World Health Organization

PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

EXPOSURE TO MERCURY: A MAJOR PUBLIC HEALTH CONCERN

Second edition

Mercury is highly toxic to human health, posing a particular threat to the development of the child in utero and early in life. It occurs naturally and exists in various forms: elemental (or metallic); inorganic (for example, mercuric chloride); and organic (for example, methylmercury and ethylmercury). These forms all have different toxicities, with different implications for health and for measures to prevent exposure *(1)*. Elemental mercury is a liquid that vaporizes readily. It can stay for up to a year in the atmosphere, where it can be transported and deposited globally. It ultimately settles in the sediment of lakes, rivers or bays, where it is transformed into methylmercury, absorbed by phytoplankton, ingested by zooplankton and fish, and accumulates especially in long-lived predatory species, such as sharks and swordfish *(2)*.

Mercury releases

- Natural: volcanic activity, weathering of rocks, water movements, biological processes.
- Human activities: mercury-added products; manufacturing processes in which mercury or mercury compounds are used; artisanal and small-scale gold mining; coal-fired power plants; coal-fired industrial boilers; smelting and roasting processes used in the production of non-ferrous metals; waste incineration facilities; cement clinker production facilities.
- Remobilization of legacy sources: mercury in soil, sediment, water, landfill, waste.

Sources of exposure to mercury

Industrial processes

Most of the mercury in the environment results from human activity, particularly from coal-fired powerplants, coal-fired industrial boilers and waste incineration facilities. Artisanal and small-scale gold mining (where mercury is used to form an amalgam before being burned off) is the single largest source of global anthropogenic (caused by human activity) emissions *(3)*.

Food

Eating contaminated fish and shellfish is the main source of methylmercury exposure, especially in populations that rely heavily on consumption of predatory fish. Cooking does not eliminate mercury from fish. Joint Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) guidance exists for national food safety authorities to assess the net health benefits or risks of fish consumption, taking into account the existing information on the benefits of eating fish *(4)*.

WHO guidance values: provisional tolerable weekly intake

In 2003 the Joint FAO/WHO Expert Committee on Food Additives (JECFA) established a tolerable intake of 1.6 µg/kg body weight per week for dietary exposure to methylmercury in order to protect the developing fetus from neurotoxic effects *(5)*. In 2006, JECFA clarified that life stages other than the embryo and fetus may be less sensitive to the adverse effects of methylmercury *(6)*. For adults, up to about twice the tolerable intake per week would not pose any risk of neurotoxicity. However, available data did not allow firm conclusions to be drawn for children (aged up to about 17 years), as they may be more sensitive than adults. Hence the tolerable intake established in 2003 applies also to children.

In 2010 JECFA established a provisional tolerable weekly intake for inorganic mercury of 4 µg/kg body weight, applicable to dietary exposure to total mercury from foods other than fish and shellfish *(7)*.

Health care

Significant releases of mercury to the environment result from the use of mercury-containing thermometers and blood pressure measuring devices, and from the incineration of the associated medical waste *(8, 9)*.

Dental amalgam is a potentially significant source of release since it can contain up to 50% elemental mercury. It is released as vapour, ions or fine particles and may be inhaled or ingested. Although no adverse health effects have been proven, use of dental amalgam is declining progressively. Amalgam may represent an occupational risk for dentists and can cause release of mercury into wastewater during dental care and to the atmosphere during cremation. While effective measures exist to capture dental amalgam waste in oral health care facilities and to limit mercury emission during cremation, and have been recommended as best management practice, they have not been universally implemented.

Thiomersal (sodium ethylmercury thiosalicyclate or thimerosal), which contains 49.6% ethylmercury, is used in very small amounts as a preservative in some vaccines and pharmaceuticals. Ethylmercury does not accumulate and is actively excreted via the gut. Concerns raised in 1999 about the cumulative amount of mercury in infant immunization schedules led to further investigation of the safety of thiomersal and review by the WHO Global Advisory Committee on Vaccine Safety. This review concluded that numerous well designed epidemiological studies conducted in many countries have failed to find a causal relationship between exposures to thiomersal in vaccines and neurodevelopmental disorders *(10)*.

Consumer products

Mercury in some traditional, complementary and integrative medicine represents a risk of exposure due to the practice itself or from accidental spills. Elemental mercury or mercury compounds may be added as an ingredient, or may be present as a contaminant. However, the extent of the problem is unknown *(11, 12)*.

Some types of batteries and compact fluorescent lamps and light bulbs are also sources of exposure to elemental mercury.

Mercury is a common but dangerous ingredient found in many skin lightening creams and soaps. Many such products contain mercury levels higher than the limit established in the Minamata Convention on Mercury. Despite having been banned in many countries, mercury-containing skin lightening products are often easily obtainable *(13)*.

