



Putting it into Practice: Pediatric Environmental Health Training Resource

Persistent Organic Pollutants

User Guide



Children's
Environmental
Health
Network

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I. What are Persistent Organic Pollutants

Persistent organic pollutants (POPs) are organic (carbon-based) chemicals that remain in the environment for long periods of time because of their resistance to degradation. They bioaccumulate and biomagnify as they move through the food chain. POPs are found in certain pesticides and industrial chemicals, and as by-products of manufacturing processes and waste incineration.¹

II. Characteristics of POPs

These compounds are lipophilic and so are found in greatest concentration in fatty organs, such as liver and adipose tissue, and in organisms with extensive body fat, such as seals. Because they are refractory to the usual biochemical pathways of degradation in soil bacteria, mold, and in animal species, these compounds are also subject to bioconcentration and biomagnifications, accumulating to greater concentrations in species with increasing trophic level. They migrate within the ecosystem depending on temperature. Because of these phenomena, there has been a gradual accumulation of POPs in northern latitudes.²

The chemicals' semi-volatility allows them to travel long distances through the atmosphere before being deposited. Thus POPs can be found all over the world, they tend to volatilize in hot regions and accumulate in cold regions, where they tend to condense and stay.³ The ability of POPs to travel great distances is part of the explanation for why countries that banned the use of specific POPs are no longer experiencing a decline in their concentrations; the wind may carry chemicals into the country from places that still use them.⁴

III. Classification of POPs

While a large number of compounds match the definition outlined above, the term "Persistent organic pollutants" most commonly refers to the original 12 chemicals targeted by the Stockholm Convention and are further classified as follows: 1- Intentionally Produced: i- Pesticides such as Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, and ii-Industrial chemicals such as PCB or 2-Unintentionally Produced (Result from some industrial processes and combustion) such as Dioxins and Furans.^{5,1} In 1997, under the auspices of the United Nations, the Stockholm Convention on Persistent Organic Pollutants was introduced. Better known as the "POPs Treaty," this international agreement calls on the signatory nations to monitor, reduce, and ultimately eliminate designated POPs compounds from the environment, including unused stockpiles. The POPs



Treaty has been generally effective and levels of POPs are declining throughout the world. It is considered one of the major success stories of environmental regulation on an international scale.⁶ The Convention began by targeting an initial list of **12 “Dirty Dozen”** pesticides, industrial chemicals and byproducts (see Table).⁵

The Initial Targeted ‘Dirty Dozen’ of the Stockholm Convention in 2004

POP	Global Historical Use/Source	Overview of U.S. Status
Aldrin and Dieldrin	Insecticides used on crops such as corn and cotton; also used for termite control.	Under FIFRA: No U.S. registrations; most uses canceled in 1969; all uses by 1987. All tolerances on food crops revoked in 1986. No production, import, or export.
Chlordane	Insecticide used on crops, including vegetables, small grains, potatoes, sugarcane, sugar beets, fruits, nuts, citrus, and cotton. Used on home lawn and garden pests; also used extensively to control termites.	Under FIFRA: No U.S. registrations; most uses canceled in 1978; all uses by 1988. All tolerances on food crops revoked in 1986. No production (stopped in 1997), import, or export. Regulated as a hazardous air pollutant (CAA).
DDT(dichloro-diphenyl-trichloroethane)	Insecticide used on agricultural crops, primarily cotton, and insects that carry diseases such as malaria and typhus.	Under FIFRA: No U.S. registrations; most uses canceled in 1972; all uses by 1989. Tolerances on food crops revoked in 1986. No U.S. production, import, or export. DDE (a metabolite of DDT) regulated as a hazardous air pollutant (CAA). Priority toxic pollutant (CWA).
Endrin	Insecticide used on crops such as cotton and grains; also used to control rodents.	Under FIFRA, no U.S. registrations; most uses canceled in 1979; all uses by 1984. No production, import, or export. Priority toxic pollutant (CWA).
Mirex	Insecticide used to combat fire ants, termites, and mealy bugs; also used as a fire retardant in plastics, rubber, and electrical products.	Under FIFRA, no U.S. registrations; all uses canceled in 1977. No production, import, or export.



