WORKSHOP “MERCURY CONTAMINATION AND ITS IMPACT IN HUMAN HEALTH IN BRAZIL”

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MERCURY EXPOSURE EFFECTS ON BRAZILIAN CHILDREN’S HEALTH

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FOCUS

➢ WHY MERCURY?

➢ WHY CHILDREN?

➢ WHICH ARE THE MERCURY EXPOSURE EFFECTS ON BRAZILIAN CHILDREN’S HEALTH?

➢ HEALTH SURVEILLANCE OF MERCURY EXPOSED POPULATIONS IN BRAZIL
MERCURY EXPOSURE EFFECTS ON BRAZILIAN CHILDREN’S HEALTH

EPIDEMIOLOGY: WHY MERCURY?
1) **Metallic Mercury**

is used to make an amalgam with gold (for each 1 kilo of gold we need, more than 1 kilo of mercury)

2) **Methyl Mercury**

is much more toxic than the Metallic Mercury

General population is contaminated by fish intake, especially riverine and Indians.
Mercury is very toxic! For the whole body but specially for the nervous system.

CHILDREN: MERCURY EXPOSURE

1) of the fetus via the placenta,
2) by breast milk intake in breast-feeding and then
3) fish intake

- Change in performance on cognitive tests and changes in the neurological development.
- Prenatal exposures (high levels): cerebral palsy, microcephaly, hyperreflexia, poor motor skills, intelligence, vision and hearing.
- Prenatal exposures (relatively low levels) - sub-clinical effects: Delays / deterioration of neurobehavioral development - cognitive, language, motor, adaptive behavior, and socio-emotional domains.
EPIDEMIOLOGY: WHY CHILDREN?
Exposure in children is higher compared to adults:
Higher body surface area, the greater respiratory rate
and increased intake of fluids and food in relation to
body weight. Exposure via placenta

Methylmercury: Greater absorption during
breastfeeding (decrease after the beginning of the
intake of other foods)

It is also greater the possibility of an adverse
health effect: Organ systems of children are still
under development: blood-brain barrier, respiratory,
kidney and immune systems, enzymatic capacity of
detoxification of chemicals (ATSDR, 1999).
ETC, ETC. ETC…..
Eligibility criteria: the study population was constituted of Brazilian children, from birth to 18 years old, and in the intrauterine period (studies including total population were added when they provided individualized age-specific data);

There was no limit to time of publication (years);

The literature search was conducted in the following key resources: PubMed (MEDLINE), Scopus and Web of Science with the MeSH Terms: Environmental exposure AND Brazil (filters: Human, Child (birth - 18 years) and Affiliation Author); Virtual Health Library (databases Scielo and Lilacs) with the DeCS Terms: Child OR adolescent AND Environmental exposure AND Brazil.
FOCUS

MERCURY EXPOSURE EFFECTS ON BRAZILIAN CHILDREN’S HEALTH

Systematic Review 1995 - 2015:

- 30 articles published about exposure of children to mercury
- 27 studies in Amazon Region (West and North) and 3 in Southeast region
- 16 studies: Effects on Children's health from Birth until 10 years old.
- 10 studies: Mother – infant pair
- Lactating women: 1 / Pregnant women: 1
AMAZON REGION:
✓ A body of studies has been performed with riverine and urban children in the Amazon region;

✓ Objective: To investigate the nutritional status and the physical growth and neurodevelopment (social, emotional, language, and cognitive domains);

Main Results

1. The exposure to mercury has occurred mainly through fish eating and breastfeeding

2. Hair mercury concentration was employed as an exposure biomarker to methyl-Hg in almost all studies. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
3. A significant correlation between maternal hair-Hg with respective children's hair-Hg was observed in all these studies.

**Marques et al, 2013**: 647 mother-infant pair: high fish-eating communities (urban, n = 232; rural, n = 35; and Riverine, n = 262) and low fish-eating tin-miner settlers (n = 120).

- The correlation coefficients between maternal and newborn hair were high and statistically significant for mothers living in urban ($r = 0.66, p < 0.001$), rural ($r = 0.89, p < 0.001$), and Riverine ($r = 0.89, p < 0.001$) communities not for tin miner settlers ($r = 0.07, p = 0.427$).
- After 6 months: in the mother-infant par with exclusive breastfeeding, the high correlation coefficients and statistical significance kept on for all groups, except for Tin miners.
4. The publications assessed maternal exposure to methylmercury and birth weight\textsuperscript{18} and trans-generational fish-methylmercury transfer \textsuperscript{19, 20, 21, 22, 23, 24, 25, 26, 27, 28.}

\textbf{Marques et al, 2013:} 1,433 mother-infant pair: traditional riverines (n = 396), riverines who had moved to urban (n = 676) and rural (n = 67) settings, and tin miner settlers (n = 294).

