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Lead and mercury levels in an environmentally exposed population in the Central Brazil

Avaliação dos níveis de chumbo e mercúrio em população exposta ambientalmente na Região Centro-oeste do Brasil

Evaluación de los niveles de plomo y mercurio en población expuesta ambientalmente en la región centro-oeste de Brasil

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Abstract

The objective was to assess the level of exposure to lead and mercury in a population in the Pantanal region in Mato Grosso State, Brazil. Blood lead (PbB) ($n = 119$) and urinary mercury (HgU) ($n = 109$) in local residents were measured by atomic absorption spectrometry. Comparison of means and correlations between variables used analysis of variance (ANOVA) and linear regression, respectively, with 95% confidence intervals. Mean PbB was 2.82 ± 1.53μg dL^{-1}. The comparison of PbB stratified by collection site ($p \leq 0.01$), work activity ($p \leq 0.01$), and consumption of locally produced cow's milk ($p \leq 0.05$) showed statistically significant differences. There were also positive associations between PbB and collection site ($p \leq 0.01$), participants' profession ($p \leq 0.05$), local milk ($p \leq 0.01$), and source of drinking water ($p \leq 0.01$). Mean HgU was 1.41 ± 0.98μg L^{-1}. The levels only showed significant differences for participants' profession ($p \leq 0.01$), and positive associations emerged between HgU and work activity ($p \leq 0.01$) and body mass index ($p \leq 0.01$). The samples showed low lead and mercury levels, similar to those found in other environmentally exposed populations. Despite these low concentrations, current knowledge on the toxicity of these metals shows that health effects can already be felt at levels that were previously considered safe, thus characterizing a health hazard.

Lead; Mercury; Environmental Exposure

Introduction

Anthropogenic contamination of air with metals comes from gases and particles resulting from the use of fossil fuels in industry and vehicles, as well as burning biomass. Other important sources of contamination are mining and smelting, which supply metals as raw material for manufacturing utensils, machines, and other objects, thereby increasing the environmental levels of these elements. More recently industry, agriculture, and medicine have found a number of further uses for metals. Such activities have thus expanded the exposure of consumers of different products, as well as of workers related to these substances. Especially in processes that use very high temperatures, metallic emissions increase considerably [1,2].

Lead (Pb) is one of the most common elements in the environment, due especially to the countless industrial activities that favor its distribution. However, this metal can also be found in zinc, silver, and copper ore, the deposits of which are distributed worldwide [3]. The natural concentration of Pb in groundwater varies according to the composition of the soil and bedrock, while Pb levels in the soil are influenced by anthropogenic activities and airborne transfer of Pb, which depends on atmospheric conditions and particulate size [4]. Other natural sources of atmospheric Pb include geological weathering, coal, oil, and wood among others [3].

The respiratory and gastrointestinal tracts are the principal exposure routes for Pb. The toxicity of Pb to humans and animals involves mainly the nervous and hematopoietic systems, in addition to the kidneys and gastrointestinal tract. Pb also affects reproduction and development and can have cardiovascular and possible mutagenic and carcinogenic effects [5].

Mercury (Hg) is widely distributed at low concentrations throughout the Earth's crust, and is used on a wide scale in gold mining due to its amalgamation capacity. Airborne transfer of Hg is rapid when compared to other environmental reservoirs, allowing Hg dispersion and exchange in the global environment. Thus, the population residing in gold-mining areas is exposed to Hg through the metallic vapors dispersed in the air or methyl Hg found in the water and contaminated fish [6]. Metallic Hg can oxidize to inorganic Hg, which in turn can be converted to methyl Hg by microorganisms. Organic Hg is more toxic, since it is fat-soluble. It can thus be distributed in all the body's tissues and easily crosses the blood-brain and placental barriers, causing neurological developmental deficits in newborns and children [4]. The central nervous system and kidneys are the principal targets of the toxicity of Hg and its compounds [6].

In Brazil, the leading source of greenhouse gas emissions is deforestation, which threatens biodiversity by felling and burning trees [7] and contributing to the environmental emission of Pb and Hg [3,6]. In some states of Brazil, particularly Mato Grosso, besides the high incidence of forest fires [8], there is a concern with gold mining, which can lead to environmental contamination with Hg [9].

