Tuberculosis and indoor biomass and kerosene use in Nepal
A case-control study

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Tuberculosis and Indoor Biomass and Kerosene Use in Nepal: A Case-control Study


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What is Tuberculosis (TB)?

- Infection or disease caused by bacteria that grow best in the area that have lots of blood and oxygen - mainly found in the lungs.
What is Tuberculosis (TB)?

• Tuberculosis is an air-bone disease that can spread when someone (with active TB) coughs, sneezes.

• People exposed to TB do not always become sick

• TB bacteria can hide out in a person’s body for many years, a situation called Latent TB

• In a lifetime 1/10 Latent TB patient turn in to active TB patient

• Suppression of immunity is important for this activation
Global Burden of Tuberculosis (TB)

- Major infectious cause of illness and death worldwide
- TB kills one person every 18 seconds
Burden of TB in South Asian sub-continent

- Globally - 9.2 million new TB cases in 2006 (WHO)
- Globally - 1.7 million TB related deaths in 2008 (WHO)
- Majority of new cases and deaths occurred in Africa and Asia

Nepal situation

- Annual incidence of all forms of TB – 176/100,000 people
- New infection – 48,000 new cases/year
- 30 people die every day
- 11,000 die every year
Public Health Focus to Control TB

- Case findings of smear positive cases
- Treatment with combination of drugs
- DOTs (Directly Observed Treatment Short-course strategy)
- Focus is more on treatment side than prevention side
Identification of risk factors and minimizing exposure could reduce the burden of TB in developing countries.
Definitive risk factors for Tuberculosis

• HIV
• Other immuno compromised conditions
• Diabetes mellitus
• Occupation (Silica or mining)
• Active Tobacco Smoking
• Lack of Dietary Protein and anti-oxidant deficiency
• Smoke from Cooking fire (?)
## Association between solid fuel use relative to cleaner burning fuel or electricity and risk of Tuberculosis

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study type and location</th>
<th>Outcome</th>
<th>RR (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gupta et al (1997)</td>
<td>Case-control, North India</td>
<td>Clinically confirmed-Pulmonary TB</td>
<td>2.54 (1.07-6.04)</td>
</tr>
<tr>
<td>Padilla et al (2001)</td>
<td>Case-control, Mexico</td>
<td>Clinically confirmed-Pulmonary TB</td>
<td>2.20 (1.10-4.20)</td>
</tr>
<tr>
<td>Crampin et al (2004)</td>
<td>Case-control, Malawi</td>
<td>Clinically confirmed-Pulmonary TB</td>
<td>0.60 (0.30-1.10)</td>
</tr>
<tr>
<td>Shetty et al (2006)</td>
<td>Matched case-control, South India</td>
<td>Clinically confirmed-Pulmonary TB</td>
<td>0.90 (0.46-1.76)</td>
</tr>
</tbody>
</table>
Association between **solid fuel use relative to cleaner burning fuel or electricity** and risk of Tuberculosis

- Results are inconsistent
- All the studies had limitations
- Needs to confirm the association
Hypothesis, study design and participants

• **Hypothesis**
  “Cooking with traditional biomass stoves without chimney increases the risk of tuberculosis among householders compared with cooking using liquid or gaseous fuels”

• **Cases (# 125)**
  Female aged 20 - 65 years, incident diagnoses of pulmonary TB (Sputum positive and chest x-ray)

• **Controls (# 250)**
  Female in/outpatients aged 20 - 65 years, without pulmonary TB

• **Matching**
  Cases and controls matched on age (5 years band)

• **Ratio**
  1 case: 2 controls
Study Procedure-case recruitment
Study Procedure-case/control recruitment
Data collected by questionnaire

Main Exposure of Interest

• Cooking fuel (wood/biomass, cow dung cake, coal/charcoal, biogas, kerosene, liquefied petroleum gas, electricity) and Stove type

• Heating fuel

• Lighting fuel

• Kitchen type & location

• Ventilation
Biomass fuel combustion indoors
Kerosene combustion indoors

- Wick Kerosene Stove (n=33/42)
- Wick Kerosene Lamp (n=21/22)
- Pump Kerosene Stove
- Kerosene Lantern
Gaseous fuel stove

