Biofuel smoke and child anemia in 29 developing countries: A multilevel analysis

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Overview

- Background
- Research questions
- Method
- Results
- Discussions
Background

- >3 billion people rely on biofuel (wood, straw, dung and crop residues) for cooking and heating (WHO, 2010)

- About 50% children < 5yrs in developing countries have anemia (Hb<11g/dl) (WHO, 2008)
Background

• Pollutants in biofuel smoke: Benzo(a)pyrene & cresol can cause anemia in humans

• Only 1 previous study in India (n=29,768)
  • RR= 1.58 (95% CI=1.28, 1.94) between biofuel smoke exposure at home and anemia in children
    (Mishra and Retherford, 2007)
Background

• Fever & diarrhea associated with anemia possibly mediated through infection/inflammation (Semba et al., 2008)

• Co-existence of biofuel smoke exposure and fever/diarrhea may worsen the anemia
Research Questions

• What is the strength of association between biofuel smoke exposure assessed at the country and child levels and child anemia?

• Is the effect of child-level biofuel smoke exposure on child anemia moderated by child age, fever and diarrhea?
Method

• Data from Demographic and Health Surveys (DHS)
  – Nationally-representative household surveys
  – Taken place in about 70 developing countries
Dependent variable

• Anemia
  – No anemia (Hb ≥11.0 g/dl)
  – Mild (10-10.9 g/dl)
  – Moderate/severe (<10g/dl)
Independent variables

• Biofuel smoke exposure
  – Type of fuel the households mostly used for cooking
    • Biofuel: wood, straw, animal dung, and crop residues
    • Cleaner fuel (reference group): electricity, natural gas, biogas, and kerosene
Independent variables

• Country level biofuel use
  – % households using biofuel (by aggregating household use up to the country level)
    • low (<40%)
    • moderate (40 - 79%)
    • high (≥80%)
Control variables

• Country level
  – GDP

• Child level
  – Child nutritional status (HFA, WFA)
  – Child age (mths), fever, diarrhea
  – Maternal Iron intake during pregnancy (days)
  – Maternal smoking
  – Socio-economic status
  – Place of residence (Urban or rural)
Data analysis

- Multinomial logistic regressions (MLwiN 2.18)

Level 3 Country (n=29)

Level 2 Neighbourhoods

- Level 2 Neighbourhoods 1 (N=15,886)
- Level 2 Neighbourhoods 2
- Level 2 Neighbourhoods 3

Level 1 Children

- Level 1 Children 1 (N=117,454)
- Level 1 Children 2
- Level 1 Children 3
- Level 1 Children 4
- Level 1 Children 5
## Results

**Table 1. Sample Characteristics, 29 Countries, 2003-2007**

<table>
<thead>
<tr>
<th>Country level biofuel (%)</th>
<th></th>
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<tbody>
<tr>
<td>Moderate</td>
<td>46</td>
</tr>
<tr>
<td>High</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biofuel exposure (% children)</th>
<th>74</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Child anemia (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>25</td>
</tr>
<tr>
<td>Moderate/Severe</td>
<td>39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fever (%)</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea (%)</td>
<td>15</td>
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</tbody>
</table>
Table 2. Multinomial Logistic Regressions of Mild, Moderate and Severe Anemia on study variables after adjusting for covariates

<table>
<thead>
<tr>
<th></th>
<th>Mild anemia OR (95% CI)</th>
<th>Moderate/ severe anemia OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biofuel (country level)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Ref Ref</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>NS 2.36 (1.30-4.30)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>NS 2.47 (1.14-5.38)</td>
<td></td>
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<tr>
<td><strong>Biofuel (Child level)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaner fuel</td>
<td>Ref Ref</td>
<td></td>
</tr>
<tr>
<td>Biofuel</td>
<td>1.07 (1.02-1.14)</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biofuel*child age</td>
<td>1.005 (1.003-1.006)</td>
<td>1.006 (1.004-1.007)</td>
</tr>
<tr>
<td>Biofuel*fever</td>
<td>NS 1.31 (1.20-1.43)</td>
<td></td>
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<tr>
<td>Biofuel*diarrhea</td>
<td>1.19 (1.08-1.32)</td>
<td>NS</td>
</tr>
</tbody>
</table>
Fig 1. Interaction: Biofuel exposure and child age (mths) for mild anemia
Fig 2. Interaction: Biofuel & Diarrhea for Mild Anemia
Discussion

- Biofuel use ↑ and childhood anemia ↑
  - country level: severe anemia
  - child level: mild anemia
- Moderating effects: age, fever, diarrhea
  - exacerbates the association
Limitations

• Exposure measured indirectly
• No information on:
  – Duration & extent of exposure
  – Intestinal parasitic infection
  – Lead poisoning
• Cross-sectional design
Conclusions

• Indoor air pollution → serious public health problem
• Reduce pollution levels through use of
  - cleaner fuels?
  - improved stoves with chimneys?
• Inform families of the hazard of biofuel smoke & ways to reduce exposure

(http://www.who.int/indoorair/publications/iabriefing3.pdf)
Thank You