The region of Poconé, located in the Pantanal in Mato Grosso, a Brazilian biome that is considered one of the planet's most important ecological reserves [10], has experienced cycles of mining activity, reaching their peak with more than 100 mining operations and approximately 5,000 miners [11]. During this period, the sediment and biota in some rivers in the region's basin showed high levels of Hg contamination. Mining later decreased drastically due to the rising costs of basic inputs for gold extraction and falling gold prices on the international market [11]. There are currently 14 large-scale mining operations and 200 workers mining gold. Poconé also has 5 shops for gold purchase that smelt the metal on their premises [12].

In this context, at the Sesc Pantanal Ecological Station, which belongs to the Social Service of Commerce (Sesc), there is a hotel dedicated to ecological tourism, which is becoming a model of education, nature conservation, scientific research, and ecotourism. The station is an integrated part of the Sesc Pantanal Private Natural Heritage Reserve (RPPN), an ecological conservation unit located on private land in the municipalities (counties) of Poconé and Barão de Melgaço in the Pantanal in Mato Grosso State [13].

In order to expand the necessary technical and scientific knowledge for sustainable ecological management and improve the quality of life for workers in the Sesc Pantanal Station and surroundings, a study was developed to assess the population's level of exposure to these metals, coming mainly from fires and mining operations in Poconé. For this purpose, the urinary mercury (HgU) and blood lead (PbB) concentrations, biomarkers for exposure to these metals [4], were investigated in the study participants.

Materials and methods

This was a cross-sectional study, carried out in March 2012 in the municipalities (counties) of Poconé and Barão de Melgaço. The selected area was that surrounding the Sesc Pantanal Ecological Station, an ecological reserve certified as a RPPN. The Hotel Sesc Porto Cercado, the Cuiabá and São Lourenço rivers, and the villages of São Pedro de Joselândia and Pimenteira are located within 10km of the reserve. Hotel Sesc Porto Cercado, also known as Sesc Pantanal, is located 45km from the city of Poconé (by the Poconé-Porto Cercado road) and the same distance from the Transpantaneira Highway, which has intense vehicle traffic because of the hotels distributed along its more than 150km of dirt road [13].

The study population consisted of 121 persons, selected among the employees of Hotel Sesc Pantanal (Poconé) and residents of the villages of São Pedro da Joselândia and Pimenteira (Barão de Melgaço), located around the RPPN, since there is no one living on the reserve itself (Figure 1). The exclusion criteria were age less than 18 years (for ethical and legal reasons), pregnant and breastfeeding women and women over 39 years due to metabolic changes that mobilize Pb from bones to blood, and persons with other diseases that disrupt the body's homeostasis [3].

A questionnaire used previously in other studies [14,15] was administered to all the participants (n = 121) to investigate socioeconomic variables, possible sources of exposure and health effects, and confounding variables for the evaluation of exposure to the metals. Following the interview, blood samples were taken (n = 119) as the biomarker for exposure to Pb [3] and urine samples as the biomarker for exposure to Hg [4] (n = 109). Losses were due to refusals or some participants' inability to provide samples, while others either failed to return with the urine sample or brought a reduced volume of urine.

Experimental

- **Instrumentation**

To determine the Pb and Hg concentrations as biomarkers for exposure, the AAnalyst 800 spectrometer was used, equipped with an AS-800 auto-sampler, end-cap graphite tubes, and a FIAS 400 flow injection system (all manufactured by Perkin Elmer, São Paulo, Brazil). The methodology for determining the level of the metal in biological fluids followed the established laboratory protocols at the authors' institution.

- **Materials, reagents, and solutions**

Before analysis, all the material was decontaminated as previously described [16]. All the reagents were at least analytical grade (AG) and supplied by Merck (Darmstadt, Germany), while the water used in decontamination of the material and preparation of the analytical solutions and samples was purified with the Milli-Q system (Millipore, Bedford, USA).

