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# Exposure of children to chemical hazards in food

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**Dietary exposure to potentially hazardous chemicals in children's food.**

This summary assesses the exposure of children to potentially hazardous chemicals in their food. It focuses on chemicals with the lowest safety margins, namely toxic metals, arsenic and polychlorinated biphenyls (PCBs). In estimating the current situation only the available data have been considered. They mainly address adult populations, as child-specific data are only available for children aged 4–6 years in Germany.

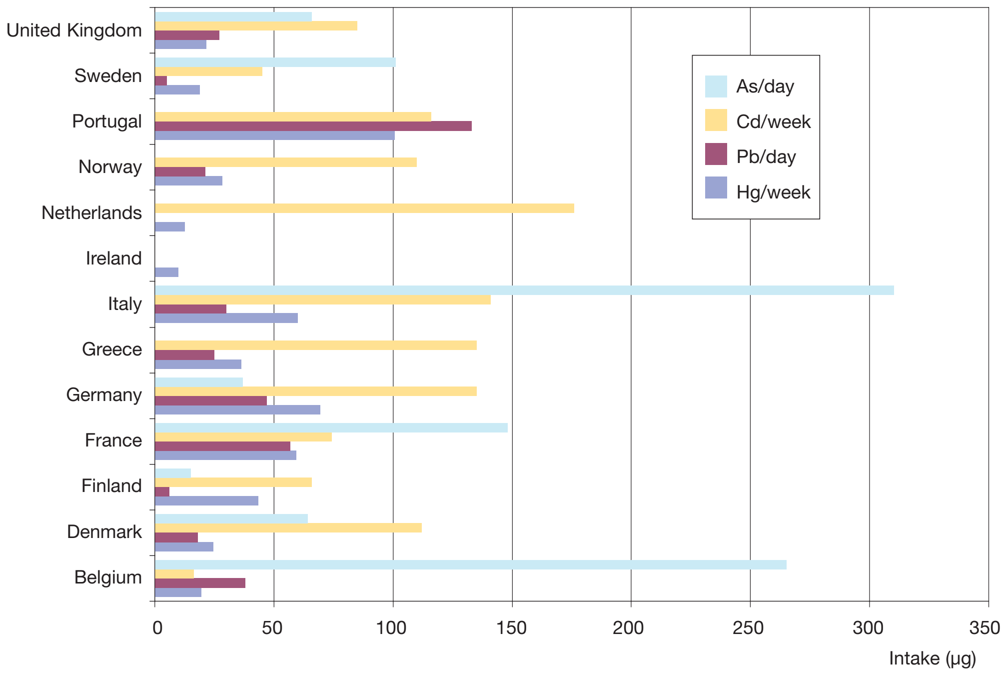
## KEY MESSAGE

Only a partial assessment can be made of the extent to which children are exposed to chemical hazards in food in European countries. In many countries, information on exposure to chemical hazards in the diet is collected for the whole population, not specifically for children. When it is collected, it may be incomplete or not comparable with other countries. In order to assess exposures to hazardous chemicals through food, interventions need to be harmonized and data collected regularly that reflect the specific risks to children in the Region.

## RATIONALE

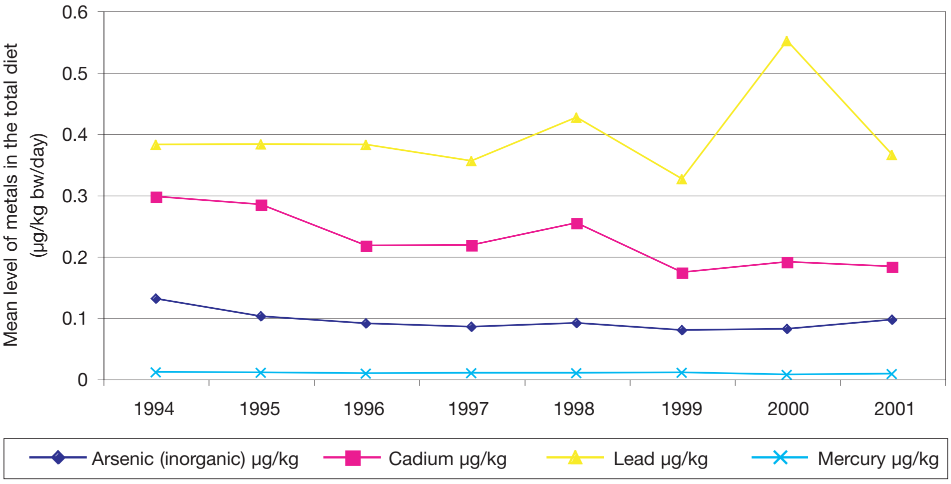
Exposure to hazardous chemicals during growth and development can result in acute long-term effects on the health of children. The strict regulations and measures applied in European countries mean that food is generally safe, but ingestion of contaminated food may still present an important route of exposure to chemical hazards. As their bodies are developing and they generally consume more food on a body weight basis than adults, children are at particular risk of illness from exposure to chemical hazards in food. This indicator focuses on a few contaminants in food, mainly toxic metals. Unacceptably high exposures can be avoided when the levels of hazardous substances in food are monitored.

