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Toxic Chemicals and A Child's Brain Development

EARLY EXPOSURES CAN CAUSE LONG-TERM EFFECTS

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TODAY, ONE IN SIX CHILDREN IN THE UNITED STATES HAS A DEVELOPMENTAL OR learning disability.[1] Some experts say many of these may be due in part to early exposures to toxic chemicals.[2] The number of children diagnosed with these disabilities has increased dramatically over the past four decades.[3,4] While heightened awareness and changes in diagnostic criteria have contributed to this upsurge, they do not fully explain the rise.[5] A recent National Research Council committee concluded that 3 percent of developmental disabilities are due to toxic exposures in the environment and that another 25 percent result from gene-environment interactions.[6]

These disabilities are costly to families and society. The Centers for Disease Control and Prevention (CDC) estimates that each person afflicted with an intellectual disability incurs over $1 million in direct and indirect costs during his or her lifetime.[7]

Prenatal Chemical Exposures & Potential Neurotoxic Effects

CHEMICAL	MATERNAL EXPOSURE ROUTE	KNOWN OR POSSIBLE NEUROTOXIC EFFECTS
Bisphenol A (BPA)	Plastics, food containers, water bottles	Hyperactivity, aggression, developmental neurotoxicity[8,9]
Chlorpyrifos	Widely used pesticide (Dursban) used on golf courses and in agriculture	Lower birth weight, impaired mental and motor development, behavior problems such as ADHD[10]
Methylmercury	Emitted by coal-burning power plants and incinerators; exposure via fish	Severe mental retardation at high dose, fetal neurotoxicity with reduced IQ at lower exposures[11,12]
Polychlorinated biphenyls (PCBs)	Electrical equipment, insulators, plastics, lubricating oils; exposure via fish	Low birth weight, delayed development, lower IQ, spatial reasoning deficits, growth impairment[13,14]
Polybrominated diphenyl ethers (PDBEs)	Flame retardants found in a number of consumer products—computers, mattresses, furniture	Deficits in learning and memory, adverse behavior and physical effects, lower IQ, developmental neurotoxicity[15,16,17]

Since the Toxic Substances Control Act (TSCA) was enacted in 1976, remarkable advances in neuroscience have led to a greatly increased understanding of the developing brain and nervous system. It is now well-established and widely accepted that chemical exposures may cause profound and irreversible brain damage to children at very low doses.[18] During critical windows of vulnerability in prenatal and early brain development, even small chemical disruptions can cause long-term damage to children at levels that do not harm an adult.[19,20] The table at the left presents a snapshot of chemicals that may irreversibly harm an infant's developing brain *in utero* if a mother is exposed during pregnancy.

While a small number of chemicals have been proven toxic to the developing brain, this may

represent only the visible tip of a much larger iceberg. Emerging research has found over 200 industrial chemicals to be neurotoxic in adults who are exposed occupationally, and another 1,000 chemicals are known to be neurotoxic in laboratory animals.[21] Of the roughly 3,000 high production volume chemicals in commerce, 80 percent have no information about developmental or pediatric toxicity, and fewer than half have been subjected to basic laboratory testing for toxicity.[22] More than 700 of these chemicals are used in consumer products, and their expanding use results in widespread exposure to chemical mixtures. CDC surveys find measurable levels of over 200 synthetic chemicals in Americans, and virtually all Americans have at least some of these chemicals in their bodies.[23] The toxic potential of these complex mixtures is almost entirely unknown.

ENDNOTES

1 Coleen Boyle, P. Decouflé and M. Yeargin-Allsopp, "Prevalence and Health Impact of Developmental Disabilities in US Children," *Pediatrics* 93, no. 3 (1994): 399-403.

2 National Research Council, *Scientific Frontiers in Developmental Toxicology and Risk Assessment*, (Washington, DC: National Academy Press, 2000).