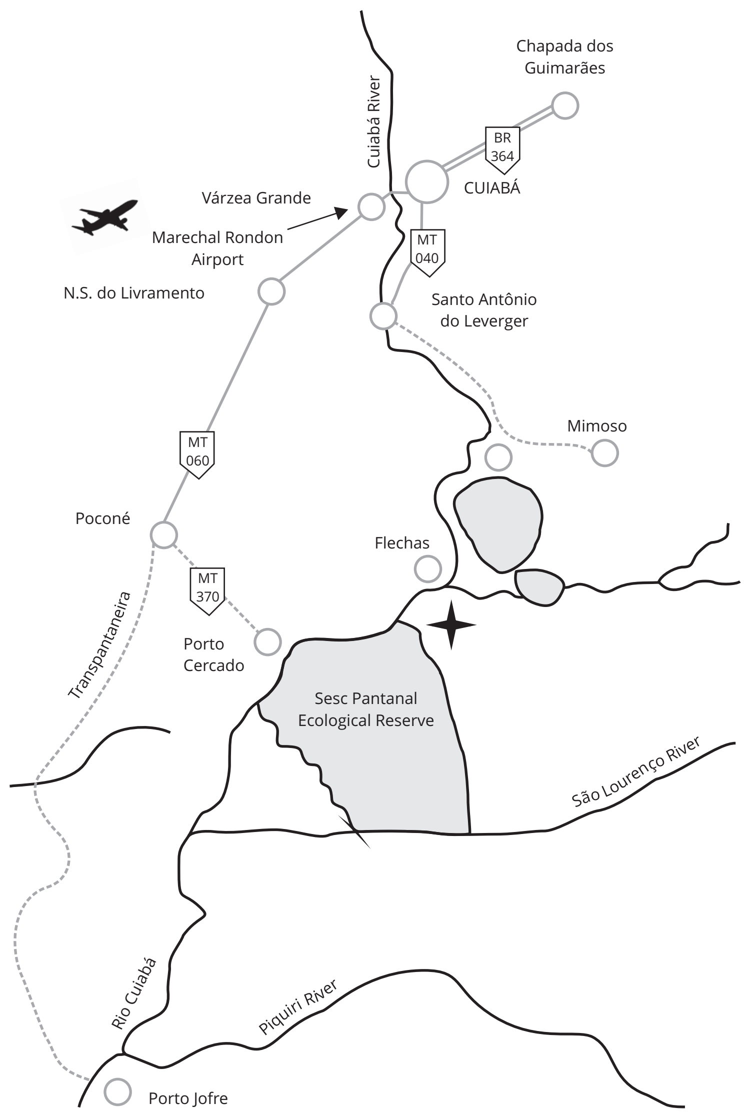
The results' accuracy was accompanied by analysis of the reference materials in each series of samples. For Pb, samples were used from Contox Blood Lead Controls (Kaulson Laboratories, New Jersey, USA), while the Inter-Laboratory Quality Control Program of the Spanish National Institute of Work Safety and Hygiene (Barcelona, Spain) supplied the material in the case of Hg.

Stock solutions of 1,000µg L^{-1} were prepared with a concentrated solution of 1,000µg mL^{-1} of Pb or Hg. The analytical Pb solutions were prepared daily by appropriate dilutions of the stock solution in 0.2% (v/v) nitric acid. Preparation of the modifier used a mixture of 10g L^{-1} magnesium nitrate and 15g L^{-1} palladium nitrate in 0.2% (v/v) nitric acid, in order to contain 15µg of palladium and 10µg of magnesium in 10µL of solution inside the oven. The whole blood was diluted in 0.1% (v/v) Triton X-100 at a ratio of 1+9 for determination of Pb.

The Hg standards were prepared daily with adequate volumes of the stock solution in 10mL of a mixture containing 15g L^{-1} (m/v) nitric acid and sulfuric acid, to which were added appropriate amounts of the oxidizing solution 5% (m/v) $KMnO_4$ and the anti-foaming agent octanol. Reading of the calibration and sample solutions used a reducing solution prepared with 3% (m/v) $NaBH_4$ and

Figure 1

Study area in the SESC Pantanal Ecological Reserve. São Pedro de Joselândia and Pimenteira, located within 10km of the Ecological Reserve, Mato Grosso State, Brazil. Porto Cercado: site of the SESC Pantanal Hotel (within 10km of the Ecological Reserve).



