HOUSING CHARACTERISTICS AND INDOOR AIR QUALITY IN HOUSEHOLDS OF AN CHILDREN WITH CHRONIC LUNG CONDITIONS

Arctic Health Sciences Seminar
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Pneumonia hospitalizations, Alaska Native infants, by region, 2009-2011

Foote et al., Alaska Native Research Conference, 2014
Risk Factors for LRTI and RSV Hospitalizations, Alaska Native children

- Medically high-risk (premie, congenital heart disease, or chronic lung disease)
- Absence of breastfeeding
- Household crowding
- <2 rooms with sinks
- No piped water
- Woodstove in the house
- Vomiting after feeding
- Low income

Household Crowding in the U.S. 2000 Census Data

Figure 9. Crowded Housing: 2000

Percent of occupied housing units with more than one person per room by state

- 9.5 to 19.3
- 5.7 to 6.4
- 3.8 to 5.6
- 1.3 to 3.7

American Indian Reservations

Alaska Native Villages

Long Term Effects of Pneumonia

- **Chronic Suppurative Lung Disease/Bronchiectasis**
  - Airway damage leads to loss of elasticity ("ectasia") of bronchi
  - Classic symptom is "**Chronic Wet Cough**"
  - Progress: Protracted bronchitis $\rightarrow$ chronic suppurative lung disease $\rightarrow$ CT scan confirmed Bronchiectasis
  - 1:63 YK children had bronchiectasis vs. 1:2,000 U.S. children w/ CF

- **Decreased lung function and COPD in Adulthood**
  - Adults with childhood pneumonia had lower FEV1 than others
Partnering with:
ANTHC Div. Environmental Health & Engineering
ANTHC Community Health and Environment
Improving the Respiratory Health of Alaska Native People through Home-based Interventions: The Healthy Homes Study

Background
- Alaska Native children have high rates of pneumonia and bronchiolitis hospitalizations and chronic lung disease/

Methods
- Evaluate the impact of simple home renovations and education on improving respiratory symptoms
- Measure indoor air quality, respiratory visits, and respiratory symptoms before and after interventions

Investigators:
- AJ Salkoski
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- Leif Albertson REHS, MS
- Joseph Klejka MD
- Lisa Bulkow MS
- Jennifer Skarada
- George Goodwin

Institutions:
- ANTHC DEHE
- AIP- CDC
- YKHC
- BBAHC

Status: Finished study activities. Manuscript with baseline data.
Methods

- Choose YKHC and BBAHC communities
- Choose eligible homes with child who has chronic lung problems
- ANTHC, Regional Health Corporation Staff, & Housing Authority Staff assess home:
  - Inadequate ventilation, leaky woodstove, moisture problems
  - Identify contaminants and risky behaviors
- The resident, housing and environmental health personnel decide scope of work
- ANTHC Environmental Health does air sampling and household education
- Housing Personnel complete modifications
New and/or Improved Vents

Ventilation intake plugged with a rag

New ventilation intake
Woodstove Replacement

Old woodstove

New EPA-certified, low-emission woodstove
How do study houses compare with other U.S. homes?

<table>
<thead>
<tr>
<th>Housing</th>
<th>Study houses</th>
<th>US houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean # occupants</td>
<td>7.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Median sq. feet</td>
<td>920</td>
<td>2,465</td>
</tr>
<tr>
<td>% &gt;1 person/room</td>
<td>73%</td>
<td>3%</td>
</tr>
<tr>
<td>% with woodstove primary heat</td>
<td>16%</td>
<td>2%</td>
</tr>
<tr>
<td>% w/ smokers</td>
<td>49%</td>
<td>26%</td>
</tr>
<tr>
<td>% no running water</td>
<td>60%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

U.S. data from 2008-2012 Census, American Community Survey

Smaller, crowded, more smokers & woodstove use, less running water
Healthy Homes Study: Baseline findings

- **Indoor Air Quality**
  - High Volatile Organic Compounds (VOCs) and Particulates (PM2.5)

- **Respiratory symptoms in study household children**
  - high rates of cough between colds, hospitalization for lung infections, history of pneumonia, and wheezing.

