

**Breastfeeding, Formula Feeding, and Infant Health During Lead Water Contamination Crises:  
An Annotated Bibliography of Existing Research**

**Compiled by the WE-RISE Initiative**  
*(Water and Environmental Research for Infants' Safe Eating)*

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**Executive Summary:**

The following bibliography includes a comprehensive list of available research on lead water contamination and safe infant feeding. Taken together, this research suggests that lead water contamination can impact infant health and safety through exposure to infant formulas and / or breastfeeding. In most cases, breastfeeding is the safest way to feed a baby, including during a lead water contamination crisis. If maternal blood lead levels exceed 40 µg/dL, however, an alternative approach may be warranted to protect infant health. When babies consume infant formula, it is important these formulas are mixed with water that is filtered or bottled to reduce lead exposure. It is also important to note that warm or hot water use when sterilizing bottles or preparing infant formula may include elevated lead levels over cold water preparations. The complexity of safe infant feeding during lead water contamination crises seems to merit blood lead level testing for all families who would like this; the free provision of lead water filters for all homes, along with updated filters as needed; and increased education and awareness among all members of the community.

**Annotated Bibliography:**

➤ **Lead in Water**

- Author: Centers for Disease Control and Prevention
- Publication Date: February 2016
- Website: <https://www.cdc.gov/nceh/lead/tips/water.htm>

**Summary:** This website gives information on the presence of lead in drinking water, including its transfer and health effects. It suggests children and pregnant women consume bottled water or water from a filtration system for cooking, drinking, and baby formula preparation.

➤ **Breastfeeding and Lead**

- Author: Centers for Disease Control and Prevention
- Publication Date: January 24, 2018
- Website: <https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/environmental-exposures/lead.html>

**Summary:** Initiation / early breastfeeding period most at risk period of contaminant transfer. Nonetheless, breastfeeding is recommended despite the presence of contaminants; the benefits of breastfeeding presently appear to outweigh dangers of exposure.

➤ **Breastfeeding and Environmental Exposures/Toxicants**

- Author: Centers for Disease Control and Prevention
- Publication Date: January 24, 2018
- Website: <https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/environmental-exposures/index.html>

**Summary:** According to this report, pregnant/lactating women with blood levels greater than/equal to 5 µg/dL should attempt to determine the source of lead exposure, working with the local health department/occupational medicine specialists for environmental assessment/case management. It is recommended that mothers with BLLs below 40 µg/dL should breastfeed while monitoring infant blood levels, temporarily discontinuing consumption of human milk if they surpass 5 µg/dL. If water contains lead levels exceeding 15 ppb, bottled water or a filtration system should be used for cooking and drinking.

➤ **Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women**

- Author: Centers for Disease Control and Prevention
- Publication Date: November 2010
- Website: <https://www.cdc.gov/nceh/lead/publications/leadandpregnancy2010.pdf>

**Summary:** Despite scientific evidence of the adverse effects of lead exposure, there exists a lack of recommended risk assessment/management during pregnancy/lactation. This fault in standard testing of pregnant women and managing of those identified with lead exposure has created confusion in clinical and public health sectors. There is also a need for further research regarding pregnancy outcomes and infant development associated with maternal lead exposure. Recommended methods of mitigation include removed interaction with lead sources (for BLLs greater than/equal to 15 µg/dL), chelation therapy being an option for extreme cases (greater than/equal to 45 µg/dL), and mothers reducing breastfeeding if their blood lead levels are above 40 µg/dL.

➤ **Department of Health & Human Services, Center for Disease Control and Prevention, Environmental Protection Agency, and American Water Works Association**

- Author: The United States Environmental and Drinking Water
- Publication Date: Not specified
- Website: <https://www.cdc.gov/healthywater/emergency/pdf/DWACT-2016.pdf>

**Summary:** This toolbox offers information to water providers for the planning, development, implementation, and evaluation of communication activities with the public in the event of a drinking water advisory. In the segment pertaining to breastfeeding, it asserts “breastfeeding is best,” and suggests infants continue to consume human milk, so long as breastfeeding is an option.