**Fig. 1. Heavy metal intake through food by adults, selected EU countries, 2004**




*Note. The intake of mercury (Hg) and cadmium (Cd) is weekly, that for lead (Pb) and arsenic (As) – daily.*
*Source: European Commission (1).*

**Fig. 2. Mean level of selected hazardous metals in the total diet of the general population of the Czech Republic, 1994–2001**




*Source: GEMS/Food contaminants database (2).*

## PRESENTATION OF DATA

Figure 1 shows the average intake of heavy metals and arsenic by adult population in various European countries *(1)*.
Figure 2 depicts the mean values of hazardous metals in the total diet of the Czech Republic's general population from 1994 to 2001 (note that Fig. 2 is per kg body weight in contrast to Fig. 1). Data are obtained from 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) *(2)*. Only in the case of cadmium can a consistent downward trend be observed.

## HEALTH – ENVIRONMENT CONTEXT

Chemical hazards in food are toxic substances that either occur naturally, such as aflatoxins and marine toxins, or are manmade. Manmade toxins can be added to food intentionally, such as antibiotics, preservatives and colorants, or can unintentionally contaminate food, for example, metals, cleaning agents, pesticide residues, animal drugs, other agrochemicals and packaging materials used to keep food safe and fresh. Unintentional contamination may occur through environmental pollution of the water, air and/or soil *(3)*.
Infants and children are especially vulnerable to the acute, sub-acute and chronic effects of ingestion of chemical hazards. Since children consume more food per kilogram of body weight than adults, they are more exposed to chemical hazards in food than are adults. Infants consume twice the amount of food per unit of body weight as adults. Moreover, developing organs and tissues are more susceptible to the toxic effects of certain chemicals. For example, exposure to lead or methylmercury during gestation or early childhood will cause serious damage to the developing brain with consequent loss of intellectual potential, while an adult experiencing the same exposure will suffer no considerable effects to his/her intellectual capacity. With greater exposure and more severe health effects, chemicals in food are more harmful to children than adults *(4)*.

The effects of long-term exposure to chemical hazards in food are of particular concern. Symptoms related to prolonged low-level exposure may not be apparent until later in life and, when they do occur, they may be chronic and irreversible. Serious illness due to long-term exposure to various toxic chemicals may include damage to the immune and nervous systems, impairment of reproductive function and development, congenital anomalies in offspring, cancer and organ-specific damage.
This fact sheet focuses on only a few contaminants (lead, methylmercury, cadmium and arsenic) because, firstly, these are best known for their toxicity and, secondly, the existing data most systematically cover these chemicals. Public concerns about hazards due to chemicals in food are growing due to the increasing number and volume of chemicals produced and used in developed countries, in particular chemicals whose long-term toxicity following chronic exposure has not been yet evaluated (endocrine disruptors, chemicals with toxic effects to reproductive organs, etc). These may or may not be well founded, but better information is necessary.

*Lead*

Lead is one of the most dangerous chemicals to children. Aside from its acute toxicity, the most important effect of exposure is chronic neurotoxicity, which is particularly severe during the first two to three years of life when early development of the central nervous system occurs. Exposure to lead during this time increases the risk of mild mental retardation, attention deficit hyperactivity disorder and other developmental disabilities *(5–7)*. There are many different ways in which children can be exposed to lead, including through contaminated food and drinking-water, the use of lead-glazed ceramics in cooking and ingestion of paint-chips (especially connected with pica-syndrome typical of poor nutrition) *(4)*. Cumulative exposure from all of these sources should not exceed the provisional tolerable weekly intake (PTWI) of 25 µg/kg body weight/week.[1]

