Cognitive assessment of riparian schoolchildren from the Western Brazilian Amazon.

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INTRODUCTION

Several studies suggest that exposure to Methilmercury may affect children's cognitive development (Axelrad et al., 2007; Fonseca et al., 2008). The Brazilian Amazon riverine population is exposed to MeHg through fish consumption (Barbosa et al., 2001; Passos et al., 2003; Bastos et al., 2006).

This study is part of the Mercury Health Impact Project, in a region where two Hydroelectric Power Plants are being built in the Amazon (Santo Antônio and Jirau).

Santo Antonio hydroelectric plant is being built on a stretch of the Madeira River, about 10 km from Porto Velho, capital of Rondônia State.

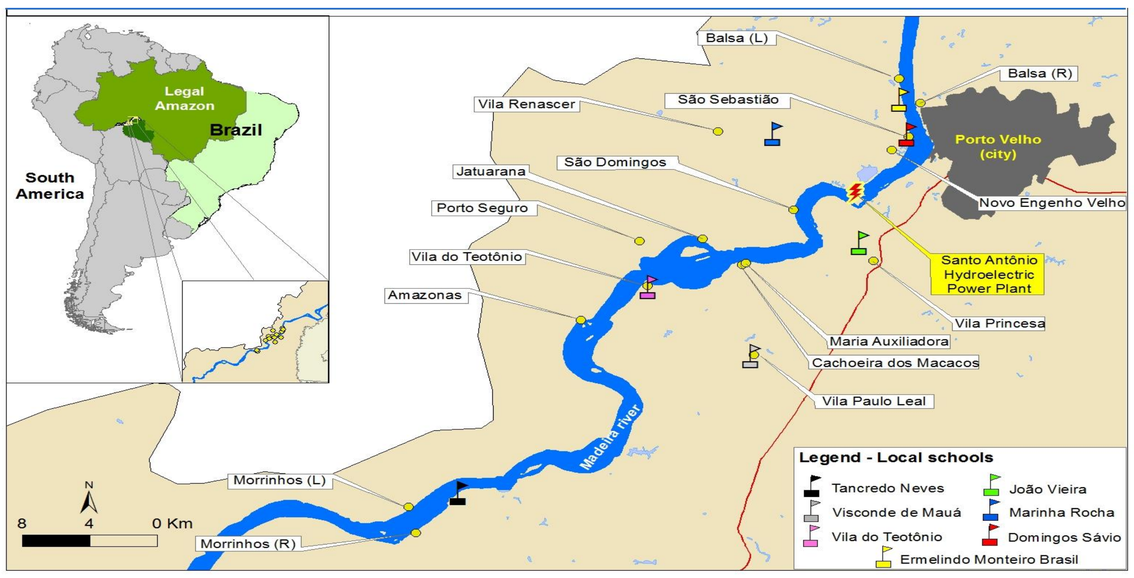
This region is a vast area of mercury contamination due to gold mining in the 80's/90's, and natural emissions of Hg that are exacerbated by the process of biomass burning.

The Madeira River, the second largest river in the Amazon, is the main tributary of the Amazon River, in addition to being the home of a diverse fauna, and it is one of the largest sediment loads in rivers in the world. The Amazon basin covers Peru, Bolivia and Brazil, an area of 1.5 million km, and covers about one fourth of the Brazilian Amazon (Garcia, 2008).

OBJECTIVE

The aims of this study are: (i) to describe the cognitive assessment; and (ii) to evaluate the association between cognitive responses and hair mercury levels, as well as individual's characteristics and anemia.

MATERIAL AND METHODS



This is a cross-sectional study with a sample of about 300 riparian schoolchildren, living along the Madeira River during the years 2009 and 2010.

The cognitive test battery consisted of Raven Colored Progressive Matrices test (RCPM), Rey Complex Figure test (RCF - Copy and Memory), and Wechsler Intelligence Scale for Children test (WISC- Symbol and Digit subtests). The tests were performed by psychologists.

Hair and blood samples were analyzed.

An interview questionnaire was used to collect information on socio demographic characteristics, fish-eating habits, neurological symptoms, vaccination history, health problems, and other relevant information.

Data analyses were based on descriptive statistics and logistic models.

RESULTS

About 40% of the children presented mercury concentration in hair above 6μg/g.

The average concentration was 8.5μg/g (95%CI: 7.2 – 9.8), and the maximum value was 92.1μg/g.

The blood test showed that about 68% of the children who went through the blood exam were anemic. However, not all of them were submitted to the exam.

The Hg levels in hair were associated with daily fish intake.

The test results aggregated into two categories: intellectually disabled (score <5) or not.

