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Persistent Organic Pollutants (POPs) in Human Milk

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Persistent organic pollutants (POPs) in human milk. POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.

This summary is based on data on concentrations of various persistent organic pollutants (POPs) in human milk in a number of European countries.

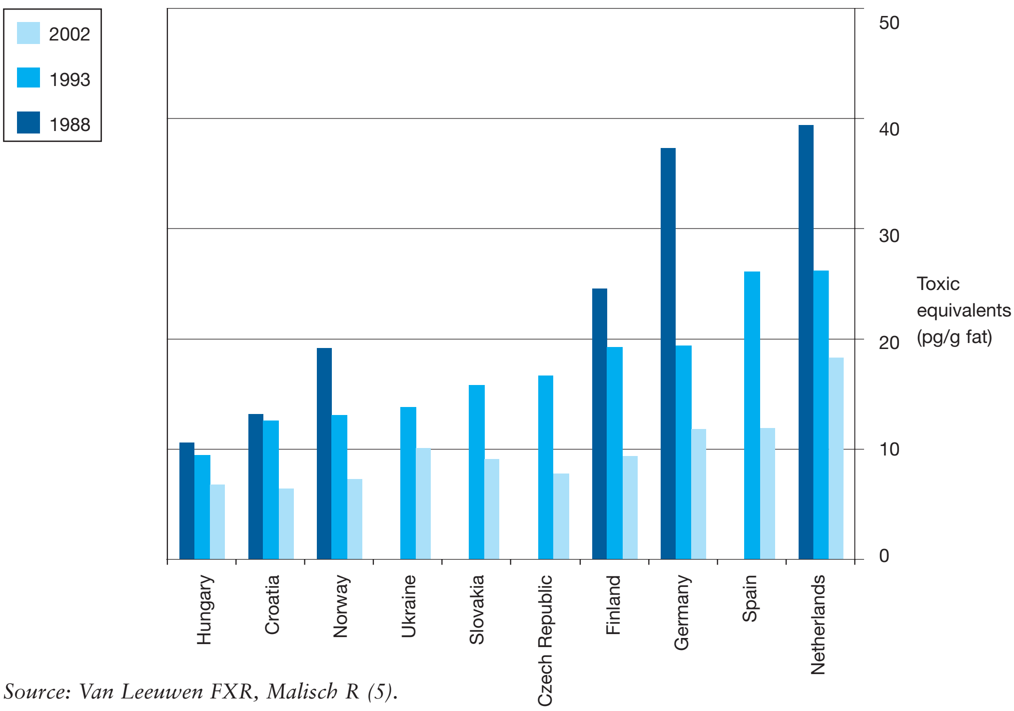
KEY MESSAGE

The indicator shows clear differences in POP levels between European countries. For dioxins the differences were initially as much as three- to five-fold. It also shows a clear decrease in most countries, especially in those with the highest initial levels. This mainly reflects successful abatement at source, such as bans on their production and use and improved waste incinerators. Dioxins and dioxin-like compounds, including furans and polychlorinated biphenyls (PCBs), are probably the group of POPs with the lowest safety margin. The levels of pesticide POPs are very low, but some newer compounds have emerged (polybrominated and polyfluorinated compounds); although these are still present at reasonably low levels, they need to be monitored.

RATIONALE

POPs are lipophilic compounds resistant to both physicochemical and biological degradation: they accumulate in biological organisms and subsequently in humans via food. This causes a risk of, for example, developmental effects, which are the most sensitive adverse health endpoints *(1–4)*. Levels in human milk fat are a good indicator of levels in the population as a whole. This measure is also relevant in measuring the developmen-tal exposure of unborn children.

