of studies on animals. Mice are the easiest animal to work with, and they have found also a lot of different changes in the microbiome. So, they just found that the microbiome is changing in mice that are being fed for 60 days with plastic.

So, the microbiota that is inside is changing. They are not completely sure how the microbiota is changing or what these changes are bringing, but they know that the enzymatic biomarkers are changing and the metabolomics is also changing. So, there are some changes because of the microplastic.

There is no—I have not heard about—data in humans about the microbiome. And there's also, if we talk about the digestive system, there's also a few interesting studies about non-alcoholic fatty liver disease that microplastic can cause this disease in mice. So, not just the gut, but also the liver can be exposed to microplastic, and this might be harmful.

Dr. Mariam Hanna:
Interesting. Okay. So, the discussion about plastics truly has been ongoing for the past couple of years. Certain parts of the world discuss it a little bit more than others. I recently actually saw it make the news, which pushed me even further for us to do this podcast to say that some human samples were found to have plastics on tissue. Can we speak a little bit about that? What data do we know or do we have now to say that they've identified plastics in human samples?

Dr. Magdalena Zemelka-Wiecek:
Pretty much they have found plastic everywher e. So, they have found plastic in the lung, which is obvious, right? But in breast milk, also in liver, in spleen, in placenta—placenta actually was one of the first of the studies that identified microplastic in human samples—also in blood, sputum, colon, saliva, feces.

What is interesting, they have not found microplastic in kidneys, and they have not identified microplastic in the lungs of stillborn babies. However, they found it in a live baby; they found microplastic in them also. And they have found a lot of different colors, a lot of different sizes from nano up to microplastic and the status of our life.

So, what we do—if we're healthy or we have a disease, if we smoke, or we're pregnant, age, and all the other factors—also influence the number of plastics that we can accumulate. There is—I've read it a few times in research—that we assume that probably a human being is swallowing five grams of plastics per week.

Dr. Mariam Hanna:
Gulp, that sounds like a lot.

Dr. Magdalena Zemelka-Wiecek:
That's like a credit card. This is the size of a credit card. So, we eat it with food or drink it with water. And the problem is that we don't know how much of that is being accumulated and how much of that is just being released. And how,

Dr. Mariam Hanna:
As an expert in this area, Dr. Wiecek what is the most significant finding for you about plastics and human health? What do you think would be significant for us to pay attention to?

Dr. Magdalena Zemelka-Wiecek:
I think that the most important is that the plastic just degrades into smaller pieces. Right now, we can identify nanoplastic, the smallest one, but we don't know, maybe it's getting even smaller, and we don't know how it affects our cells.

So, for me, the in vitro studies are obviously very important, but the studies that show that humans can get some diseases or that the disease can get worse—I think this is the most significant thing. And since most of the plastics do not biodegrade, so it's not becoming a biomass and water and meat at the end, it's being accumulated everywhere. The plastic has been found everywhere on Earth. So, we get more and more; we accumulate it for sure. Every day, every year, we get more and more plastic.

Dr. Mariam Hanna:
Interesting. Okay. So I, as a physician in my office, I will tell you, I get lots of families who are expecting or with their newborn, and they're asking about ways that they can mitigate progression of allergic disease or make their baby as healthy as possible. Any suggestions from my pediatrician life or my allergy life that I can give them? What is it that you would make as suggestions to populations that are interested or that perhaps see themselves as being more vulnerable to these diseases that they can do while we're still learning about this?

Dr. Magdalena Zemelka-Wiecek:
Well, I think we have to start from ourselves and try to use less plastic. Well, I come from Poland, and here we have some commercials on TV that you should use, instead of a plastic bottle, one that is reusable—a reusable water bottle that can be reused multiple times.

But on the other hand, what I do, I also think about what I use. I mean, I'm trying not to use plastic bottles. I try to use glass bottles. And even in this, I was talking about this correlation about the microplastic in fecal samples and inflammatory bowel disease, and they also checked there who had more plastic. And they found out that people who were using plastic bottles and did not cook at home, but were taking takeaway food in plastic boxes, they had a bigger amount of plastic in their samples.

So, I guess we just have to, as I said, start from the very basics, from ourselves, and try to use less plastic. And if we buy something, we should think about it—do we really need it, or can we replace it with non-plastic material?

Or, for example, which is also, I think, a very important issue, a lot of things are packed. If you buy some items, they're packed in plastic foil or in some other materials. So, it's also important to pick up those things that are packed with less material or plastic, because this is a waste. You just buy something, and you throw it away in one second.

Dr. Mariam Hanna:
So, not only is it better for your health, but also better for the environment as well.

Dr. Magdalena Zemelka-Wiecek:
Well, exactly. So, here is this really nice idea, which is called One Health. So, One Health is that

we take care of humans, animals, and the planet, and this is all combined together. So, this is very important—how we take care of our environment and our animals that live with us—because we're all in the same cycle. So, if we save the planet, we also will be more safe.

Dr. Mariam Hanna:
I love that. Okay, time to wrap up and ask today's allergist, Dr. Magdalena Zemelka-Wiecek, for her top three key messages to impart to patients and physicians on today's topic: nano and microplastics. Dr. Magdalena Zemelka-Wiecek, over to you.

Dr. Magdalena Zemelka-Wiecek:
Thank you. So, nano and microplastics do not biodegrade like organic materials. Instead, they break down into smaller particles that persist in the environment.

Nano and microplastics have been detected virtually everywhere on Earth, from the deepest ocean to the highest mountain peaks.

And nano and microplastics have been confirmed in various human samples, but the full understanding of their health impact remains unclear and requires further research, but we know that it is harmful.

Dr. Mariam Hanna:
Wonderful. Thank you, Dr. Zemelka-Wiecek, for joining us on today's episode of *The Allergist.*

Dr. Magdalena Zemelka-Wiecek:
Thank you very much.

Dr. Mariam Hanna:
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Sincerely, *The Allergist.*