



ENHIS
EUROPEAN ENVIRONMENT AND
HEALTH INFORMATION SYSTEM

EXPOSURE OF CHILDREN TO CHEMICAL HAZARDS IN FOOD

FACT SHEET 4.4 • December 2009 • CODE: RPG4_Food_Ex1

Exposure of children to potentially hazardous chemicals in food

This fact sheet assesses the exposure of children to potentially hazardous chemicals in their food. It focuses on chemicals for which real exposures are close to the toxic doses, notably toxic metals and arsenic. In estimating the current situation, data addressing adult populations have mainly been used since child-specific exposure data are available only for children aged 4–6 years in Germany. The summary also contains information on the environment and health context and the policy relevance, and an assessment of the situation in the WHO European Region.

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. Exposure assessments are based on two components, one being the level of contaminants in various foods and the other the amounts of the food consumed by the population. In many countries, information on exposure to chemical hazards in the diet is collected only for the whole population, not specifically for children with food consumption habits different from those of adults. When child-specific data are collected, they may be incomplete and not comparable with those from other countries. To assess exposures to hazardous chemicals through food, assessments need to be harmonized (e.g. defined age groups) and data collected regularly so as to reflect the specific risks to children in the Region.

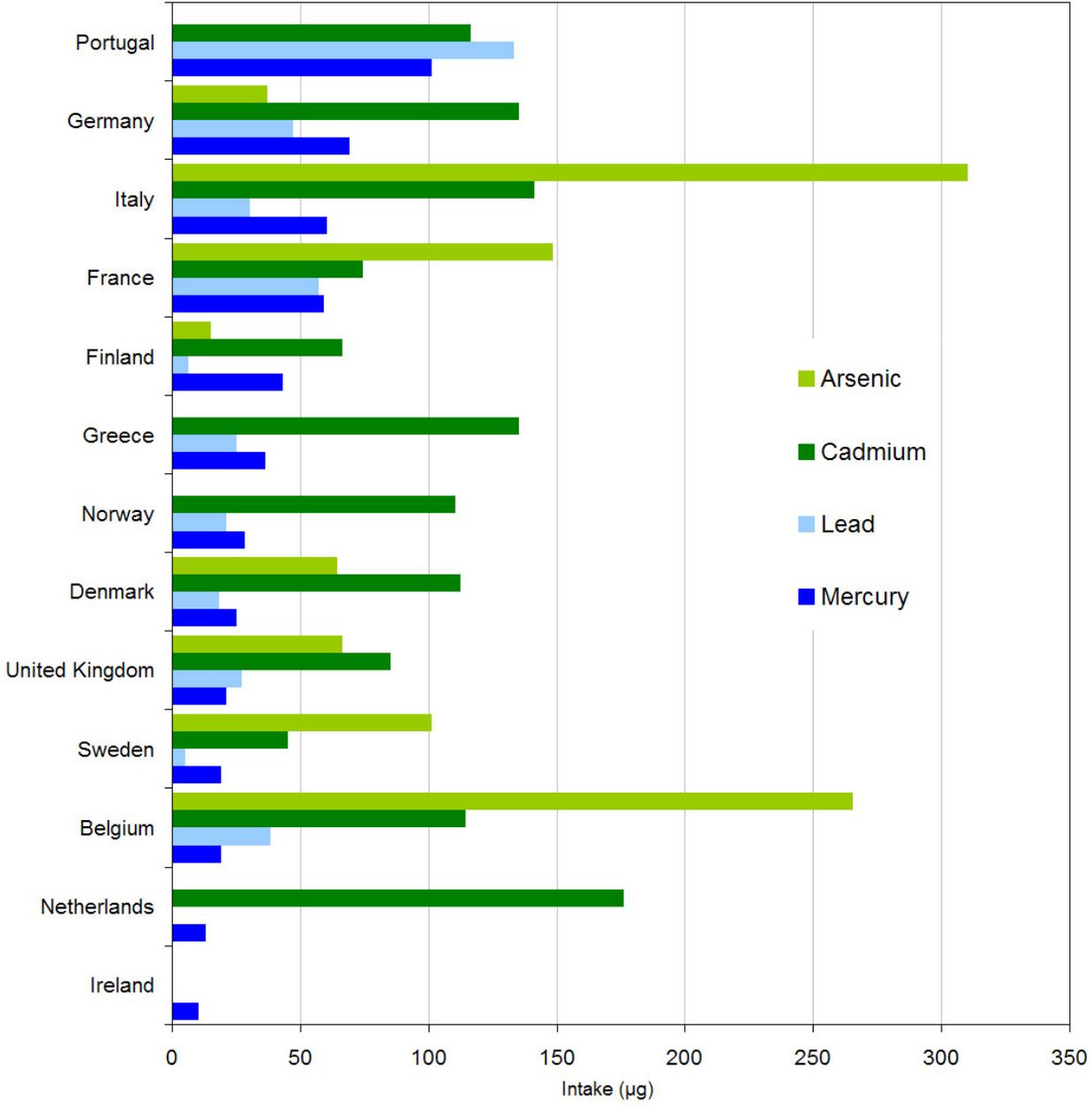
RATIONALE

Exposure to hazardous chemicals during growth and development can result in 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 per unit body weight than adults, children are at particular risk of illness from exposure to chemical hazards in food. This fact sheet focuses on a few contaminants in food, mainly heavy metals. Unacceptably high exposures can be avoided when the levels of hazardous substances in food are monitored and controlled.

PRESENTATION OF DATA

Fig. 1 shows the average intake of heavy metals and arsenic by adult populations in various European Union (EU) countries (1).

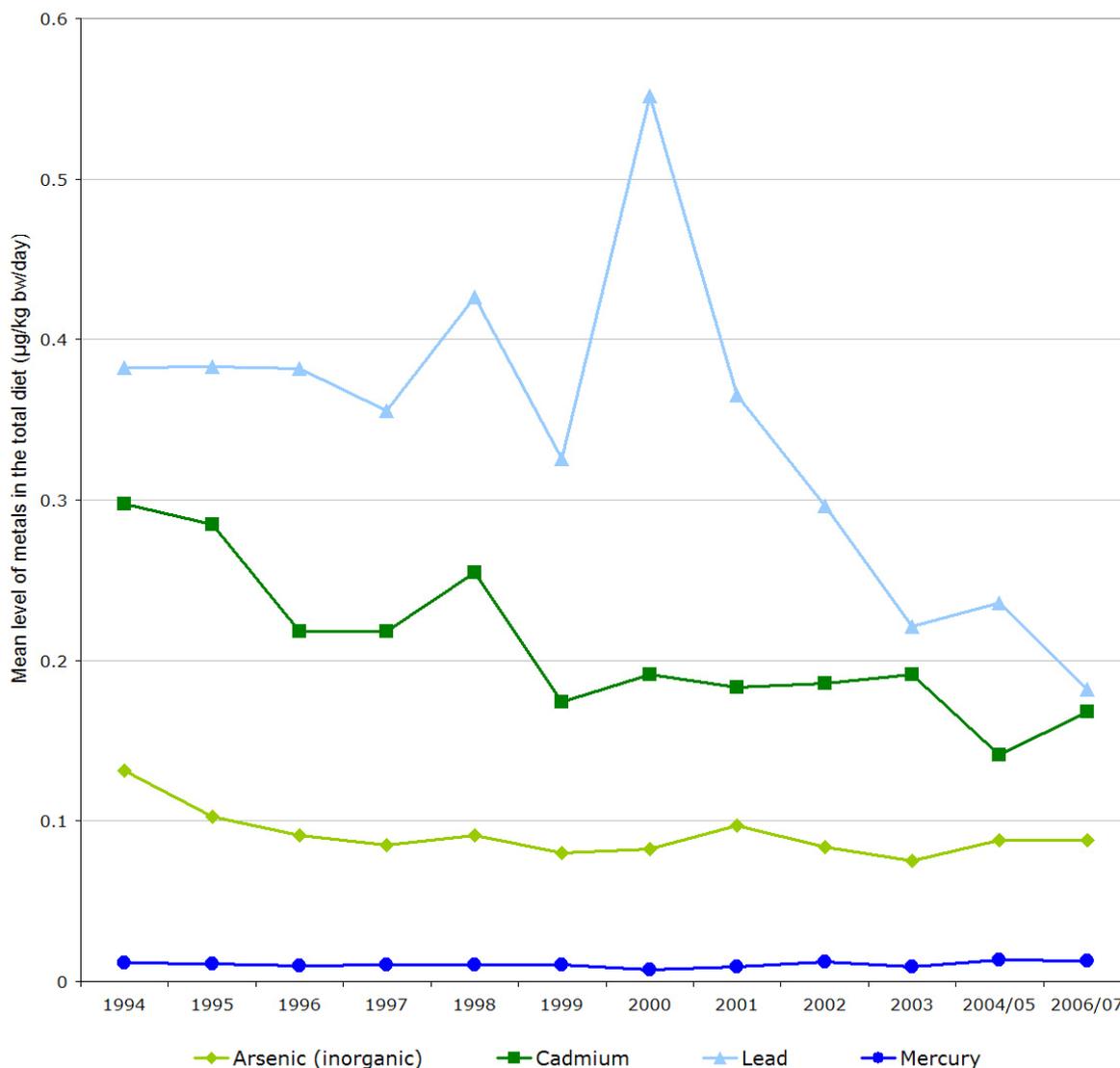
Fig. 1. Heavy metal intake through food by adults, selected EU countries, 2004



