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Big Picture: An Analysis of Human Mercury Exposures Worldwide, with Niladri Basu

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Methylmercury, the most toxic form of mercury, is found in seafood around the world, and it can cause severe health effects in people who are exposed to it. Governments are working to reduce the amount of mercury that finds its way into the environment. Dozens of countries have pledged to implement measures to reduce mercury pollution. In this podcast, Niladri Basu discusses his recent systematic review, which estimates global baseline mercury exposures. These estimates will help countries gauge the success of their control measures. https://doi.org/10.1289/EHP6421

NARRATOR [00:00:00]: *EHP* presents "The Researcher's Perspective."

[Theme music]

AHEARN [00:00:10]: It's "The Researcher's Perspective." I'm Ashley Ahearn.

There's an old saying, "mad as a hatter," that originated in the days when hat makers were using mercury compounds to improve the quality of felt hats—and they were suffering the neurological effects of mercury exposure.[1]

Mercury is a naturally occurring metal that is toxic to humans and other animals. Today, people around the world are exposed to methylmercury, the most toxic form of mercury, largely through the consumption of contaminated fish.

Well, political leaders wanted to do something about that. In 2013, close to 140 countries signed a UN treaty known as the Minamata Convention.[2] It includes both mandatory and voluntary measures to control mercury emissions from various sources, to phase the element out of certain products and industrial processes, to restrict its trade, and to eliminate the mining of mercury.

But there was a missing piece of information: How widespread is human exposure to mercury now? In other words, how will we know if those control measures are working? That's where the science comes in.

Dr. Niladri Basu led a team that conducted a systematic review[3] of the scientific literature on human mercury exposure around the world as part of the 2018 Global Mercury Assessment[4] for the UN Environment Programme.

Dr. Basu is the Canada Research Chair in Environmental Health Sciences at McGill University in Montreal and joins me now to talk about the findings.

Dr. Basu, welcome to "The Researcher's Perspective."

BASU [00:01:35]: Hi, Ashley. Thanks for having me.

AHEARN [00:01:36]: So before we dive into your research, why don't you give us a quick rundown on how mercury exposure affects human health?

BASU [00:01:42]: Sure. So basically, mercury is a highly reactive metal that can penetrate deep into the sensitive parts of our bodies, such as the brain or the fetus. In terms of mercury's health impacts, the current evidence base is quite strong that mercury is a very potent neurotoxic agent, especially towards a developing nervous system, though we're also starting to see that there are growing concerns about mercury's effects on the cardiovascular system[5] and more recently, even on the immune system.[6]

AHEARN [00:02:10]: We can be exposed to mercury from a variety of sources, right? But what really matters is what form of mercury we're exposed to and how our bodies metabolize it. Can you tell me a little bit more about that?

BASU [00:02:21]: Sure. So the chemistry of mercury is really critical in understanding its risk. So mercury, like other elements, can exist in many chemical forms, and mercury specifically has three main chemical forms. And by understanding the chemical forms, we can then understand how we're exposed and then what happens to mercury once it enters our bodies.

So elemental mercury or inorganic mercury salts, they largely occur in occupational settings such as mining, maybe in dentistry. These are types of mercury that might be found in skin lightening creams or fluorescent light bulbs. And these are forms of mercury that we might inhale or we ingest. Once they get inside of our bodies, they might target our kidneys, and they might be excreted through the urine.

Another form of mercury that you mentioned earlier is the methylmercury form. This is a form of mercury that's built up in the food chain. It can contaminate aquatic ecosystem. We're largely exposed to methylmercury through ingestion, and once inside of our body, this is a type of mercury that can target the brain.

AHEARN [00:03:21]: And what do you see as the most prevalent exposure pathways for mercury in people around the world?

BASU [00:03:25]: For most communities worldwide, it's really about consumption of contaminated fish, shellfish, and other types of foods, especially items of food that might be at the top of the food chain, like tuna. These are contaminated with relatively high levels of methylmercury, and this is thus the most important source of exposure.

Unfortunately here, though, seafood is arguably the main source of protein for maybe a billion people worldwide,[7] and thus balancing the risks of mercury in the seafood alongside the benefits of the essential nutrients in that seafood poses many dilemmas to populations worldwide. We see in many cases that these groups are especially vulnerable: They come from low- and middle-income countries and communities, along with many indigenous peoples worldwide.

AHEARN [00:04:10]: Now, coal plants also emit mercury. How big of a contributor or problem is that pathway of exposure?

BASU [00:04:17]: Coal plants do release mercury every time they burn off coal, and this is one of the most important sources of mercury into the environment. What happens here is that mercury gets released as an elemental form. It can travel far, far distances away from the coal-fired power plant. Ultimately, it gets oxidized in the air, and it can be deposited into aquatic ecosystems. Once that form of mercury makes its way into the water bodies, bacteria can grab ahold of it, methylate it, and that form of mercury, which again is that methylmercury form, can build up in aquatic food chains.

AHEARN [00:04:50]: Artisanal and small-scale gold mining is another source of mercury exposure, and I'm wondering, how big of a source is this?

BASU [00:04:56]: Yeah. So artisanal/small-scale gold mining is a huge source of mercury worldwide. And even though this type of activity has been occurring for centuries, it's only in the last decade or so that we begin to realize how much of an important contributor it can be.

So this is a type of gold mining that largely occurs in relatively poor communities throughout Africa and Asia and Latin

America, and it's a way that many communities can lift themselves out of poverty. So there's great thirst of gold by many countries worldwide. And this type of gold mining occurs in which we use mercury to bind gold and rocks and essentially liberate the gold from the rocks. But in doing so, we burn off the mercury, and that mercury then gets emitted into the air and contaminates the communities.

