Lead exposure in indigenous children of the Peruvian Amazon

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The Corrientes river basin

- Northeastern part of Peru
- Loreto Region
- Extension 425 km
- 36 villages (total population: 8000) Achuar, Quichua and Urarina
- oil installations
Oil industry in the Corrientes

Since 1970
- Environmental impacts
  • Discharging of produced waters into the rivers
  • disposal of sewage and industrial waste
  • frequent oil spills.
  • Documented:
    - 1987: high levels of Hg, Cr, TPH, in surface waters.
    - 1998-2007: oils, fats, TPH and heavy metals
    - 2006-2009: 158 oil spills, 10 damaged sites

(FECONACO, 2011).

- Health and social impacts

No comprehensive assessment yet. Continuous communities’ demands and protests.
THE CASE

Lead exposure in the Corrientes

2004 - 2005
Indigenous leaders and health officials (CENSOPAS) planned first assessment of health impacts

July 2005
Study: Blood lead and cadmium
74 children, 7 communities

Limitations to assess oil exposure’s indicators.
Selection of Pb and Cd
THE CASE

Lead exposure in the Corrientes

June 2006
Elevated blood Pb (66%)
Elevated blood Cd(99%)

Attributed to the Oil-related pollution
THE CASE

Lead exposure in the Corrientes

October 2006: DORISSA Agreement

Funding for an independent study to clarify the source of heavy metals exposure
THE STUDY

Participatory epidemiological study

January 2008: Collaboration agreement

July 2008: I joined the research team, PhD project
To understand the reasons for the elevated BLLs in order to suggest control and prevention strategies
Specific objectives

To determine:
- sources
- risk factors
- pathways
Specific objectives

To understand:
- lead exposure
- oil activity

Oil Activity → ? → BLLs
The participatory research process (2008-2011)

- **2008**: Establishing the collaborative partnership
- **2009**: Rethinking the sources
- **2009**: Communicating results
- **2010**: New study
Communities exposed to oil activity → Higher exposure to oil-related contamination → Higher lead exposure
2 villages exposed
1 village non exposed to oil activity
Participants

All residents aged 0-17 years, whose families had lived in the area for the last five years and whose parents authorized their participation.
STUDY I

PROCEDURES

1. **Lead population**: BLL in all children 0-17 years using the Leadcare

2. **Lead environment**: water and soil samples in villages and selected dwellings

3. **Risk factors**: Hb levels, anthropometrics questionnaire and risk map
RESULTS STUDY I

**Table 4.** Demographic characteristics of children in three communities, Corrientes river basin, Peruvian Amazon, 2009.

<table>
<thead>
<tr>
<th></th>
<th>San Cristobal</th>
<th>Peruanito</th>
<th>Sta. Isabel de Copal</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>13(5.8)</td>
<td>88(39.8)</td>
<td>120(54.3)</td>
<td>221(100.0)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>9 (69.3)</td>
<td>47(53.4)</td>
<td>68(56.7)</td>
<td>124(56.1)</td>
</tr>
<tr>
<td>Boys</td>
<td>4(30.7)</td>
<td>41(46.6)</td>
<td>52(43.3)</td>
<td>97(43.9)</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-3</td>
<td>6(46.2)</td>
<td>19(21.6)</td>
<td>33(27.5)</td>
<td>58(26.2)</td>
</tr>
<tr>
<td>4-6</td>
<td>3(23.1)</td>
<td>21(23.8)</td>
<td>26(21.7)</td>
<td>50(22.6)</td>
</tr>
<tr>
<td>7-17</td>
<td>4(30.7)</td>
<td>48(54.5)</td>
<td>61(50.8)</td>
<td>113(51.1)</td>
</tr>
</tbody>
</table>

# RESULTS STUDY I


<table>
<thead>
<tr>
<th>n</th>
<th>GM BLL ug/dl</th>
<th>BLL &gt; 10ug/dl</th>
<th>BLL &gt; 5ug/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>208</td>
<td>8.7 ug/dL</td>
<td>27.4%</td>
<td>85%</td>
</tr>
</tbody>
</table>
RESULTS STUDY I

Regardless exposure to oil activity No ≠ in GM BLLs

Elevated BLLs

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>%</th>
<th>Geometric mean BLL, μg/dL</th>
<th>GSD, μg/dL</th>
<th>BLL ≥ 10 μg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community of residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With oil activity</td>
<td>88</td>
<td>42.3</td>
<td>9.08</td>
<td>3.9</td>
<td>26</td>
</tr>
<tr>
<td>Without oil activity</td>
<td>120</td>
<td>57.7</td>
<td>8.38</td>
<td>4.1</td>
<td>31</td>
</tr>
</tbody>
</table>

TABLE 1. Descriptive characteristics and blood lead levels in children from two study communities (n = 208) in Corrientes River basin, Peru, 2009
RESULTS STUDY I

Older age: group 7-17 years old has 3.7 times greater likelihood...than the group 0-3 years old.

Boys: 2.12 times more likely than girls of having BLLs ≥ 10ug/dL

Risk factors

Environmental assessment

Pb levels below reference values
Rethinking ...