Note. The intake of mercury and cadmium is per week; that for lead and arsenic is per day.
Source: European Commission (1).

Fig. 2 depicts the mean values of hazardous metals in the total diet of the general population of the Czech Republic from 1994 to 2007 (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 Information on Global Health Trends (SIGHT) (2). Only for cadmium and lead can downward trends be observed.

Fig. 2. Mean level of selected hazardous metals in the total diet of the general population of the Czech Republic, 1994–2007



Source: GEMS/Food contaminants database (2).

HEALTH AND ENVIRONMENT CONTEXT

Chemical hazards in food are potentially toxic substances that either occur naturally, such as aflatoxins and marine toxins, or are man-made. Man-made chemicals can be added to food intentionally, such as preservatives and colorants, they may be present as residues of pesticides and animal drugs, or they can unintentionally contaminate food through the environment or through the production process, for example, metals, cleaning agents and packaging materials used to keep food safe and fresh. Unintentional contamination may also occur through environmental pollution of the water, air and/or soil (3). As demonstrated by the melamine scandal in China in 2008 (4), even criminal adulteration of food is an important rationale for food control. Further, owing to the increase in international food trade, any incident may rapidly have a global impact.

Infants and children are potentially more vulnerable to the effects of ingesting chemical hazards, owing to still developing organ systems and higher exposure. Children consume more food per unit of body weight than adults: in the case of infants, twice the amount. Moreover, developing organs and tissues are more susceptible to the toxic effects of certain chemicals. For example, excessive exposure to lead or methylmercury during gestation or early childhood may cause serious damage to the developing brain with consequent loss of intellectual potential, while an adult experiencing the same exposure will suffer no great effect on his/her intellectual capacity (5).

Symptoms related to prolonged low-level exposure may not be apparent until later in life and, when they do occur, 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 the offspring, cancer, and organ-specific damage.

This fact sheet focuses on only a few contaminants (lead, methylmercury, cadmium and arsenic) because first, there is reliable information on their adverse effects and second, the existing exposure data cover these chemicals most systematically. There are public concerns about other chemical hazards in food, owing to the increasing number and volume of chemicals produced and used (endocrine disruptors, chemicals with toxic effects to reproductive organs, etc). These concerns may or may not be well founded, and better information is necessary before the risks associated with them can be compared with the substances dealt with here.

Lead

Lead is one of the most dangerous chemicals to children. The most important effect of long-term exposure is neurotoxicity, particularly during the first 2–3 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 (6–8). There are many ways in which children can be exposed to lead, including through contaminated food and drinking-water, the use of lead-glazed ceramics for food storage, and ingestion of lead-containing paint (especially connected with pica-syndrome typical of poor nutrition) (5). Cumulative exposure from all of these sources should not exceed the provisional tolerable weekly intake (PTWI) of 25 µg/kg body weight per week.¹

Methylmercury

Mercury is an environmental contaminant that is present in fish and seafood products largely as methylmercury. It is assumed that all of the mercury in fish is present as methylmercury (1). Food sources other than fish and seafood products may contain 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 toxicity. The JECFA has established a PTWI of 1.6 µg/kg body weight per week. The estimated intakes of methylmercury in Europe vary by country and region, 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. 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 healthy diet (9).