The above list of consumer products that may contain mercury is not exhaustive. For additional information as well as information on controls needed on sources of mercury products see the text and annexes of the Minamata Convention on Mercury *(14)*.

WHO guideline values

Water: 6 µg/litre for inorganic mercury *(15)*.

Air: 1 µg/m^3 (annual average) *(16)*.

WHO estimated a tolerable concentration of 0.2 µg/m^3 for long-term inhalation exposure to elemental mercury vapour, and a tolerable intake of total mercury of 2 µg/kg body weight per day *(17)*.

Health effects

- Elemental mercury and methylmercury are toxic to the central and peripheral nervous system. The inhalation of mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal. The inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested *(18)*.
- Neurological and behavioural disorders may be observed after inhalation, ingestion or dermal application of different mercury compounds. Symptoms include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction. Mild subclinical signs of central nervous system toxicity can be seen in workers exposed to an elemental mercury level in the air of 20 µg/m^3 or more for several years. Kidney and immune effects have been reported. There is no conclusive evidence linking mercury exposure to cancer in humans.
- Children are especially vulnerable and may be exposed directly by eating contaminated fish. Methylmercury bioaccumulated in fish and consumed by pregnant women may lead to neurodevelopmental problems in the developing foetus. Transplacental exposure is the most dangerous, as the fetal brain is very sensitive. Neurological symptoms include intellectual disability, seizures, vision and hearing loss, delayed development, language disorders and memory loss. In infants and young children, a condition called acrodynia (or “pink disease”), characterized by red and painful extremities with local swelling and intense itching, and which can be accompanied by insomnia, irritability, and sensitivity to light, has been reported to result from chronic mercury exposure.
- Biological measurement (biomonitoring) of mercury, for example in hair, blood, nails and urine, allows exposure to be quantified and linked to possible health effects. Biomonitoring data directly reflect the total body burden resulting from all routes of exposure, and inter-individual variability in exposure levels, metabolism and excretion rates. Assessment of prenatal exposure to mercury can be done with guidance from the WHO human biomonitoring survey and standard operating procedures *(19, 20)*.

WHO recommendations

National, regional and global actions, both immediate and long-term, are needed to reduce or eliminate releases of mercury and its compounds to the environment. In line with the Minamata Convention on Mercury and the related World Health Assembly resolution WHA67.11 (2014) *(21)* and Executive Board Resolution EB148/R1 on oral health (2021) *(22)*, WHO is committed to work with the health sector and national, regional and global health partners to:

- address the public health aspects of mercury and mercury compounds in the context of the health sector, including phasing out mercury-containing medical measuring devices, phasing down dental amalgam, and stopping the manufacture, import and export of mercury-containing skin lightening products;
- develop public health strategies to address mercury in artisanal and small-scale gold mining;
- undertake strategic planning to identify measures and preparatory actions to be taken by health ministries for implementation of the health-related articles of the Minamata Convention;

- create tools, offer guidance, and provide training materials to support WHO Member States in managing the public health impacts of mercury and mercury compounds.

Elimination of mercury-related diseases requires strategic action to:

- conduct national assessments of mercury usage and disposal and implement educational activities for the health, environment and other sectors *(23)*;
- promote the use of mercury-free alternatives, for example for sphygmomanometers and thermometers, and ensure that mercury-containing medical measuring devices are taken back by the manufacturer or properly disposed of;
- develop mercury clean-up and waste handling, storage and safe handling procedures, and promote environmentally sound management of health-related waste containing mercury (as set out in the United Nations Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal) *(24)*;
- develop technical guidance on environmentally friendly and less invasive dentistry to support countries in the implementation of strategic interventions aligned with the nine measures set out in Part II of Annex A to the Minamata Convention on Mercury;
- encourage countries to establish or improve policies and legislation on mercury and engage different parts of society in implementing policies and laws, highlight the role of the health sector in dealing with mercury-containing material, health care waste and emission reduction, and promote effective ways to control mercury emissions from cremation;
- encourage international agencies to work with manufacturers, wholesalers and retailers to develop and make widely available inexpensive mercury-free consumer products;
- assist countries in preparing advice for pregnant and lactating women and children about the risks and benefits of fish consumption, indicating the type of fish that may be eaten and how often, while recognizing that WHO strongly recommends breastfeeding, since the presence of methylmercury in breast milk is not sufficient to outweigh its benefits;
- identify traditional practices and folk medicines involving mercury and disseminate information on mercury hazards, exposure prevention and how to clean up spillages;
- advocate regulatory actions by governments as well as media and advocacy campaigns to stop the manufacture, import and export of mercury skin lightening products;
- promote long-term monitoring (including biological measurements of exposure) and programmes to reduce occupational exposure.

References