1% (m/v) NaOH. Urine samples were submitted to a solubilizing process after transferring 1mL of each sample directly to the reaction flask, containing 10mL of a mixture of 15g L^{-1} (m/v) nitric acid and sulfuric acid with 200µL 5% (m/v) $KMnO_4$ and 50µL octanol.

- **Collection and storage of samples**

Heparinized 7mL vacuum tubes, specific for the determination of trace elements, were used for collecting the whole blood samples. Urine samples were collected in decontaminated containers (50mL each). The samples were stored at -20ºC until analysis.

Statistical analysis

PbB and HgU concentrations were chosen as the dependent variables. The independent variables were sample collection site, profession, sex, age, family income, schooling, smoking, body mass index (BMI), morbidity, source of drinking water, and consumption of local fish, local milk, and locally grown fruits and vegetables.

The descriptive statistics served to characterize the study subjects and present the Pb and Hg levels in the study population. The Kolmogorov-Smirnov test was used to verify normality of the results' distribution. The difference in means between the groups (three or more) was shown by the ANOVA test, while factors associated with PbB and HgU were investigated by simple linear regression, r and r^2, in which r measures the intensity of the relationship between the variables and r^2 is the percentage of the dependent variable explained by the independent variable.

Unless specified otherwise, $p < 0.05$ and 95% confidence interval were used in the analyses. All the statistical operations used SPSS 17.0 for Windows (SPSS Inc., Chicago, USA).

The study was approved by the Institutional Review Board of the authors' institution. All the study subjects participated voluntarily and signed a free and informed consent form before answering the questions and providing biological samples.

Results and discussion

Study population

The study population consisted of 101 adult males (83.5%) and 20 adult females (16.5%), for a total of 121 participants, with mean age 38.8 ± 13.3 years. The study subjects worked in farming/livestock raising (47.9%), hotels (26.4%), construction and carpentry (6.6%), healthcare (3.3%), and administrative activities (2.5%), plus a group called "others", consisting of schoolteachers, homemakers, and unemployed (13.2%). Table 1 lists the participants' characteristics.

Blood and urine samples

All the samples showed concentrations that were similar to reference values found in populations with similar exposure characteristics to those in the study population, found in other studies [17,18,19]. The current study's results were consistent with the region's characteristics, where industrial activity is limited, with an economy based mainly on crop farming and livestock-raising, growing tourism, gold placer mining, all located in a state with high incidence of forest fires [8] and flooding [20]. Table 2 shows the descriptive data on PbB and HgU, and Table 3 lists the concentrations according to the sample collection site.

Lead

In the current study, mean PbB concentration (2.82 ± 1.53µg dL^{-1}) was higher than the levels recorded in the U.S. population by the *National Health Nutrition and Examination Survey* (NHANES) 1999-2000, in which the range was 1.62-1.68µg dL^{-1}. In the United States, recent decades have witnessed a striking reduction in environmental Pb sources, greater protection from occupational exposure to the metal, and an overall downward trend in PbB levels in adults. As a result, mean PbB decreased from 1.2 (NHANES 2009-2010) to 0.86µg dL^{-1} in NHANES 2013-2014 [21]. Still, low-dose Pb exposure can lead to adverse cardiovascular and renal effects, cognitive dysfunction, and adverse reproductive outcomes. Current research has pointed to decreased renal function associated with PbB ≤ 5µg dL^{-1}, and increased risk of hypertension and essential tremor in PbB less than 10µg dL^{-1}, levels that had previously been considered safe [22]. Given such evidence, in 2015 the National Institute for Occupational Safety and Health (NIOSH), the U.S. agency for work-related research, of the Centers for Disease Control and Prevention (CDC), defined 5µg dL^{-1} as the reference for PbB in adults and began to consider levels ≥ 5µg dL^{-1} as elevated. However, from 2009 to 2015 only PbB greater than 10µg dL^{-1} was

Table 1

Characteristics of the study population (n = 121).