Cadmium

Cadmium is present at very low levels in a wide variety of foods, and food products account for more than 90% of human exposure, except in the vicinity of cadmium-emitting industries. Some phosphate fertilizers and wastewater sediments used as fertilizers may contain cadmium, which is taken up by cultivated plants. Generally, the highest levels in food are found in the kidneys of animals as well as in contaminated rice, soybeans and seafood, in particular where local industries and mining operations may emit cadmium. The main problem for patients chronically exposed to cadmium is kidney damage (10,11) with a disturbed 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. This is the basis for the PTWI of 0.007 mg/kg body weight per week established by JECFA (Table 1). Maternal exposure to cadmium is associated with low birth weight and an increase of spontaneous abortion (12,13).

Arsenic

Arsenic is ubiquitous, being found in air, water, fuels and marine life. The daily human intake of arsenic contained in food is in the range 0.1–1 mg, with the greatest amounts coming from fish and crustaceans. In some areas, groundwater contains high concentrations of arsenic. 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 death is rare. Survivors may have severe disabilities secondary to organ damage. Chronic exposure to arsenic can have severe effects owing to its neurotoxicity, cardiovascular and renal toxicity and carcinogenicity. The European

¹ The PTWI is a tolerable intake value used for food contaminants such as heavy metals with cumulative properties. It represents permissible human weekly exposure to those contaminants unavoidably associated with the consumption of otherwise wholesome and nutritious foods. The level is provisional because it is subject to review when new information becomes available. The PTWI for lead was set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The most recent evaluation was undertaken in 1999 and reconfirmed 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.

Food Safety Authority (EFSA) is in process of collecting data for exposure assessment (14). JECFA established in 1988 a PTWI of 0.015 mg/kg body weight per week.

Table 1. Summary of PTWI values for toxic metals as established by JECFA

Hazard	PTWI (mg/kg body weight)	Year of latest evaluation
Arsenic (total)	0.015	1988
Cadmium	0.007	1999
Lead	0.025	2005 (PTWI established in 1988)
Methyl mercury	0.0016	2003 (clarified 2006)

It is difficult to estimate the true extent of the impact of chemical hazards in food on children's health, owing 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 demonstrate an association. As a result, knowledge of the effects on health of exposure to hazardous chemicals in the diet is incomplete (15).

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 (16).

In the European Region, WHO is assisting countries to develop and strengthen their food safety programmes in line with the recommendations of the WHO European Action Plan on Food and Nutrition Policy 2007–2012 (17). This includes harmonizing legislation with Codex Alimentarius guidelines (18) and EU policies, strengthening food control services and promoting quality assurance systems. The WHO food safety programme also supports countries in priority actions on surveillance of foodborne diseases, monitoring chemical contamination in the food chain, and risk assessment, risk management and risk communication. The Action Plan underlines the importance of a holistic and intersectoral approach to food safety based on the entire food-chain and including environmental aspects.

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 (19).

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 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 a continuing safety evaluation programme for chemically defined flavouring substances.
3. *Contaminants*. The legislation on contaminants, as for all other food chemicals, 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 chloropropenols) in order to protect public health. Criminal adulteration of food with foreign substances is possible and interim measures can be taken until the adulteration is under control.
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 (20).

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 (21). EFSA 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 (22). Surveys show that the levels of hazardous chemicals in food in the EU 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 (23).

Global context

To ensure adequate standards of food safety and quality, the Food and Agricultural Organization (FAO) and WHO developed the Codex Alimentarius (18). 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. Codex has established several standards for food contaminants, such as maximum limits in certain foods. Total intake of the contaminant from all food sources should not exceed the PTWI. Standards and recommendations developed by the Codex are based on scientific advice, generally provided by Joint FAO/WHO expert meetings such as JECFA and JMPR (Joint Meeting on Pesticide Residues). In 1985, the United Nations recommended that national governments adopt food safety standards from the Codex Alimentarius (18). Codex standards have become the benchmark against which national food measures and regulations are evaluated within the legal parameters of the World Trade Organization agreements.

In the light of advances in the science of risk assessment and the recognition that the evaluations performed by JECFA and JMPR serve as the scientific foundation for international food standards that are of increasing importance within the Codex Alimentarius Commission and the World Trade Organization, FAO and WHO have initiated a joint project to update and consolidate principles and methods for the risk assessment of chemicals in food (24). As a result, guidelines on good practice in chemical risk assessment in food will be released within the Environmental Health Criteria series.

ASSESSMENT

Chemical hazards that give most cause for concern with regard to children's health due to the lower safety margins 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 are 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: total intake seems to be lower than in adults, but intake per unit of body weight is higher (1).

