Impact of mercury exposure from chlor-alkali plants

An EU project, EMECAP\(^1\), has investigated levels of mercury exposure to populations living near chlor-alkali plants and the impact on human health. It found that the overall health risk was low, but was higher for some workers at the plants and for those who consumed contaminated fish or had mercury dental fillings.

Mercury is a natural element but human activities, such as mining and coal-combustion in power plants, add to environmental levels. It usually occurs in combination with other chemicals, forming salts or compounds such as methylmercury. A major anthropogenic source of mercury is the manufacture of chlorine, (a chemical used as a disinfectant, among many other uses), by the mercury cell chlor-alkali (MCCA) process. In Europe this method is being replaced with alternative processes that do not use mercury.

Mercury is highly toxic and can affect a number of organs, including the kidneys. It can be inhaled from the air, but it is primarily taken in through diet, especially through fish and seafood consumption.

The researchers studied an area around a large MCCA plant in Tuscany, Italy, which discharges waste directly into the Mediterranean Sea. They sampled the local air, soil, vegetables and fish to assess exposure to mercury in adults living in the vicinity of the plant. The samples were compared to a reference area 20 kilometres away.

In general, the impact of mercury was in the immediate vicinity of the plant. Increased levels of mercury in the atmosphere were found close to the plant - 8.0–8.7 ng/m\(^3\) (nanograms per cubic metre) in summer and 2.8–4.2 ng/m\(^3\) in winter. Peaks of up to 100 ng/m\(^3\) were observed under particular meteorological conditions. However, three kilometres away, the mercury dropped to the background level (typical level) of 2 ng/m\(^3\). Total emissions of mercury to the air were around 285 kilograms per year. Of this, only 14 per cent is deposited within 5 kilometres from the plant. 86 per cent is transported away from the area, highlighting the contribution of local sources of mercury to global pollution.

Levels of inhaled mercury from the air were approximately 18 times higher around the MCCA plant (0.06-2.0μg/day (micrograms per day)) compared with the reference area. However, this is still relatively low and is only 50 per cent of the 4μg/day level recommended by the WHO\(^2\). However, exposure is increased for those with mercury dental fillings. For some of those in the area with mercury dental fillings, the overall level of exposure was estimated to be over 4μg/day.

Relatively low concentrations of total mercury and methylmercury were found in soil samples and in vegetables taken from around the MCCA plant, at levels only slightly higher than in the reference area. Total mercury concentrations in local fish varied: 39 per cent of samples exceeded the 0.5mg/kg (fresh weight) limit\(^3\) set by the EU for all marine species (other than marine tuna, swordfish and shark). However, there are many other sources of mercury in the Mediterranean Sea and these levels could not be directly related to the MCCA plant.

Intake of mercury from fish, vegetables, other foods and drinking water appeared to be similar to the intake of those living in the reference area and was well below the limit of 2μg inorganic mercury per kg body weight per day set by the WHO, showing no unacceptable risk to human health, again, except for those who have a higher number of mercury dental fillings.

In contrast, mercury in the form of methylmercury could pose a real health risk: daily exposure to methylmercury, primarily through the consumption of local fish and vegetables, ranged up to 474 per cent of the daily tolerable dose set by the Joint WHO/FAO Expert Committee on Food Additives\(^2\).
The project also looked to see if actual health impacts on local residents could be identified. The researchers questioned residents about lifestyle and took urine samples to see if there was a link between early signs of kidney damage and high levels of mercury in the urine. In addition to the Italian plant, they also studied populations living near MCCA plants in Poland and Sweden. The participants included staff from the MCCA plants who were compared with residents who lived far away from the plants.

No association between mercury levels in the urine and signs of early kidney dysfunction was found for residents living close to the MCCA plants. In general, mercury levels were low. The highest levels of mercury (measured as 1.2μg per gram of creatinine (C), a natural chemical found in urine) were found in the Italian participants, with lower levels in the Polish (0.22μg/gC) and Swedish (0.21μg/gC) groups. However, urinary mercury levels were not significantly different between people living near MCCA plants and those living further away. They did find that urinary mercury levels were higher in individuals who had mercury dental fillings and in those who ate fish.

Similar levels of mercury in urine were detected for workers in the MCCA plants in all three countries: 3.8μg/gC for Swedish, 4.6μg/gC for Italian and 6.0μg/gC for Polish employees. Compared with earlier studies on MCCA workers, these levels are lower, which indicates that more recent safety measures to protect workers have been effective.

However, in cases where MCCA workers had been highly exposed, as shown by very high mercury levels in urine (greater than 35μg/gC), there was some indication of early kidney damage, especially among the Swedish men.

Exposure to low levels of mercury over an extended period of time remains a concern, especially when the effects are combined with exposure to other toxic substances, such as lead and cadmium.

1. EMECAP (European Mercury Emission from Chlor-alkali Plants) was supported by the European Commission under the Fifth Framework Programme. See: www.emecap.com

Sources:

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