➤ **Basic Information about Lead in Drinking Water**

- Author: The United States Environmental and Drinking Water
- Publication Date: Not specified
- Website: <https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water>

**Summary:** Children, infants, and fetuses are particularly threatened by lead exposure, both through contaminated drinking water (20% of exposure) and, more specifically, mixed formula (40-60%). It also details the hazards of accumulated lead in pregnant women, as lead is released from bones as maternal calcium forms the bones of the fetus. Lead can also cross the placental barrier, leading to serious effects

to the mother and developing fetus. It also offers guidelines/suggestions in the identification/treatment of increased lead in drinking water/blood levels.

➤ **Breastfeeding, Family Physicians Supporting (Position Paper)**

- Author: American Academy of Family Physicians
- Publication Date: 2001, 2014
- Website: <https://www.aafp.org/about/policies/all/breastfeeding-support.html>

**Summary:** In regard to environmental contaminants and infant feeding, it recognizes the effect of environmental toxins on lactogenesis is an understudied field; however, through the presence of chemicals in maternal environment and human milk demonstrates the need to reduce public exposure to pollutants, current evidence indicates breastfeeding remains the healthiest option for mothers and infants.

➤ **Prevention of Childhood Lead Toxicity**

- Author: American Academy of Family Physicians
- Publication Date: 2016,2017
- Website: <http://pediatrics.aappublications.org/content/138/1/e20161493>

**Summary:** The American Academy of Pediatrics suggests resources should be directed towards reducing points of lead exposure in a cost-effective manner. Following lead exposure, it is not possible to effectively ameliorate delayed developmental results; however, it is feasible to focus on preventative methods.

➤ **Lead Screening During Pregnancy and Lactation Committee Opinion**

- Author: The American College of Obstetricians and Gynecologists
- Publication Date: 2012, 2018
- Website: <http://pediatrics.aappublications.org/content/138/1/e20161493>

**Summary:** This committee opinion offers recommendations for pregnant/lactating women with risk factors for elevated lead levels. These include comprehensive assessment of risk at the earliest contact with pregnant/lactating women through a blood lead test (if a single risk factor is identified), treatment through identification of source of lead exposure, counseling regarding avoidance of further exposure, nutritional recommendations (calcium/vitamin C supplementation), follow-up blood lead testing, treatment in consultation with experienced clinicians, and continuation of breastfeeding until confirmation of blood lead levels exceeding 40 µg/dL (at which point breast milk should be discarded until levels decrease).

➤ **Formula Feeding: What New Parents Need to Know**

- Author: Cherly Coleman
- Journal: *International Journal of Childbirth Education*
- Publication Date: June 1999

**Summary:** This article addresses formula use when water may be contaminated with lead. Especially addresses complexity of cold versus hot water preparations with different contaminants and formula use.

➤ **Exposure to Lead and Mercury through Breastfeeding During the First Month of Life; A CHECK Cohort Study**

- Author: Yelim Park, Aram Lee, Kyungho Choi, Hai-Joong Kim, Jeong Jae Lee, Gyuyun Choi, Sungjoo Kim, Su Young Kim, Geum Joon Cho, Eunsook Suh
- Journal: *Science of the Total Environment*
- Publication Date: January 15, 2018

**Summary:** This article looked at mercury and lead contamination levels in breastfed babies at 15 days and 30 days old; The study found that about 71% of 15 days old infants and 56% of 30 days old infants were estimated at risk due to lead exposure through breastfeeding.

➤ **Drinking -Water Quality, sanitation, and breastfeeding: Their interactive effects on infant health**

- Author: J VanDerslice, B Popkin, J Briscoe
- Journal: *Bulletin of the World Health Organization*
- Publication Date: 1994

**Summary:** This article states that if a sanitation barrier such as a filter cannot be in place, breastfeeding is safest for the infant so that they are not exposed to the pathogens and the toxins in unsanitary and/or contaminated water.

➤ **Lead Exposure During Breastfeeding**

- Author: Jacquelyn Choi, Toshihiro Tanaka, MD, Gideon Koren, MD FRCPC, Shinya Ito, MD FRCPC
- Publication Date: April 14, 2008
- Journal: *Canadian Family Physician*

**Summary:** Only if a woman has high lead blood levels may their breastfeeding pose risks to infants. Even in this case, breastfeeding often is recommended. Cow's milk-based formulas pose own risks, with powders themselves at times contaminated with lead and possibly the water mixed with it depending on the source.

