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Exposure to Mercury in the Urban Population of Rio Branco City, State of Acre, Brazil

E. C. de Oliveira Santos,[1] I. M. de Jesus,[1] E. S. Brabo,[1] V. de M. Câmara,[2] E. C. B. Loureiro,[1] A. F. Mascarenhas,[3] K. de F. Faial,[1] A. P. da Silva,[4] R. U. da Silva,[5] R. R. Luiz,[2] H. Higuchi[6]

[1] Evandro Chagas Institute, National Foundation of Health, Avenue Almirante Barroso, 492 Marco, Belém PA, Brazil, CEP 66090-000
[2] Rio de Janeiro Federal University (UFRJ/NESC), Avenue Brigadeiro Trompowsky, s/n, 5° andar, Ala Sul/HUCFF/UFRJ, Ilha do Fundão RJ, Brazil CEP 21941-590
[3] Executive Secretariat of Industry, Commerce and Mining, Avenue Presidente Vargas, 1020 Centro CEP 66017-000 Belém PA, Brazil
[4] Engineering and Processes, AMBIOS, Rua Califórnia, 792 Brooklin CEP 04566-061 São Paulo SP, Brazil
[5] Municipal Secretariat of Health, Avenue Getúlio Vargas 1446 Bosque, CEP 69908-650 Rio Branco AC, Brazil
[6] Emílio Goeldi Paraense Museum, Avenue Gov. Magalhães Barata 376 Nazaré, CEP 66040-170 Belém PA, Brazil

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The presence of mercury (Hg) in the Amazonian Region has been attributed to several sources, giving importance not only to the gold mining activity but also to the way this metal is found in the environment. Discussion of this subject should develop from the premise that a tropical forest area could present natural amounts of this element. A disorderly management of the forest, mainly involving deforestation and burning, could negatively affect the natural balance and eventually facilitate the emission of Hg into the environment, polluting water bodies and leading to consequences reflected in the aquatic biota, making possible the Hg introduction in the alimentary chain (Veiga et al. 1994; Roulet et al. 1998).

Each area and subarea in the Amazonian Region demands local investigation of the factors contributing to the dispersion of this metal in the environment. In general terms, the type of land use in Amazonia practiced through the last 30 years has altered the natural balance of the atmosphere and degraded the environment (Pandolfo 1991). Today, in some areas, it is probably impossible to recover information on preexistent background levels of Hg (Santos et al. 1995; Santos et al. 2000). However, studies on the levels of Hg in different types of rocks and soils should be accomplished to deepen the knowledge of Hg cycle in tropical regions, to clarify which levels could be more representative of natural patterns to the region.

The construction of hydroelectric plants and the proliferation of gold mining activities in the past few decades were indeed responsible for the emission of significant amounts of mercury into the atmosphere and aquatic systems, contributing to the dispersion of the metal in Amazonia (Aula et al. 1994; Louchouarn et al. 1993), although the extension and spreading of this degradation are not yet fully understood (Santos et al. 1995). Available data on Hg levels from populations potentially exposed to that metal are not yet sufficient to build up a profile of its influence on the communities involved, who are also exposed to other traditional endemic diseases. For this reason, it is necessary to establish differential diagnoses for persons suspected of mercury poisoning by a qualified system of health to assist and to handle situations as that (Câmara and Corey 1992).

Correspondence to: E. C. de Oliveira Santos

for hepatitis-B and German measles) and hair. Mercury determination in hair and fish samples were made by flameless atomic absorption spectrophotometry using a HG-3500 mercury analyzer (Akagi et al. 1996). Results of Hg levels in hair were sent by mail to all participants.

For data collecting, sixteen work teams were formed, including one technician for blood collecting and one or two interviewers, all previously trained in the methodology for this project and in field interviewing, as well as in collecting procedures and conservation of obtained biological material. A total of 47 people from six institutions participated in data collecting.

The sediment (particulate and soil) samples were collected mainly along the Acre and Purus rivers and some of their tributaries. Samples of superficial soil were collected in depths of up to 30 cm along the highways BR-364, AC-10, AC-40, AC-90 and stocked in plastic bags and kept cool. A mass of 2 kg was necessary for subsequent analytical procedures. Fish samples were acquired at city markets, obtained from fishermen in selected areas or else collected by a specialized team in hard-to-reach areas. For each sample, a field record was filled out with data on identification, origin, weight, size, type of conservation, transportation method, etc. A portion of the muscular tissue from the back of each fish sample was removed, frozen and sent to the laboratory for analysis.