*Methylmercury*

Mercury is an environmental contaminant that is present in fish and seafood products largely as methylmercury. Food sources other than fish and seafood products may contain mercury but mostly in the form of inorganic mercury, which is considerably less toxic than methylmercury. Methylmercury is highly toxic, particularly to the nervous system; the developing brain is thought to be the most sensitive target organ for methylmercury toxicity. The Food and Agriculture Organization/World Health Organization Joint Expert Committee on Food Additives (JECFA) has established a PTWI of 1.6 µg/kg body weight. The estimated intakes of mercury in Europe vary by country, depending on the amount and the type of fish consumed. Some population groups may frequently consume large predatory fish (such as swordfish, tuna and pike) which are at the top of the food chain and often have a higher concentration of methylmercury. Methylmercury toxicity has been demonstrated at low exposure levels, and exposure to this compound should therefore be minimized while recognizing that fish constitutes an important part of a balanced diet.

*Cadmium*

Cadmium is present at very low levels in a wide variety of food, and food products account for more than 90% of human exposure to cadmium, except in the vicinity of cadmium-emitting industries. Nevertheless, poisoning due to cadmium in food is rare. The main food sources are the kidneys of animals, which are generally higher in cadmium than are other foods, as well as contamination of rice, soy beans and seafood with cadmium by local industrial and mining operations. The packaging materials for pre-prepared and fresh foods may contain considerable levels of cadmium that may migrate into food. Intake of highly cadmium-contaminated food causes acute gastrointestinal effects, such as vomiting and diarrhoea *(8)*. The main problem for patients chronically exposed to cadmium is kidney damage *(9)* with a perturbance of phosphorus and calcium metabolism and a possible higher risk of kidney stones. The amount of cadmium in the kidney tubular cells increases during a person's lifespan and makes up the major part of the cadmium body burden. Maternal exposure to cadmium is associated with low birth weight and an increase of spontaneous abortion *(10,11)*. The International Agency for Research on Cancer (IARC) classifies cadmium as a human carcinogen group I.

*Arsenic*

Arsenic is ubiquitous, found in air, water, fuels and marine life. The daily human intake of arsenic contained in food is in the range 0.5–1 mg, with the greatest concentrations coming from fish and crustaceans. Once arsenic is in the body it binds to haemoglobin, plasma proteins and leukocytes and is redistributed to the liver, kidney, lung, spleen and intestines. Most of the arsenic in marine food is in organic form and is excreted more rapidly than inorganic arsenic. Acute arsenic intoxication resulting in fatality is rare. Survivors may have severe disabilities secondary to organ damage. Chronic exposure to arsenic over weeks and months can have severe effects due to its neurotoxicity, cardiovascular and renal toxicity and carcinogenicity.
It is difficult to estimate the true extent of the impact of chemical hazards in food on children's health due to the long latency periods that may occur between exposure and outcome. When the latency period between an exposure and its health effects is long, it is difficult to prove an association. As a result, knowledge of the effects on health of exposure to hazardous chemicals in the diet is incomplete *(12)*.

[1] *The PTWI is the maximum amount of a contaminant to which a person can be exposed per week over a lifetime without an unacceptable risk of health effects. The level is provisional because it is subject to review when new information becomes available. The PTWI for lead is set by the Food and Agriculture Organization/World Health Organization Joint Expert Committee on Food Additives (JECFA). The most recent evaluation was undertaken in 1999 and re-confirmed the PTWI for lead as 0.025 mg/kg body weight per week. This level was originally set in 1982 for infants and children, based on studies conducted with children. In 1993 the adult level was withdrawn and the infant and child level extended to all age groups.*

## POLICY RELEVANCE AND CONTEXT

*Pan-European context*

Regional Priority Goal IV of the Children's Health and Environment Action Plan for Europe aims to reduce the risks of disease and disability arising from exposure to hazardous chemicals (such as heavy metals), physical agents (such as excessive ultraviolet radiation) and biological agents and to hazardous working environments during pregnancy, childhood and adolescence *(13)*.

In the European Region, WHO is helping countries to develop and strengthen their food safety programmes. This includes harmonizing legislation with Codex Alimentarius guidelines *(14)* and EU policies, strengthening food control services and promoting quality assurance systems. The WHO food safety programme also supports countries in building and updating skills for the safety analysis, monitoring and management of food *(15)*.

*EU context*

The accession of the EU to the Codex Alimentarius Commission in 2003 strengthened consistency between the standards, guidelines and recommendations adopted under the Codex and binding obligations in the EU and its member states in the area of food standards. The measures taken by the EU with regard to food safety and food frequently invoke the Codex as justification *(16)*.

EU legislation covers the chemical safety of foodstuffs in the following five areas.

