

ASSESSMENT OF METHYLMERCURY IN CHILDREN'S HAIR FROM THE JAÚ NATIONAL PARK - AMAZON REGION



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ABSTRACT

Amazon region has been considered as being impacted by mercury, due to natural and anthropogenic processes. Human mercury contamination can be monitored through hair analysis of inorganic and organic forms of mercury such as methylmercury (Me-Hg). Public health concerns about Hg and Me-Hg in the environment have increased recently; based upon two new sets of data: reported increases in levels of Hg and Me-Hg found in biota and ecosystems and new studies on adverse health effects in human populations exposed since more than 90% of Me-Hg is in aquatic biota, the major source of human exposure. Me-Hg is the most hazardous mercury species known due to its high stability, lipid solubility and ionic properties. The purpose of this study was to assess Me-Hg in hair samples of pre-school children from some communities located at Jaú National Park, Amazon region. Children's scalp hair samples from each community were collected and prepared according to the protocol recommended by the IAEA. The method of analysis consists of the acid leaching with HCl and ion-exchange separation of inorganic from organic mercury forms. Once Me-Hg is separated it has to be decomposed to Hg^{2+} by means a mixture of acids. For Hg determination FIA/CVAAS technique was used and the measurements were performed by FIMS Perkin Elmer equipment. The validation of methodology was carried out by certified reference materials analyzes IAEA-085 (Me-Hg: 22.9 mg kg⁻¹) and IAEA-086 (Me-Hg: 0.236 mg kg⁻¹) (Human Hair). Relative standard deviation ranged from 6.0 to 15.0% and relative error from 3.1 to 6.0%, showing good precision and accuracy. The median values found for Me-Hg in hair samples were 39.9 (29.0 – 55.8) mg kg⁻¹, Cachoeira: 47.8 (20.6 – 73.3) mg kg⁻¹, Seringalzinho: 42.4 (35.7 – 59.8) mg kg⁻¹, Vista Alegre and 50.0 (40.5 – 75.9) mg kg⁻¹ Santo Elias communities. The concentration of Hg of 6 mg kg⁻¹ in the hair corresponds to the provisional weekly intake of Me-Hg established as tolerable by WHO. The high Me-Hg levels in hair samples obtained in the present work seem to be indicative of mercury environmental impact at Jaú National Park and the occurrence of children exposure levels that may lead to adverse health effects.

1. INTRODUCTION

The Amazon is seriously impacted by mercury, due to natural and anthropogenic processes (Hylander & Meili, 2003). Human mercury contamination can be monitored through hair analysis of inorganic and organic forms of mercury such as methylmercury (Me-Hg). Hair is the most useful first line medium to measure individual and population mercury exposure (Chatt, 1988). Hair is stable over a long period of time and provides a historical record of mercury assimilated from the environment (Sarmeni & Alakili, 2004).

This study assessed Me-Hg in hair samples of pre-school children from communities at the Jaú National Park (JNP), Amazon region.

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2. MATERIAL AND METHODS

1. Sampling, sample preparation and analytical methodology for MeHg

Samples were collected in several communities: Cachoeira, Santo Elias, Seringalzinho and Vista Alegre. Pre-school children hair samples (12 to 60 months old) were collected from the occipital region, very close to the scalp, in 0.2 g amount approximately. Cleaning procedures followed the International Agency of Atomic Energy protocol (IAEA, 1987). Me-Hg was extracted quantitatively with HCl 6 M from about 0.1 g of samples or reference materials. An ion exchange column was used to separate non-ionic Me-HgCl from a HgCl_2 complex, retained on the column. After separation, samples were digested in a mixture of HNO_3 and H_2SO_4 and mercury determination done by using cold vapor atomic absorption technique by FIMS from Perkin Elmer.

3. RESULTS AND DISCUSSION

The methodology validation for Me-Hg determination was carried out by reference materials analyses IAEA-085 (Human Hair) and IAEA-086 (Human Hair - unspiked). Relative standard deviation ranged from 6 to 8 % and relative error from 2.3 to 6%, showing good precision and accuracy (Table 1). The detection limit of 1 ng mL^{-1} was obtained for Hg determination.