- Birth weight was significantly different among groups but did not show a pattern consistent with that of fish consumption (and HHg).
- A multiple regression analysis showed that only family income and gestational age had a significant impact on birth weight.

5. The mercury transfer during pregnancy was examined in 3 studies\textsuperscript{15, 16, 17}. The methyl mercury concentrations were assessed in umbilical cord blood (newborn) and venous blood (mother) in 2 studies\textsuperscript{15, 16}.

\textbf{Dutra et al, 2012:} At birth, a significant correlation was observed (Spearman correlation coefficient = 0.315; \( p = 0.002 \)) between cord blood and maternal venous blood levels.

\textbf{Cord Blood Hg: Median: 10 µg/L; Mean: 14 µg/L}
2000 - Correlation between mercury levels in blood of mothers (1,510) and cord blood of newborns (1,510) from Tapajós Basin, Itaituba, Pará Brazil, 2000/2001

Santos E.O.; De Jesus I.M; Câmara V.M.; Brabo E.D.S.; de Jesus M.I.; Fayal K.F.; Asmus Froes C.I.R. Cad Saude Publica, 2007, 23 (suppl 4), S622-S629.
They also searched on neurodevelopment related with exposure to mercury 23, 24, 25, 26, 27, 28, 29.

• HHg: Hair mercury concentrations;
• Methyl mercury (MHg) and Ethyl-mercury (EthylHg) from TCV: Thimerosal vaccine, combined with adjuvant-Al (Tetanus toxoid, Hepatitis B and DTP vaccines).
• Riverine children and TOKS (tin-ore kilns and smelters): The TOKS are children of families living in the vicinity of tin-ore processing facilities. Exposure to lead.
• GDS: Gesell development scores. The scores of results from Gesell neurodevelopment tests applied for the assessed domains (motor skills, language development, adaptive behavior, and personal social behaviors).
• Lefèvre Evolutonal Neurological Test (*): motor and sensory neurological development tests
<table>
<thead>
<tr>
<th>RB</th>
<th>Context</th>
<th>Main Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[23]</td>
<td>Assessment of methylHg (from breastfeeding and fish eating) and ethylHg from TCV in three groups: urban, fisherman and cassiterite miners.</td>
<td>Inverse significant correlation ((r = -0.2300; P = 0.0376)) between HHg and GDS for urban infants, but not for the “miners” infants ((r = 0.1336; P = 0.0862)) and “fisherman” infants ((r = 0.1666; P = 0.5182)).</td>
</tr>
<tr>
<td>[24]</td>
<td>Neurodevelopment (GDS): riverine children &lt; 5 years.</td>
<td>Mean (SD) of HHg ((\mu g\cdot g^{-1})): Infants: 4.33 (1.7). Most of the children (76%) showed adequate GDS. Methylmercury exposure had not impact on GDS.</td>
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<tr>
<td>[25]</td>
<td>Exposure to mercury. Neurodevelopment (GDS): at 6, 36, and 60 months.</td>
<td>Length of lactation was positive and significantly correlated with GDS at 60 months; HHg was inverse and significantly correlated with GDS at 6 months ((r = -0.333; P=0.002)) and 60 months ((r= -0.803; P=0.010)).</td>
</tr>
<tr>
<td>[26]</td>
<td>Neurodevelopment (GDS): at birth and at 6 months in exclusively breastfed infants.</td>
<td>Median [range] of HHg ((\mu g\cdot g^{-1})): Fetal: 1.59 [0.05 - 19.65]; 6 months:1.81 [0.02 - 32.95]. Most of the infants (74%) had normal GDS. Mothers of infants with multiple delays also showed the lowest range of income and level of education.</td>
</tr>
<tr>
<td>[27]</td>
<td>Neurodevelopment (GDS): children under 5 years of age living in a transitioning (tin-mining) area of the western Amazon</td>
<td>Mean (SD) of HHg ((\mu g\cdot g^{-1})): Children: 2.56 (1.67); Infants: 2.28 (1.15). The multivariate model showed that breastfeeding, a fish consumption biomarker (HHg), maternal education, and child’s age were statistically significant associated with specific domains (language and personal-social) of the Gesell scale.</td>
</tr>
<tr>
<td>[28]</td>
<td>Neurodevelopment: GDS and milestones related to walking and talking - exposure to EtHg and MeHg. Two groups of study: fishing community and TOKS.</td>
<td>Median (range) of Mercury Hair concentration ((\mu g\cdot g^{-1})): “fisherman”:3.5 [1.0, 8.7]; “TOKS”:2.2 [0.5, 8.6]; (p&lt;0.05). There was NO distinctive pattern of neurodevelopment associated with either HHg or EtHg exposure. Nutritional status was significantly associated with GDS. Mean (SD) of HHg ((\mu g\cdot g^{-1})): Exposed: 5.37 (± 3.35(\mu g\cdot g^{-1})); Control: 2.08 (± 1.37(\mu g\cdot g^{-1})). High performance rates considered “non-normal” and “refusals” in both the study group and control group in all tests applied.</td>
</tr>
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<td>[29]</td>
<td>Neurological development Tests (*) in 2 groups of riverine children: Higher (exposed) and lower (control) fish eating to mercury.</td>
<td></td>
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</tbody>
</table>
6. The results met in these studies have suggested an association between high exposure to mercury from different sources (methylmercury assessed from hair and ethylmercury assessed from vaccination cards) and poor neurobehavioral outcomes.\textsuperscript{22, 23}

