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Mercury levels in human population from a mining district in Western Colombia

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ABSTRACT

A biomonitoring study was carried out to examine the adverse impacts of total mercury in the blood (HgB), urine (HgU) and human scalp hair (HgH) on the residents of a mining district in Colombia. Representative biological samples (scalp hair, urine and blood) were collected from volunteered participants (n = 63) to estimate the exposure levels of THg using a Direct mercury analyzer. The geometric mean of THg concentrations in the hair, urine and blood of males were 15.98 μg/g, 23.89 μg/L and 11.29 μg/L respectively, whereas the females presented values of 8.55 μg/g, 5.37 μg/L and 8.80 μg/L. Chronic urinary Hg (HgU) levels observed in male workers (32.53 μg/L) are attributed to their long termed exposures to inorganic and metallic mercury from gold panning activities. On an average, the levels of THg are increasing from blood (10.05 μg/L) to hair (12.27 μg/g) to urine (14.63 μg/L). Significant positive correlation was found between hair and blood urinary levels in both male and female individuals. Thus the present biomonitoring investigation to evaluate the Hg levels and associated health issues would positively form a framework for further developmental plans and policies in building an ecofriendly ecosystem.

Introduction

Mercury (Hg) is regarded as the sixth most toxic element on earth and it is a naturally occurring element with varied chemical forms (elemental, organic and inorganic) (Hui-Wen et al., 2011) and of significant ecological and public health concern. Natural processes like degassing of the earth's mantle/crust, evasion from soils, vegetation, wildfires, volcanic eruptions and geothermal activities are the sources of Hg (Riaz et al., 2016). On the other hand, Hg also occurs in occupational environments due to its extensive use in gold panning, pharmacology, industries and agriculture, enhancing its presence resulting in a lethal situation (WHO, 2003). Ultimately, Hg can enter human bodies through respiratory or digestive tracts and dermal absorption (Eqani et al., 2016). The transformation of inorganic to organic Hg (methylmercury MeHg) is regarded as the most toxic form and is more often intensified by bioaccumulation and biomagnification routes in the aquatic food webs

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(Ouédraogo et al., 2015). MeHg, with its lipophilic property, is highly neurotoxin and penetrates the blood–brain barrier to the central nervous system which can be fatal (WHO, 1990; Aschner et al., 1992; Ling-Chu et al., 2010). Serious occupational and complicated health issues in humans have elicited a global action called the Minamata convention (2013), which aims to protect human health and the environment by stringent plans to reduce mercury exposure and bring in harmonious living (Esteban et al., 2015).

Rising concerns of the threats to human health and environment were the motivating force behind conducting intensive and specific human monitoring programs to assess the exposure levels of Hg and the environmental risks for the populations that live in close proximity to highly polluted regions (Angerer et al., 2007). Over the past few decades, several studies have been conducted (Albert et al., 2010; Tian et al., 2011; Jin-Ling et al., 2014; Faial et al., 2015; Riaz et al., 2016; Ma et al., 2016; Bonsignore et al., 2016) to evaluate and quantify the Hg levels in human matrices namely hair, blood and urine to estimate the magnitude of its contamination. Human biomonitoring (HBM) is regarded as the most recognizable method for measuring human exposure to toxic elements and hence serves to be a valuable tool for the protection of human health.

In this regard, the aim of the present study was to investigate the levels of mercury in different biological samples (scalp hair, blood and urine) of humans from the mining district of Medio San Juan, Department of Choco, Colombia, an area impacted by gold mining.

1. Materials and methods

1.1. Study area

The mining district of Medio San Juan is located in the south central part of the Department of Chocó (Fig. 1) in Colombia along the San Juan River basin (05°09′–05°21′N; 76°33′–76°41′W) approximately covering an area of 8619 km^2. Colombia offers immense mineral potential and the Department of Chocó is considered to be the country's most resource rich provinces. The country ranks fifth in gold production and produces about 54,000 kg of gold a year, mainly in the Department of Chocó (24,500 kg), Antioquia (19,000 kg) and Bolivar (5700 kg) representing 91% of the annual gold production (Güiza and Aristizábal, 2013). The Department of Chocó mainly encompasses of Afro-Colombian population and gold panning is their foremost economic activity. Major environmental and health hazards in the region are the use of mercury in the ore beneficiation process to extract the precious metal.

1.2. Questionnaire survey

During March and May 2011, a total of 87 residents living in the Medio San Juan District from different population groups namely mine workers, gold and platinum dealers, agriculturalists, pensioners, students, pregnant women and children were involved for the present study. Participants were invited to provide data voluntarily related to an extensive questionnaire for a quick assessment of demographic information including age, sex,

Fig. 1 – Map showing the location of the study area in the mining district of San Juan, Department of Choco, Colombia.

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