Variable	n	%
Gender		
Male	101	83.5
Female	20	16.5
Age bracket (years)		
18-29	38	31.4
30-39	34	28.1
40-49	25	20.7
≥ 50	24	19.8
Work activity		
Farming/Livestock	58	47.9
Hotels	32	26.5
Construction/Carpentry	8	6.6
Health	4	3.3
Administrative	3	2.5
Others *	16	13.2

* Schoolteachers, homemakers, and unemployed.

Table 2

Blood lead (PbB) and urinary mercury (HgU) concentrations.

	PbB ($\mu g\ dL^{-1}$)	HgU ($\mu g\ L^{-1}$)
N	119	109
Mean	2.83	1.41
Standard deviation	1.53	0.98
Minimum	0.71	0.08
Maximum	8.16	6.73

Table 3

Blood lead (PbB) and urinary mercury (HgU) according to sample collection site.

	PbB ($\mu g\ dL^{-1}$)			HgU ($\mu g\ L^{-1}$)		
	Hotel	São Pedro da Joselândia	Pimenteira	Hotel	São Pedro da Joselândia	Pimenteira
N	49	45	25	43	43	23
Mean	3.50	2.53	2.03	1.26	1.56	1.41
Standard deviation	1.52	1.41	1.24	0.62	1.10	1.25
Minimum	0.90	0.84	0.71	0.79	0.08	0.79
Maximum	8.16	7.65	5.44	3.12	6.09	6.73

considered high [23]. The downward concentration of PbB in the general population is directly related to the elimination of the metal as a gasoline additive [22,23].

Mean PbB in the current study (2.83 ± 1.53μg dL^{-1}) was similar to the reference value proposed for the population in the city of São Paulo (3.3μg dL^{-1}) [24]. However, it was lower than the recommended levels for urban populations in the Southeast and South regions of Brazil (6.6 [25] and 5.5μg dL^{-1} [26], respectively). The mean level found in the current study, lower than the reference values in the three above-mentioned studies, is consistent with the study subjects, belonging to a rural population in the Central region of Brazil, living in an area where the work activities are limited to farming, education, nature conservation, scientific research, and ecotourism [13].

As shown in Table 3, PbB level was significantly higher in the hotel staff ($p > 0.05$) when compared to the population in the two other locations, São Pedro da Joselândia and Pimenteira, as well as in the samples from the hotel workers when compared to workers in other locations. Linear regression showed a correlation between PbB and collection site, with 14.7% of the Pb levels in blood samples explained by collection site, as well as a positive correlation between PbB and profession, the latter explaining 4.4% of PbB in study subjects (Table 4).

Pb particulates are also emitted during fires to clear land, which are very common in the Pantanal [27,28], where 7,740 active fires were detected in 2012, the year in which the study was conducted [29]. Depending on the direction and intensity of the air currents, pollutants can extend beyond the areas affected by the fire, with a negative impact on the environment and human health [30]. In the forests, trace elements adsorbed on the land sediments, vegetation, and organic matter in the soil are relatively immobile. However, they are released in more labile forms by volatilization, due to burning of the vegetation and organic matter in the soil. Forest fires also increase erosion, amplifying the transportation of contaminants that are remobilized into the bodies of water [31].

The samples with the highest Pb levels were from the hotel, located next to the ecological reserve and close to the highways [13] (most of the hotel employees live in Poconé). In addition, most of the study participants worked in the countryside, exposed directly to fires and plowing/turnover of the soil. Thus, the hotel employees and farm workers were subject to more intense exposure than the other participants, who worked in other activities located farther from the hotel, on the other side of the ecological reserve and thus farther away from the fires and highways. Although they were workers, their exposure was environmental rather than occupational, since the target metals were not handled as part of their work.

PbB levels between 5 and 10μg dL^{-1} suggest the existence of some type of environmental exposure [32]. Based on this, nine individuals in the study were exposed to low Pb levels, i.e., 7.57% of the study population showed environmental contamination with Pb. Of these nine, six worked in the hotel (66.6%), two in agriculture and cattle-raising (22.2%), and one had an administrative job in one of the villages (11.1%), but he had worked in crop weeding for 10 years.

