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Baby Steps Forward: Recommendations for Better Understanding Environmental Chemicals in Breast Milk and Infant Formula

Carrie Arnold

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The infant diet is typically limited to breast milk and/or infant formula for the first months of life. Yet relatively little is known about the environmental chemicals present in these foods and their potential short- and long-term effects on health. In two systematic reviews published in *Environmental Health Perspectives*,[1,2] Geniece Lehmann of the U.S. Environmental Protection Agency, Judy S. LaKind of LaKind Associates, LLC, and colleagues identified points where better-designed studies would help characterize infant exposures via breast milk and formula, as well as improve risk assessment.

More than 40,000 chemicals are currently in use in the United States.[3] Pregnant women and infants may be exposed to chemicals in their environment via oral, inhalation, or dermal routes; there is also some risk of transplacental chemical exposures. Even for the small subset of environmental chemicals that are well studied, the effects of early life exposures are often unclear. "There are substantial gaps in our understanding of what chemicals, as well as what levels of them, would be concerning [for infants]," says Suzan Carmichael, a perinatal and nutritional epidemiologist at Stanford University, who was not involved with the reviews. Most of what we suspect, she says, is extrapolated from animal and adult data.

Breast milk is a dynamic mixture of fats, sugars, and proteins, with compositional changes occurring both throughout a single feeding and over the course of lactation. The complex chemistry of breast milk makes it especially difficult for scientists to study its load of environmental chemicals, says Benedikt Warth, an analytical food chemist at the University of Vienna, who also was not involved in the reviews. It becomes even more challenging when researchers move from targeted studies of samples, which measure levels of specific compounds, to untargeted chemical screening, which tries to determine all chemicals present.

During lactation, a woman's body mobilizes its adipose stores to produce fat-rich milk. That means that fat-soluble chemicals stored in the mother's adipose tissue can be passed into her milk and on to her infant. Persistent organic pollutants, such as polychlorinated biphenyls, dioxins, and polybrominated biphenyl ethers (PBDEs), are especially likely to be transmitted this way, Lehmann says. But non–fat-soluble chemicals may still end up in breast milk. For example, per- and polyfluoroalkyl substances

Young babies are unique among all people in that their diet is typically limited to breast milk and/or infant formula. That makes it especially important, from a risk assessment perspective, to understand the environmental chemicals that get into these foods. Image: © iStockphoto/lisegagne.

(PFAS) can accumulate in fat tissue by binding to serum proteins.[4] From there, they too may be released during lactation.

Although an estimated 81% of U.S. infants receive breast milk in the days immediately after birth, that number drops to about 52% by 6 months of age, and only half those infants are exclusively breastfed, according to the Centers for Disease Control and Prevention.[5] Commercially available infant formula, mostly derived from cow's milk or soy, fills in the gap, and there's "almost a complete lack of information on environmental chemicals in infant formula," Lehmann says—potentially including chemicals in the water used to mix that formula.

"The fact that we know so little about chemicals in infant formula is surprising to me," Lehmann says. "When comparing sources of infant nutrition, we need to know what chemicals are present in all of the candidate sources. Breast milk contains chemicals from the environment, but information about chemicals present in formula is also needed to support decisions about infant feeding."

The team aimed to assess the potential threat posed by background levels of environmental chemicals in breast milk and formula. In the first of the two reviews,[1] they screened 3,076 articles on chemicals in breast milk and 485 on chemicals in formula. Their goal was to determine what researchers currently know about the types and levels of these chemicals, and to assess the use of mathematical models to quantify potential health risk.

The authors focused on research conducted in the United States since 2000 to estimate typical present-day exposures in U.S. women. A total of 44 articles on breast milk and 13 on formula met all inclusion criteria, including measurements of various environmental chemicals that enabled the authors to estimate average infant exposures. An in-depth risk analysis of three example studies—one on PBDEs in breast milk,[6] one on dioxins in breast milk,[7] and one on PFAS in formula[8]—demonstrated that some studies to date may be used to assess potential health impact. However, a full risk analysis cannot be performed for most chemicals, given that safe exposure levels are unknown.

In the second review,[2] the authors screened studies on health outcomes related to environmental chemical exposures via breast milk and infant formula. Their goal in this review was to assess whether the scientific literature supports associations between chemical exposures via breast milk or formula and health outcomes later in life. For breast milk, they found 85 studies that met the inclusion criteria; for formula, they found none. The team grouped health outcomes into four broad categories: growth and maturation, morbidity, biomarkers, and neurodevelopment. Although they did not identify consistent evidence for negative health effects from background levels of environmental chemicals, they noted that very few chemicals have been studied—fewer than 200 in all the studies reviewed. Much more research is needed to conclusively rule out the potential for negative health impacts.

The team used a data storage and presentation tool called Tableau to make their results easier to navigate. The result was a series of interactive figures that are much more transparent than traditional figures. "Readers can easily identify the studies that go with each data point, which allows them to refer back to our original source material to verify our findings or conduct their own analyses," Lehmann says.

The authors pointed to several areas where future studies can help fill in the many data gaps, with specific recommendations for study design. For example, investigators need to measure a wider variety of chemical types in breast milk and formula. Studies must be properly powered and include participants with both high and low chemical exposures. And study replicability is critical for conducting evidence synthesis.

They also highlighted study areas that must be bolstered to inform risk assessment. They called for more studies on chemical mixtures and differentiation between prenatal and lactational exposures. In addition, future studies should measure chemical concentrations over the course of lactation as well as assess how breast milk concentrations of short-lived chemicals vary over time.

Environmental health scientist Philippe Grandjean of the University of Southern Denmark calls the reviews "useful but incomplete" because the researchers excluded studies from outside the United States and those examining chemical exposures from natural sources, such as mycotoxins. He also feels the reviews should have highlighted that the duration of breastfeeding was incompletely analyzed in the source articles. But Grandjean, who was not involved in the reviews, raises a broader concern about the body of literature on children's exposures in general. "Both prenatal and the early postnatal periods are highly vulnerable times. We need to focus more on exposures during these windows," he says.

Even with the potential chemical exposures via breast milk, Lehmann emphasizes that this does not mean breastfeeding is not safe and beneficial. "There are many well-documented health benefits of breastfeeding,[9] both for babies and their mothers," she says. "From a public health perspective, we could continue to capitalize on these benefits by encouraging breastfeeding while reducing chemical exposures via breast milk by reducing mothers' exposures to chemicals in the environment."

According to the evidence that's currently available, she adds, the benefits of breast milk continue to outweigh risks for most infants.[9] However, women should consult with their health care providers if they have questions or concerns about what to feed their babies.

Carrie Arnold is a freelance science writer living in Virginia. Her work has appeared in *Scientific American*, *Discover*, *New Scientist*, *Smithsonian*, and more.

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