Patna Childhood Lead Exposure and Source Identification Study

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Prepared for: USAID
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INTRODUCTION

PROJECT BACKGROUND

Nearly two decades have passed since India completed its phase-out of leaded petrol. The pressing question now is: what are the sources of lead that continue to contribute to elevated blood-lead levels in India? Through our work in India and around the world, Pure Earth has identified the informal manufacturing of lead-acid batteries and the repair and recycling of used lead-acid batteries (ULAB) as a common and significant source of lead contamination. ULAB activities are often conducted in residential areas and with a lack of environmental or occupational health controls, thus spreading lead dust into areas frequented by children such as roadways and schoolyards or brought home on the shoes, hair and clothing of family members who work in this industry. Of all the lead used in India today, 70% comes from recycled batteries. However, less than 50% of used car batteries are currently recycled by formally registered, adequately financed and safely operated licensed recyclers, according to representatives of the India Lead-Zinc Development Association.

In addition to the contamination caused by informal ULAB activities and other industries, certain foods and consumer products in India have been shown to contain lead, most notably through contaminated spices, traditional medicines, and cosmetics. Individuals may also be exposed through characteristics of the home, such as the presence of lead-based paint or lead-contaminated drinking water. A better understanding of these various sources will allow the development of more tailored and effective interventions to lower lead exposures.

Site Background

This study was carried out in the city of Patna, Bihar, over a two-week period in February 2020. Pure Earth India began working in Bihar State in 2017, by identifying and assessing lead-contaminated sites in Patna. In 2018, Pure Earth selected a site in the community of Karmalichak for a pilot cleanup. The project was well-received by local officials including the Mayor and the Bihar State Pollution Control Board, community leaders, local NGOs, specifically the Institute of Environment & Eco Development (IEED), and the public at large, demonstrated by strong participation in trainings and education events. However, the pre- and post-intervention blood-lead tests did not decline as much as we expected (or desired), suggesting that there may be additional sources of lead exposure in the community.

Simultaneously, the national government requested that Pure Earth conduct a pilot lead exposure and source study in one state or locality to better understand which sources of lead (e.g., improper battery recycling, spices, cosmetics, drinking water, etc.) are contributing to
elevated blood-lead levels and to what extent. Given our experience in Karmalichak, it was decided that conducting the pilot lead source study in Patna would leverage our existing data and partnerships that had been established.

Project Partners
Led by Pure Earth, this study was carried out by a consortium of partners. The Indian National Centre for Disease Control provided Epidemic Intelligence Service Officers to act as team leads in the field. The Institute for Environment and Eco Development is Pure Earth's longtime implementing partner for the Toxic Sites Identification Program (TSIP) in Bihar, and thus provided critical knowledge of the locations of ULAB activities, as well as served as local liaisons. The Bihar Pollution Control Board provided staff to assist in the environmental sampling. Finally, the Patna-based Mahavir Cancer Institute and Research Centre conducted the ethics review for the study and provided pediatric phlebotomists.

Dr. Ashok Ghosh was critical in supporting the effort. He has dual appointments as the Chairman of the Bihar State Pollution Control Board, as well as the Head of Research at Mahavir. The project also had the support of the Bihar State Health Society, the state level heath authority.

Project Summary
The study was a representative, cross-sectional population-based cluster design survey, with the aim of evaluating the blood lead levels in children less than 6 years old in areas considered to be impacted by ULAB operations (within 300m of assembly, repair, recycling or lead smelting sites) and control areas considered to not be impacted by such operations (more than 5km away). Random households were selected from within the designated study areas. The three main components of the study were an environmental assessment of each participating child’s household, a demographic and behavioral questionnaire, and a venous blood lead sample.

APPROACH
The investigators were divided into two separate

Identification of participants - Efforts were made to secure census data or school roster data, and we ultimately were not successful in obtaining this information. Consequently, we relied on the generation of random points using GIS. When

Teams

Blood lead levels were determined by running venous samples on a Lead Care II Analyzer.
Using the XRF, we collected data on soil, spices, paint, toys, and cookware from participating households. Dust wipes, drinking water and a subset of soil samples were analyzed in a laboratory setting. Furthermore, the behavioral questionnaire responses will provide a wealth of information on factors such as the child’s diet, use of traditional makeup (kohl) or medicines, and potential take-home exposures from parents.

**PRELIMINARY RESULTS**

A total of 136 children under the age of 6 years participated in the study. With the quantity of data collected, considerable analysis will have to be conducted before we have a complete picture. Pure Earth and our partners have begun to examine the blood lead results and potential contributing sources.

