Researchers develop a new tool for estimating people's total exposure to potentially harmful chemicals

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A novel metric that estimates our "burden," or cumulative exposure, to a family of thousands of synthetic chemicals that we encounter in everyday life with potentially adverse health impacts, has been created by a team of researchers at Mount Sinai.

In a paper published in *Environmental Health Perspectives*, the team reported that its sophisticated tool could have distinct advantages for epidemiologists and researchers who routinely measure exposure levels to this class of chemicals, known as PFAS (per- and polyfluoroalkyl substances), which have been associated with high cholesterol, liver damage, thyroid disease, and hormone disorders.

"There are few existing methods to quantify total exposure burden of individuals to mixtures of PFAS chemicals that are found in our everyday lives," says lead author Shelley Liu, Ph.D., Assistant Professor in the Center for Biostatistics, Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai.

"For the first time we've developed a PFAS burden calculator that takes into account patterns of exposure to many chemicals within the PFAS family, and not just individual chemical concentrations which current methods are focused on. As a result, this robust tool could be extremely useful for biomonitoring by regulatory agencies, and for disease and health risk assessment."

PFAS is a class of more than 5,000 chemicals whose fluorine-carbon bond gives them the ability to repel oil and water. That construct has made them an integral part of a growing number of industrial applications and consumer products in recent decades, such as stain and water repellents, Teflon nonstick pans, paints, cleaners, and food packaging.

Moreover, PFAS chemicals do not disintegrate in the environment or in our bodies. Instead, they accumulate in our surroundings and in our blood, kidneys, and liver, as underscored by a Centers for Disease Control and Prevention study in 2007 that found PFAS could be detected in the blood of 98 percent of the U.S. population.

Mount Sinai researchers used national biomonitoring data from the National Health and Nutrition Examination Survey to develop their exposure burden score using item response theory. Item response theory was developed in the educational testing literature to score standardized tests, and Mount Sinai researchers are the first to use it in environmental epidemiology to develop an exposure burden score, highlighted by this transdisciplinary investigation. Specifically, they used serum concentrations from eight common PFAS chemicals taken from adults and children.

By combining a participant's core biomarker concentrations with their much broader "exposure pattern," that is, their relative exposure to other PFAS biomarkers within the entire chemical class, researchers were able to estimate a cumulative or summary PFAS exposure burden. This statistical methodology can be accessed by other researchers and epidemiologists by simply plugging their data sets into the PFAS burden calculator, which is available online.

The benefits are significant. "We found our method enables comparisons of exposure burden to chemical mixtures across studies even if they do not measure the same set of chemicals, which supports harmonization across studies and consortia," explains Dr. Liu, whose research is heavily focused on environmental health through latent variable modeling and longitudinal data analysis.

Moreover, the calculator offers a straightforward way to include exposure biomarkers with low detection frequencies, and to reduce exposure measurement errors by considering both a participant's concentrations and their exposure patterns to estimate exposure burden to chemical mixtures.

"By capturing individual biomarker variability, we're essentially holding the exposure metric constant so it can be used for a variety of

applications," says Dr. Liu.

"These could include, for example, looking across populations to determine if there are differences in exposure burden across racial/ethnic or socioeconomic strata, or if exposure burdens are the same between people in the United States or Canada. Or looking across physiological systems and health outcomes—such as cardiometabolic, hormonal, and immune—to see which are most perturbed by exposure to PFAS chemicals. This range of applications takes us well beyond anything currently available to the field of population health."

Other co-authors in the study were from the Johns Hopkins Bloomberg School of Public Health, the Department of Psychology at Fordham University, and the Stroud Center at Columbia University.

More information: Shelley H. Liu et al, Developing an Exposure Burden Score for Chemical Mixtures Using Item Response Theory, with Applications to PFAS Mixtures, *Environmental Health Perspectives* (2022). DOI: 10.1289/EHP10125 , dx.doi.org/10.1289/EHP10125

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