1. *Additives.* Legislation on food additives is based on the principle that only those additives that are explicitly authorized may be used, often in limited quantities in specific foodstuffs.
2. *Flavouring.* The existing legislation on flavourings sets limits on the presence of undesirable compounds. There is an ongoing safety evaluation programme for chemically defined flavouring substances.
3. *Contaminants.* The legislation on contaminants is based on scientific advice and the principle that contaminant levels shall be kept as low as can be reasonably achieved by following good working practices. Maximum levels have been set for certain contaminants (for example, mycotoxins, dioxins, heavy metals, nitrates and chloropropanols) in order to protect public health.
4. *Residues.* Legislation on the residues of veterinary medicinal products used in food-producing animals and on the residues of pesticides has set maximum residue limits. In some cases the use of such substances is prohibited.
5. *Contact materials.* The legislation on food contact materials provides that these materials shall not transfer their components into food in quantities that could endanger human health or change the composition, taste or texture of food *(17)*.

The European Food Safety Authority (EFSA) was established in 2002 (Regulation (EC) 178/2002) to ensure common principles and responsibilities regarding food, scientific quality and efficient procedures for decision-making in matters of food safety *(18)*. It is responsible for collecting data on food contaminants. The regulation was based on the White Paper on Food Safety, which proposed a radical revision of the EU's food hygiene rules *(19)*. Surveys show that the levels of hazardous chemicals in food are generally below the maximum amounts permitted by health authorities. The Scientific Cooperation on Questions Related to Food (SCOOP) project, coordinated by EFSA, aims to retrieve pooled data from across the EU on particular issues of concern regarding food safety. These data are used to assist the Commission in developing EU legislation to increase the protection of consumers *(20)*.

*Global context*

In order to ensure adequate standards of food safety and quality, the Food and Agricultural Organization (FAO) and WHO developed the Codex Alimentarius *(14)*. The Codex was created in 1963 and includes a collection of standards for food labelling, additives, contaminants, food hygiene, methods of analysis and sampling and for residues of veterinary drugs and pesticides in foods. In 1985, the United Nations recommended national governments to adopt food safety standards from the Codex Alimentarius *(14)*. At present, food standards apply to individual contaminants in various foods in terms of total intake from all food sources. WHO's Global Environment Monitoring System/Food Contamination Monitoring and Assessment Programme (GEMS/Food) encourages all countries, in particular developing countries, to undertake total diet studies *(21)*.

## ASSESSMENT

Chemical hazards that give most concern with regard to children's health due to the lower safety margins in children's food are toxic metals (lead, methylmercury, cadmium, arsenic) and some persistent organic pollutants (POPs), notably dioxin-like compounds.

SCOOP data from 2004 on average intake levels of lead, mercury, cadmium and arsenic in adults' diet is available for 13 European countries (Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Sweden and the United Kingdom). In most European countries adult intake levels have been 10–30% of PTWI levels, sometimes higher. The data on intake among children are very patchy. The total intake seems to be lower than in adults, but per kg body weight the intake is higher *(1)*.

Monitoring of chemical contaminants in food in the Czech Republic through total diet studies is an established practice and recent, nationally representative data on the levels of chemical hazards in food are available. The observed amount of all metals in the total diet of the general population between 1994 and 2001 was far below the PTWI values (Table 1).

**Table 1. Tolerable intake values of selected toxic metals for adults**

| Hazard | Provisional tolerable weekly intake (PTWI) mg/kg body weight |
|---|---|
| Arsenic (total) | PTWI 0.015 mg/kg body weight |
| Cadmium | PTWI 0.007 mg/kg body weight |
| Lead | PTWI 0.025 mg/kg body weight |
| Mercury | PTWI 0.0016 mg/kg body weight |

*Note. These values are not isolated dietary intake values. A full risk assessment of dietary intake of metals should also take into account other sources of exposure (such as dermal and inhalation exposures).*

The total diet studies in the Czech Republic estimate levels of contaminants in the diet of the general population. Due to the fact that young children tend to eat different types of food and a different amount per kilogram body weight than adults, these values are not directly applicable to children under three years old who are particularly vulnerable to the neurotoxic effects of chemical hazards.

In summary, due to the scarcity of child-specific data on food consumption, the extent of the exposure of children to chemical hazards in food is still patchy. For many countries, data on contamination of and exposure through food are not collected or may be incomplete or collected in a way that makes it difficult to make intercountry comparisons.