Monitoring of chemical contaminants in food through total diet studies is an established practice in the Czech Republic 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 2007 was far below the PTWI values. Owing to the fact that young children tend to eat different types of food and a different amount per unit of body weight than adults, these results are not directly applicable to children under three years of age, who are particularly vulnerable to the neurotoxic effects of chemicals.

In summary, owing 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. WHO's Global Environment Monitoring System/Food Contamination Monitoring and Assessment Programme (GEMS/Food) encourages all countries, particularly developing countries, to undertake total diet studies as a cost-effective way of generally ensuring that the dietary intake of chemicals is within safe limits and for setting priorities for further study (25).

National authorities are responsible for ensuring 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 and amounts of food consumed) and outcomes (susceptibility to neurotoxic effects) among children of different ages should be considered. When assessing risks from chemicals in food, additional safety factors for infants and children may be necessary. Available information on aggregate exposure to single chemicals should be considered, including exposure through food and drinking-water. 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, fruits, berries and fish, regardless of contaminants that may be present.

The potential negative effects on health of consuming contaminated food can be greatly reduced by preventing exposure by reducing environmental pollution, improving the 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 effects on children, the initial focus for action should be 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 heavy metals and POPs, and to which chronic exposure at even low levels may cause serious health problems (26).

DATA UNDERLYING THE INDICATOR

Data source

The data used for this indicator were collected from the SCOOP reports by EFSA (27) and from the GEMS/Food database (2).

Description of data

SCOOP projects are specific projects launched in the EU for estimating 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 among countries.

The GEMS/Food total diet study database contains information from 1971 to 2005 on dietary contaminants in 15 countries in 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: the Czech Republic.

Period of coverage

2004 for SCOOP; 1994–2007 for GEMS/FOOD.

Frequency of update

For SCOOP data, the measures were not repeated in time. GEMS/FOOD data were updated annually.

Data quality

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

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 the Czech Republic are lower than SCOOP data and it was not possible to clarify this difference. The data are, therefore, only valuable in showing trends in food contamination over time for the Czech Republic.

To assess the exposure of children to hazardous chemicals in food, their actual dietary intake should be assessed. To compare exposure across all the WHO European 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.

