

MIND, DISRUPTED

How toxic chemicals may change how we think and who we are



Organochlorine Pesticides

What Are Organochlorine Pesticides?

Pesticides are a group of chemicals made for the purpose of killing or otherwise deterring “pest” species. The word *pesticide* may refer to insecticides, herbicides, fungicides, or other pest control formulations. Pesticides are inherently toxic and often associated with adverse health effects in non-target organisms.¹

Organochlorine pesticides are a large class of multipurpose chlorinated hydrocarbon chemicals. Organochlorine pesticides break down slowly in the environment and accumulate in the fatty tissues of animals. Thus, they stay in the environment and food web long after the being applied.² DDT, now banned in the United States because of its harm to the health of wildlife and people, is a notable example of an organochlorine pesticide.

Many organochlorine pesticides are endocrine disrupting chemicals, meaning they have subtle toxic effects on the body’s hormonal systems.³ Endocrine disrupting chemicals often mimic the body’s natural hormones, disrupting normal functions and contributing to adverse health effects.

Organochlorine Pesticides in Our Bodies

Organochlorine pesticides are ubiquitous environmental contaminants because they break down very slowly. According to the Centers for Disease Control and Prevention (CDC), most people have organochlorine pesticides present in their bodies.⁴ Many organochlorine pesticides are persistent organic pollutants (POPs), a class of chemicals known to break down very slowly and bioaccumulate in lipid rich tissue such as body fat.²

Exposure to low concentrations of organochlorine chemicals over a long period may eventually lead to a substantial body burden of toxic chemicals.⁵ Chemicals in a maternal body burden may be transferred to fetuses *in utero* via the placenta and to children through breast feeding. This means that children who are born years after maternal exposure to toxic organochlorine pesticides can still be affected.⁶

How Are We Exposed?

Because of the multiple types and uses of organochlorine pesticides, there are many ways people can be exposed to these

chemicals. Wind and rain may move pesticides away from where they were used, causing contamination of surface waters, groundwater and/or soil.^{7,8} Using pesticides in your home or on your land may increase your exposure to these chemicals, and living or working close to where pesticides are used is also a risk factor.⁹ Organochlorine pesticides are not often used in personal products because of their toxicity, but some products, such as lice shampoos, may be a source of exposure.¹⁰

Exposure may also occur through consumption of contaminated foods. Organochlorine pesticides are carried long distances via atmospheric and oceanic currents from where they are manufactured and used, and build up in the fatty tissues of animals.¹¹ Many studies have linked organochlorine pesticide exposure with consumption of contaminated animal products, mostly meat, dairy, fish, and marine mammals.^{12,13,14,15} Fetuses and children may be exposed to pesticides *in utero* as well as through breast milk.⁶

What Does Exposure to Organochlorine Pesticides Mean for Our Health?

The presence of environmental chemicals in the human body does not necessarily imply that they are causing adverse health effects; however, environmental chemical exposures can and do affect human health. It is important to note that both the dosage and the timing of exposure have significant effect on any potential health outcome.

The following information is intended to inform the reader about the current state of knowledge on the health effects of organochlorine pesticides, including both human and animals studies.

The health effects of organochlorine pesticide exposure depend on the specific pesticide, the level of exposure, the timing of exposure and the individual. Different pesticides result in a range of health symptoms.

Cancer

Numerous studies have linked organochlorine pesticide exposures with cancers and other health effects. Exposure to DDT has been linked to pancreatic cancer and non-Hodgkin’s

lymphoma.^{16,17} Exposure to DDT early in life is associated with an increased breast cancer risk later in life.¹⁸ Many other organochlorine pesticides, such as mirex, chlordane and toxaphene, are known to be carcinogenic as well.¹⁹ A study of women from an agricultural area in India showed that women with breast cancer had much higher total organochlorine pesticide concentrations in their blood. The women had average total pesticide concentrations of $7,468 \pm 771$ ppb (ng/mL) in their blood.²⁰