Fig. 1. Dioxin levels in human milk in selected countries, 1988–2002

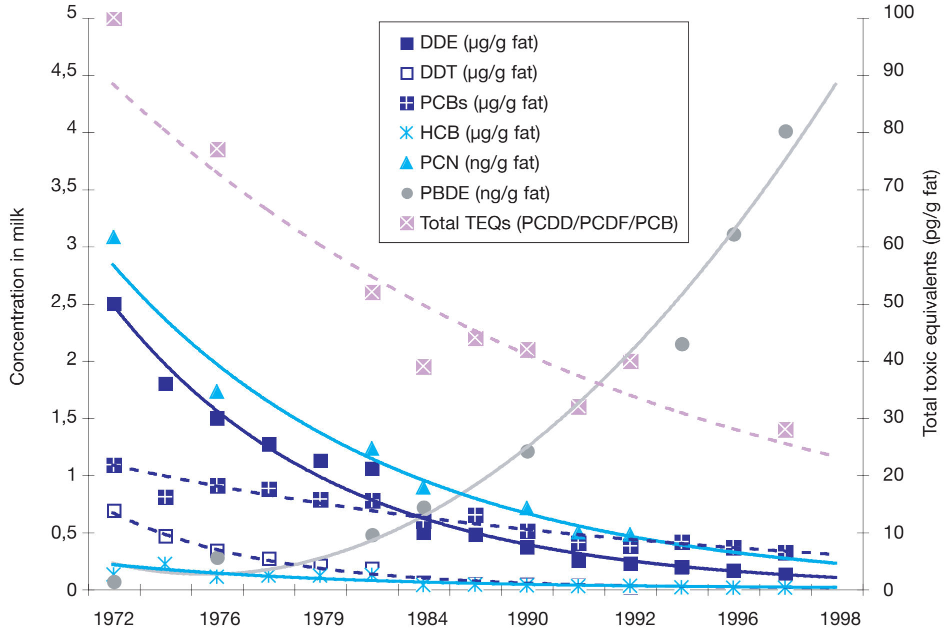


Source: Van Leeuwen FXR, Malisch R (5).

PRESENTATION OF DATA

The most systematic information on POPs in humans is based on three rounds of human milk analysis studies of dioxins coordinated by WHO *(5)*. The first round, in 1987/1988, included 12 European countries and indicated major differences between them in lipid-based concentrations expressed in WHO toxic equivalents (WHO-TEQs): for example, about 10 pg per gram WHO-TEQs in Hungary to about 40 pg/g WHO-TEQs in the Netherlands (Fig. 1). The decrease in concentrations has been of the order of 5% or more per year, highest in countries with the highest initial concentrations. More countries joined the second and third rounds; the results of the fourth round are pending. The methodology is controlled by intercalibration and considered highly reliable. The present concentrations are about 10 pg/g (range of 5–20 pg/g WHO-TEQ) in most countries (Fig. 1). There are longer series of measurements from some countries, for example, Sweden. These show that the decrease started as early as the late 1970s, when the concentrations were about five times higher than the present levels (Fig. 2).

Fig. 2. POPs levels in human milk, Sweden, 1972–1997



Source: Lunden A, Noren K (6); Noren K, Meironyte D (7).

There are many fewer systematic data on other POPs. Swedish long-term analyses *(6,7)* of human milk indicate a decrease of 90% in DDT and its metabolite p,p'-DDE, and lesser decreases in total PCBs, hexachlorobenzene (HCB) and polychlorinated naphthalenes (PCNs) (Fig. 2; note different units for different compounds: pesticides and PCBs are in micrograms, PCNs and PBDEs in nanograms, and dioxin-like compounds in picograms). Because there are no coordinated analyses, data from different countries are difficult to compare. However, all organochlorine pesticide levels in Europe are very low. There have been recent increases in polybrominated diphenylethers (PBDEs) and perfluorinated compounds. PBDEs now seem to be decreasing as a result of the ban on penta- and octa-derivatives taken up by biota and humans (this is not yet visible in the graph).

HEALTH – ENVIRONMENT CONTEXT

POPs have long been recognized as a serious concern for human health and the environment. As early as the 1960s and 1970s some POPs, for example, DDT and PCBs, were banned or phased out in many industrialized countries. Over time it became clear that this was not sufficient. POPs are very persistent and stay in the environment for long periods. They are also prone to bio-accumulate in higher organisms and to bio-magnify in the food-chain, that is, levels increase by several orders of magnitude from sea plankton through food items such as fish up to humans *(8)*. Owing to their semi-volatility and persistence some of them are transported over long distances to locations where they have never been used, e.g. the Arctic. At high concentrations POPs cause severe environmental effects, such as reproductive and developmental effects in wild and laboratory animals *(1,9,10)*. There is more uncertainty about human health effects, especially at the present environmental levels, because the intakes of humans are much lower than those of some animal species.

