Rachel's Environment & Health News
#512 - PCB Exposure Linked to Low IQ
September 18, 1996

A study published September 12, 1996, in the NEW ENGLAND JOURNAL OF MEDICINE confirms that children exposed to low levels of PCBs in the womb grow up with low IQs, poor reading comprehension, difficulty paying attention, and memory problems.[1] PCBs are a family of toxic industrial chemicals commercialized in 1929 by Monsanto, and now found in nearly all humans on earth. (See REHW #327.) This latest study describes a group of 11-year-old children whose mothers ate 2 to 3 meals per month of fish from Lake Michigan for at least 6 years before giving birth. The children's mental and physical growth have been followed since birth. The greatest mental deficits have occurred in the 11% of the children whose mothers ate the most fish.[2]

Since 1980, Joseph and Sandra Jacobson, psychologists at Wayne State University in Detroit, Michigan, have studied 242 children whose mothers had eaten salmon and lake trout from Lake Michigan an average of 2 to 3 times each month for many years.[3] Those children have been compared to a control group of 71 babies whose mothers had not eaten any Lake Michigan fish. (See REHW #295, #372, #411.) Large fish in Lake Michigan, such as lake trout and salmon, are typically contaminated with PCBs, mercury, and a host of other chlorinated organic chemicals. [4]

The Jacobsons analyzed PCB levels in the blood of the babies' umbilical cords, thus providing a reliable measure of pre-natal exposure. At birth, a mother's overall fish consumption and the PCB level in her baby's blood both correlated with the baby's birth size. Eating more fish was linked to babies with reduced head size, diminished girth in the chest and shorter gestation.[3] On standardized tests for infant development, higher fish consumption was correlated with abnormally weak reflexes, less responsiveness to stimulation, more jerky, unbalanced movement, and more startles in the babies.[5] At birth, the babies whose mothers had eaten the most PCB-contaminated fish were clearly different from normal children.

At age seven months, 123 of the original 242 infants were tested for "visual recognition memory." Each baby was shown a pair of identical photos of human faces for about 20 seconds; then one of the photos in the pair was changed and the new pair was presented to the infant. Normal babies spend more time looking at the new face. Babies with more PCBs in their blood, and babies whose mothers had eaten more Lake Michigan fish, spent less time looking at the new faces. The Jacobsons concluded that the high-PCB babies had memory problems: they could not remember the first photo pair well enough to recognize that the second photo pair was different. Lower scores on this test (which is known as the Fagan Test of Visual Recognition or the Fagan Test of Infant Intelligence) have been shown to correlate with lower intelligence later in life.[6]

Two hundred and thirty-six of the original 242 children were tested again at the age of four.[7] Two effects became apparent. First, 17 of the children whose mothers had the highest levels of PCBs in their breast milk refused to complete the tests; they were balky and uncooperative. Secondly, the remainder of the children were given a series of tests to measure memory and general mental capabilities and, again, the children whose mothers had eaten the most fish had the poorest memories.

The balky, uncooperative behavior is of some interest by itself. Helen Daly, of the Center for Behavioral Effects of Environmental Toxins at the State University of New York (SUNY) at Oswego, has been studying humans and laboratory animals exposed to PCBs and other chlorinated hydrocarbons. She reports that when rats were fed contaminated salmon from Lake Ontario, they overreacted to negative events when life was made unpleasant (by such means as mild electric shock, or disappointment at feeding time). Significantly, the offspring of those rats showed the same pattern of altered responses to stress, even though the offspring themselves were not fed contaminated fish. Helen Daly wonders whether rats and children don't develop similar overreactions to stress after being exposed to PCBs while in the womb. Commenting on the refusal of 17 4-year-olds to complete the Jacobsons' tests, Daly says, "If one can assume that taking a test is a mildly negative experience for 4 year olds, it appears as if those children probably exposed to higher levels of toxins due to breast feeding reacted more negatively to the testing procedure."[8]