Neurodevelopmental Outcomes

There is clear evidence that exposure to organochlorine pesticides disrupts normal development. In one study, exposure to DDT shortly after birth created a lifelong sensitivity to other pesticide exposures in mice, and permanent behavioral changes upon secondary exposure through food.²¹ Prenatal exposure to the organochlorine pesticide chlordane has been linked to reduction of testosterone in adult female rats and behavioral changes in both sexes.²² Rats prenatally exposed to varying levels of DDT showed behavioral alterations that lasted into adulthood.²³

Organochlorine pesticide exposure is associated with neurodevelopmental health effects in humans. Exposure to organochlorine pesticides has been linked to decreased psychomotor function and mental function, including memory, attention, and verbal skills in children.^{24,25} Children born in agricultural areas where pesticides were applied were found to have lower performance on numerous neurobehavioral assessments when compared to children not born in an agricultural region.²⁶ There is also some evidence that organochlorine pesticide exposure is associated with the development of autism, although this is based on limited research.²⁷

Reproductive Effects

In humans, maternal concentrations of DDE (a metabolite of DDT) above 10 ppb ($\mu\text{g/L}$) are associated with preterm birth and babies' size. The higher the concentration of DDE in the mother's blood, the more likely she was to have a preterm birth and the baby was more likely to be small for its gestation age.²⁸ Maternal exposure to beta-HCH, a byproduct of lindane manufacture, is associated with preterm births. Women in the study had beta-HCH average concentrations of 9.83 ppb (ng/mL) in their blood.²⁹

Thyroid Disruption

Organochlorine compounds, including pesticides, have been found to alter levels of maternal thyroid hormones during pregnancy. Women with hexachlorobenzene concentrations that ranged from 7.5-841.0 ppb (ng/mL) had altered thyroid hormone levels.³⁰ Another study found that dieldrin exposure was associated with decreased T_4 levels. Women with decreased thyroid hormone had average dieldrin concentrations of 5380 ppb (ng/mL).³¹

Many organochlorine chemicals, including DDT, endosulfan and lindane, are known to produce anti-thyroid effects.³² Thyroid hormones are critical for normal growth and development in fetuses, infants, and small children.³³ Thyroid deficiencies during

pregnancy and post partum are known to cause altered development, retardation, decreased intellectual capacity, psychomotor delays, and deafness. Additionally, there is speculation that thyroid disrupting chemicals may play a role in the development of autism.³²

Neurodegenerative Disease

Neurodegenerative diseases such as Parkinson's disease and Alzheimer's disease are more common in people with general pesticide exposures, including organochlorine pesticide exposure.³⁴

Lindane and Endosulfan are both current use organochlorine pesticides. They are excellent examples of pesticides with numerous documented negative health impacts.

Lindane

Lindane is a pesticide used both as an agricultural insecticide and as a treatment for scabies and lice. In May 2009, governments from around the world included lindane to be phased out under provisions of the Stockholm Convention on Persistent Organic Pollutants (POPs), a global United Nations (UN) treaty to eliminate the use of POPs.

In a study of women giving birth, high levels of lindane in maternal blood were found to be associated with intra-uterine growth retardation in fetuses.³⁵ Lindane exposure has been associated with recurrent miscarriages. Women with recurrent miscarriages had average lindane concentrations of 6.99 ppb (ng/mL).³⁶

Lindane also disrupts natural levels of estrogens, androgens and thyroid hormones in rodents.³⁷ Lindane produces behavioral and neurochemical changes in developing rats at doses that do not produce symptoms in adults. This is significant because it suggests that lindane may have the greatest effect during development.³⁸

Both acute and sub-chronic exposures to lindane were found to reduce dopamine concentrations in the brains of rats by about 46%. Dopamine is an important neurotransmitter with effects on mood and behavior.³⁹ Lindane exposure during postnatal development in rats was associated with alterations in levels of detoxification enzymes in the brain that lasted until adulthood—it is not known how this alteration might affect the outcome of future exposures.⁴⁰ Exposure to lindane decreased both thyroid hormones and progesterone in developing lambs.⁴¹

Endosulfan

Endosulfan is an organochlorine pesticide used primarily in agriculture. It is known to build up in the environment,⁴² and the scientific review committee of the Stockholm Convention on Persistent Organic Pollutants has found that it meets criteria for inclusion under the treaty for its persistence, toxicity and bioaccumulation.