- **Household factors and child symptoms**
  - VOCs
  - Primary wood heat
  - PM2.5
  - VOCs

- **Cough between colds**
- **Wheeze between colds**
- **Asthma diagnosis**
## Home Characteristics: Study vs. U.S.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study (N=63) (90% CI)</th>
<th>United States*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ft² – mean</td>
<td>888 Ft²</td>
<td>(2,465 Ft² for homes built after 2000)</td>
</tr>
<tr>
<td>% &gt;1 person/room</td>
<td>73%</td>
<td>3.2%</td>
</tr>
<tr>
<td>% Primary woodstove</td>
<td>16%</td>
<td>2.1%</td>
</tr>
<tr>
<td>% Fuel Oil as 1º heat</td>
<td>78%</td>
<td>6.5%</td>
</tr>
<tr>
<td>% with smokers</td>
<td>49%</td>
<td>26.2%</td>
</tr>
<tr>
<td>% no running water</td>
<td>60%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

# Indoor Air Measures: Study Homes

<table>
<thead>
<tr>
<th>Measure</th>
<th>Cut-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM 2.5 (ug/m3)</td>
<td>51% over the cutoff</td>
</tr>
<tr>
<td>CO2 (ppm)</td>
<td>70% over the cutoff</td>
</tr>
<tr>
<td>Ave. Rel Humidity (%)</td>
<td>&lt;30 over half of time (30%) &gt;60 over 1% of time (18%)</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td>Average 74, Max 84</td>
</tr>
</tbody>
</table>
# Volatile Organic Compounds: Study Homes

<table>
<thead>
<tr>
<th>VOC (µg/m³)</th>
<th>ATSDR MRL*</th>
<th>% &gt; ASTDR MRL</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>9.58</td>
<td>23%</td>
<td>3</td>
<td>170</td>
</tr>
<tr>
<td>m,p-Xylene</td>
<td>220</td>
<td>8%</td>
<td>11</td>
<td>640</td>
</tr>
<tr>
<td>o-Xylene</td>
<td>220</td>
<td>2%</td>
<td>4.5</td>
<td>430</td>
</tr>
<tr>
<td>BTEX**</td>
<td></td>
<td>45</td>
<td>2070</td>
<td></td>
</tr>
<tr>
<td>Total VOC</td>
<td></td>
<td>99</td>
<td>2794</td>
<td></td>
</tr>
</tbody>
</table>

* ATSDR MRL Agency for Toxic Substances and Disease Registry minimum risk levels
** BTEX = total of benzene, toluene, ethylbenzene, o-xylene & m,p-xylene
## Household factors vs. Lung Symptoms in Study Household Children

<table>
<thead>
<tr>
<th>Lung Sx.</th>
<th>Household Factor</th>
<th>Odds Ratio (p-value)</th>
<th>Unadjusted</th>
<th>Crowding, piped water, high risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough between colds</td>
<td>Smoker in home BTEX &gt;100 µg/m³ 1º Wood Heat PM2.5&gt;25 µg/m³</td>
<td>3.1 (0.005)</td>
<td>2.3 (0.037)</td>
<td>4.42 (&lt;0.001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.2 (0.037)</td>
<td>3.18 (0.027)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.18 (0.026)</td>
</tr>
<tr>
<td>Wheeze between colds</td>
<td>BTEX &gt;100 µg/m³</td>
<td>2.1 (0.024)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma Dx.</td>
<td>BTEX&gt;100 µg/m³ CO2&gt;1000 ppm</td>
<td>2.9 (0.011)</td>
<td>3.02 (0.031)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3 (0.038)</td>
<td></td>
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</tr>
</tbody>
</table>
In Summary:

• We described the Alaska Native child health inequities in household IAQ factors and their relationship to child respiratory symptoms.

Next Steps:

• Pilot project to determine the feasibility of a hospital-based environmental consultation program at ANMC.

• Train tribal health providers in recognition and treatment of children with bronchiectasis.

Thank You!
INTRODUCTION: Alaska Native children experience high rates of respiratory infections and conditions. Household crowding, indoor smoke, lack of piped water, and poverty have been associated with respiratory infections.

METHODS: We monitored indoor particulate matter (PM2.5), CO2, relative humidity %, temperature and volatile organic compounds (VOCs), and interviewed caregivers about children’s lung symptoms.

RESULTS: Compared with general U.S. households, study households were more likely overcrowded (73% vs. 3.2%); and had higher woodstove use as primary heat source (16% vs. 2.1%); higher proportion of children in a household with a smoker (49% vs. 26.2%); and higher proportion with no running water or sewer (60% vs. 0.5%). VOCs (BTEX >100 μg/m³), presence of a smoker, primary wood heat and PM2.5 >25 μg/m³ were associated with higher risk for cough between colds; VOCs were associated with higher risk for asthma diagnosis in high risk and other household children.

CONCLUSIONS: In Alaska Native households with children who have chronic respiratory conditions, high indoor air pollutants levels were associated with respiratory symptoms in all of the household children, likely related to overcrowding, poor ventilation, woodstove use, use of homes as workshops, and tobacco smoke.