Effects of Improved Cookstove Emissions on Normal Human Bronchial Epithelial Cells

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I. Abstract

Motivation for this work:
Do improved cookstoves reduce lung inflammation in vitro?

Approximately ½ the world’s population uses biofuels for cooking and heating, with wood being the fuel source used most heavily. Human exposure to biofuel combustion emissions (i.e., woodsmoke) has been associated with pulmonary disease, childhood respiratory infections, eye sight, degeneration, cancer, and adverse pregnancy outcomes. Consequently, woodsmoke exposure is an important global health concern. Recent effort has been given to the design and dissemination of ‘improved cookstovess,’ with the expectation that an improved cookstove will reduce fuel consumption, reduce emissions and improve health. There is a lack of information on the health effects associated with exposure to improved cookstove emissions. This research seeks to investigate inflammation and stress in human bronchial epithelial cells exposed to emissions from improved cookstoves.

II. Experimental Design

Cells grown at an Air Liquid Interface (ALI) for > 21 days

• Squamous layer of NHBE cells
• Progressive differentiation
• Pseudo-stratified columnar epithelium. Signs of basal, goblet, and ciliated cell types

Exposed mature cells cookstove emissions

• Simmer phase of standard water boil test (45 minutes)
• Filtered air controls
• 3 donors, 2 exposures per donor, 24 experimental runs
• Cells were Exposed to Cookstove Emissions using an Electrostatic Aerosol In Vitro Exposure System (Figure 1)

• Approximate Dose

<table>
<thead>
<tr>
<th>Stove Type</th>
<th>Three-stone fire</th>
<th>Envirofit Gen3300</th>
<th>Philips Gasifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose (µg/cm²)</td>
<td>5-6</td>
<td>1-3</td>
<td>1-3</td>
</tr>
</tbody>
</table>

Table 1: Estimated dose delivery per cellular area

• Measured Transcriptional Markers of Inflammation at 1 and 24 Hours Post Exposure:
  - Interleukin-8 (IL-8)
  - Heme oxygenase-1 (HOX-1)
  - Cyclooxygenase-2 (COX-2)
  - Glyceraldehyde 3-Phosphate Dehydrogenase (GAPDH)

V. Results and Conclusions

• Improved Cookstoves Reduce Inflammation In Vitro

![Figure 1: The EAVES2 is a direct aerosol-to-cell deposition system.](image1)

- *significant reduction in inflammatory biomarkers
- Most significant reduction was seen with HOX-1 and COX-2 expression at 1hr post exposure

![Figure 2: Expression of IL-8, HOX-1, and COX-2 at 1 Hour Post Exposure](image2)

![Figure 3: Expression of IL-8, HOX-1, and COX-2 at 24 Hours Post Exposure](image3)

Conclusions:

• ALI cell culture and EAVES offers greater physiological relevance than current in vitro exposure techniques
• Data support the improved cookstove hypothesis
• Fuel efficient stove models reduced the expression of biomarkers associated with inflammation in vitro
• Most significant reduction was seen with HOX-1 and COX-2 expression at 1hr post exposure
• Dose required to observe effects was much lower than traditional in vitro studies

References:


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