Evidence of mercury exposure in a particular low-income community in South Africa

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BACKGROUND

South Africa relies mainly on coal for its energy needs. In addition, the country is one of the main producers of gold. Both coal combustion and gold mining are sources of mercury pollution, contributing to South Africa being one of the leading countries in terms of mercury emissions to the environment[1]. The human nervous system is very sensitive to mercury[2]. When metallic mercury vapour in the air is inhaled, it may cross the blood-brain barrier and cause permanent brain damage (**Figure 1**). Bacteria in water and soil convert metallic mercury into methylmercury, which accumulates in the food chain, causing larger and older fish to have the highest concentrations[2]. When people drink water or eat fish containing methylmercury, they may suffer permanent damage to the nervous system[2]. The half-life of mercury in the human body is about two months[2].

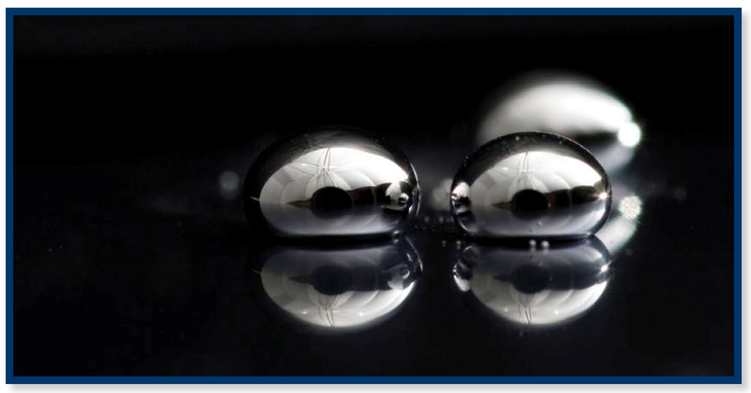

Figure 1: Droplets of metallic mercury

A CSIR study determined the extent of mercury exposure in a community close to mercury sources. This community was situated in an area where there are coal-fired power stations and within 5km of gold mining activities. The houses in the community were situated far apart amongst dense vegetation. Structures were informal, even though 83.3% of the participants indicated that they had been living there for at least five years. Participants were mostly dependent on the river as their source of water (66.7%) and 63% regularly ate fish from the same river (**Figure 2**).

Figure 2: Participants drew water from the river for consumption

METHODS

A trained field worker carried out a questionnaire survey through interviewing 30 participants. Questions were asked about lifestyle, living conditions, socio-economic status, occupation and occupational exposure and health status. Information on confounders (factors unrelated to mercury poisoning but having similar symptoms) of mercury exposure, such as alcohol consumption and head injuries, were also obtained. Blood and urine samples were collected from the participants by a qualified and registered nursing sister. These samples were analysed for mercury by an accredited pathology laboratory. Ethical clearance for this study was obtained from the University of Pretoria Ethics Committee (clearance certificate number 108/2007).

In a separate study by the CSIR (conducted within six months from this study), mercury concentrations in water and fish samples (**Figure 3**) from the river of concern, were determined to establish the community's possible exposure through their consumption of water and fish.

Figure 3: Water and fish samples collected for mercury analysis

RESULTS AND DISCUSSION

Potential sources of exposure

Domestic exposure

The following results were found:

- The concentrations of total mercury in the water (maximum 3.81 ng/l) were below guideline values for South Africa (water guideline: 1 µg/l)[1];
- The concentrations of total mercury in fish (maximum 0.34 µg/g) were below the World Health Organization guideline (guideline for mercury in fish tissue: 0.5 µg/g)[1];
- Only 20% (6 out of 30) of respondents used coal for cooking[1].

It was therefore unlikely that exposure was from indoor coal combustion or from consumption of water and fish from the river.

OCCUPATIONAL EXPOSURE

Levels of mercury in urine and blood samples were compared to the South African guidelines for individuals who are not exposed to mercury in the workplace[1]. The following were found:

- 57.1% (16 out of 28) of the urine sample levels were at or above the guideline of 5 µg/g creatinine (**Figure 4**). The maximum urine level detected was 63.5 µg/g creatinine
- 21% (3 out of 14) of the blood sample levels were at or above the guideline of 10 µg/l. The maximum blood level detected was 24.0 µg/l.
- The urine and blood maxima were also above the occupational Biological Exposure Index (BEI) for South Africa, which are 35 µg/g creatinine for urine and 15 µg/l for blood[1].