In the NEW ENGLAND JOURNAL OF MEDICINE September 12 the Jacobsons reported their most recent examination of 212 of the original children. At age 11, maternal exposure to PCBs was correlated with lower overall IQ and lower verbal IQ score. The 11% of the children whose mothers had the highest exposures now have IQs 6.2 points lower than average. In these 11-year-olds, prenatal exposure to PCBs was linked to poor word comprehension and poor reading ability. The highest-exposed children were twice as likely to be at least two years behind their peers in word comprehension. The Jacobsons summarize: "Our IQ results indicate deficits in general intellectual ability, short-term and long-term memory, and focused and sustained attention." They speculate that the mechanism of harm is PCB interference with thyroid hormones, which are essential for development of the brain.[1]

It is especially noteworthy that the children's intellectual deficits correlate most closely with the mother's overall fish consumption. PCBs passed to the children DURING BREAST FEEDING did not correlate well with poor mental performance (though, as we saw above, they may correlate with inability to handle stress). The data indicate that these children were harmed most by PCBs PASSED TO THEM BY THEIR MOTHERS PRIOR TO BIRTH. It was not the mother's fish-eating habits during pregnancy that was important --it was the mothers' CUMULATIVE LIFETIME EXPOSURE to PCBs that lowered their children's IQs. In other words, exposure of females to PCBs at any time in their lives before they bear children may eventually translate into mental deficits for their offspring. This has profound implications for regulatory agencies. It means "lifetime exposure" must be regulated.

The children studied by the Jacobsons had PCB exposures which, though on the high side, are still considered to be within normal background exposure levels. Many other possible causes, such as exposure to lead or pesticides, or the mother's use of tobacco or alcohol, were ruled out. (Unfortunately, maternal exposure to methyl mercury was not assessed by the Jacobsons, weakening their study.[9])

Four previous studies of children had reported similar problems from PCB exposures, ranging from small size at birth to developmental disorders.[10,11,12]

Diminished ability to handle stress, combined with reduced attention span, short-term memory problems, and reading disabilities add up to a familiar profile of modern problems shared by many U.S. school children. No one is saying cause and effect has been proven but suspicions have certainly been raised by the Jacobsons' studies because exposure to PCBs and other dioxin-like chemicals is widespread in the U.S. (as it is among human populations worldwide), and so are problems of intellectual development. "These were not people who were eating fish every day," Linda Birnbaum, who is lead scientist for the ongoing EPA (U.S. Environmental Protection Agency) dioxin study (see REHW #390, #391), told Katherine Dold of DISCOVER magazine. "I believe the data suggest there are subtle changes going on in at least a portion of our population," Birnbaum said.[13]

Importantly, the Jacobsons' latest findings have been mirrored in several animal studies,[14] and in studies of Taiwanese children accidentally exposed to high levels of PCBs.[15]

And the PCB problem is not going away soon. Between 1929 and 1989, total world production of PCBs (excluding the Soviet Union) was 3.4 billion pounds, or about 57 million pounds per year. Even after the U.S. banned PCBs in 1976, world production continued at

36 million pounds per year from 1980-1984 and 22 million pounds per year, 1984- 1989. The end of PCB production is not in sight.[16]

The whereabouts of 30 percent of all PCBs (roughly a billion pounds) remains unknown. Another 30 percent reside in landfills, in storage, or in the sediments of lakes, rivers, and estuaries. Some 30 percent to 70 percent remain in use. The characteristics of PCBs (their stability and their solubility in fat) tend to move them into the oceans as time passes. Nevertheless, it is estimated that only one percent of all PCBs have, so far, reached the oceans.[16] Without major efforts to locate, capture, and destroy the one-to-two billion pounds of PCBs that are "out there," future generations will continue to be poisoned by PCBs, at great social (and individual) cost. We hear much of late about the good intentions of the Monsanto Corporation. Some of our friends tell us this corporation has turned over a new leaf, and is committed to behaving responsibly. If this is so, Monsanto could demonstrate its awakening by leading an effort to locate and destroy PCBs. Monsanto created (or licensed the creation of) all the PCBs in the world. This corporation could demonstrate its commitment to environmental sustainability by cleansing the planet of this brain-damaging substance, to the extent possible. An obvious first step would be to undertake a comprehensive inventory of the problem, assessing the damage done so far and cleanup-costs, as a demonstration of good faith and serious intentions.