Individuals that consumed locally produced milk showed significantly higher PbB than those who consumed industrialized milk or did not drink milk. There was a significant association between blood Pb and the habit of drinking locally produced milk, with 9.2% of PbB explained by the source of the milk consumed by study subjects (Table 4).

Cow's milk can be contaminated when cows graze on pasture or drink water contaminated with Pb [33,34]. This situation emphasizes the relevance of quality control for milk, which should undergo routine biochemical testing, as well as the importance of waste management on farms. The fact that PbB concentration in the study samples was significantly associated with the habit of drinking locally produced milk suggests that local production requires better health control measures.

The study showed that 57% of the individuals used well water for drinking and cooking, while 24% used mineral water, 11.6% piped water, and 7.4% other sources. Individuals that used well water showed significantly higher PbB than users of piped, filtered, or mineral water. There was a correlation between PbB and type of water consumed by participants, with 9.3% of the Pb found in blood samples explained by the source of water (Table 4).

It is common for rural populations to use well water. The risk of contamination of well water with metals and other pollutants is also well-known, resulting in contamination of the users [35,36]. Water can be a source of exposure to Pb, which reaches the bodies of water by deposition of vapors and particulates from the atmosphere and/or dumping of effluents, thus contaminating the aquatic ecosys-

Table 4

Linear regression (r) and r-squared linear regression (r^2) applied to blood lead (PbB) and urinary mercury (HgU).

Metals	Variables	r	r^2	p-value
Lead	Collection site	0.383	0.147	≤ 0.01
	Work activity	0.210	0.044	≤ 0.05
	Source of milk	0.303	0.092	≤ 0.01
	Source of drinking water	0.305	0.093	≤ 0.01
Mercury	Work activity	0.313	0.098	≤ 0.01
	Body mass index	0.442	0.195	≤ 0.01

tems. Pb in household drinking water is usually the result of corrosion or wear to elements in the piping system containing the metal [3]. Since more than half of the study population consumed well water without any treatment, the association between PbB and type of water supply may be explained by contamination with the Pb emitted during fires, common in the area, deposited in the soil and leached down to the water table [37]. In the flooding season in the Pantanal, the lowest areas are flooded due to the relatively flat terrain and the difficulty in the water running off due to the soaked soil, making the area look like an inland sea [20]. The pollutants in the soil can thus disperse and contaminate huge areas.

This study did not find a statistically significant difference in PbB levels according to sex, age, family income, schooling, smoking, consumption of locally produced foods, or BMI. Although some of these association have already been reported in other studies, especially related to age [24,38,39], the sample's composition (with 83% men) may have influenced the result. However, among the eight individuals that presented concentrations within the previously mentioned exposure range (5-10μg dL^{-1}), five were overweight (55.55%) and one was severely obese (11.11%), while only two showed normal BMI (22.22%).

Neither did this study find an association between PbB and self-reported morbidity, although the exposure to low Pb concentrations (< 10μg dL^{-1}) and damages to health such as decreased renal function, increased blood pressure, hypertension, and essential tremor has been proven in adults. In the case of pregnant women, there is sufficient proof that PbB levels < 5μg dL^{-1} are associated with lower fetal growth and low birth weight, and limited evidence that increases in spontaneous abortion and premature birth are associated with PbB < 10μg dL^{-1} [22]. In children, the most common adverse effects in PbB < 5μg dL^{-1} are attention deficit, reduced cognitive performance, and increased incidence of behavioral disorders, in addition to decreased post-natal growth, reduced head circumference, weight, and other growth indicators, and delayed puberty with PbB levels < 10μg dL^{-1} [23].

Mercury

In the current study, mean HgU concentration (1.41 ± 0.97μg L^{-1}) was 28.85% of the mean (4.89μg L^{-1}) found in 1995 in residents of the city of Poconé, when the gold mining operations were in full swing in the region [40]. However, this level was above the mean HgU in dentists who did not use the metal in their work (0.92 ± 0.33μg L^{-1}) [15] and the mean (0.44 ± 0.41μg L^{-1}) in adult women living in the vicinity of the Aamjiwnaang First Nation Reserve (Ontario, Canada), in the Great Lakes region, known for Hg pollution [41].

