



Biotempo (Lima)



ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

POISONING BY INORGANIC MERCURY IN MINORS IN AN URBAN AREA OF ILLEGAL MINING

ENVENENAMIENTO POR EL MERCURIO INORGÁNICO EN MENORES EN UNA ZONA URBANA DE MINERÍA ILEGAL

Jesús Rojas-Jaimes¹; Rodrigo Corcuera-Ciudad^{2,3} & José Iannacone^{4,5}

¹ Carrera de Obstetricia, Universidad Privada del Norte, Lima- Perú.

² Escuela de Medicina, Universidad Científica del Sur, Lima-Perú.

³ Sociedad Científica de Estudiantes de Medicina de la Universidad Científica del Sur (SCIEM UCSUR), Panamericana Sur Km. 19, Lima- Perú.

⁴ Facultad de Ciencias Biológicas. Universidad Ricardo Palma. Santiago de Surco, Lima, Perú.

⁵ Laboratorio de Ecología y Biodiversidad Animal (LEBA). Facultad de Ciencias Naturales y Matemática (FCNNM). El Agustino, Lima, Perú.

Corresponding author: jesus.rojas.jaimes@gmail.com

ABSTRACT

Mercury is a heavy metal with toxic effects, especially at the level of the central nervous system. The poisoning by this metal can be acute when the damage occurs in a limited time or chronic when the deleterious effect is sustained. Inorganic mercury poisoning in minors who were never linked to illegal mining, an activity that takes place where minors reside, was determined. Of 118 children under 18 years, 28.8% (34/118) exceeded the permissible limits (5 µg Hg·g⁻¹) of creatinine. The percentage of contaminated minors was high given that they are people who are not linked to mining activity, so they must have been accidentally contaminated by activity generated by someone close to the minors. This premise was demonstrated in the case of the minor who was contaminated every time the mercury vapor was emitted by a chimney that was near the window of her room when mercury amalgam was re-founded on the first floor of the minor's residence. A high percentage of contaminated minors was demonstrated. Minors that are not related to the activity of illegal mining that is a serious threat to public health, especially since this group is highly vulnerable due to the cognitive development that would be affected by the inhalation of heavy metals.

Key words: Mercury – minors – poisoning – public health

RESUMEN

El mercurio es un metal pesado con efectos tóxicos, especialmente a nivel del sistema nervioso central. El envenenamiento por este metal puede ser agudo cuando el daño ocurre en un tiempo limitado o crónico cuando se mantiene el efecto perjudicial. Se determinó la intoxicación por mercurio inorgánico en menores que nunca fueron vinculados a la minería ilegal, una actividad que tiene lugar donde residen los menores. De 118 niños menores de 18 años, el 28,8% (34/118)

excedió los límites permisibles ($5 \mu\text{g Hg}\cdot\text{g}^{-1}$) de creatinina. El porcentaje de menores contaminados fue alto, agregando que son personas que no están vinculadas a la actividad minera, por lo que deben haber sido contaminadas accidentalmente por alguna actividad generada por alguien cercano a los menores. Esta premisa se demostró en el caso de una menor, en la que la niña se contaminaba cada vez que el vapor de mercurio era emitido por una chimenea que estaba cerca de la ventana de la habitación de la niña cuando la amalgama de mercurio era refundada en el primer piso donde residía la menor. Se demostró un alto porcentaje de menores contaminados. Menores que no están relacionados con la actividad de la minería ilegal que genera una situación grave de daños a la salud pública, especialmente siendo este grupo altamente vulnerable debido al desarrollo cognitivo que se vería afectado por la inhalación de metales pesados.

Palabras clave: Envenenamiento – Mercurio – Menores – Salud pública

INTRODUCCIÓN

Small-scale informal mining is a poverty-related activity in more than 70 countries, in which mercury is used to extract gold, associated with high levels of mercury exposure (Chevier *et al.*, 2009; Langeland *et al.*, 2017). In Madre de Dios, high levels of mercury have been found in the population residing in mining areas, as well as in the non-involved population (Ashe, 2012; Diringer *et al.*, 2015). Communities located hundreds of km away from places where small-scale artisanal gold mining takes place are at risk of exposure to mercury through consumption of fish with high levels of mercury (Passos & Mergler, 2008; Barbieri & Gardon, 2009; Ashe, 2012; Marques *et al.*, 2016). Of the fish consumed 60% have mercury levels above the permitted limits, and there was a 90% increase in mercury levels in fish between 2009 and 2012 (Fernandez, 2013).

Informal mining in Madre de Dios is widespread and is one of the most alarming public health problems in that region, affecting not only people who work or do not work in mining, but also the environment (Plenge *et al.*, 2012).