REFERENCES

1. Assessment of the dietary exposure to arsenic, cadmium, lead and mercury of the population of the EU member states. *Brussels, Commission of the European Communities, Directorate-General of Health and Consumer Protection, 2004 (SCOOP task 3.2.11)* (http://ec.europa.eu/food/food/chemicalsafety/contaminants/scoop_3-2-11_heavy_metals_report_en.pdf; accessed 13 August 2009).
2. Global Environment Monitoring System – Food Contamination Monitoring and Assessment Programme (GEMS/Food) Contaminants Database [online database] (<http://www.who.int/foodsafety/chem/gems/en/index.html>). Accessed through WHO Summary Information on Global Health Trends (SIGHT) [web site]. Geneva, World Health Organization, 2009 (http://www.euro.who.int/foodsafety/Chemical/20040728_1, accessed 13 August 2009).
3. Etzel RA, ed. *Pediatric environmental health, 2nd ed.* Elk Grove Village, IL, American Academy of Pediatrics, 2003:165–180.
4. European Food Safety Authority. *Statement of EFSA on risks for public health due to the presences of melamine in infant milk and other milk products in China.* EFSA Journal, 2008, 807:1–10 (http://www.efsa.europa.eu/cs/BlobServer/Statement/contam_ej_807_melamine,0.pdf?ssbinary=true, accessed 13 August 2009).
5. Pronczuk de Garbino J, ed. *Children's health and the environment: a global perspective.* Geneva, World Health Organization, 2004 (http://whqlibdoc.who.int/publications/2005/9241562927_eng.pdf; accessed 13 August 2009).
6. Lidsky TI, Schneider JS. *Lead neurotoxicity in children: basic mechanisms and clinical correlates.* Brain, 2003, 126:5–19.
7. Needleman HL, Gatsonis CA. *Low-level lead exposure and the IQ of children. A meta-analysis of modern studies.* Journal of the American Medical Association, 1990, 263:673–678.
8. Needleman HL et al. *The long-term effects of exposure to low doses of lead in childhood. An 11-year follow-up report.* New England Journal of Medicine, 1990, 322:83–88.
9. Castoldi A et al. *Human developmental neurotoxicity of methylmercury: impact of variables and risk modifiers.* Regulatory Toxicology and Pharmacology, 2008, 51:201–214.
10. Nordberg GF. *Cadmium and health in the 21st century – historical remarks and trends for the future.* Biometals, 2004, 17:485–489.
11. Frery N et al. *Environmental exposure to cadmium and human birthweight.* Toxicology, 1993, 79:109–118.
12. Shiverick KT, Salafia C. *Cigarette smoking and pregnancy. I: ovarian, uterine and placental effects.* Placenta, 1999, 20:265–272.
13. Barbier O et al. *Effect of heavy metals on, and handling by, the kidney.* Nephron Physiology, 2005, 99:105–110.
14. Request for data on arsenic levels in foodstuffs and drinking water. Parma, European Food Safety Authority, 2008 (EFSA/DATEX/2008/012) (http://www.efsa.europa.eu/cs/BlobServer/Call_Consultation/Datex_cfd_arsenic_en,0.pdf?ssbinary=true, accessed 13 August 2009).
15. *Children's Environmental Health [web site]. Chemical hazards.* Geneva, World Health Organization, 2007 (<http://www.who.int/ceh/risks/cehchemicals/en/>, accessed 13 August 2009).
16. *Children's Environment and Health Action Plan for Europe. Declaration.* Fourth Ministerial Conference on Environment and Health, Budapest, Hungary, 23–25 June 2004. Copenhagen, WHO Regional Office for Europe, 2004 (document EUR/04/5046267/6) (<http://www.euro.who.int/document/e83335.pdf>, accessed 13 August 2009).
17. WHO European Action Plan for Food and Nutrition Policy 2007–2012. Copenhagen, WHO Regional Office for Europe, 2008 (<http://www.euro.who.int/Document/E91153.pdf>, accessed 13 August 2009).
18. *Codex alimentarius [web site]. Rome, Food and Agricultural Organization and Geneva, World Health Organization, 2006* (http://www.codexalimentarius.net/web/index_en.jsp, accessed 13 August 2009).
19. *Council Decision 2003/822/EC of 17 November 2003 on the accession of the European Community to the Codex Alimentarius Commission.* Official Journal of the European Union, 2003, L309:14–21 (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:309:0014:0021:EN:PDF>, accessed 13 August 2009).
20. *Food safety – from the farm to the fork. Chemical safety of food [web site].* Brussels, European Commission, 2007 (http://ec.europa.eu/food/food/chemicalsafety/index_en.htm, accessed 13 August 2009).

21. Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Official Journal of the European Union, 2002, L31:1–24 (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R0178:EN:HTML>, accessed 13 August 2009).
22. White Paper on food safety. Brussels, European Commission, 2000 (COM (1999) 719 final) (http://ec.europa.eu/dgs/health_consumer/library/pub/pub06_en.pdf, accessed 13 August 2009).
23. Council Directive 93/5/EEC of February 1993 on assistance to the Commission and cooperation by the Member States in the scientific examination of questions relating to food. Official Journal of the European Union, 1993, L52:18–21 (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0005:EN:HTML>, accessed 13 August 2009).
24. International Programme on Chemical Safety. Chemicals in Food: Project to update the principles and methods for the assessment of chemicals in food [web site]. Geneva, World Health Organization, 2008 (<http://www.who.int/ipcs/food/principles/en/> accessed 13 August 2009)
25. GEMS Food. Total diet studies: a recipe for safer food. Geneva, World Health Organization, 2005 (http://www.who.int/foodsafety/chem/TDS_recipe_2005_en.pdf, accessed 13 August 2009).
26. Robertson A et al., eds. Food and health in Europe: a new basis for action. Copenhagen, WHO Regional Office for Europe, 2004 (WHO Regional Publications, European Series, No. 96) (<http://www.euro.who.int/document/E82161.pdf>, accessed 13 August 2009).
27. SCOOP [web site]. Brussels, European Commission, 2007 (http://ec.europa.eu/food/fs/scoop/index_en.html, accessed 13 August 2009).

FURTHER INFORMATION

Authors of the May 2007 version: Pia Vracco, National Institute of Public Health, Ljubljana, Slovenia; Jouko Tuomisto, National Public Health Institute, Kuopio, Finland; Jennifer Grad, WHO European Centre for Environment and Health, Bonn, Germany; Eva Kunseler, National Public Health Institute, Kuopio, Finland.

Update 2009: Jouko Tuomisto, National Institute for Health and Welfare, Kuopio, Finland.