Gold extraction in Poconé is now estimated to be 40% lower than in 1995. However, the mining areas today are located inside the Poconé city limits, where there are also shops that smelt the placer gold on their premises [12]. The mining operations and smelting shops thus serve as a source of Hg exposure for the entire region. In addition, the abandoned pits left behind by gold mining have become lakes, containing tailings with Hg, which can remain available for methylation in the sediments for several years, even after the source of emission is eliminated [42]. These abandoned pits thus pose a permanent risk of contamination to the region.

There was no statistically significant difference ($p < 0.05$) between mean HgU levels in the different sample collection sites (Table 3). Part of the resident population in the two villages and the hotel workers have already worked in gold mining at some time in life and still have a close relationship to Poconé, since it is the largest nearby city with the most resources. The group consisting of schoolteachers, homemakers, and unemployed showed significantly higher HgU than in individuals from other professions. A positive association was confirmed between HgU and profession, with 9.8% of HgU explained by the study subjects' work activities (Table 4).

Human activity, especially mining and burning coal, has increased the mobilization of Hg into the environment, increasing the metal's levels in the air, soil, freshwaters, and oceans. Most Hg emissions are associated with the generation of energy from fossil fuels, pushing industrial and economic growth in Asia and South America, which in turn stimulates the high demand for metals, including artisanal and small-scale gold mining worldwide [9]. The contribution of gold placer mining and forest fires to environmental contamination with Hg and thus the exposure of neighboring populations has been well documented [43,44]. After emission, elemental Hg can be carried long distances before its deposition. It remains in the atmosphere from several months to several years and can be transported and deposited in remote locations like the Arctic and Antarctic [44]. Since the majority of the current study participants (74.38%) worked close to the mining and burning areas, this could explain the positive association between HgU concentration and work activity.

Individuals with normal BMI showed significantly lower HgU than the groups with overweight and types I and II obesity. The study also showed a positive association between HgU and BMI in the study subjects, and BMI explained 19.5% of HgU level (Table 4). These results are consistent with two studies on the relationship between Hg concentration in hair (HgH) and blood (HgB) and BMI in Japanese and Korean adults, respectively. These findings showed that Hg correlated positively and significantly with BMI [45,46]. However, no statistically significant correlation was found between HgH and BMI in a riverine population on the Rio Negro in the Brazilian Amazon [47].

Among the study participants, 97.1% reported that they ate locally caught fish at least three times a week. In the human diet, consumption of fish is the source of exposure to methyl Hg. However, the species and age of the fish have a direct impact on the amount of this metal absorbed in the organic form [44]. As expected, no association was observed in this study between HgU and routine fish consumption, since the Hg eliminated in the urine is the best biomarker for chronic exposure to elemental and inorganic Hg and also as an indicator of body load, while Hg in the blood or hair has been used as a marker of recent exposure to methyl Hg through the diet [43].

No associations were found between HgU and sex, age, family income, schooling, smoking, self-reported morbidity, source of drinking water and milk, or the consumption of locally produced greens, vegetables, and fruits. However, in the Korean study, HgB was significantly affected by various sociodemographic factors (sex, age, and place of residence), lifestyle (tobacco and alcohol), and eating habits (fish consumption). The increase in blood Hg was associated with metabolic syndrome, suggesting that exposure to the metal can increase the risk of cardiovascular diseases [46].

Conclusions

Despite the low concentrations of Pb and Hg found in the study, current knowledge on the toxicity of these metals shows that the health effects can already be felt at levels that were previously considered safe. Since Pb and Hg are not essential metals and have no physiological function, they should not be present in the human body; their presence provides evidence of exposure to these elements, even at low doses, thus characterizing a health hazard.

Pb appears to originate from forest fires in the region, highlighting the need for a new stance on this issue, which involves environmental, social, economic, and institutional dimensions at the world level. In the case of Hg, in addition to the fires, there are also mining operations and smelting in the gold shops, despite the reduction in mining in the area. The metal, known as a global pollutant due to its great potential for dispersion, continues to contaminate the local residents.