7. Nevertheless, the researchers considered that the living conditions, the cultural patterns\textsuperscript{29} the nutritional status\textsuperscript{28} and the maternal education\textsuperscript{26, 27} could have been interfering with the results observed and must be considered in the evaluation of the effects of this metal on the cognitive ability of the studied population.
**SOUTHEAST REGION: Determination of Mercury Biologic Concentrations in children**

**Farias et al, 2008:** Total hair mercury (mg.kg\(^{-1}\)) in children from a coastal population in Cananéia, São Paulo State, Brazil:

<table>
<thead>
<tr>
<th>Reference</th>
<th>AREA</th>
<th>Total HHg (mg.kg(^{-1})) Mean (DP)</th>
<th>IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbosa et al, 2001</td>
<td>North Amazon</td>
<td>18.52 (10.04)</td>
<td>0.51 – 45.89</td>
</tr>
<tr>
<td>Santos et al, 2000</td>
<td>North Amazon</td>
<td>5.84 (4.91)</td>
<td>1.09 – 20.46</td>
</tr>
<tr>
<td>Marques et al, 2013</td>
<td>West Amazon</td>
<td>5.37 (3.35)</td>
<td>0.58 – 17.14</td>
</tr>
<tr>
<td>Marques et al, 2007</td>
<td>North Amazon</td>
<td>21.06 (14.38)</td>
<td>0.10 – 94.50</td>
</tr>
<tr>
<td>Farias et al, 2008</td>
<td>Southeast Region</td>
<td>0.48 (0.35)</td>
<td>&lt;0.01 – 3.33</td>
</tr>
</tbody>
</table>

**WHO:** 2.0 mg.kg\(^{-1}\) (for an adult population unexposed to Hg).
Contribuição para o estabelecimento de níveis de referência para a concentração de mercúrio no sangue de crianças na cidade do Rio de Janeiro

A Contribution for the establishment of reference values for total mercury levels in blood of children from Rio de Janeiro

Olga Leticia Penido Xavier¹, Carmen Ilides R. Fróes Asmus², Anamaria Testa Tambellini³, Armando Meyer⁴, Volney de Magalhães Câmara⁵

Reference Values - WHO

<table>
<thead>
<tr>
<th>Límites Biológicos</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Sangue</strong></td>
<td>5 – 10 µg/L (mercúrio total)</td>
</tr>
<tr>
<td><strong>Urina</strong></td>
<td>50 µg/g creatinina (mercúrio total)</td>
</tr>
<tr>
<td><strong>Cabelo</strong></td>
<td>7 µg/g**</td>
</tr>
</tbody>
</table>

**Tabela 4.** Média geométrica e intervalo de confiança da concentração de mercúrio total (µg/L) nos escolares participantes do estudo e outros estudos internacionais selecionados

