

TITLE

Behavioral Sexual Dimorphism in School-Age Children and Early Developmental Exposure to Dioxins and PCBs: A Follow-Up Study of the Duisburg Cohort

AUTHOR(S)

Gerhard Winneke, Ulrich Ranft, Jürgen Wittsiepe, Monika Kasper-Sonnenberg, PeterFürst, Ursula Krämer, Gabriele Seitner, and Michael Wilhelm

ABSTRACT

Background:

Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), known as dioxins, and polychlorinated biphenyls (PCBs) are persistent organic pollutants, meaning that they resist natural degradation processes and therefore persist in the environment. Dioxins are by-products of combustion, pesticide manufacturing, paper production, and other processes, and PCBs were synthesized and used in many industrialized applications until their production and use was discontinued in the late 1970s. PCBs may still exist in materials made prior to that ban, such as transformers and other electrical materials, thermal insulators, caulking, adhesives, tape, fluorescent light ballasts, cable insulation, and oil based paint. Poorly maintained hazardous waste sites, illegal dumping, and burning of waste can cause a release of this PCB into the environment which, like dioxins, may remain for many years. Although exposures to these toxicants have decreased in the general population, they still pose human health risks because of their accumulation in the food chain and in the human body, and because of their potential toxicity at even environmental background concentrations. Diet is the major source of human exposure to PCBs and dioxins, particularly via the ingestion of contaminated fish, meat, and dairy products. Both toxicants accumulate in the fatty tissues of the human body. A child can be exposed via a mother with a high body burden because the pollutants can cross the placenta and be transmitted via human breast milk.

Many toxicological properties have been reported for both dioxins and PCBs, including neurodevelopmental dysfunction and adverse reproductive health effects. Research suggests a link between prenatal exposure to these compounds and interference with hormone regulating systems (endocrine systems), which may alter the normal sexual structuring of the brain during development and cause permanent gender-related behavioral alterations in boys and girls.

Objective:

This study investigated associations of prenatal exposure to PCDD/Fs (dioxins) and PCBs with parent reported sex characteristic behaviors in children.

Methods:

Between September 2000 and October 2002 blood samples were obtained from the study participants--healthy pregnant women, at 28-43 weeks of gestation, living in Duisburg, Germany--and were analyzed for dioxins and PCBs. Breast milk was also collected and analyzed during the first 3 weeks post-partum. Sex characteristic behaviors of the study participants' children at age 6-8 years were measured using a parent-completed questionnaire that grouped assessment items into 3 categories: preferred toys; preferred activities; and behavioral characteristics. Adjustments were made in the analyses for possible confounders such as birth weight, maternal smoking or alcohol consumption, duration of pregnancy, parental education, etc.

Results:

Analyses revealed that exposure to dioxins and PCBs in boys was associated with more feminine behavior, whereas in girls exposure was associated with less feminine behavior. For instance, the sum of all 18 PCB concentrations measured in breast milk was significantly and positively associated with boys', and significantly and negatively associated with girls', reported femininity.

Conclusion:

Building on previous study findings, the authors conclude that the endocrine disrupting effects of dioxins and PCBs can modify sexual characteristic behaviors in children.

POLICY IMPLICATIONS

Dioxins: The regulatory approach for dioxins is to reduce their levels in the environment, which will subsequently reduce their levels in food. Most federal regulation of dioxin is promulgated under the Clean Air Act (CAA), in which dioxin compounds are regulated as hazardous air pollutants (HAPs), and the Clean Water Act (CWA). The U.S. Environmental Protection Agency (EPA) has placed strict regulatory controls on all major industrial sources of dioxins, leading to an emissions reduction of more than 75% from their levels in the 1980s.

Both the U.S. Agency for Toxic Substances and Disease Registry/Centers for Disease Control and Prevention and EPA have set minimum tolerable oral exposure levels for dioxins. The U.S. Food and Drug Administration (FDA) and the U.S. Department of Agriculture Food Safety and Inspection Service (FSIS) monitor the dioxin levels in food and feed, conduct investigations when unacceptable levels (levels above EPA's estimates for background dietary occurrence) are found, and take action to remove an identified source of increased dioxins, if feasible.

PCBs: The Toxic Substances Control Act (TSCA) bans the manufacture, processing, use, and distribution in commerce of PCBs and gives EPA the authority to develop, implement and enforce regulations concerning the use, manufacture, cleanup and disposal of PCBs. PCBs are also included, as a group, as one of the HAPs listed in the 1990 CAA Amendments and is regulated from more than 170 industrial source categories by EPA.

FDA has set PCB tolerance levels in the edible portion of fish in the commercial food supply and sold in interstate commerce, and periodically tests fish sold in markets for levels of PCBs and other contaminants. Products found to contain PCB levels that exceed tolerance levels are confiscated. However, FDA does not monitor PCB concentrations in supplements such as fish oil. FDA has also set tolerance levels in bottled water and in other foods, including the lowest tolerance level for infant and young children's foods.

POLICY IMPLICATIONS, continued

Despite the ban on PCBs and the regulations addressing both PCBs and dioxins, many people in the U.S. are still exposed to these persistent pollutants. Individual exposure may begin in utero and as this study found, is associated with altered sex characteristic behaviors in young children. Thorough testing of all chemicals' toxicological effects, with particular attention to prenatal and early childhood exposures, and including mixed exposures, should be completed prior to their production and use in the marketplace.

Note: Despite studies showing detectable levels of PCBs and dioxins in breast milk, FDA and the Centers for Disease Control and Prevention firmly support breastfeeding, as the benefits outweigh any potential risk from environmental contaminants in all but extreme cases.

REFERENCE

[Article](#) available in [Environmental Health Perspectives](#).

KEY WORD(S)

[Polychlorinated biphenyls \(PCBs\)](#), [Dioxins](#)