The current study's results show the need for environmental and biological monitoring of Pb and Hg, as well as the adoption of measures to prevent or reduce the negative impacts of these exposures on the health of populations, including those of Poconé and Barão de Melgaço. Importantly, prevention is the best way to reduce the impact of diseases that result from exposure and are thus avoidable.

Contributors

L. D. F. Jesus, M. F. R. Moreira, S. V. Azevedo, R. M. Borges, R. A. A. Gomes, F. P. B. Bergamini, and L. R. Teixeira participated in the study design, data analysis and interpretation, writing and critical review of the intellectual content of the article, and final approval of the version to be published; all authors are responsible for all aspects of the work in ensuring the accuracy and integrity of the work.

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Resumo

O objetivo foi avaliar o nível de exposição ao chumbo e mercúrio em população do Pantanal Mato-grossense, Brasil. Chumbo no sangue (Pb-S) (n = 119) e mercúrio na urina (Hg-U) (n = 109) de moradores da região foram determinados por espectrometria de absorção atômica. A comparação de médias e correlação entre as variáveis utilizaram o teste ANOVA e a regressão linear, respectivamente, com 95% de confiança. Pb-S médio foi 2,82 ± 1,53µg dL^{-1}*. A comparação de Pb-S estratificado por local de coleta (p ≤ 0,01), atividade laboral (p ≤ 0,01) e consumo de leite produzido na região (p ≤ 0,05) mostrou diferenças estatisticamente significativas. Também houve associações positivas entre Pb-S e local de coleta (p ≤ 0,01), profissão dos participantes (p ≤ 0,05), consumo de leite da região (p ≤ 0,01) e origem da água de consumo (p ≤ 0,01). A média de Hg-U foi 1,41 ± 0,98µg L*$^{-1}$*. Os teores mostraram diferenças significativas apenas quanto à profissão dos participantes (p ≤ 0,01), e associações positivas surgiram entre Hg-U e atividade profissional (p ≤ 0,01) assim como índice de massa corporal dos sujeitos de estudo (p ≤ 0,01). As amostras apresentaram baixos níveis de chumbo e mercúrio, semelhantes àqueles encontrados em populações também expostas ambientalmente. Apesar dessas baixas concentrações, o conhecimento atual sobre toxicidade desses metais mostra que efeitos à saúde já podem ser sentidos em níveis antes considerados seguros, o que caracteriza o perigo.*

Chumbo; Mercúrio; Exposição Ambiental

Resumen

El objetivo fue evaluar el nivel de exposición al plomo y mercurio en una población del Pantanal Mato-grossense, Brasil. El plomo en sangre (Pb-S) (n = 119) y mercurio en la orina (Hg-U) (n = 109) de los habitantes de esa región se determinó por espectrometría de absorción atómica. La comparación de medias y la correlación entre las variables utilizaron el test ANOVA y la regresión lineal, respectivamente, con un 95% de confianza. Pb-S medio fue 2,82 ± 1,53µg dL^{-1}*. La comparación de Pb-S estratificado por lugar de recogida (p ≤ 0,01), actividad laboral (p ≤ 0,01) y consumo de leche que se produjo en la región (p ≤ 0,05) mostró diferencias estadísticamente significativas. También hubo asociaciones positivas entre Pb-S y el lugar de recogida (p ≤ 0,01), profesión de los participantes (p ≤ 0,05), consumo de leche de la región (p ≤ 0,01) y origen del agua de consumo (p ≤ 0,01). La media de Hg-U fue 1,41 ± 0,98µg L*$^{-1}$*. Los porcentajes mostraron diferencias significativas sólo respecto a la profesión de los participantes (p ≤ 0,01), y las asociaciones positivas surgieron entre Hg-U y la actividad profesional (p ≤ 0,01), así como índice de masa corporal de los sujetos de estudio (p ≤ 0,01). Las muestras presentaron bajos niveles de plomo y mercurio, semejantes a aquellos encontrados en poblaciones también expuestas ambientalmente. A pesar de esas bajas concentraciones, el conocimiento actual sobre toxicidad de estos metales muestra que los efectos sobre la salud, ya pueden ser apreciados en niveles antes considerados seguros, lo que caracteriza el peligro.*

Plomo; Mercurio; Exposición a Riesgos Ambientales

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