➤ **An Update on Water Needs during Pregnancy and Beyond**

- Author: Kristen S, PhD, RN
- Journal: *The Journal of Perinatal Education*
- Publication Date: June 1, 2002

**Summary:** Important reminder that women who are pregnant and breastfeeding often drink more water than the average person, and thus their risk in instances of water contamination is heightened.

➤ **Mercury and Lead During Breastfeeding**

- Author: José G. Dorea
- Journal: *British Journal of Nutrition*
- Publication Date: July 2004

**Summary:** This article systematically examines the presence and transfer for lead and mercury through lactation. Through mercury and lead are dispersed within the environment, infant risk of exposure is influenced by maternal dietary habits, metal speciation, and nutritional status, leading to variable toxicity and development outcomes. Dorea's study ultimately concludes both metals appear in breast milk at a fraction of maternal blood levels supplied to fetus during gestation. Therefore, lactating mothers should continue to breastfeed, as cow's milk-based formulas tend to pose a greater threat to infant exposure than human milk.

➤ **Early (In Uterus and Infant) Exposure to Mercury and Lead**

- Author: José G. Dorea
- Journal: *Clinical Nutrition*
- Publication Date: June 2006

**Summary:** This article examines how toxic metals spread in the environment, the bioaccumulative potential of mercury and lead of particular concern. Lead exposure is typically more acute to fetal development during gestational periods than during breastfeeding, warranting greater caution in lead

consumption during pregnancy; however, breastfeeding is established as essential to complete infant development, and lead exposure monitoring and reduction important.

➤ **Maintenance of elevated lead level in drinking water from occasional use and potential impact on blood leads in children**

- Author: Brian L. Gulson, Matt James, Angela M. Giblin, Ann Sheehan, Peter Mitchell
- Journal: *Science and the Total Environment*
- Publication Date: October 20, 1997

**Summary:** This study measured variation in lead concentration in household tap water throughout the day, under the conditions a pipeline system is not fully flushed. It concluded flushing greatly reduces concentrations of lead in water samples. While consuming flushed water, lactating and pregnant women run very small risk of surpassing the EPA's lead level of concern (10 µg/dL); however, infants can very easily exceed the recommended concentration in consuming formula mixed with first flush water.

➤ **Higher Infant Blood Lead Levels with Longer Duration of Breastfeeding**

- Author: Betsy Lozoff MD, Elias Jimenez MD, Abraham W. Wolf PhD, Mary Abgelilli MD, Jigna Zatakia BA, Sandra W. Jacobson PhD
- Journal: *The Journal of Pediatrics*
- Publication Date: November 2009

**Summary:** This study was performed to determine whether longer breastfeeding is associated with higher infant lead concentrations. Data was analyzed from Costa Rica, Chile, and Detroit. It confirmed the hypothesis that longer breastfeeding was associated with higher blood lead concentrations in these countries, regardless of breastfeeding patterns or environmental sources. It recommends monitoring of lead concentrations in breastfed infants.

➤ **Breastfeeding and Child Lead Exposure: A Cause for Concern**

- Author: Michael Weitzman MD, BA, Meredith Kursmark BA
- Journal: *The Journal of Pediatrics*
- Publication Date: November 2009

**Summary:** This article weighs the risks and benefits of breastfeeding and lead exposure. Mobilization of lead from bone loss and ingestion through contaminated water sources both contributed to elevated lead blood levels in lactating women. The study concludes that, although breast milk may be a source of lead exposure, so long as infant lead levels remain below 40 µg/dL, the benefits of breastfeeding far outweigh the risks of chemical transfer. It also calls the creation of evidence-based guidelines for lead screening in infants and nursing women, including a practical questionnaire to identify at-risk mothers and children.

➤ **Health Concerns of Women and Infants in Times of Natural Disasters: Lessons Learned from Hurricane Katrina**

- Author: William M Callaghan, Sonja A Rasmussen, Denise J Jamieson, Sherry L Farr
- Journal: *Maternal and Child Health Journal*
- Publication Date: July 2007

**Summary:** This report cites the example of Hurricane Katrina to focus on the needs of pregnant women and infants, who they conclude are at special risk during times of natural disasters / environmental crises.