Health impacts and HBM in populations exposed to elemental mercury vapor or methylmercury

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Three Chemical forms of Hg

- **Elemental**
  - Metallic: \( \text{Hg}^0 \)

- **Inorganic:** \( \text{Hg}^{++} \)

- **Organic:** \( \text{CH}_3\text{Hg}^+ \)
  - Methylmercury

Methylmercury is the most common form.
Mercury use for gold extraction in ASGM

Hg gold amalgam → Burning → Gold!
Symptom of Hg vapor intoxication
HBM and health examination in Hg mine workers exposed to Hg vapor

2005 in Guiyang, China

Mercury mine

Smelting

Hand tremor / postural sway examinations

Urine sampling
Urinary Hg concentrations for controls, miners, and smelters

## Hand tremor intensity (mean ± SD) between Hg mine workers and controls

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Exposed workers (n=27)</th>
<th>Control subjects (n=54)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant hand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.234 ± 0.111</td>
<td>0.172 ± 0.077</td>
<td>0.006</td>
</tr>
<tr>
<td>1-6</td>
<td>0.090 ± 0.038</td>
<td>0.071 ± 0.019</td>
<td>0.004</td>
</tr>
<tr>
<td>6-10</td>
<td>0.160 ± 0.063</td>
<td>0.143 ± 0.063</td>
<td>0.258</td>
</tr>
<tr>
<td>10-14</td>
<td>0.112 ± 0.076</td>
<td>0.071 ± 0.051</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Postural sway and renal disorder in Hg mine workers.

Background of Minamata disease and MeHg pollution in Minamata Bay

MeHg was produced as a by-product of acetaldehyde production and directly discharged into Minamata Bay. The people who consumed a lot of contaminated fish showed neurological disorders so called Minamata disease.

Chisso Co., Ltd. Minamata Factory (1959)
Methylmercury transfer to the brain and fetus

Methylmercury transfer to the brain and fetus occurs through specific barriers and transport mechanisms. Methylmercury (MeHg) is converted to MeHg-cysteine, which is then transferred as L-type E-AA (Epsilon-Amino Acid). The process involves the transport proteins LAT (L-amino acid transporter) in the blood-brain and blood-placenta barriers, facilitating the transfer of MeHg-cysteine to the brain and fetus.
Historical time-course changes of MeHg concentrations in preserved umbilical cords from Minamata-area inhabitants

(2010 Env Saf Tox Sakamoto et al)
Minamata Disease

Video from NIMD.
MeHg Intoxication in Iraq

Video from Rochester University.
Severe Fetal-type MeHg Intoxications

Minamata disease 1956, 1965

Photo by Eugene Smith

Iraq MeHg intoxication 1971

Photo by Bakie
Distribution of hair mercury concentration of the present study

Male:
- GM = 17.2 ppm
- Max: 102 ppm

Female:
- GM = 17.2 ppm
- Max: 73 ppm
Main cohort studies on the effects of MeHg on child development

◆ Seychelles Study
- Rochester Univ. group
- 1989–90
- Fish
- Biomarker: Maternal hair
- 6.8 (Range: 0.5–27) ppm by hair Hg
- No significant effects
- NOAEL (Non Observed Adverse Effect Level): 12 ppm

◆ Faroe islands study
- Odense Univ. group
- 1986–87
- Pilot whale
- Biomarker: Umbilical cord blood
- 4.3 (Range: 0.2–39.1) ppm by hair Hg
- Effect to language, attention and memory.
- BMDL (Boston Naming Test): 10 ppm

The results were not consistent with each other.
Correlation coefficients (r) among biomarkers at parturition:

- Maternal blood
- Maternal hair
- Maternal nails
- Fetal (Cord) blood
- Placenta
- Cord tissue

Correlation coefficients:
- Maternal blood to Placenta: 0.88
- Maternal blood to Fetal (Cord) blood: 0.84
- Maternal hair to Fetal (Cord) blood: 0.80
- Maternal nails to Placenta: 0.70
- Maternal nails to Cord tissue: 0.92
- Maternal nails to Fetal (Cord) blood: 0.88

Diagram colors:
- Black: ER 2015
- Purple: EI 2014