RCPM test indicated that 36% of the individuals were intellectually disabled and it was associated (p-value<0.10) with gender, age, river bank, school year, failure in school at least once in life, and anemia. A multiple logistic regression model (MLRM) adjusted by school year estimated an odds ratio (OR) of 1.66 (p-value=0.070) for children with hair mercury levels above 6μg/g.

The ECF Memory test pointed 43% of them as intellectually disabled. Variables associated (p-value<0.10) were age, school year, diagnosis of malaria, smoking in pregnancy, anemia and hair mercury levels. A MLRM adjusted by age, failure in school, anemia and smoking in pregnancy estimated an OR of 3.43 (p-value=0.004) for children with levels of mercury in hair above 6μg/g.

WISC Digit test indicated that 12% of the children were intellectually disabled. Variables associated (p-value<0.10) were age, school year, anemia, more agitated than normal, abnormal mental development, irritability, and hair mercury levels. A MLRM adjusted by anemia estimated an OR of 2.48 (p-value=0.0523) for children with levels of mercury in hair above 6μg/g.

Table 1. Mercury levels according to test results.

Tests	Average	N	Std. Deviat.	Median	Min	Max
***Raven Colored Progressive Matrices test**						
Intellectually Disabled	8.79	93	12.20	4.60	0.06	92.13
Bellow Average	8.50	65	10.17	4.07	0.18	55.09
On Average	6.63	78	8.27	3.98	0.19	38.64
Above Average	7.25	22	10.19	3.33	0.40	46.87
Superior	10.45	1	-	10.45	10.45	10.45
Total	7.94	259	10.41	4.19	0.06	92.13
***Rey Complex Figure test - Copy**						
Intellectually Disabled	7.92	161	8.86	4.55	0.06	49.02
On Average	9.02	40	12.66	3.14	0.23	55.09
Above Average	7.79	30	16.85	3.13	0.19	92.13
Superior	6.40	26	6.05	4.23	0.33	23.88
Total	7.92	257	10.47	4.14	0.06	92.13
***Rey Complex Figure test - Memory**						
Intellectually Disabled	8.15	107	8.42	5.10	0.08	49.02
On Average	7.73	62	13.05	3.19	0.06	92.13
Above Average	8.80	50	12.18	3.65	0.23	55.09
Superior	6.46	38	8.62	4.23	0.19	38.64
Total	7.92	257	10.47	4.14	0.06	92.13
***WISC - Subtest Symbol**						
Intellectually Disabled	6.65	15	5.53	4.99	1.47	16.25
On Average	12.48	35	13.03	6.30	0.23	49.60
Above Average	7.30	72	7.90	4.94	0.06	38.64
Superior	8.14	147	11.96	3.79	0.07	92.13
Total	8.40	269	10.97	4.31	0.06	92.13
***WISC - Subtest Digit**						
Intellectually Disabled	10.35	34	10.43	6.27	0.26	41.52
On Average	8.77	146	11.77	4.74	0.06	92.13
Above Average	7.93	92	10.47	3.80	0.07	55.09
Superior	4.78	7	6.12	1.33	0.46	16.75
Total	8.59	279	11.08	4.36	0.06	92.13

*p-value>0,05

Table 2. Mercury levels according to the schools.

Schools	Average	N	Std. Deviat.	Median	Min	Max
Antonio Augusto Vasconcelos	12.12	147	13.63	7.13	0.06	92.13
Domingos Savio	5.83	11	3.54	4.42	2.07	12.08
Ermelindo Monteiro Brasil	5.00	102	5.167	3.80	0.07	31.30
Marinha Rocha	1.01	16	0.84	0.77	0.19	3.38
Tancredo Neves	8.45	3	3.50	6.96	5.95	12.45
Visconde de Maua	2.99	3	3.69	0.86	0.85	7.25
Total	8.53	282	11.04	4.34	0.06	92.13

p-value = 0.000

Table 3. Mercury levels according to fish consumption.

Fish Consumption	Average	N	Std. Deviat.	Median	Min	Max
Never	2.25	7	1.81	1.27	0.07	4.36
Every 15 days	8.24	65	11.26	3.64	0.08	49.02
1 to 3 days a week	7.78	102	12.20	4.25	0.18	92.13
>3 days in a week	8.91	62	9.34	4.91	0.24	34.86
Daily	11.01	38	11.31	6.99	0.06	55.09
Total	8.45	274	11.13	4.32	0.06	92.13

p-value = 0.022

CONCLUSIONS

These results suggest that current exposure was associated with cognitive test responses except for the ECF Copy test and WISC Symbol test.

These results reflect the past exposure to mercury levels. Studies showed that the formation of reservoirs for hydroelectric power generation favors the mobilization of mercury and methylmercury production (Palermo et al, 2002). Thus, it is important to follow the study population after filling the reservoir, since the levels of mercury in the body may increase and may be associated with the cognitive effect.

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