Heptachlor	Insecticide used primarily against soil insects and termites; also used against some crop pests and to combat malaria.	Under FIFRA: Most uses canceled by 1978; registrant voluntarily canceled use to control fire ants in underground cable boxes in early 2000. All pesticide tolerances on food crops revoked in 1989. No production, import, or export.
Hexachlorobenzene	Fungicide used for seed treatment; also an industrial chemical used to make fireworks, ammunition, synthetic rubber, and other substances; also unintentionally produced during combustion and the manufacture of certain chemicals; also an impurity in certain pesticides.	Under FIFRA, no U.S. registrations; all uses canceled by 1985. No production, import, or export as a pesticide. Manufacture and use for chemical intermediate (as allowed under the Convention). Regulated as a hazardous air pollutant (CAA). Priority toxic pollutant (CWA).
PCBs (polychlorinated biphenyls)	Used for a variety of industrial processes and purposes, including in electrical transformers and capacitors, as heat exchange fluids, as paint additives, in carbonless copy paper, and in plastics; also unintentionally produced during combustion.	Manufacture and new use prohibited in 1978 (TSCA). Regulated as a hazardous air pollutant (CAA). Priority toxic pollutant (CWA).
Toxaphene	Insecticide used to control pests on crops and livestock, and to kill unwanted fish in lakes.	Under FIFRA: No U.S. registrations; most uses canceled in 1982; all uses by 1990. All tolerances on food crops revoked in 1993. No production, import, or export. Regulated as a hazardous air pollutant (CAA).
Dioxins and Furans	Unintentionally produced during most forms of combustion, including burning of municipal and medical wastes, backyard burning of trash, and industrial processes; also can be found as trace contaminants in certain herbicides, wood preservatives, and in PCB mixtures.	Regulated as hazardous air pollutants (CAA). Dioxin in the form of 2,3,7,8-TCDD is a priority toxic pollutant (CWA).

FIFRA: Federal Insecticide, Fungicide and Rodenticide Act, **TSCA:** Toxic Substances Control Act, **CAA:** Clean Air Act, **CWA:** Clean Water Act .



IV. Vulnerability of Infants and Children

Paternal and maternal toxicity by POPs occurs prior to conception through the sperm and ovocyte.^{7,8} Fetuses are exposed to POPs through the placenta.^{9,10} Newborns are exposed through breast milk.¹¹⁻¹³ Children are more susceptible than adults to the adverse effects of the POPs because they have higher inhalational rates, surface body area and dermal exposure. They also move through frequent developmental windows of vulnerability, are unaware of or ignore environmental risks, and are powerless from a social point of view. Moreover, they have more years of future life ahead and thus more time to develop chronic diseases.

V. POPs and Adverse Effects on Human Health

Persistent Organic Pollutants have been associated with delayed neurodevelopment,^{14,15} lower mental developmental index,¹⁶ lower IQs,¹³ memory impairment,^{17,18} neural tube defects,¹⁰ hypotonia and hyporeflexia.¹⁹ Endocrine system derangements, particularly with regard to functioning of the thyroid gland²⁰ (including in newborns²¹) have also been associated with POPs. Those alterations of thyroid hormones are related to either *in utero* or childhood exposure to PCBs or dioxins.^{22,23} Other health effects associated with POPs include decreased male births,²⁴ urogenital malformation in males,²⁵ increased risk of diabetes,²⁶ overgrowth and obesity,²⁷ and attention deficit hyperactivity disorders.²⁸ Persistent Organic Pollutants have been associated with impaired immunity²⁹ and carcinogenicity in adults as breast cancer.³⁰ The greatest concern for toxicity to human beings has been dioxin-like metabolic effects, cancer risk, and endocrine-mimicry activity. The best-documented effect to date, however, has been an inferred immune defect that is thought to be responsible for increased frequency of otitis media in Inuit children in the high Arctic, where ecologic fate and disposition pathways, steep food chains, and a lipid-rich diet have resulted in the highest exposure levels recorded.² The United Nations Environment Programme's (UNEP) governing council set up an international negotiating committee that led to an international agreement to phase out production, use, and release of POPs. The **Stockholm Convention** on Persistent Organic Pollutants was adopted in 2001 and came into force in May 2004.²

VI. Testing

Testing is typically only available for research purposes and not informative if individuals get tested. Also, there are no reference levels. However, the futility and impracticality of testing doesn't change the potential harm posed by POPs. CDC and EPA-funded Pediatric Environmental Health Specialty Units are available around the country to advise doctors and patients: www.pehsu.net



VII. Prevention

Exposure to POPs may be decreased through consumer education, public health programs, legislation, and environmental health infrastructure in the country.³¹ Despite increasing regulatory efforts to curtail production of most POPs, they will continue to persist in the environment, ecosystem, and food supply for years to come.³² Moreover, additional classes of chemicals have been added to the list of POPs, such as persistent toxic substances (PTS) and other “living chemicals” that are still being produced and are in use.³¹

The optimal method for prevention involves international elimination of these chemicals. Efforts to counsel and educate individuals should begin in their childhood, so that good eating habits are established and women enter their reproductive years with a minimal body burden of potentially fetotoxic substances. Breast milk remains the healthiest and safest form of nutrition for newborn babies.³²

KEY RESOURCES FOR FURTHER READING

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Note: This User Guide is intended to accompany the PowerPoint module of the same name. It elaborates on some studies which may require more in-depth information than what is provided on the slides. However, the contents of all slides in the module are equally important to present.

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