**Blood Lead Analysis**

The most striking result is the prevalence of elevated blood lead levels among the participating children, both within our “exposed” ULAB area and in the “control”. Based on preliminary analyses, approximately 85% of all participating children had blood lead levels above 5 ug/dL; approximately 65% had levels above 10 ug/dL. The prevalence of elevated blood lead levels in both the control and exposed areas indicates the presence of other significant contributing sources of lead aside from ULAB activities.
<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>S.E. Mean</th>
</tr>
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<tbody>
<tr>
<td>BLL (ug/dL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed</td>
<td>67</td>
<td>13.47</td>
<td>9.13</td>
<td>1.12</td>
</tr>
<tr>
<td>Control</td>
<td>70</td>
<td>15.96</td>
<td>10.46</td>
<td>1.25</td>
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<table>
<thead>
<tr>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
<th>Lower</th>
<th>Upper</th>
</tr>
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<tbody>
<tr>
<td>-1.48</td>
<td>135.00</td>
<td>.141</td>
<td>-2.49</td>
<td>1.68</td>
<td>-5.81</td>
<td>.84</td>
</tr>
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</table>

No significant difference between mean BLL in our “exposed” and “control” areas. However, the prevalence of elevated BLLs was an unexpected and alarming finding. The highest BLL identified was 53.9 ug/dL.

Soil
Typical background levels in an urban environment in
Figure XX displays the soil XRF readings, grouped by “Control” area and “Exposed” area. This greater variability between the two groups is also captured by the percentiles of

<table>
<thead>
<tr>
<th>Pb_conc</th>
<th>Exposed</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>90</th>
<th>95</th>
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<tbody>
<tr>
<td>Control</td>
<td>Average</td>
<td>15.15</td>
<td>17.30</td>
<td>20.75</td>
<td>28.00</td>
<td>37.00</td>
<td>55.70</td>
<td>71.85</td>
</tr>
<tr>
<td></td>
<td>Tukey’s Hinges</td>
<td>21.00</td>
<td>28.00</td>
<td>37.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed</td>
<td>Average</td>
<td>19.00</td>
<td>22.00</td>
<td>28.00</td>
<td>46.50</td>
<td>101.75</td>
<td>240.60</td>
<td>587.00</td>
</tr>
<tr>
<td></td>
<td>Tukey’s Hinges</td>
<td>28.00</td>
<td>46.50</td>
<td>100.50</td>
<td></td>
<td></td>
<td></td>
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In the case of participant 1, an active battery recycling shop was found within XX meters of the home.

Spices

One such subject requiring additional examination and analysis is the prevalence of common cooking spices with significant levels of lead. We look forward to making full use of this unique and comprehensive dataset to generate and disseminate public health recommendations.

One subject requiring additional examination and analysis is the prevalence of common cooking spices with significant levels of lead. Alarming concentrations of lead were identified in turmeric in
particular, although elevated levels were also seen in coriander and chili powder. Once the current COVID-19 situation allows, collaborators at Stanford University have agreed to run lab analyses of the spice samples to determine what lead compounds are present in order to better understand the supply chain.

Drinking water

Please see Appendix XX for a map of water

Four primary sources of drinking water were identified during the – check against the questionnaire

Paint

Toys/etc.

Questionnaire
The questionnaire responses will provide a wealth of information on factors such as the child’s diet, use of kohl or traditional medicines, and potential take home exposures from parents.

DISSEMINATION

In coordination with the study’s partner organizations, we will endeavor to publish major findings in a peer-reviewed journal.

Once further analysis is completed, we look forward to generating and disseminating public health recommendations. A project completion report is currently being drafted.
LESSONS LEARNED

Despite reducing the radius to within 300 meters of identified battery operations, we encountered very few homes with elevated levels of lead in soil. A study with this design would be better suited for a larger scale battery operation with extensive lead smelting activities.

The identification of subjects
As described previously, we relied on the generation of random points to select households for the study. While this did allow randomization within our desired radius, it was very time consuming for the sampling team to visit each point, only to determine that there were no eligible households in the area. We also encountered an issue where the surveyors were met with some distrust when entering certain neighborhoods without prior explanation.

In an urban setting like Patna, it proved difficult for the survey team to

5 teams versus 4 – having environmental following survey team

Use of Epi Info – large time-saving benefit of not having to digitize responses.
Many issues with version control or business rules not working correctly.
Relied on CDC staff to make changes
one instance where data did not upload

Need for staff support – sample handling/management
Analysis
Supplies
Vehicles

System for returning results

Soil samples – XRF bag next
include battery in home question on questionnaire
TECHNICAL APPENDICIES AND CHARTS (IF APPLICABLE)