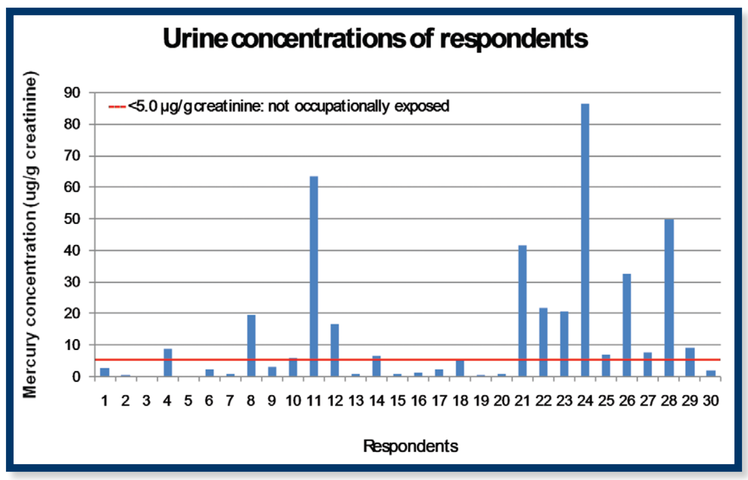

Figure 4: Concentrations of mercury per urine sample. The guideline is in red

These results therefore suggest that the participants were exposed to concentrations similar to those found in an occupational environment. However, only two of the participants were employed, as a farm worker and a shop owner respectively. Occupational exposure therefore did not seem to be a likely source of mercury exposure.

HEALTH EFFECTS IN PARTICIPANTS

Symptoms associated with mercury exposure were also detected in participants with elevated mercury levels in their blood or urine (**Table 1**):

Table1: Prevalence of symptoms experienced by respondents with elevated mercury levels

Symptom	Prevalence in group with elevated mercury levels
Metallic taste in mouth	21% (3/14)
Bad appetite	57% (8/14)
Lost >10 kg in past year	14.3% (2/14)
Get tired easily	14.3% (2/14)
Have tremors	0%
Have palpitations	7.1% (1/14)
Headaches	28.6% (4/14)
Numbness	7.1% (1/14)
Feel nervous	14.3% (2/14)
Feel sad	42.9% (6/14)
Have problems concentrating	14.3% (2/14)

The question therefore remained: What was the cause of the mercury exposure? The high unemployment rate and low level of schooling (51.7% or participants had no schooling or other education) together with the close proximity to gold mining activities, created the perception that these individuals may be involved in small-scale gold mining. This activity is, however, illegal in South Africa, and could therefore explain why participants did not indicate that they were indeed involved in small-scale mining during the questionnaire interviews.

Small-scale gold mining provides an important source of livelihood for communities in regions where economic alternatives are limited. Small-scale mining, although often conducted in below-standard environmental and occupational health conditions, have the potential to empower disadvantaged communities[3]. It has been suggested that approximately 20 000 small-scale gold miners could participate in this industry in South Africa[4]. Mercury is used as an amalgam for gold. Gold amalgamation is popular amongst small-scale miners because it is efficient in extracting gold from the concentrates obtained through their operations and the technique has a low investment cost. The gold/mercury amalgam is then heated to remove the mercury from the gold. During the heating process, individuals are exposed to mercury vapours[5]. Studies showed that for every 1g of gold produced through small-scale gold mining, 1.2 to 1.5g of mercury is emitted to the environment, mostly (70 to 80%) to the atmosphere[6].

The small-scale miners are generally unaware of the dangers of mercury. A lack of capital further contributes to health and safety being ignored during operations. There exists a need to conduct public health awareness campaigns among small-scale miners on the handling of mercury as it is foreseen that this practice will continue at least as long as poverty drives the miners, or until alternative employment options become available.

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