Nail keratin is reliable test for arsenic exposure from water

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Millions of people worldwide consume drinking water that contains potentially unsafe levels of arsenic. Identifying those at greatest risk can be a challenge, especially in remote regions where water-quality testing and health assessments are difficult.

But a new study, conducted in Ethiopia's Rift Valley by Duke University researchers, may provide a simple way to evaluate health risks from arsenic exposure before adverse effects are apparent.

"We found that by measuring arsenic levels in toenail keratin, we can reliably detect a person's exposure to arsenic in drinking water—before long-term exposure leads to illness," said Avner Vengosh, a professor of geochemistry and water quality at Duke's Nicholas School of the Environment.

"This is a simple, non-intrusive test that can identify the route and extent of arsenic exposure," he said.

Vengosh and his team published their findings this week in the peer-reviewed *Journal of Exposure Science and Environmental Epidemiology*.

To conduct their study, they collected groundwater samples from 34 communal water wells located within a 210-kilometer area of the central Rift Valley in Ethiopia. They selected the location because past studies have shown that average arsenic levels in the groundwater there exceed the World Health Organization's recommended guideline of 10 parts per

billion for safe consumption, and because seafood—another common source of arsenic exposure—is not part of the local diet.

Toenail clippings were collected from 58 volunteers, all of whom lived in the valley and relied on its water wells as their sole source of drinking water. Nail samples were collected from both women and men of all ages. Participants completed a questionnaire to help the researchers identify any confounding factors, such as smoking or poor diet, that might affect their health or present additional routes of potential arsenic exposure.

"We found that 53 percent of the wells had arsenic concentrations above WHO guidelines, and that arsenic levels in the water samples corresponded positively, across almost the entire spectrum, with arsenic concentrations in the nail keratin of both men and women who consumed well water. It was a strong match," Vengosh said.

While gender didn't seem to be a factor in determining arsenic accumulation in the body, age and diet did seem to play a role.

"We found that males under the age of 18 had higher arsenic concentrations in their nails on average than adult males who consumed the same amount of contaminated water," Vengosh said. "We also found that residents who eat meat more frequently had lower concentrations than those who are eating meat less than once a month."

R. Brittany Merola, a Ph.D. student of Vengosh's at Duke, is the lead author of the new study, which will be part of her doctoral dissertation.

Exposure to high levels of arsenic can cause nausea, vomiting, abdominal pain, diarrhea, renal failure and shock. Long-term exposure to lower levels—typical of what is found in drinking water supplies contaminated by naturally occurring arsenic—can increase the risk of

diabetes, cardiovascular diseases, and lung, skin, kidney, urinary and bladder cancer, among other illnesses.

Detecting long-term exposure is particularly challenging, Merola explained, because a person can consume low-to-moderate amounts of arsenic daily for years before symptoms of illness appear.

"There also may be multiple confounding factors that make it difficult to detect if the exposure is coming from drinking water," she added. "The person may be exposed to arsenic from other sources, such as seafood consumption, or their symptoms may be at least partly attributable to other factors, such as smoking, genetics, poor nutrition or sun exposure. This study helps address these factors."

Vengosh said if arsenic is present in well water, there are several technologies for removal. "We hope that once we show the actual bioaccumulation of arsenic in the human body, the level of awareness will change," he said.

Merola and Vengosh's co-authors are Julia Kravchenko, a research scientist at the Duke University Medical Center's Clinical Research Institute, and Tewodros Rango, a postdoctoral research associate in Vengosh's lab.

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More information: "Arsenic Exposure of Rural Populations from the Rift Valley of Ethiopia as Monitored by Keratin in Toenails" R. Brittany Merola, Julia Kravchenko, Tewodros Rango, Avner Vengosh, Published Nov. 5, 2013 in *Journal of Exposure Science and Environmental Epidemiology*, DOI: 10.1038/jes.2013-77

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