<table>
<thead>
<tr>
<th>Estudo, Ano, País</th>
<th>Média de mercúrio total (µg/L)</th>
<th>IC95%</th>
<th>Referências</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presente estudo, 2009, Brasil</td>
<td>0,51</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Czech Republic, 2001–2003</td>
<td>0,43</td>
<td>1,19–2,02</td>
<td>Batáriová et al.¹⁸</td>
</tr>
<tr>
<td>GerES, 2003–2006, Alemanha</td>
<td>1,0</td>
<td>0,6–1,0</td>
<td>Wilhelm, Schulz e Schwenk¹⁶</td>
</tr>
<tr>
<td>NHANES, 2003–2006, Estados Unidos</td>
<td>0,44</td>
<td>0,36–0,48</td>
<td>Caldwell et al.¹⁵</td>
</tr>
<tr>
<td>CHMS, 2007–2008, Canadá</td>
<td>0,31</td>
<td>0,23–0,43</td>
<td>Wong e Lye¹⁷</td>
</tr>
</tbody>
</table>
Rio Birth Cohort Study of Environmental Exposure and Childhood Development

➢ To investigate alterations in childhood development associated with exposure to environmental pollutants, from pregnancy until the age of 4.

➢ The study population will be all children born at the Maternity School of Federal University of Rio de Janeiro, Rio de Janeiro/Brazil, from July 1st, 2019 to June 30th, 2020.

➢ The study will collect social, demographic and health information, in addition to biological samples from parents and newborns.
Rio Birth Cohort Study of Environmental Exposure and Childhood Development

Development Marks:
- Immune and respiratory System
- Neurodevelopment
- Growth and Weight gain

Clinical and Neuripsicological Exams

Outcomes
- Pregnancy 28° - 32° w
- Birth
- 1° Month
- 3° Month
- 6° Month
- 1° year
- 2° year
- 3° year
- 4° year

Exposure
- Environmental Form Blood, Urine and Hair
- Cord Blood Newborn urine
- Maternal Milk Newborn urine
- Infant urine
- Infant urine and hair

Children: urine Environmental Form
Rio Birth Cohort Study of Environmental Exposure and Childhood Development

PILOT STUDY: September, 2017 – July, 2018

147 children – mother pair

Preliminary results: 20 mother-newborn pair

<table>
<thead>
<tr>
<th>Mercury µg/L</th>
<th>Median</th>
<th>Geometric Mean</th>
<th>P95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cord Blood</td>
<td>3,85</td>
<td>3,80</td>
<td>6,78</td>
</tr>
<tr>
<td>Maternal Blood</td>
<td>3,1</td>
<td>3,48</td>
<td>8,21</td>
</tr>
</tbody>
</table>
HEALTH SURVEILLANCE OF MERCURY EXPOSED POPULATIONS IN BRAZIL

HEALTH MINISTRY of BRAZIL

HEALTH SURVEILLANCE SECRETARY

ENVIRONMENTAL AND WORKER HEALTH SURVEILLANCE DEPARTMENT

ENVIRONMENTAL HEALTH SURVEILLANCE COORDINATION

WORKER HEALTH COORDENATION
MERCURY EXPOSURE EFFECTS ON BRAZILIAN CHILDREN’S HEALTH

ENVIRONMENTAL HEALTH SURVEILLANCE COORDINATION

ENVIRONMENTAL HEALTH SURVEILLANCE BRAZILIAN SYSTEM

HEALTH SURVEILLANCE OF CHEMICAL POLLUTANTS EXPOSED POPULATIONS

- Health Surveillance of Populations living in contaminated areas
- Drinking Water Quality Surveillance Brazilian Program

Develop integrated health actions aimed at the adoption of measures to prevent risk factors, promote and surveillance the health of populations exposed to chemical pollutants.
Spatial distribution of Mercury intoxication cases, 2007 to 2017, Brazil (places in which there was the register of one case, at least).

Number of Mercury intoxication cases, domestic and occupational accidents, 2007 to 2017, Brasil.

1. Underreporting of mercury intoxication cases
2. Reporting of acute cases: domestic and occupational accidents
3. Almost NONE register from Amazon region
CONCLUSIONS

1. This chronic exposure is demonstrated through the mercury concentrations in biological samples – blood (umbilical cord and maternal), urine, hair and maternal milk of population living in Amazon region.

2. This chronic mercury exposure can be determining the occurrence of "underlying or subclinical" effects on children's health, which do not have specific symptoms, therefore dificulting the establishment of a cause-effect relationship.

3. The current Brazilian Surveillance Systems are not prepared, and they are unable, to detect and to register this situation
Systematic Review Studies – Bibliography References

15. Santos E.O.; De Jesus I.M; Câmara V.M.; Brabo E.D.S.; de Jesus M.I.; Fayal K.F.; Asmus Froes C.I.R. Correlation between blood mercury levels in mothers and newborns in Itaituba, Pará State, Brazil. Cad Saude Publica, 2007, 23 (suppl 4), S622-S629.
Gracias!  
Obrigado!  
Thanks!