

PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

Mercury Exposure and Health Impacts among Individuals in the Artisanal and Small-Scale Gold Mining (ASGM) Community

The Minamata Convention

In January 2013, governments agreed to legally binding text for the Minamata Convention on Mercury.¹ Article 7 and Annex C of the Convention address artisanal and small-scale gold mining (ASGM).¹ Annex C addresses the development of national plans for ASGM including a public health strategy that addresses the gathering of health data, training for health-care workers and awareness-raising through health facilities.

Mercury Use in ASGM

Mercury is used in gold mining to extract gold from ore by forming “amalgam” – a mixture composed of approximately equal parts mercury and gold.^{2,3} The amalgam is heated, evaporating the mercury from the mixture, leaving the gold.² This method of gold extraction is used in the ASGM community because it is cheaper than most alternative methods, can be used by one person independently, and is quick and easy.³ On a global basis, ASGM is responsible for approximately 37% of mercury emissions and is the largest source of air and water mercury pollution.⁴ Mercury vapors in the air around amalgam burning sites can be alarmingly high and almost always exceed the WHO limit for public exposure of 1.0 $\mu\text{g}/\text{m}^3$. These exposures affect not only ASGM workers but also those in the communities surrounding the processing centers.³ The vaporized mercury eventually settles in soil and the sediment of lakes, rivers, bays, and oceans and is transformed by anaerobic organisms into methylmercury. In waterbodies, the methylmercury is absorbed by phytoplankton, ingested by zooplankton and fish thereby contaminating the food chain. It especially accumulates in long-lived predatory species including shark and swordfish.^{3,5-8}

ASGM Hot Spots

Approximately 15 million people, including approximately 3 million women and children, participate in the ASGM industry in 70 countries.¹ These countries are found primarily in East and Southeast Asia, Sub-Saharan Africa, and South America. Some ASGM activity also occurs in South Asia and the Commonwealth of Independent States (former Soviet republics) and other European countries.^{3,7}

Mercury Exposure due to ASGM

Much of the available literature regarding mercury exposure among ASGM communities, miners and communities affected by ASGM, examines mercury levels in hair. Hair concentrations correlate with dietary methylmercury intake.⁸ Other biological matrices where mercury is measured include urine and blood. Blood mercury concentrations

characterize recent or current exposure and can represent both elemental and methylmercury exposure while urinary mercury reflects elemental and inorganic mercury exposures.^{8,9}

Individuals residing in or near ASGM communities are typically exposed from methylmercury-contaminated fish or from the mercury vapor produced during the burning process.³ Urinary mercury among those who heat mercury to remove it from the gold or who amalgamate the gold with mercury can be extraordinarily elevated. Many of these studies¹⁰⁻¹⁷ report urinary mercury concentrations well above 50 µg mercury/g-creatinine, a urinary concentration where renal tubular effects are believed to occur,¹⁸ and/or 100 µg mercury/g-creatinine, a urinary concentration where the probability of developing the classical neurological signs of mercury intoxication is “high”¹⁹ Even those who simply reside in ASGM areas have been reported to have urinary mercury concentrations higher than 100 µg mercury/g-creatinine including children.^{15,20-22} Persons living downstream of ASGM operations have been found to have hair mercury concentrations that are more than ten times the hair mercury concentration (2.5 µg mercury/g) associated with the Provisional Tolerable Weekly Intake (PTWI).²³⁻²⁹ The PTWI for methyl mercury was established by the FAO/WHO Joint Expert Committee on Food Additives (JECFA).²⁸

Mercury and Health Outcomes

- Elemental 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.⁵
- Neurological symptoms include mental retardation, seizures, vision and hearing loss, delayed development, language disorders and memory loss. In children, a syndrome characterized by red and painful extremities called acrodynia has been reported to result from chronic mercury exposure.^{5,8}

Mercury and Health in ASGM Communities

The current epidemiological literature regarding health impacts from mercury exposure in ASGM communities consists of cross-sectional studies in multiple countries on three continents – South America, Asia, and Africa. The main health outcomes examined in these studies include neurological disorders, kidney dysfunction, and immunotoxicity/autoimmune dysfunction.

Neurological Disorders and Symptoms

- Several studies examining children in ASGM communities have found associations between mercury levels and increased deep tendon reflexes, poor leg coordination, decreased performance on visuospatial organization tests, and reduction in motor function, attention, visual contrast sensitivity and manual dexterity.^{17,30-32}
- A study of Philippine children residing near a gold mill and processing plant reported significant adverse neurological findings.³³
- A recent study conducted in Burkina Faso found that the prevalence of symptoms, including frequent headaches, sleep disorder, unusual tiredness, trembling, and vision disorder, was increased among individuals involved in either mercury-gold amalgamation and heating of the amalgam or gold dealing and selling.¹¹ A study among gold miners in Ecuador reported an association between blood and urinary mercury levels and an increase in tremor, reaction time and postural stability.¹⁰

- Investigators that conducted a study in the Tapajos River basin in Amazonian Brazil diagnosed three individuals with mild Minimata disease and suspected Minimata disease in 3 other individuals.³⁵

Kidney Dysfunction

- Exposure to high levels of elemental mercury has been associated with kidney effects.⁹ Two studies have found an association between mercury concentrations and kidney dysfunction or kidney microdamage in residents of ASGM communities.^{36,37}

Immunotoxicity/Autoimmune Dysfunction

- Four studies report an association between methylmercury exposure and autoimmune dysfunction in mining communities in Amazonian Brazil.³⁸⁻⁴¹

Alternatives to Mercury in Gold Mining

The use of mercury can be eliminated or substantially reduced in ASGM. The United Nations Environment Programme has made the following recommendations:

- Practices such as whole ore amalgamation, open burning of amalgam without vapor capture systems or retort, and reprocessing of mercury-contaminated tailings with cyanide, should be discontinued to reduce mercury exposure and emissions.^{3,42}
- Alternatives, such as “gravity only”, direct smelting and safe chemical leaching, could be employed in the ASGM industry to reduce or eliminate mercury exposure and emissions.³

Conclusions

Mercury exposure in ASGM communities is associated with adverse health effects including kidney dysfunction, autoimmune dysfunction, and neurological symptoms. Urinary mercury concentrations in ASGM communities are above the concentrations that have been associated with neurologic and kidney effects. Fish, a major source of protein for many populations in ASGM areas, are contaminated with methyl mercury as evidenced by hair mercury concentrations. Many of the hair mercury concentrations are reported to be considerably above the concentration associated with the PTWI.

For further WHO information on mercury, please visit:

http://www.who.int/ipcs/assessment/public_health/mercury/en/index.html

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