The young are a group very susceptible to mercury contamination, especially in preconception, pregnancy and post natal stages due to the relationship with the development of the central nervous system (Bose-O'Reilly *et al.*, 2010; Freitas *et al.*, 2019). Volatile mercury can reach the encephalic level of the fetus, because it easily crosses the blood-brain barrier and the placental route (Clarkson *et al.*, 1972). The brain is the most affected organ, but mercury can also alter renal, endocrine, muscular and immune functions, as well as causing severe types of dermatitis and peripheral nerve involvement (Bernhoft, 2012). In a study reported that

the reference values for people who are not occupationally exposed should be less than $5 \mu\text{g Hg}\cdot\text{g}^{-1}$ creatinine (Ashe, 2012; MINSA, 2015). And the detection of mercury in urine is a validated method and is an ideal marker for chronic exposure to elemental and inorganic mercury (Park & Zheng, 2012).

This research evaluates poisoning by inorganic mercury in minors in an urban area of illegal mining.

MATERIAL AND METHODS

Our study analyzed the data of the project in humans that was carried out cross section and analytical component titled "Levels of exposure to mercury in the population of Huetuhe-Madre de Dios, Peru and risk factors 2010". The data was based in a population that was captured passively on a default sample of 292 people in the district of Huetuhe, to whom a urine sample was requested for the analysis of mercury concentrations. We selected the data of 118 children less than 18 years of age not linked to the handling of mercury. The sample was processed at the National Health Center Occupational and Environmental Protection for Health "CENSOPAS", the validated technique for measuring mercury that was used was (MET-CENSOPAS-002), mercury vapor cold-spectrophotometry technique Atomic absorption AA-400. According to the Reports of Test No. 048/10-LQ-DEIPCROA-CENSOPAS / INS not exposed occupationally to those with ranges of mercury in urine $<5 \mu\text{g/g}$ creatinine and exposed persons occupationally with a biological tolerance limit of mercury in urine $<35 \mu\text{g/g}$ creatinine.

Ethical aspects: The authors adopted the Declaration of Helsinki and the Code of Ethics of the World Health Organization.

RESULTS

In the data in the study in Huetpetuhe (Figure 1), Madre de Dios, high mercury levels were found in minors (28.8%) (Figure 2).

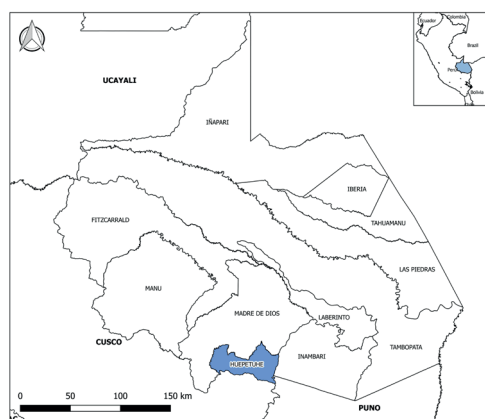


Figure 1. Map of the study place.

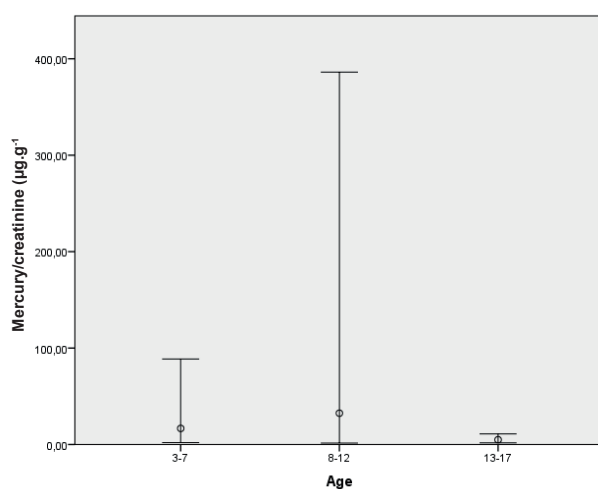


Figure 2. Values of $\mu\text{g Hg}\cdot\text{g}^{-1}$ in children under age 18 sampled in Huetpetuhe, Madre de Dios, Peru.

