Researchers, community partners tackle health threats from 'forever chemicals'

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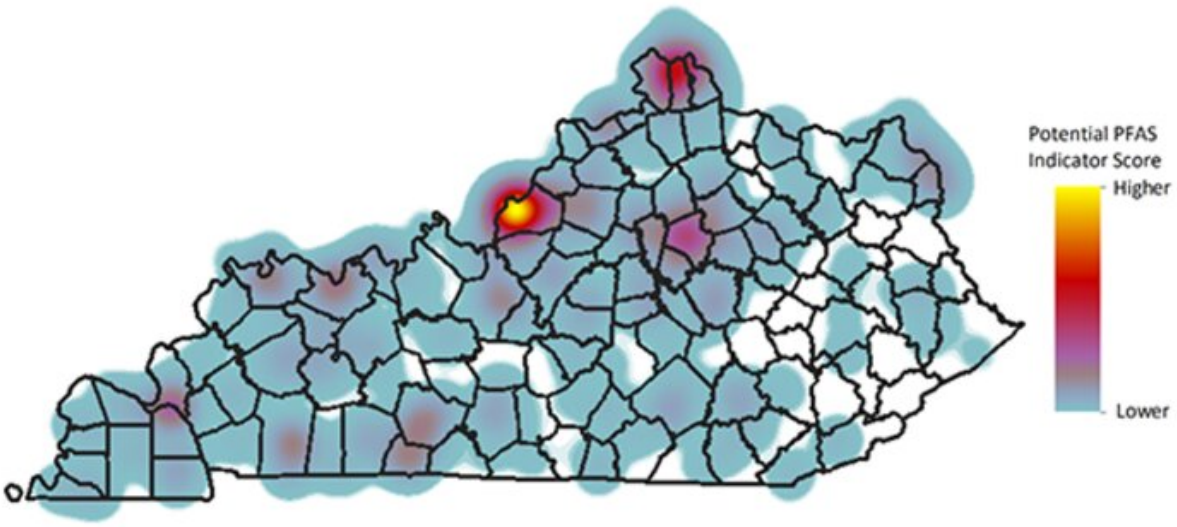

Map of results. Credit: University of Kentucky

Nearly every person in the United States has been exposed to per- and polyfluorinated alky substances (PFAS) at some point in their life. These "forever chemicals" are the focus of a targeted investigation by

University of Kentucky Superfund Research Center (UKSRC) researchers who are working collaboratively with community partners to protect Kentuckians.

PFAS have been widely used since the 1940s. This class of chemicals is used to make products grease proof, waterproof, stick proof and stain resistant. They breakdown slowly, persist in the environment and are difficult to remediate. PFAS gained significant attention less than a decade ago and major producers—3M, Dupont and Chemours—began transitioning to alternative chemicals in response to environmental and human health impacts.

Thousands of PFAS are known to exist, and two of the most common are perfluorooctanoic acid (PFOA) and perfluorosulfonic acid (PFOS). In 2016, the U.S. Environmental Protection Agency (EPA) set initial health advisory levels (HALs) for PFOA and PFOS, alone or in combination, at 70 parts per trillion (ppt).

"HALs are useful as guidelines for decision makers seeking to manage health risks as new information continues to emerge. HALs are non-enforceable and non-regulatory," explained Kelly Pennell, Ph.D., director of the UKSRC and professor of civil engineering in the College of Engineering.

"In 2022 in response to new scientific data about adverse health effects, HALs were significantly decreased—to limits below or near that of detection or quantitation at 0.004 ppt PFOA and 0.02 ppt PFOS. The significant changes in PFAS HALs have left federal, state and local agencies scrambling on how to respond and community health concerns continue to grow. Researchers here at UK are responding to community requests for information by forming partnerships and building new understandings."

Erin Haynes, Ph.D., the Kurt W. Deuschle Professor of Preventive Medicine and Environmental Health, chair of the Department of Epidemiology and Environmental Health in the College of Public Health, and UKSRC researcher, served as a committee member on National Academies of Science Engineering and Medicine's 2022 Guidance for PFAS Exposure, Testing, and Clinical Follow-up.

This report summarizes specific health outcomes associated with PFAS exposure, including certain cancers, thyroid dysfunction, changes in cholesterol and reductions in birth weight. The report also calls for universities, communities, state and federal agencies to build relationships to address the challenges associated with widespread PFAS exposure.

Haynes said, "It was an honor serving on the National Academies of Sciences Engineering and Medicine's Committee. I hope that our work is useful for federal agencies, researchers, health care providers and community members grappling with their exposure to PFAS."

As director of UKSRC, Pennell has been interacting with several communities as well as state and federal regulatory agencies to assess needs, broker knowledge and develop partnerships to respond to growing concern about PFAS in Kentucky.

She explains that the UKSRC seeks to promote health equity in communities through an intervention and prevention paradigm that reduces the disease risks associated with exposure to environmental pollutants by investigating the benefits of healthy lifestyles and by developing innovative engineered solutions to mitigate future exposures.