--Peter Montague (National Writers Union, UAW Local 1981/AFL-CIO)

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[1] Joseph L. Jacobson and Sandra W. Jacobson, "Intellectual Impairment in Children Exposed to Polychlorinated Biphenyls in Utero," NEW ENGLAND JOURNAL OF MEDICINE Vol. 335 No. 11 (September 12, 1996), pgs. 783-789.

[2] Joseph L. Jacobson and Sandra W. Jacobson, "Dose-Response in Perinatal Exposure to Polychlorinated Biphenyls (PCBs): The Michigan and North Carolina Cohort Studies," TOXICOLOGY AND INDUSTRIAL HEALTH Vol. 12, Nos. 3/4 (1996), pgs. 435-445.

[3] Greta G. Fein and others, "Prenatal exposure to polychlorinated biphenyls: Effects on birth size and gestational age," THE JOURNAL OF PEDIATRICS Vol. 105 (August 1984), pgs. 315-320.

[4] Deborah C. Rice, "Neurotoxicity of Lead, Methylmercury, and PCBs in Relation to the Great Lakes," ENVIRONMENTAL HEALTH PERSPECTIVES Vol. 103 SUPPLEMENT 9 (December 1995), pgs. 71-87. And see Christopher J. Schmidt and others, "National Contaminant Biomonitoring Program: Residues of Organochlorine Chemicals in U.S. Freshwater Fish, 1976- 1984," ARCHIVES OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY Vol. 19 (1990), pgs. 748-781.

[5] Hugh A. Tilson and others, "Polychlorinated Biphenyls and the Developing Nervous System: Cross-Species Comparisons," NEUROTOXICOLOGY AND TERATOLOGY Vol. 12 No. 3 (1990), pgs. 239-248.

[6] Sandra W. Jacobson and others, "The Effect of Intrauterine PCB Exposure on Visual Recognition Memory," CHILD DEVELOPMENT Vol. 56 (1985), pgs. 853-860.

[7] Joseph L. Jacobson and others, "Effects of in utero exposure to polychlorinated biphenyls and related contaminants on cognitive functioning in young children," JOURNAL OF PEDIATRICS Vol. 116 (January 1990), pgs. 38-45. And see: Joseph L. Jacobson and others, "Effects of Exposure to PCBs and Related Compounds on Growth and Activity in Children," NEUROTOXICOLOGY AND TERATOLOGY Vol. 12 (1990), pgs. 319-326. And see: Joseph L. Jacobson and others, "Effects of Prenatal PCB Exposure on Cognitive Processing Efficiency and Sustained Attention," DEVELOPMENTAL PSYCHOLOGY Vol. 28 No. 2 (1992), pgs. 297-306.

[8] See Helen B. Daly, "The Evaluation of Behavioral Changes Produced by Consumption of Environmentally Contaminated Fish," in Robert L. Isaacson and Karl F. Jensen, editors, THE VULNERABLE BRAIN AND ENVIRONMENTAL RISKS (New York: Plenum Press, 1992), pgs. 151-171. And see Helen B. Daly, "Reward Reductions Found More Aversive by Rats Fed Contaminated Salmon," NEUROTOXICOLOGY AND TERATOLOGY Vol. 13 (1991), pgs. 449-453.

[9] Joseph L. Jacobson and Sandra W. Jacobson, "Sources and Implications of Interstudy and Interindividual Variability in the developmental Neurotoxicty of PCBs," NEUROTOXICOLOGY AND TERATOLOGY Vol. 18 No. 3 (1996), pgs. 257-264.

[10] E. Dewailly and others, "Health Status at Birth of Inuit Newborn Prenatally Exposed to Organochlorines," CHEMOSPHERE Vol. 27 No. 1-3 (1993), pgs. 359-365. And see: Lars Rylander and others, "Decreased birthweight among infants born to women with a high dietary intake of fish contaminated with persistent organochlorine compounds," SCANDINAVIAN JOURNAL OF WORK, ENVIRONMENT, AND HEALTH Vol. 21 (1995), pgs. 368-375.

