

PFAS exposure from high-seafood diets may be underestimated, finds study

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A Dartmouth-led study suggests that people who frequently consume seafood may face an increased risk of exposure to PFAS, the family of ubiquitous and resilient human-made toxins known as "forever chemicals."

The findings stress the need for more stringent public health guidelines that establish the amount of seafood people can safely consume to limit their exposure to perfluoroalkyl and polyfluoroalkyl substances, the researchers report in the journal *Exposure and Health*. This need is especially urgent for coastal regions such as New England, where a legacy of industry and PFAS pollution bumps up against a cultural predilection for fish, the authors write.

"Our recommendation isn't to not eat seafood—seafood is a great source of lean protein and omega fatty acids. But it also is a potentially underestimated source of PFAS exposure in humans," said Megan Romano, the study's corresponding author and an associate professor of epidemiology at Dartmouth's Geisel School of Medicine.

"Understanding this risk-benefit tradeoff for [seafood consumption](#) is important for people making decisions about diet, especially for vulnerable populations such as pregnant people and children," Romano said.

The study paired an analysis of PFAS concentrations in fresh seafood with a statewide survey of eating habits in New Hampshire. National data indicate that New Hampshire—along with all of New England—is among the country's top consumers of seafood, which made the state ideal for understanding the extent of people's exposure to PFAS through fish and shellfish.

"Most existing research focuses on PFAS levels in [freshwater species](#), which are not what people primarily eat," said Romano, who studies the effects of PFAS and other endocrine-disrupting chemicals in drinking water on New England communities. "We saw that as a knowledge gap in the literature, especially for a New England state where we know people love their seafood."

The study also drew on New Hampshire's extensive data on the sources and effects of PFAS, which are a staple of consumer products such as plastics and nonstick coatings. The molecular stability that makes PFAS versatile also makes them nearly indestructible, leading them to be called forever chemicals.

In humans, PFAS are associated with cancer, fetal abnormalities, [high cholesterol](#), and thyroid, liver, and reproductive disorders. The chemicals have accumulated in soil, water, and wildlife, and studies have shown that nearly all Americans have measurable amounts in their blood.

"PFAS are not limited to manufacturing, fire-fighting foams, or municipal waste streams—they are a decades-long global challenge," said study co-author Jonathan Petali, a toxicologist with the New Hampshire Department of Environmental Services. "New Hampshire was among the first states to identify PFAS in drinking water. We're a data-rich state due to years spent investigating the impacts of PFAS and trying to mitigate exposure."

The researchers measured the levels of 26 varieties of PFAS in samples of the most consumed marine species: cod, haddock, lobster, salmon, scallop, shrimp, and tuna. The seafood studied was purchased fresh from a market in coastal New Hampshire and originated from various regions.

Shrimp and lobster clocked the highest concentrations with averages ranging as high as 1.74 and 3.30 nanograms per gram of flesh, respectively, for certain PFAS compounds, the researchers report. Concentrations of individual PFAS in other fish and seafood measured generally less than one nanogram per gram.

The prevalence of PFAS in the environment makes it difficult to know exactly where and how the chemicals enter the marine food chain, the researchers report. Some shellfish may be especially vulnerable to the

buildup of PFAS in their flesh due to feeding and living on the sea floor, as well as their proximity to sources of PFAS that are near the coast. Larger marine species may ingest PFAS by eating smaller species that, like shellfish, are prone to having the compounds accumulate in their systems.

Buttressing the study is a survey of 1,829 New Hampshire residents the researchers conducted to gauge how much seafood Granite Staters eat—and it's a lot.

The survey found that men in New Hampshire eat just over one ounce of seafood per day and women eat just under one ounce. Both are higher than what the National Health and Nutrition Examination Survey found for men and women in the Northeast, and more than 1.5 times the national average for both. Daily intake for New Hampshire children aged 2 to 11 years old was about 0.2 ounces, the highest end of the range for children nationwide.

About 95% of adults the researchers surveyed reported that they had eaten seafood within the past year, and 94% of that group had consumed fish or shellfish within the previous month. More than two-thirds of those respondents had eaten seafood within the past week.

But people in New Hampshire do not eat seafood uniformly. More than half of the people who had eaten seafood in the week before the survey lived on the state's coast or near the border with Massachusetts. More than 60% of people with a [household income](#) below \$45,000 per year reported consuming seafood at least once per week, whereas people with higher household incomes reported eating seafood less often.

Of the species the researchers tested for PFAS, shrimp, haddock, and salmon were consumed by more than 70% of the adults who ate seafood once a month or more. Lobster was eaten by just over 54% of these

adults. Salmon, canned tuna, shrimp, and haddock were the most commonly consumed species among children.

Federal guidelines for safe seafood consumption exist for mercury and other contaminants, but there are none for PFAS, said Celia Chen, a co-author of the study and a research professor in the Department of Biological Sciences at Dartmouth.

"Top predator species such as tuna and sharks are known to contain high concentrations of mercury, so we can use that knowledge to limit exposure. But it's less clear for PFAS, especially if you start looking at how the different compounds behave in the environment," said Chen, who leads several projects examining how and where PFAS accumulate in aquatic food webs in New Hampshire and Vermont.

The establishment of safety guidelines would help protect people who are especially susceptible to pollutants, said Kathryn Crawford, the study's first author and an assistant professor of environmental studies at Middlebury College.

"Seafood consumption advisories often provide advice for those individuals that is more conservative than for the rest of the population," said Crawford, who began the project as a postdoctoral researcher in the Romano Lab at Dartmouth. "People who eat a balanced diet with more typical, moderate amounts of seafood should be able to enjoy the health benefits of seafood without excessive risk of PFAS exposure."

More information: Patterns of Seafood Consumption Among New Hampshire Residents Suggest Potential Exposure to Per- and Polyfluoroalkyl Substances, *Exposure and Health* (2024). [DOI: 10.1007/s12403-024-00640-w](https://doi.org/10.1007/s12403-024-00640-w)

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