Table 2 shows Me-Hg concentration levels in children's hair. Total Hg values in hair of people not exposed in Brazil are between 1 and 2 mg kg^{-1} (Saiki et. Al, 1998).

Table 1- Reference materials analyses results (mean of 4 determinations).

Reference Materials	Me-Hg (mg kg^{-1}) (mean \pm s.d.)	Certified Value (mg kg^{-1})	R.S.D. (%)	R.E. (%)
IAEA-086 (Human Hair)	0.264 ± 0.022	0.258 (0.236-0.279)	8	2.3
IAEA-085 (Human Hair)	21.6 ± 1.3	22.9 (21.9-23.9)	6	6

Table 2 - Methylmercury levels in children's hair samples from JNP.

Communities (JNP)	Me Hg (mg kg^{-1})		
	Median	Mean	Range
Cachoeira	39.9	40.5 ± 13.8	29.0 – 55.8
Santo Elias	55.6	55.1 ± 36.0	28.32 – 74.4
Seringalzinho	47.6	47.2 ± 26.4	20.6 – 73.3
Vista Alegre	42.4	45.1 ± 20.1	35.7 – 59.8



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The new U.S. Environmental Protection Agency (EPA) guidelines for diet methylmercury are 0.1 micrograms of Hg per kilogram of body weight per day (0.1 µg/kg/day). This is 4.7 times more strict than World Health Organization's 0.47 µg/kg/day standard. Hg in hair is approximately 90% Me-Hg and according to WHO, the value of 50 mg kg⁻¹ of total mercury in the hair of groups with a high fish consumption is associated with a 5% risk of neurological damage to adults (WHO, 1991).

Me-Hg concentration in hair analyzed samples were very high. Pre-school children dietary intake presents fish as one of their staple diets, probably with a significant contribution to their overall mercury intake. Fish consumption is normally considered as the main contamination pathway of Me-Hg in human beings and the importance of fish in Amazon populations living along the rivers has been previously documented (Santos et al., 2000). The comparison of total Hg levels in children's hair from JNP and other communities are shown in Table 3.

Table 3 - Total mercury contents comparison in scalp hair between residents in various communities of Brazil.

Communities Age group (years)	Total Hg (mg kg ⁻¹)		
	Mean	Range	Reference
Brasília Legal (Pará state): 0 – 5	5.84 ± 4.91	1.09 – 20.46	(Santos et al., 2000)
São Luiz do Tapajós (Pará state): 0- 5	21.06 ± 14.38	0.10 – 94.50	(Santos et al., 2000)
Rio Negro (Amazon region): < 15	18.52 ± 10.04	0.51 – 45.9	(Barbosa et. al., 2001)
Jaú (PNJ) (Amazon region): 1- 5	15.3 ± 7.6	0.59 – 36.0	(Farias et. al., 2004)

4. CONCLUSION

Me-Hg determination procedure developed in the present study showed good precision and accuracy. The results obtained children for Jaú National Park presented very high Me-Hg hair levels, close to the WHO value of 50 mg kg⁻¹ for total mercury in the hair of high fish consumption groups, which is associated with a 5% risk of neurological damage to adults. These values are related to Me-Hg values and the age group of 1 to 6 years old, much more sensitive to Me-Hg exposition. Many controversies exist as to what is acceptable Me-Hg level exposure. Some stem from the science underlying the toxicity data base for Me-Hg. There is disagreement over which studies and points of concern should be used to derive an acceptable level. It is known that consumption of freshwater fish is an excellent nutritional source and most people cannot eliminate this protein source completely from their diet, but they have reason to limit their fish consumption or to change the fish species consumed. Exposure assessment of the Brazilian population – including those with high fish consumption – is needed to provide a full picture of the Me-Hg and total Hg distribution and exposure both nationally and regionally.



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