WHO recognizes the concern about the potential risks of POPs in human milk. Nevertheless, the beneficial effect of breastfeeding as the optimal food source for newborn babies should always be emphasized. In particular, when sharing information with the general public it should be made clear that the presence of dioxins and PCBs in human milk is not an indication for avoiding breastfeeding *(11)*. Body burden is clearly age-dependent and is lowest in the young age groups most at risk during pregnancy or breastfeeding *(12)*.

POLICY RELEVANCE AND CONTEXT

The international community has responded to the threat from POPs by negotiating a global treaty, the Stockholm Convention on POPs, with the objective of protecting human health and the environment from POPs *(13)*. The Convention was adopted in May 2001, entered into force in May 2004 and has at present 133 parties (October 2006). The twelve POPs included in the Convention are aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, HCB, mirex, toxaphene, PCBs, polychlorinated dioxins (PCDDs) and furans (PCDFs).

The Convention requires that parties phase out or ban the production, use, import and export of intentionally produced POPs, with the exception of DDT, which will be permitted for vector control according to WHO guidelines until feasible alternatives have been found. For unintentionally produced POPs, namely dioxins and PCDFs, parties should minimize and, where feasible, eliminate emissions from anthropogenic sources. In doing this, parties shall promote the application of measures that may achieve a realistic and meaningful level of reduction of releases or elimination of sources, for example, by the introduction and use of best available technologies and best environmental practices. A financial mechanism is included to support the implementation of the Convention, particularly in developing countries and countries with economies in transition, for which the major entity at present is the Global Environmental Facility. This Facility has opened a POPs area to provide funding for the development of national implementation and action plans and further implementation activities. By October 2006, 35 parties had submitted their national implementation plans.

The Convention also requires the Conference of Parties to evaluate its effectiveness, starting four years after its entry into force. To facilitate this evaluation, the Conference of Parties should initiate arrangements to provide itself with comparable monitoring data on the presence of POPs and their regional and global environmental transport. The first evaluation will take place in 2008 and should be a baseline for future evaluations. It will focus on core data from appropriate matrices, such as air and human tissues (blood and/or human milk), and rely extensively on existing programmes *(14)*, for example, the Arctic Monitoring and Assessment Programme, the Global Air Passive Sampling project and the WHO Global Survey of Human Milk for POPs *(15)*. The aim is to provide core data for the 12 POPs from all the five United Nations regions. Strategic arrangements and partnerships should be established, involving the health sector.

European Union (EU) Regulation (EC) No. 850/2004 on POPs entered into force on 20 May 2004 *(16)*. This implements the provisions of the Stockholm Convention. Dioxins, PCDFs and PCBs are listed as unintentionally released POPs the releases of which should be continuously and cost-effectively reduced as quickly as possible *(17)*. The links between the exposure of children to POPs and their health effects are specifically addressed by the EU Science, Children, Awareness, EU Legislation and Continuous Evaluation (SCALE) initiative (8) and the Children's Environment and Health Action Plan for Europe indicator RPG IV *(18)*. Policy action should follow from these European strategies that take into account children's sensitivity to these pollutants *(19)*.

ASSESSMENT

Among the POPs, dioxins (polychlorinated dibenzo-p-dioxins) and dioxin-like chemicals (including polychlorinated dibenzofurans and dioxin-like polychlorinated biphenyls) seem to have the lowest safety margin and to be the most likely group to cause adverse effects in humans. During the 1970s, at concentrations three to five times higher than at present, they were possibly the cause of subtle effects such as developmental effects in teeth *(9,20)*. The major sources of these compounds have been incineration of municipal waste, chlorine gas bleaching of wood pulp, the metal industries and a number of minor sources. Until the 1980s there were also important impurities in the production of certain chemicals (PCBs, chlorophenols and their derivatives). The advances in abatement have been most remarkable in waste incineration and major industries, including forest industries. This can be seen in environmental samples, such as lake and sea bottom sediment layers, in fish, in fish-eating birds and seals and in human milk (Figs 1 and 2). The biggest sources remaining are metal and cement industries, landfill fires and small-scale wood and biomass burning. There may still be considerable variations between countries.