RESEARCH VISIT TO PERUANITO

- Group discussions
- Interviews
- Households visits

- Metal lead for fishing sinkers
- Recycling high tension cables from the oil company waste’ deposits
- Car batteries, ammunition, vendors

Group discussions
- Interviews
- Households visits

- Metal lead for fishing sinkers
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STUDY II

- Practices involving contact with metal Pb
- Living near oil facilities (greater access to lead)
- Higher level of lead exposure
6 villages
≠ exposure to oil activity
6 communities

- Geographic location
- History of oil exposure
- Distance to nearest oil installation
- Number of oil spills (OS) from 2006

**High exposure:**
- JO: 2.5km; 5OS
- AN: 2.5km; 6OS

**Medium exposure:**
- PE: 5km; 0OS
- SC: 5km; 7OS
- PA: 4km; 7OS

**No exposure:**
- SI: 42 km
Participants

All children aged 0-17 years, whose families had lived in the area for the last five years and whose parents authorized their participation.
STUDY II

PROCEDURES (Similar to study I)

Environmental assessment
- sediments, fish, soil (communities)
- indoor dust, stove ash, foodstuff (dwellings)

Risk factors questionnaire
- activities/practices involving the contact with Pb
### RESULTS STUDY II

<table>
<thead>
<tr>
<th>n</th>
<th>GM BLL ug/dl</th>
<th>BLL≥10ug/dl</th>
<th>BLL≥5ug/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>346</td>
<td>7.5 ug/dL</td>
<td>27%</td>
<td>78%</td>
</tr>
</tbody>
</table>

Table 3: Age group-specific multivariate logistic models of OR and 95% CI for BLLs ≥10 μg/dl in children from six indigenous communities of the Peruvian Amazon, 2010

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall n=346</th>
<th>0–6 years n=182</th>
<th>7–17 years n=153</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys*</td>
<td>3.7 (2.1–6.5)</td>
<td>1.5 (0.6–3.7)</td>
<td>1.2 (0.5–3.4)</td>
</tr>
<tr>
<td>Age group 4–6 years†</td>
<td>2.9 (1.1–7.5)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Age group 7–17 years†</td>
<td>6.9 (1.8–26.2)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Reside in a community with high exposure to oil activity‡</td>
<td>2.7 (1.2–6.3)</td>
<td>7.2 (2.5–20.2)</td>
<td>4.6 (1.2–16.8)</td>
</tr>
<tr>
<td>Play with pieces of lead</td>
<td>NA</td>
<td>7.2 (2.5–20.2)</td>
<td>NA</td>
</tr>
<tr>
<td>Fish ≥ three times/week§</td>
<td>NA</td>
<td>NA</td>
<td>7.8 (2.9–21.3)</td>
</tr>
<tr>
<td>Chew lead scraps</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Drive motorboat</td>
<td>NA</td>
<td>NA</td>
<td>3.4 (1.0–9.9)</td>
</tr>
</tbody>
</table>

Note: NA: not applicable.
*Compared to girls.
†Compared to age group 0–3 years.
‡Compared to reside in a community with no exposure to oil activity.
§Compared to not fishing.
RESULTS STUDY II

0-6 years
- Play with pieces of lead
  - Fish ≥3 times per week
  - Chew pieces of lead to make fishing sinkers

7-17 years

had an increased risk of having elevated BLLs
<table>
<thead>
<tr>
<th>Overall</th>
<th>Living in a community highly exposed to oil activity increased the risk for elevated BLLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection to oil activity</td>
<td>proximity of communities to oil facilities and greater access to lead cables and other wastes</td>
</tr>
<tr>
<td>Environmental assessment</td>
<td>Pb levels below reference values</td>
</tr>
</tbody>
</table>
CONCLUSIONS
Chewing lead to make fishing sinkers

Playing with pieces of lead

Living in a community highly exposed to oil activity

Metal lead

BLLs 7-17 years

BLLs 0-6 years
Connection with oil activity

Proximity to oil battery facilities
Greater access to metal lead
Communities near oil facilities

- Greater access to industrial wastes from which to extract Pb.

- The majority of men work in the company.

- Families keep scraps of lead at home.
Recommendations

A community-based lead control and prevention plan

Introduce substitute non-harmful material(s) for fishing sinkers

Ensure secure containment of the oil company’s waste deposits
Thanks....
STUDY II  Data collection

a) **assessment of BLL.** Leadcare system
b) assessment of Hb levels. HEMOCUE
c) **Risk factors questionnaire** to the heads of all families
d) **environmental sampling in communities:**
   - Sediments, soil, fish (EPA protocol)
e) **environmental sampling in selected dwellings:**
   - Indoor dust, foodstuff (EPA protocol)

Chemical analysis
- Total Pb in all samples by inductively coupled plasma- sector field mass spectrometer (ICPSFMS)
- Modified U.S. EPA method 200.8. Laboratory ALS Scandinavia

Data analysis
Descriptive statistics, bivariate analysis. Logistic regression with GEE