DISCUSSION

It is presumable that these children are unintentionally contaminated at the time of mercury amalgam burning. According to the survey, in this study there were 118 children under 18 years of age not linked to the handling of mercury, as was verified in the follow-up of a case of a 12-year-old girl with a value of $217.57 \mu\text{g Hg}\cdot\text{g}^{-1}$ of

creatinine due to chronic air pollution with exposure on an average of two years; mercury entered through the window of the minor each time the amalgam was burned. Of the total group of children 28.8% (34/118) exceeded the permissible limits ($5 \mu\text{g Hg}\cdot\text{g}^{-1}$ of creatinine), these values being surprisingly high. The populations surveyed were volunteers from the health center in the urban area of Huetpetuhe, a city convulsed by illegal mining in the middle of a region that boasts one of the greatest biodiversities in the world (Plenge *et al.*, 2012). It should be noted that in the urban area there are no mines, the mining sites being located at an average of 5 km distance in the surrounding areas. Mercury contamination in minors is a serious event due to the sustained damage that is caused to the motor and cognitive system of this vulnerable population (Clarkson *et al.*, 1972; Bose-O'Reilly *et al.*, 2010). This constitutes a warning about the expectation of finding much higher values in a survey using active recruitment of study subjects, demonstrating that a large percentage of people including children become passively contaminated.

These cases must alert the public health system to the necessity to take preventive and remediation measures as contamination affects one of the most vulnerable groups.

Competing Interests: The authors have declared that no competing interests exist.

ACKNOWLEDGMENTS

Thanks to Illa Rocconi Quintanilla for revision of English text.

BIBLIOGRAPHIC REFERENCES

- Ashe, K. 2012. Elevated mercury concentrations in humans of Madre De Dios, Peru. *PLoS One*, 7:1–6.
- Barbieri, F.L. & Gardon, J. 2009. Hair mercury levels in Amazonian populations: spatial distribution and trends. *International Journal of Health Geographics*, 8:71.
- Bernhoft, R.A. 2012. Mercury toxicity and treatment: A review of the Literature. *Journal of Environmental and Public Health*, 2012: 1–10.
- Bose-O'Reilly, S.; McCarty, K., Steckling, N. & Lettmeier, B. 2010. Mercury exposure and children's health. *Current Problems in Pediatric and Adolescent Health Care*, 40:186–215.

- Chevrier, C.; Sullivan, K.; White, R.F.; Comtois, C.; Cordier, S. & Grandjean, P. 2009. Qualitative assessment of visuospatial errors in mercury-exposed Amazonian children. *NeuroToxicology*, 30: 37–46.
- Clarkson, T.W.; Magos, L. & Greenwood, M.R. 1972. The transport of elemental Mercury into fetal tissues. *Biology of the Neonate*, 21:239–244.
- Diringer, S.E.; Feingold, B.J.; Ortiz, E.J.; Gallis, J.A.; Araujo-Flores, J.M.; Berky, A. Pan, W.K. & Hsu-Kim, H. 2015. River transport of mercury from artisanal and small-scale gold mining and risks for dietary mercury exposure in Madre de Dios, Peru. *Environmental Science: Processes & Impacts*, 17:478–487.
- Fernández, L. 2013. *Mercurio en Madre de Dios: Concentraciones de mercurio en peces y seres humanos en Puerto Maldonado*. Carnegie Amazon Mercury Ecosystem Project. Research Brief 1.
- Freitas, J.S.; Lacerda, E.M.C.B.; Rodrigues, D.R.Jr.; Corvelo, T.C.O.; Silveira, L.C.L.; Pinheiro, M.C. & Givago S. Souza. 2019. Mercury exposure of children living in Amazonian villages: influence of geographical location where they lived during prenatal and postnatal development. *Anais da Academia Brasileira de Ciências*, 91(Suppl. 1): e20180097.
- Langeland, A.L.; Hardin, R.D. & Neitzel, R.L. 2017. Mercury levels in human hair and farmed fish near artisanal and small-scale gold mining communities in the Madre de Dios river basin, Peru. *International Journal of Environmental Research and Public Health*, 14:302.
- Marques, R.C.; Bernardi, J.V.E.; Mônica P.L.C. & Dórea, C.J.G. 2016. Impact of organic mercury exposure and home delivery on neurodevelopment of Amazonian children. *International Journal of Hygiene and Environmental Health*, 219: 498–502.
- MINSA (Ministerio de Salud). 2015. *Guía de Práctica Clínica para el Diagnóstico y Tratamiento de la Intoxicación por Mercurio*. Dirección General de Salud de las personas. Lima. pp. 2–9.
- Park, J.D. & Zheng, W. 2012. Human Exposure and Health Effects of Inorganic and Elemental Mercury. *Journal of Preventive Medicine and Public Health*, 34445:344–352.
- Passos, C.J.S. & Mergler, D. 2008. Human mercury exposure and adverse health effects in the Amazon: a review. *Cadernos de Saúde Pública*, Rio de Janeiro, 24 (Sup 4): S503-S520.
- Plenge, F.O.; Rojas, J. & Manrique, C. 2012. Minería informal e ilegal y contaminación con mercurio en Madre de Dios: Un problema de salud pública. *Acta Médica Peruana*, 29:38–42.

Received May 25, 2019.

Accepted June 03, 2019.