Endosulfan has been shown to compete with estradiol for binding with an estrogen receptor—if estradiol cannot bind to the receptor site, then it cannot influence the cell's growth and

Reducing Your Exposure

You can prevent or minimize exposure to organochlorine pesticides in the following ways:

- Wash fruits and vegetables, including local berries and greens, before eating to remove traces of pesticides.
- Safe alternatives can be used to solve nearly all pest problems without the need for toxic chemicals. We recommend prevention and use of non-toxic alternatives first. For example:
 - You can prevent pests from entering your home by sealing cracks in windows, doors and baseboards.
 - Use mousetraps instead of poison bait
 - Store food properly and clean food or beverage spills to help keep unwanted pests out of your home.
 - Mechanical removal of lice with a lice comb, or alternative treatments such as hot air, are very effective. Similarly, essential oil such as tea tree oil or neem oil are effective scabies treatments.
- If possible, reduce or eliminate the use of pesticides in and around your home or workplace.
- If you are exposed to pesticides at work, take actions to reduce the amount of pesticide on your clothes and possessions when you go home. Consider leaving contaminated clothes and tools at work or outside, removing shoes and outerwear before entering your home, and bathing at work or soon after you return home.
- Whenever possible, buy organic fruits and vegetables and other organic products to reduce your exposure.
- Consider eating less fat, as some pesticides build up in the fat of animals.
 - Consider removing fat that you see on meat and fish whenever possible.
 - Consider eating leaner meats whenever possible.
 - Consider eating smaller amounts of dairy products; or, if available, choose low fat or nonfat dairy products.

development.⁴³ In addition, several of endosulfan's metabolites are estrogenic.⁴⁴ Endosulfan has been shown to act like estrogen and reduce the levels of testosterone and other hormones in rats.^{45,46} Endosulfan exposure has been linked to delayed sexual maturation in boys with mean serum concentrations of 7.47 ppb.⁴⁷ The metabolites (breakdown products) of endosulfan have been found in the human placenta and umbilical cord blood signifying that maternal endosulfan may enter developing fetuses.⁴⁸

Chronic exposure to endosulfan has been associated with abnormal behavior in rats. Immature rats were found to be more sensitive to the effects of endosulfan than their adult counterparts. Researchers found that exposure to endosulfan during growth and development is likely to cause permanent neurobehavioral impairment.⁴⁹

Studies of toad tadpoles showed that levels of endosulfan found in the environment were enough to delay development, increase mouth and skeletal abnormalities, and increase mortality.⁵⁰

Regulation of Organochlorine Pesticides

In the U.S., pesticides are regulated by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). States may also regulate pesticides under FIFRA, but only in a more restrictive manner than the EPA. The UN and World Health Organization (WHO) may also influence use of pesticides through treaties and declarations.

The Stockholm Convention on Persistent Organic Pollutants, a UN treaty, has established global bans on several organochlorine pesticides including DDT, hexachlorobenzene, pentachlorobenzene, chlordane, dieldrin, endrin, heptachlor, mirex, toxaphene, hexachlorocyclohexane (alpha-HCH, beta-HCH, and gamma-HCH (lindane)), and chlordane. The European Union (EU) recently proposed that endosulfan be included under provisions of the Stockholm Convention as well.

Although the U.S. banned the use of lindane for agricultural uses, the Food and Drug Administration still allows use of lindane in pharmaceutical products for the treatment of head lice and scabies.

Endnotes

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Fact sheets on toxic chemicals for the *Mind, Disrupted* Biomonitoring Project provided by the Alaska Community Action on Toxics (www.akaction.net) and Commonwealth (www.commonweal.org). For more information, please visit the *Mind, Disrupted* website at www.minddisrupted.org, or contact Pam Miller at pkmiller@akaction.net or Sharyle Patton at spatton@igc.org.