3 James M. Perrin, Sheila R. Bloom and Steven L. Gortmaker, "The Increase of Childhood Chronic Conditions in the United States," *Journal of the American Medical Association* 297, no. 24 (2007): 2755-2759.

4 Michael Szpir, "Tracing the Origins of Autism," *Environmental Health Perspectives* 114, no. 7 (2006): A412-419.

5 Irva Hertz-Picciotto and Lora Delwiche, "The Rise in Autism and the Role of Age at Diagnosis," *Epidemiology* 20, no. 1 (2009): 84-90.

6 National Research Council, *Scientific Frontiers in Developmental Toxicology and Risk Assessment*.

7 Centers for Disease Control and Prevention, "Intellectual Disability," Department of Health and Human Services, http://www.cdc.gov/ncbddd/dd/mr4.htm (accessed March 28, 2010).

8 Joe M. Braun et al., "Prenatal Bisphenol A Exposure and Early Childhood Behavior," *Environmental Health Perspectives* 117, no. 12 (2009): 1945-1952.

9 Center for the Evaluation of Risks to Human Reproduction, *NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of Bisphenol A*, (National Toxicology Program, Department of Health and Human Services, 2008), http://cerhr.niehs.nih.gov/chemicals/bisphenol/bisphenol.pdf (accessed March 27, 2010).

10 Virginia A. Rauh et al., "Impact of Prenatal Chlorpyrifos Exposure on Neurodevelopment in the First 3 Years of Life Among Inner-city Children," *Pediatrics* 118, no. 6 (2006): e1845-1859.

11 National Research Council, *Toxicological Effects of Methylmercury*, (Washington, DC: National Academy Press, 2000).

12 Frodi Debes et al., "Impact of Prenatal Methylmercury Exposure on Neurobehavioral Function at Age 14 Years," *Neurotoxicology and Teratology* 28, no. 3 (2006): 363-375.

13 Yueling L. Guo et al., "Yucheng: Health Effects of Prenatal Exposure to Polychlorinated Biphenyls and Dibenzofurans," *International Archives of Occupational and Environmental Health* 77, no. 3 (2004): 153-158.

14 Phillipe Grandjean and Philip J. Landrigan, "Developmental Neurotoxicity of Industrial Chemicals," *Lancet* 368, no. 9553 (2006): 2167-2178.

15 Julie B. Herbstman et al., "Prenatal Exposure to PBDEs and Neurodevelopment," *Environmental Health Perspectives*, [available online ahead of print January 4, 2010], http://dx.doi.org/10/1289/ehp.0901340.

16 Lucio G. Costa and Gennaro Giordano, "Developmental Neurotoxicity of Polybrominated Diphenyl Ether (PBDE) Flame Retardants," *Neurotoxicology* 28, no. 6 (2007): 1047-1067.

17 U.S. Environmental Protection Agency, *Polybrominated Diphenyl Ethers (PBDEs) Action Plan*, (2009), http://www.epa.gov/oppt/existingchemicals/pubs/pbdes_ap_2009_1230_final.pdf (accessed March 28, 2010).

18 Ted Schettler, "Toxic Threats to Neurologic Development of Children," *Environmental Health Perspectives* 109, suppl. 6 (2001): 813-816.

19 Deborah Rice and Stan Barone Jr., "Critical Periods of Vulnerability for the Developing Nervous System: Evidence from Humans and Animal Models," *Environmental Health Perspectives* 108, suppl. 3 (2000): 511-533.

20 Grandjean and Landrigan, "Developmental Neurotoxicity of Industrial Chemicals."

21 Ibid.

22 Lynn R. Goldman and Sudha Koduru, "Chemicals in the Environment and Developmental Toxicity to Children: A Public Health and Policy Perspective," *Environmental Health Perspectives* 108, no. 3 (2000): 443-448.

23 Centers for Disease Control and Prevention, *Fourth National Report on Human Exposure to Environmental Chemicals*, (Department of Health and Human Services, 2009), http://www.cdc.gov/exposurereport/ (accessed March 27, 2010).

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