Sweta Ojha, a UKSRC trainee working with Pennell, utilized geospatial data from public sources, including the EPA's Toxic Release Inventory, to identify locations where PFAS may be present in drinking water

sources and published an article in the *Integrated Environmental Assessment and Management* journal that includes maps that visualize potential exposure risks.

"In the absence of rigorous testing data, maps like these can help focus resources to address community needs, treat contaminated areas and prevent further exposure to PFAS chemicals," Pennell said. "With the extent of PFAS contamination being currently underrepresented in the nation, and in Kentucky, and the lack of widespread testing, as well as the lack of federal and state regulations, at UKSRC we are also interested in mitigating health outcomes associated with past or present exposure to PFAS."

Based on this information and partnerships developed by UKSRC graduate students and state agency staff, the center was able to collect samples from drinking water wells in South Shore, Kentucky. Ojha and fellow UKSRC trainee Molly Frazar conducted student-led treatability studies on these samples using novel cationic hydrogel sorbents designed to remove PFAS from contaminated water sources.

These novel sorbents are innovative solutions able to selectively remove specific PFAS, unlike other commonly available water treatment technologies, such as ion exchange or activated carbon.

Studies show that drinking water is a potentially important source of human exposure to PFAS. In Kentucky, 95% of drinking water is provided by public sources. UKSRC researchers continue to develop Ojha's screening model and have implemented it as a statewide tool to assist key decision-makers in identifying and prioritizing sampling locations to gather data on PFAS exposure from public drinking water sources.

Although there are no state or federal laws regulating PFAS chemicals in

Kentucky, the Kentucky Energy and Environment Cabinet tests for PFAS, makes the results of this testing publicly available and is developing state-specific resources aimed to better understand environmental and health outcomes related to PFAS contamination.

"PFAS chemicals continue to be detected in the Ohio River, in every major Kentucky watershed and they have been found at levels greatly exceeding the current HALs in several Kentucky drinking water systems such as South Shore in Greenup County, Kentucky," said Pennell said.

"Despite a water emergency declaration enacted earlier this year by their mayor, many residents of South Shore were virtually unaware of PFAS concerns."

That was until a news story broke in September 2022 about South Shore's drinking water.

"The residents of Henderson, Kentucky, faced a similar situation in 2020 when high levels of PFAS were found in the groundwater and in the air near a manufacturing facility," Pennell said.

As a result, the city of Henderson created a 16-member PFAS working group of community leaders, health professionals and concerned citizens to share important information and update the public on ongoing PFAS testing and clean-up procedures.

Ariel Robinson, a UKSRC Ph.D. student, has been closely working with city and state stakeholders to investigate how drinking water sources become vulnerable to PFAS contamination and possible paths to mitigate PFAS releases to the environment.

Frazar, led by Zach Hilt, Ph.D., and Thomas Dziubla, Ph.D., chemical engineering professors and UKSRC researchers, published research

related to their novel sorbents in the special issue of *Functionalized Gels for Environmental Applications*.

Two other UKSRC trainees, Francisco Leniz and Rollie Mills, who work with UKSRC researcher Dibakar Bhattacharya, Ph.D., the UK Alumni Professor in Chemical Engineering, published articles in the American Chemical Society's *ACS ES&T Water* and the Chemical Engineering Journal that demonstrate innovative membrane separation techniques to remove PFAS from water.

Isabel Escobar, Ph.D., Chellgren Endowed Chair and UKSRC researcher, is collaborating with Olga Tsyusko, Ph.D., in the College of Agriculture, Food and Environment, and Nirupam Aich, Ph.D., University of Buffalo, State University of New York, on a newly funded National Science Foundation grant to investigate sustainable PFAS treatment technologies.

In November 2022, UKSRC researchers Bernie Hennig, Ph.D., College of Agriculture, Food and Environment, and Pan Deng, Ph.D., College of Pharmacy, and UKSRC trainee Jerika Durham, published results from their research in Environmental Health Perspectives. They conducted metabolic analyses in mice exposed to PFOS and fed soluble and insoluble dietary fibers and demonstrated, for the first time, detailed mechanisms of how nutrition can counteract PFAS exposure.

"Our recent nutritional intervention study demonstrates the power of nutritional interventions to counteract exposure and toxicity of persistent organic pollutants, like PFAS," Hennig said.

"The bottom line is that consuming nutrients that reduce oxidative stress and inflammation is beneficial to our health, and we should try to eat more fresh whole foods with each meal. Thus, healthy lifestyles, including healthful nutrition and physical activity, are a meaningful way

to protect our bodies from many age-related diseases that may be triggered by exposure to environmental pollutants."

Pennell said, "Collectively, this research by our faculty and student investigators is providing exciting results in the laboratory and holds promise for effectively addressing PFAS exposures in our communities."

The work is published in the journal *Integrated Environmental Assessment and Management*.

Provided by University of Kentucky