Bio-gas stove

Liquefied Petroleum Gas (LPG) stove
Explanatory variables/ Potential confounders

- Age
- Education
- Religion
- Residency (rural/urban, residency district)
- Smoking habits and quantity/amount of smoke (pack-years)
- Types of smoke (cigarette, bidis, hukka)
- Number of family members who smoked indoors
- Alcohol consumption
- Whether taking vitamin supplements
- Family history of TB
- Ventilation in the kitchen
- Socio-economic variables (house construction, income)
Multivariate logistic regression model and unadjusted results for cooking fuel use in relation to TB in women in Pokhara, Nepal [from Pokhrel et al., EHP in press, 2010]

<table>
<thead>
<tr>
<th>Cooking fuel</th>
<th>Adjusted RR (95% CI)</th>
<th>Unadjusted RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Biomass</td>
<td>1.21 (0.48-3.05)</td>
<td>1.98 (1.24-3.17)</td>
</tr>
<tr>
<td>Kerosene</td>
<td>3.36 (1.01-11.22)</td>
<td>2.54 (1.26-5.12)</td>
</tr>
</tbody>
</table>

† Adjusted for age, religion, income, education level, urban/rural residency, residency district, present house construction, whether always lived in the present house, pack-years of smoking, number of family members who smoked indoors, alcohol consumption, whether taking vitamin supplements, family history of TB, and whether there is ventilation in the kitchen
Multivariate logistic regression model and unadjusted results for heating fuel use in relation to TB in women in Pokhara, Nepal [from Pokhrel et al., EHP in press, 2010]

<table>
<thead>
<tr>
<th>Heating fuel</th>
<th>Adjusted RR (95% CI)</th>
<th>Unadjusted RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No heating fuel use or electricity</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Biomass, coal or kerosene</td>
<td>3.45 (1.44-8.27)</td>
<td>2.81 (1.78-4.42)</td>
</tr>
</tbody>
</table>

† Adjusted for age, religion, income, education level, urban/rural residency, residency district, present house construction, whether always lived in the present house, pack-years of smoking, number of family members who smoked indoors, alcohol consumption, whether taking vitamin supplements, family history of TB, and whether there is ventilation in the kitchen.
Multivariate logistic regression model and unadjusted results for lighting fuel use in relation to TB in women in Pokhara, Nepal [from Pokhrel et al., EHP in press, 2010]

<table>
<thead>
<tr>
<th>Lighting fuel</th>
<th>Adjusted RR (95% CI)</th>
<th>Unadjusted RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Kerosene lamp</td>
<td>9.43 (1.45-61.32)</td>
<td>10.35 (3.42-31.3)</td>
</tr>
</tbody>
</table>

† Adjusted for age, religion, income, education level, urban/rural residency, residency district, present house construction, whether always lived in the present house, pack-years of smoking, number of family members who smoked indoors, alcohol consumption, whether taking vitamin supplements, family history of TB, and whether there is ventilation in the kitchen.
Biological Plausibility

• Inhalation of particles and chemicals from smoke damages the cells in the airways (macrophages)

• Damage results into loss of cells defense system

• Continuous exposure, reduces the capacity to defend against micro-organisms
Population Attributable Fractions (PAFs) of TB from fuel use exposure
[from Pokhrel et al., EHP in press, 2010]

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<th>Variables</th>
<th>Percentage (95% CI)</th>
</tr>
</thead>
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<tr>
<td>Biomass-fuel stoves</td>
<td>9 (-42-41)</td>
</tr>
<tr>
<td>Kerosene-fuel stoves</td>
<td>12 (0.1-22)</td>
</tr>
<tr>
<td>Biomass- fuel heating</td>
<td>47 (22-64)</td>
</tr>
<tr>
<td>Kerosene lamp</td>
<td>12 (0.1-22)</td>
</tr>
</tbody>
</table>

† Adjusted for age, religion, income, education level, urban/rural residency, residency district, present house construction, whether always lived in the present house, pack-years of smoking, number of family members who smoked indoors, alcohol consumption, whether taking vitamin supplements, family history of TB, and whether there is ventilation in the kitchen.
Take home message

- Indoor exposure to smoke from biomass fuel combustion is an important risk factor for TB—mainly heating fuel

- The study also suggests that exposure to smoke from kerosene fuel combustion, either in stoves or lamps, is a risk factor for TB
Suggestions

– Replace unflued stove with flued stove

– Replace kerosene lamps with solar lamps

– Design better kerosene combustion/stove
Acknowledgement

• Advisors (Drs. Kirk Smith, Michael Bates, Katharine Hammond, John Balmes)
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• Regional Tuberculosis Center – Pokhara
• Manipal Teaching Hospital-Pokhara
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• Berkeley Air Monitoring Group
Thank You

Questions?