[11] Marcel Huisman and others, "Neurological condition in 18-month-old children perinatally exposed to polychlorinated biphenyls and dioxins," EARLY HUMAN DEVELOPMENT Vol. 43 (1995), pgs. 165-176.

[12] E. Lonky and others, "Neonatal Behavioral Assessment Scale performance in humans influenced by maternal consumption of environmentally contaminated Lake Ontario fish," JOURNAL OF GREAT LAKES RESEARCH Vol. 22 No. 2 (1996), pgs. 198-212.

[13] Catherine Dold, "Hormone Hell," DISCOVER Vol. 17 No. 9 (September, 1996), pgs. 52-59. To reprint quotations from DISCOVER magazine, you must get permission from Marcia Bell (marcia_bell@cp.disney.com; telephone: (212) 633-4812).

[14] For monkey data, see note 5 above. And see: Per Eriksson and Anders Fredriksson, "Neonatal exposure to 2,2',5,5'-tetrachlorobiphenyl causes increased susceptibility in the cholinergic transmitter system at adult age," ENVIRONMENTAL TOXICOLOGY AND PHARMACOLOGY (1996), pgs. 217-220. And: Per Eriksson and Anders Fredriksson, "Developmental neurotoxicty of four ortho-substituted polychlorinated biphenyls in the neonatal mouse," ENVIRONMENTAL TOXICOLOGY AND PHARMACOLOGY (1996), pgs. 155-165. And: Edel Holene and others, "Behavioral Effects of Pre-and Postnatal Exposure to Individual Polychlorinated Biphenyl Congeners in Rats," ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY Vol. 14 No. 6 (1995), pgs. 967-976. And: Susan L. Schantz and others, "Spatial Learning Deficits in Adult Rats Exposed to Ortho-Substituted PCB Congeners During Gestation and Lactation," FUNDAMENTAL AND APPLIED TOXICOLOGY Vol. 26 (1995), pgs. 117-126. And: Susan L. Schantz and others, "Effects of Gestational and Lactational Exposure to TCDD and Coplanar PCBs on Spatial Learning," NEUROTOXICOLOGY AND TERATOLOGY Vol. 18, No. 3 (1996), pgs. 305-313.

[15] Yueliang L. Guo and others, "Growth Abnormalities in the Population Exposed in Utero and Early Postnatally to Polychlorinated Biphenyls and Dibenzofurans," ENVIRONMENTAL HEALTH PERSPECTIVES Vol. 103

SUPPLEMENT 6 (September 1995), pgs. 17-122.

[16] Carol W. Bason and Theo Colborn, "U.S. Application and Distribution of Pesticides and Industrial Chemicals Capable of Disrupting Endocrine and Immune Systems," in Theo Colborn and Coralie Clement, editors, Chemically-Induced Alterations in Sexual and Functional Development: The Wildlife/Human Connection [Advances in Modern Environmental Toxicology Vol. XXI] (Princeton, N.J.: Princeton Scientific Publishing Co., 1992), pgs. 342-343.

CORRECTION

In RACHEL'S #511, we said, "However, most species disappear in natural aquatic ecosystems at higher pH values (more acidic conditions) than predicted by laboratory tests, thus suggesting that, in ecosystems, additional stresses enhance the effects of acidification." Obviously, this should have said "(less acidic conditions)."

Descriptor terms: pcbs; polychlorinated biphenyls; fish; central nervous system damage; great lakes; lake michigan; lake ontario; children; joseph jacobson; sandra jacobson; endocrine disrupters; oswego; helen daly; monsanto;

Rachel's Environment & Health News is a publication of the Environmental Research Foundation, P.O. Box 160, New Brunswick, NJ 08903-0160; Phone: (732) 828-9995; Fax (732) 791-4603; E-mail: erf@rachel.org; http://www.rachel.org. Unless otherwise indicated, Rachel's is written by Peter Montague.