

Understanding bioavailability of arsenic and lead in soils at Superfund sites

Narrator: Metals like arsenic and lead can occur naturally in soil with levels varying by geologic region. Human activities, such as mining, agriculture, and manufacturing can increase the amount of these metals in the soil and in some cases can result in levels that are unsafe for human health. When that happens, regulatory agencies like the U.S. Environmental Protection Agency (EPA) may need to intervene. One way EPA acts to protect human health is to designate a location as a Superfund site and determine a clean-up strategy.

Dana Haine is a science educator with the Superfund Research Program at the University of North Carolina at Chapel Hill. She and her colleagues developed a factsheet to help communities impacted by Superfund sites better understand the risks of exposure to contaminated metals and actions they can take to reduce their exposures.

Haine: People can be exposed to metals in soil and dust through ingestion of contaminated soil, but also food that's been grown in soil, if it's not washed properly could have residual arsenic or lead on it, and also inhalation of soil particles or dust particles can also be problematic.

Narrator: Health impacts from short-term exposure to arsenic can include nausea, vomiting, and diarrhea, while long term exposure to arsenic can cause cancer. Lead exposure can also result in numerous health problems, including developmental delays, problems related to learning and hearing, and other behavioral problems. These impacts are especially relevant for children who have smaller bodies than adults and are still growing and developing. Children also engage in behaviors that make them more likely to come into contact with contaminated soil, such as crawling on floors or in dirt, and putting their hands in their mouths.

Bioavailability is an important factor in determining exposure and health risks to metals like arsenic and lead. This scientific term is usually unknown or confusing to community members impacted by metals contamination, but because bioavailability has important implications for human health and clean-up decisions at Superfund sites, it is vital for impacted communities to understand what it means.

Haine: Bioavailability is going to refer to the amount of a contaminant or any food item really, it doesn't have to be something that's bad for us, but anything we ingest, how much of that is actually absorbed into the body, so from the digestive tract in to the bloodstream where it can be distributed throughout the body.

Narrator: Haine and her colleagues developed the factsheet to communicate this complex concept to the public. There were many important factors for the team to consider to convey the message effectively.

Haine: One thing we considered while designing the fact sheet was trying to make it visually appealing, scientifically accurate, but also not overwhelming to the point where someone would not want to read it, for instance. We also tried to consider how to visualize the concept of bioavailability. So what we ended up doing on the fact sheet was showing a picture of two children playing in dirt, which could be a route of exposure, and sort of zoomed in on a magnifying glass showing a piece of dirt with both bioavailable and non-bioavailable forms of arsenic or lead. And then we showed how if those forms become present on the fingers, and if hand to mouth contact happens, then both forms can be taken in to the body. And so we tried to show through graphics that while a person can ingest both bioavailable

and not bioavailable forms of arsenic or lead, it's only the bioavailable forms that are actually going to leave the digestive tract and enter the body to impact the organs of the body. The non-bioavailable forms of arsenic or lead, would stay in the digestive tract and be excreted.

Narrator: So why does bioavailability matter? Well, it turns out that contaminants like arsenic and lead must be bioavailable in order to pose a risk to human health. Regulatory agencies like EPA can take this into consideration to refine risk estimates and devise clean up strategies for impacted sites that are not overly burdensome while still effectively protecting human health.

Haine: Knowing the bioavailability of a contaminant like arsenic or lead at a superfund site can provide a more accurate estimate of the human health risk of exposure and it can inform the clean-up strategy in terms of what strategy is ultimately best for the site, and it can also impact the cost of that remediation.

One example from North Carolina where bioavailability was used to inform clean up was the Barber Orchard Superfund site. They did analysis of soil samples there and determined that the average bioavailability, and this was a conservative estimate, was 51%. So 51% of the total arsenic was determined to be bioavailable. And taking that in to account then, meant that they didn't have to excavate as many acres of the soil from the site, so they actually excavated about 40 acres fewer of soil, and that resulted in a 5 million dollar cost savings.

Narrator: The factsheet also provides important information on how impacted communities can reduce their exposures to arsenic or lead in contaminated soil and dust.

Haine: In addition to writing out tips to reduce exposure to arsenic or lead, we had these visuals, so trying to be aware of the different literacy levels of our audience. And it includes things like taking shoes off at the door, cleaning pets' feet and fur when they come into the house after they've been out, washing hands after handling soil or handling food that's been grown in soil. Also practicing safe gardening and washing foods grown in contaminated soil, using damp mopping techniques, and also thinking about other sources of exposure in your environment. So if you're aware that your garden might have soil with high levels of arsenic or lead, trying to minimize exposure to those chemicals from other places like drinking water or other foods.

Narrator: The bioavailability factsheet has been well received by EPA, and has been used by the National Institute of Environmental Health Sciences in communicating with teachers. It will also be useful for remediation managers as they communicate clean-up strategies to impacted communities.

To learn more about arsenic and lead bioavailability and to download the factsheet, you can visit our website at niehs.nih.gov/podcasts.

Thanks to today's guest Dana Haine for joining us.

You've been listening to Environmental Health Chat. Our podcast is brought to you by the Division of Extramural Research and Training at NIEHS, part of the National Institutes of Health, an agency of the U.S. Department of Health and Human Services.