Developmental effects are thought to be the effects that occur at the lowest dose levels *(1,9,20)*. Human milk is an ideal medium for monitoring these. It gives a long-term average of the body burden because most of these compounds have long half-lives, thus it is relevant for the risk during pregnancy and also for measuring the intake of the breastfed baby. Both of these steps are believed to be crucial for assessing the risk to the whole population of developmental effects, which is also the basis of the latest WHO risk assessment of dioxins *(1)*. For older populations with higher body burdens *(12)*, the relative risk of cancer, while real, is not very high even at the highest industrial exposures *(1,21)*. In Seveso, Italy, after a very high accidental exposure, there were reports of developmental effects on teeth, altered sex ratios and a possible increase in some rare cancer types *(4,22,23)*.

It is more difficult to assess the health risks of compounds other than dioxins as the data on both exposures and effects are less systematic. Organochlorine pesticides can be still found in human samples in Europe but the concentrations are low and their health relevance has clearly decreased. This is most clearly seen with DDT, for which some countries have long-term exposure data (Fig. 2). The parent compound is present at very low concentrations but some of its long-half-life metabolites, for example, p,p'-DDE, can still be found albeit at lowered concentrations.

Some compounds have more recently come into focus. PBDEs (flame retardants used in plastics and textiles) were found in human milk at the end of 1990s (Fig. 2). Lower brominated diphenylethers, such as tetra- to octa-congeners, are absorbed by different animal species and they bioaccumulate to some extent. They were, therefore, banned by the European Commission in 2004 and their concentrations are now decreasing, in contrast to the United States where levels are about an order of magnitude higher and still increasing *(24)*. Monitoring is still warranted even in Europe because there is uncertainty about the metabolic fate of decabromo-diphenylether, which continues to be produced. It is itself very poorly absorbed by biota but it may be broken down to lower brominated species.

Another new group of halogenated compounds is perfluorinated alkyl compounds (PFAS), such as perfluorooctane sulfonate, which were increasingly used as water repellents and for many other uses. These are also highly resistant in the environment and were shown to accumulate in biota. Some of these compounds have, therefore, been voluntarily phased out by the industries but they are worth monitoring because of their persistence.

DATA UNDERLYING THE INDICATOR

Data source
References *(5–7,12)* were the main data sources used in this fact sheet. In addition, the Global Environment Monitoring System – Food Contamination Monitoring and Assessment Programme (GEMS/Food) Contaminants Database, accessed through the WHO Summary of Information on Global Health Trends (SIGHT), was also consulted *(25)*. The latter gives information on 20 countries throughout the WHO European Region/European Union.

Description of data
Data from references *(5–7)* were mostly from pooled representative human milk samples collected and analysed according to the WHO protocol for the biomonitoring of human milk for POPs *(15)*. Results were generally expressed as ng/g milk fat and WHO-TEQs (pg/g fat).

The data were collected by GEMS/Food participating institutions using standardized methods for sampling and measuring contaminants and for submitting data to the GEMS/Food database. They included levels of dioxins, PCDFs and PCBs in human milk gathered under the SCOOP/EU/RIVM project. The database contains data on many other POPs. Results are expressed as concentrations of POPs in µg/kg milk fat and µg/kg whole milk but mostly as µg/kg of unspecified matrix (that is, no distinction if it is only milk fat or whole milk).

Method of calculating the indicator
Studies with concentrations of POPs in µg/kg (or alternative mass/mass unit) in milk fat were used. The concentrations of PCDD/Fs and dioxin-like PCBs were converted to WHO-TEQs relative to 2,3,7,8-tetrachlorodibenzo-p-Dioxin (TCDD), based on toxic equivalency factors as recommended by WHO *(26)*.

Geographical coverage
Croatia, Czech Republic, Finland, Germany, Hungary, Netherlands, Norway, Slovakia, Spain, Sweden and Ukraine.

Period of coverage
1971–2005.

Frequency of update
Varies between compounds and countries.

Data quality
Data quality varied between compounds and countries. However, data used in this fact sheet were of good quality, representative of the whole country and sampled and analysed in officially accredited laboratories or in laboratories that had successfully participated in relevant proficiency tests.

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Further information

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