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Mercury in breast milk – A health hazard for infants in gold mining areas?

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Abstract

Breast-feeding can be a source of mercury exposure for infants. The main concern up to now is methyl-mercury exposure of women at child-bearing age. Certain fish species have high levels of methyl-mercury leading to consumer's advisory guidelines in regard of fish consumption to protect infants from mercury exposure passing through breast milk. Little is known about the transfer of inorganic mercury passing through breast milk to infants. Epidemiological studies showed negative health effects of inorganic mercury in gold mining areas. Small-scale gold miners use mercury to extract the gold from the ore. Environmental and health assessments of gold mining areas in Indonesia, Tanzania and Zimbabwe showed a high exposure with inorganic mercury in these gold mining areas, and a negative health impact of the exposure to the miners and the communities. This paper reports about the analysis and the results of 46 breast milk samples collected from mercury-exposed mothers. The median level of 1.87 μg/l is fairly high compared to other results from literature. Some breast milk samples showed very high levels of mercury (up to 149 μg/l). Fourteen of the 46 breast milk samples exceed 4 μg/l which is considered to be a "high" level. US EPA recommends a "Reference Dose" of 0.3 μg inorganic mercury/kg body weight/day [United States Environmental Protection Agency, 1997. Volume V: Health Effects of Mercury and Mercury Compounds. Study Report EPA-452/R-97-007: US EPA]. Twenty-two of the 46 children from these gold mining areas had a higher calculated total mercury uptake. The highest calculated daily mercury uptake of 127 μg exceeds by far the recommended maximum uptake of inorganic mercury. Further systematic research of mercury in breast milk from small-scale gold mining areas is needed to increase the knowledge about the bio-transfer of mercury from mercury vapour-exposed mothers passing through breast milk to the breast-fed infant.

Keywords: Mercury vapour; Breast milk; Small-scale gold mining; Tanzania; Zimbabwe; Indonesia

Introduction

Mercury is a neuro-toxic substance and a hazard for the healthy development of infants (Clarkson et al., 2003; Davidson et al., 2004; Clarkson and Magos, 2006).

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Mercury is excreted into breast milk, and breast-fed infants are thereby exposed to this toxic heavy metal (United States Environmental Protection Agency, 1997; Risher and DeWoskin, 2004). Recent studies in fish eating communities showed a significant adverse effect of methyl-mercury to the regular development of infants exposed in utero (Grandjean et al., 1997; Myers and Davidson, 2000; Myers et al., 2003; van Wijngaarden et al., 2006). Breast milk containing mercury exposes breast-fed infants to mercury (Grandjean et al., 1995). In animal experiments it was shown that a maternal exposure to lipophilic methyl-mercury contributes more to the mercury burden of breast milk than an exposure to hydrophilic inorganic mercury ions (Hg^{2+}) (Sundberg et al., 1999a, b). The redistribution and excretion of mercury into breast milk from mothers exposed to lipophilic mercury vapour (Hg^0) is not well examined (Sundberg et al., 1999a, b).

A high mercury vapour burden is to be found prevalently in small-scale gold mining areas. In these mining areas all over the developing world, small-scale gold miners extract the gold from ore by using liquid mercury. Mainly the smelting (''burning'') of gold amalgam, a gold–mercury compound exposes the miners and the communities to very high levels of mercury vapour (Drasch et al., 2001).

The authors Bose-O'Reilly, Drasch and Lettmeier had the opportunity to examine more than 1000 exposed volunteers and controls in four different mining areas in Indonesia (Kalimantan and Sulawesi), Tanzania and Zimbabwe as part of a major UNIDO project (Veiga and Baker, 2004).

In each of the different gold mining areas more than 10,000 people live and work. In the mining areas there is no proper separation of working and housing areas, leading to a continuous exposure of the whole community to dangerous mercury vapours. The small-scale gold mining areas are characterised by severe poverty and insufficient health care systems (Spiegel et al., 2005).

Extensive environmental assessment was performed as part of the UNIDO programme in each of the mining sites. The results are published as UNIDO reports of the ''Global Mercury Project'' (Bose-O'Reilly et al., 2004a, b; Drasch and Bose-O'Reilly, 2004) and elsewhere (Castilhos et al., 2006; Taylor et al., 2005). In small-scale gold mining areas, the source of mercury burden is typically mercury vapour (Hg^0). The assessment of the environment did not show any major local methyl-mercury exposure. Notably local fish was not severely contaminated with methyl-mercury (Castilhos et al., 2006; Taylor et al., 2005). The main health hazard therefore is the exposure of the local population to mercury vapour.

Within the scope of the epidemiological health study, anamnestic health data, data from neurological examinations and neuro-psychological tests and human bio-monitoring results were obtained. The main results were, that the amalgam burners showed severe symptoms of a chronic mercury intoxication (Drasch et al., 2001; Bose-O'Reilly et al., 2003). People living in mining communities, exposed to mercury, including children showed typical signs of a chronic mercury intoxication (Bose-O'Reilly et al., 2004a, b; Drasch and Bose-O'Reilly, 2004). Due to the fact, that breast-feeding women in mining communities were also exposed to mercury, they were requested to give voluntarily a breast milk sample.

Materials and methods

Participants

In 2003 and 2004, participants from exposed communities were randomly selected to participate voluntarily in a preliminary study in mining areas in Indonesia (Kalimantan and Sulawesi), Tanzania (Geita) and Zimbabwe (Kadoma). Over 1000 participants gave a written consent in their national language for the examination including bio-monitoring sampling. Forty-six breast-feeding women were identified and gave a breast milk sample. Breast milk was collected anytime during the day.

The exposure of the individual participant is due to the place of living, working with immediate Hg contact, duration of exposed working and living, and possible other sources of Hg, such as fish or amalgam fillings.

In this study, only women living in exposed mining areas are included, since the number of breast-feeding women in non-exposed control areas was too small. In the gold mining communities there is no separation of housing and working. Thus, in this preliminary study all breast-feeding women are considered as Hg exposed.

Medical investigations, especially a neuro-paediatric assessment of the infants, were not in the scope of the ''Global Mercury Project''. Therefore, one of the main limitations of this preliminary study is the lack of data of the breast-fed children like age, exclusiveness of breast-feeding or medical data.

Laboratory methods

Collection of blood, urine, breast milk and hair samples

The collection of the bio-monitors was performed by following well-established practices. The blood samples were taken in EDTA-coated vials. The spontaneous urine samples were collected in urine boxes, transferred into urine vials and then acidified for preservation with nitric acid. After cleaning the breast, the breast milk was collected in boxes and then transferred into vials, especially made for samples containing toxic metals. All the samples were stored under continuous cooling at 4 °C in a cooling box until analysis.

A strand of hair was taken from the back of the head near the scalp with a pair of scissors made of stainless