RESULTS AND DISCUSSION

Soil sample analyses (n = 42) revealed a mean Hg concentration of 0.077 μg/g with a range of variation between 0.017 and 0.200 μg/g. Mean Hg levels in bottom sediments (n = 94) from the rivers Acre, Purus and some of their tributaries was 0.027 μg/g. Background values for soils vary according the region. Those usually adopted as reference range from 0.200 to 1.860 μg/g. For bottom sediments, values lower than 1.0 μg/g are considered indicative of a non-polluted atmosphere (Prater and Anderson 1977; Brasil 1986).

For mercury determination in fishes, 1,205 samples of 39 different species were obtained among those consumed by the residents of Rio Branco. Of those, 673 were samples of species with a carnivorous habit (fish, crustacean, mollusk and worm eaters) and 513 of non-carnivorous fishes (plant and mud eaters and plankton feeders). Mean Hg levels found for non-carnivorous fishes was 0.115 μg/g, which is considered within the normal values (under 0.5 μg/g) established by the World Health Organization (WHO 1990).

The distribution of Hg levels in carnivorous fish species consumed by the population of Rio Branco *vis-à-vis* their respective fishing grounds are presented in Table 1. Carnivorous fishes obtained from artificial ponds and those coming from the State of Rondônia presented mercury levels below the 0.5 μg/g lower limit recommended by the WHO. Others from different places of the State of Acre itself, as well as those coming from the State of Amazonas and from Bolivia presented levels up two or three times the WHO limit.

Table 1. Distribution of mercury levels in carnivorous fishes by fishing grounds. Rio Branco, AC, Brazil, 1998.

Fishing grounds	Number of specimens	Mean Hg level(μg/g)
Acre – artificial ponds	11	0.03
Rondônia	58	0.33
Acre – different localities	268	0.99
Bolivia	15	1.65
Amazonas	321	1.73

Note: Lower limit as recommended by the WHO = 0.5 μg/g

A total of 1,211 households was selected for this survey, being 303 houses uninhabited or they were cases of refusal in participating in the project. From then, 2,442 persons (1,479 females and 962 males) were interviewed and their distribution for age and sex is presented in Table 2. The mean of mercury levels in hair was 2.41 μg/g, and 91.4% of the population presented levels up to 6.0 μg/g and 8.6% with variation interval between 6.18 to 72.26 μg/g and an average of 11.67 μg/g (Table 3).

The results concerning levels of mercury in soils and sediments were below the reference limits, coinciding with other researches developed in the Amazonian area. However, as mercury levels in the biota reached up to 1.734 μg/g and the state of Acre does not have any type of gold mining activity, it is necessary to deepen environmental research to investigate the origin of that pollution.

Table 2. Distribution for sex and age from the population studied. Rio Branco, AC, Brazil, 1998.

Age	Male	Female	Total
0 - 5	103	91	194
6 - 10	105	137	242
11 - 15	143	144	287
16 - 20	115	195	310
21 - 25	78	157	235
26 - 30	79	137	216
31 - 35	68	128	196
36 - 40	48	111	159
41 - 45	46	80	126
46 - 50	44	69	113
51 - 55	33	55	88
56 - 60	28	46	74
> 60	72	130	202
Total	962	1,479	2,442

Note: Samples of hair were obtained from 2,318 persons.

Table 3. Levels of total mercury in hair from the study population. Rio Branco, AC, Brazil, 1998.

Levels of mercury (μg/g)	Number of persons	Mean of mercury (μg/g)	Percentage from the population	Accumulated frequency	Standard deviation
0 - 2	1,524	0.82	65.7	65.7	0.546
3 - 6	595	3.41	25.7	91.4	1.085
7 - 10	112	7.61	4.8	96.2	1.146
11 - 15	48	11.89	2.1	98.3	1.359
16 - 20	20	16.80	0.9	99.2	1.480
21 - 50	18	27.32	0.8	100	7.208
> 50	1	72.68	0.0	100	-
Total	2,318	2.418	100.0	100	3.850

Although we could presume that fish could be an exposure source of mercury, only 8.6% of the population present levels of mercury in hair above the limit of biological tolerance of 6.0 μg/g.

It is opportune to pay attention for some peculiarities concerning to the city of Rio Branco. Unlike in the almost totality of the Amazonian cities, fish consumption doesn't represent the main source of proteins in Rio Branco. Fishing doesn't exist as a major regular economic activity.

Despite the existence of dams creation of fish, fish for consumption, mainly for the middle class, comes from other areas, as for instance, Guajará Mirim in Rondônia State, Boca do Acre in Amazon State and Sena Madureira in the own State of Acre, with prices considered expensive for the low income population. Additionally, there is a strong cattle activity in the surroundings that guarantees alternatives for less expensive protein intake. It is also important to emphasize the role of Northeastern in the Acre State colonization, that usually doesn't have the habit of fish intake. It is necessary also to investigate riverine communities from the interior of the Acre State because they have a different lifestyle and probably a different fish consumption, increasing or reducing the exposure risk to the mercury.

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