National authorities have the responsibility and obligation to ensure that toxic chemicals such as pesticides, metals, environmental contaminants and naturally occurring toxins are not present in food at levels that may adversely affect the health of their citizens. To assess the risk to children's health arising from the presence of hazardous chemicals in food, the actual dietary intake of chemicals should be estimated and compared with their corresponding toxicological reference intakes, such as PTWI. Estimation of the actual dietary intake of chemical hazards is essential for risk assessment and can be used in determining whether there may be a relationship between the observed adverse effects in humans and exposure to a particular contaminant. Standardizing the methods of data collection across the Region will strengthen such risk and health impact assessments.

Any assessment of the exposure of children to chemical hazards in food should address their unique biological characteristics and exposure patterns. The different exposures (according to different types of food consumed) and outcomes (susceptibility to neurotoxic effects) among children of different ages should be considered. In adults, 200 chemicals are known to cause clinical neurotoxic effects. Despite an absence of systematic testing, many additional chemicals have been shown to be neurotoxic in laboratory models. The toxic effects of such chemicals in the developing human brain are not known and they are not regulated to protect children. When assessing risks from chemicals in food, additional safety factors for infants and children need to be applied. Available information on aggregate exposure from single chemicals should be considered, including exposure through dietary and drinking-water sources and other exposures. Available information on the cumulative effects of chemicals with common toxicity mechanisms should be considered.

At the same time, the highest risks in food for children are not contaminants or added chemicals, but unhealthy food choices including snack foods with too much fat, sugar and salt. These may affect children's health even decades later as risk factors for obesity, diabetes, hypertension, cardiovascular diseases and cancer. It is important to emphasize the health value of vegetables, fruit, berries and fish regardless of contaminants that may be present.

The potential impacts on health of consuming contaminated food can be greatly reduced by preventing exposure through improved production, processing and handling of food and educating people to avoid high-risk foods. Sound management of chemicals, particularly metals, pesticides and POPs, is vital to the protection of children's health. In view of the seriousness of their impact on children, the initial focus for action should be placed on chemicals that are toxic to the developing human brain: lead, mercury and PCBs. Chemicals of particular concern are those that tend to accumulate in the body, such as cadmium and POPs, and to which chronic exposure at even low levels may cause serious health problems *(21)*.

## DATA UNDERLYING THE INDICATOR

*Data source*

The data used for this indicator were collected from the SCOOP reports by EFSA *(23)* and from the GEMS/Food database by the United Nations Environment Programme *(2)*.

*Description of data*

SCOOP projects are specific projects launched in the EU for the estimation of dietary intake of contaminants, carried out before EFSA was set up. Data from member states were collected but the methods and techniques were not harmonized, so the quality of data and the results may vary between countries.

The GEMS/Food total diet study database contains information from 1972 to 2003 on contaminants in the diets of 15 countries throughout Europe. Information is submitted to the database by participating institutions, which use standardized methods for measuring contaminants and submitting data. The database contains information from total diet studies, which provide the most accurate estimate of dietary intakes of contaminants. By explicitly taking into account the kitchen preparation of foods, total diet studies assess the levels of contaminants in food as it is consumed.

*Method of calculating the indicator*

The exposure is estimated by average intake of selected chemicals. This includes data on the presence of a chemical in individual foods and diets, including its fate during the processes within the food production chain, and data on the consumption patterns of the individual foods containing the relevant chemicals.

*Geographical coverage*

For SCOOP data: Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Sweden and the United Kingdom

For GEMS/FOOD data: Czech Republic.

*Period of coverage*

2004 for SCOOP. 1994–2001 for GEMS/FOOD.

*Frequency of update*

For SCOOP data, the measures were not repeated in time. GEMS/FOOD data were updated on a yearly basis.

*Data quality*

Data from both sources refer mostly to the adult population. Specific data on the exposure of children are not available.

The SCOOP data are collected from different countries, with no harmonized methods and techniques so that the quality of data from different countries may vary. They only reflect the situation at one point in time. There are no updates for time trend estimation.

The GEMS/Food data from Czech Republic are one order of magnitude lower than SCOOP data and it was not possible to clarify this difference. The data are, therefore, only valuable to show trends in food contamination in time.

To assess the exposure of children to hazardous chemicals in food, their actual dietary intake should be estimated. In order to compare exposure across all the European Region Member States, a standard methodology should be employed. In particular, attention should be paid to collecting data on representative samples of the child population. Standardizing the methods of data collection across the Region can strengthen common efforts for the development of policies and action to reduce hazardous exposures and their effects on health.

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