We're starting to see that there might be 10 to 15 million artisanal/small-scale gold miners worldwide.[4] But equally as concerning, there might be 100 million people that live in these artisanal/small-scale gold mining communities; many of these are women and children.[4] It really is a poverty-driven activity.

AHEARN [00:06:04]: And is the Minamata Convention set up to reduce this kind of mercury contamination?

BASU [00:06:09]: It is. So it's exactly what the Convention is designed to do. And the Convention is unique in that it extends beyond just addressing the chemical. But if you read the text of the Convention,[2] it talks a lot about education in these communities, providing access to health care alongside technological advancements and solutions in which we want to really promote these economic activities in these poorer communities. But we want to minimize their exposure to mercury.

AHEARN [00:06:38]: Dr. Basu, your recent paper[3] in *Environmental Health Perspectives* sought to get a handle on the levels of mercury exposure in populations around the world. I mean, it was, it was really quite an exhaustive literature review. I'm wondering if you could tell me how you went about gathering all of this information: How many studies did you review, how many countries, and really how many people were included in all those studies?

BASU [00:06:58]: Sure. Yes. So it was quite the activity. It took us about 2 or 3 years to get this project going. So we put together an expert team of some of the top mercury scientists. And we spent a lot of time sort of talking about how we're going to design the work, and we consulted widely, and eventually, we came up with a strategy that we were very satisfied with that the community had also sort of supported. So in the end, what we found were 312 publications from which we were able to extract 424,000 mercury biomarker measurements that represent about 335,000 people from 75 different countries.

AHEARN [00:07:37]: And going through all of these studies, what did you find?

BASU [00:07:41]: So quite simply, we found that we're all exposed. And we found that all people worldwide are exposed to some amount of mercury, even though there is great variability in exposures within and across countries and regions.

AHEARN [00:07:54]: Where did you find the highest levels of mercury in human populations?

BASU [00:07:57]: Yeah. So in our assessment, we identified three populations of particular concern. First are indigenous peoples worldwide, especially communities in the north, such as Inuit and the Arctic. They have some of the highest exposures to mercury worldwide, largely because of their reliance on country foods such as fish and marine mammals for sustenance.

Second are communities that live beside/inhabit tropical river ecosystems in tropical environments, as well as coastal and small island communities that rely upon fish consumption. We found that these groups are also very highly exposed.

And the third group that we identified were these artisanal/small-scale gold miners, as mentioned previously. Their exposures to mercury can be orders of magnitude higher than the exposures that us in the general background population experience.

AHEARN [00:08:47]: So you were looking at mercury biomarkers in human populations worldwide from the time period 2002 to 2018. I wonder, within that time period, did you get a sense of how exposure levels might have changed?

BASU [00:09:00]: Yeah. So when we started the work, this is something that we were hoping we could answer. But again, remember that our effort was the first one to try and understand exposures worldwide. And as we embarked upon that, we felt that we couldn't generalize on a global scale. With that being said, we were able to identify some stories of note.

First, we see that across countries like Canada and the U.S., that urinary mercury levels have been decreasing, and this is largely reflecting efforts in society to move away from [dental] amalgams that contain mercury.[8]

Second, we've also seen that exposures in certain communities in which fish consumption advisories have been made, that the mercury exposures have also come down, though in these cases, we also recognize that there might be additional concerns because we know that fish consumption is associated with a range of health benefits. So even though the exposures are coming down because of advisories, there are concerns sometimes with the advisories and what they say.

AHEARN [00:09:55]: So is it too soon to say what the Minamata Convention has accomplished, from a scientific standpoint?

BASU [00:10:01]: Yeah, I think so, because the Convention just came into legal force in the last year or so. But nonetheless, the Convention is important because we do have here a chemical, mercury, that's highly toxic and highly widespread, is responsible for a tremendous burden of disease—especially among notable vulnerable populations like pregnant women or indigenous peoples—many environmental justice stories feature mercury as the prime antagonist. So it's important to take action against a chemical like this.

AHEARN [00:10:30]: Dr. Basu, if I call you in 10 years or 20 years, what do you think you'll be telling me? Or maybe I should ask, what do you *hope* you'll be telling me about mercury contamination and exposure?

BASU [00:10:40]: Well, what I hope I can tell you is that we've seen global exposures trend downwards, especially in the most vulnerable populations. And the Convention is designed to take action so that these communities can greatly minimize their exposures, their health impacts related to mercury can come down, and ultimately their livelihoods improved. So I would hope that in the next 5 or 10 years, that we start to see exposures come down in these particular communities.

AHEARN [00:11:08]: Dr. Basu, thanks so much for joining me.

BASU [00:11:10]: Thank you, Ashley.

AHEARN [00:11:11]: Dr. Niladri Basu is the Canada Research Chair in Environmental Health Sciences at McGill University in Montreal.

[Theme music]

I'm Ashley Ahearn, thanks for listening to "The Researcher's Perspective."

[Theme music fades up and out]

The views and opinions expressed in this podcast are solely those of our guest and do not necessarily reflect the views, opinions, or policies of Environmental Health Perspectives *or the National Institute of Environmental Health Sciences.*

References and Notes

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8. Dental amalgam consists of elemental mercury and a powdered alloy of silver, tin, and copper. According to the U.S. Food and Drug Administration (https://www.fda.gov/medical-devices/dental-amalgam/about-dental-amalgam-fillings), dental amalgam contains about 50% elemental mercury by weight.