A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP6519.

Reduced Bone Mineral Density in Children: Another Potential Health Effect of PFAS

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https://doi.org/10.1289/EHP6519

Per- and polyfluoroalkyl substances (PFAS) are among the most stable industrial compounds ever created.[1,2] Used for decades to make nonstick cookware, stain-resistant fabrics, firefighting foam, and other products, they persist indefinitely in the environment and accumulate in the bodies of exposed people.[3] A study in adults associated higher PFAS levels in blood with lower bone mineral density, which is a risk factor for osteoporosis.[4] Now a study in *Environmental Health Perspectives* provides new evidence associating the chemicals with lower bone mineral density in children, too.[5]

Bone mass accumulates rapidly during childhood and peaks when individuals reach their late teens and early 20s.[6] Therefore, "identifying environmental factors with an influence on bone health during childhood and adolescence can inform preventive interventions with potentially large impacts on fracture risk in later life," says senior author Abby Fleisch, a pediatric endocrinologist at the Maine Medical Center Research Institute in Portland.

For this study, Fleisch's team reviewed data from children participating in a long-term study of mothers and their children called Project Viva.[7] Sponsored in part by Harvard Medical School, Project Viva recruited just over 2,000 pregnant women between 1999 and 2002 and is still following the mother–child pairs today. Fleisch and her colleagues focused specifically on a subset of 576 children who had undergone bone density scans and provided blood plasma samples for chemical analysis when they were between 6 and 10 years of age. The researchers narrowed their analysis to the six most commonly detected PFAS: summed isomers of perfluorooctanoic acid (PFOA), summed isomers of perfluorooctanesulfonic acid (PFOS), perfluorodecanoic acid (PFDA), perfluorohexane sulfonic acid, *N*-methyl perfluorooctane sulfonamidoacetic acid, and perfluorononanoic acid. They expressed bone mineral density measures as *z*-scores normalized for age, sex, race, and height.

To generate their results, the authors used linear regression models to see whether lower *z*-scores (indicating lower bone mineral density) were associated with higher plasma concentrations of individual PFASs. In addition, they used a method called weighted quantile sum (WQS) regression to examine the association of *z*-scores with the PFAS mixture as a whole.

According to the analysis, higher concentrations of each individual PFAS were associated with lower *z*-scores, with the strongest

Peak bone mineral density in youth strongly predicts an individual's susceptibility to osteoporosis later in life.[8] If evidence bears out that PFAS affects bone mineral density, childhood exposures could have long-term implications for bone health. Image: © iStockphoto/nkbimages.

associations estimated for PFOA, PFOS, and PFDA. A similar association was noted for the PFAS mixture. Specifically, every incremental increase in the WQS index was associated with a corresponding reduction in the *z*-score for bone mineral density.

Most of the children came from relatively high socioeconomic backgrounds and had college-educated mothers. Fleisch acknowledges that could limit the generalizability of the findings to the broader population. She points out that wealthier families may be "more prone to use things that have PFAS, such as carpets and furniture with stain-repellant properties."

Naila Khalil, an associate professor at Wright State University who was not involved in the study, notes, "Researchers tend to focus more on soft-tissue and immune impacts from PFAS exposure. Bone is harder to study, especially in growing children. That makes this paper a robust addition to the limited research on PFAS and its impacts on skeletal health."

Antti Koskela, a physician and researcher who specializes in bone development at the University of Oulu, Finland, points to several strengths of the study. Koskela, who also was not involved in the study, specifically cites the large number of participants, the assessment of a complex PFAS mixture on bone health, and the use of total body dual-energy X-ray absorptiometry for measuring bone density, which is considered the gold standard method. "The data confirm earlier findings and underline concerns about PFAS exposure in children," he says. "The concern [about potential bone effects] is not just for adults anymore."

Charles W. Schmidt, MS, an award-winning science writer from Portland, ME, writes for *Scientific American*, *Science*, *Undark*, various *Nature* publications, and many other magazines, research journals, and websites.

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