Air pollution and Tuberculosis

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Rationale

Many studies have found an association between tobacco smoking and Tb
Air pollution

- Tobacco smoking
- Passive smoking
- Indoor Air pollution
- Ambient Air pollution
## State of knowledge: Passive smoking

<table>
<thead>
<tr>
<th>Study*</th>
<th>Country</th>
<th>Sample size</th>
<th>Odds ratio (95% CI)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tipayamongkholgul (2005)</td>
<td>Thailand</td>
<td>130/130</td>
<td>9.31 (3.14, 27.58)</td>
<td></td>
</tr>
<tr>
<td>Altet (1996)</td>
<td>Spain</td>
<td>93/95</td>
<td>5.39 (2.44, 11.91)</td>
<td></td>
</tr>
<tr>
<td><strong>Adult</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ariyothai (2004)</td>
<td>Thailand</td>
<td>100/100</td>
<td>2.37 (0.94, 6.01)</td>
<td></td>
</tr>
<tr>
<td>Alcaide (1996)</td>
<td>Spain</td>
<td>46/46</td>
<td>2.50 (1.00, 6.20)</td>
<td></td>
</tr>
</tbody>
</table>

**Heterogeneity:** $I^2=41.3\%$

Note: The horizontal axis is on log scale

*All studies are case control studies

Lin HH et al., PLoS Medicine, 2007
## State of knowledge: Indoor air pollution

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Sample size</th>
<th>Odds ratio (95% CI)</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case control</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Shetty (2006)</td>
<td>India</td>
<td>189/189</td>
<td>0.90 (0.46, 1.76)</td>
<td></td>
</tr>
<tr>
<td>Crampin (2004)</td>
<td>Malawi</td>
<td>598/992</td>
<td>0.60 (0.30, 1.10)</td>
<td></td>
</tr>
<tr>
<td>Perez-Padilla (2001)</td>
<td>Mexico</td>
<td>288/545</td>
<td>2.20 (1.10, 4.20)</td>
<td></td>
</tr>
<tr>
<td><strong>Heterogeneity</strong>: $i^2=74.1%$</td>
<td></td>
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<tr>
<td><strong>Cross sectional</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mishra (1999)</td>
<td>India</td>
<td>2,034/260,162</td>
<td>2.58 (1.98, 3.37)</td>
<td></td>
</tr>
<tr>
<td>Gupta (1997)</td>
<td>India</td>
<td>NR/707</td>
<td>2.54 (1.07, 6.04)</td>
<td></td>
</tr>
<tr>
<td><strong>Heterogeneity</strong>: $i^2=0%$</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note: The horizontal axis is on log scale

Lin HH et al., PLoS Medicine, 2007
## State of knowledge: Ambient Air pollution

<table>
<thead>
<tr>
<th>Author, Date</th>
<th>Population</th>
<th>Geographical location</th>
<th>Exposure</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>?, 2008</td>
<td></td>
<td>Russia (Amur)</td>
<td>Ambient air pollution, mercury-containing pesticides, emission of metallic mercury at gold mining</td>
<td>No association found</td>
</tr>
<tr>
<td>Reid A, 2008</td>
<td>2552 women, residents of blue asbestos mining and milling townships, not involved in mining or milling</td>
<td>Wittenomm, Western Australia</td>
<td></td>
<td>SMR = 5.38 (0.14-30.0)</td>
</tr>
</tbody>
</table>
Evidence of causal relationship

- Dose-response relationship
- Biological plausibility
Mechanisms
1st level of host defense

• Impairment of the normal clearance of secretions on the tracheobronchial mucosal surface
Mechanisms
2nd level of host defense

• Reduced activity of
  – Alveolar macrophages
  – Dendritic cells
  – Natural killer cells
Mechanisms
Pulmonary Alveolar Macrophages (1)

• Reduced adherence to surfaces
• Reduced phagocytic ability
• Lower level of secreted proinflammatory cytokines
Mechanisms
Pulmonary Alveolar Macrophages (2)

• Elevated iron content
  - Iron overload impairs defense against intracellular microorganisms through reduced production of TNF and NO
Mechanisms
Pulmonary Alveolar Macrophages (3)

• Action on nicotinic acetylcholine receptors
  ➢ Decreased TNF-a
    ➢ Impairment of intracellular killing of M. tuberculosis
Intervention studies

- Effect of smoking cessation of household members on TB treatment outcomes?
A modelling study

- Complete cessation of smoking and solid-fuel use by 2033 would reduce the projected annual tuberculosis incidence in 2033 by
  - 14-52% if 80% DOTS coverage is sustained
  - 27-62% if 50% coverage is sustained
  - 33-71% if 20% coverage is sustained

Lin HH et al., Lancet, 2008
Conclusions

• Exposure to respirable pollutants (tobacco and biomass fuels) increases the risk of both TB infection and TB disease

➢ Policy implications