Does household use of biomass fuel cause lung cancer? A systematic review and evaluation of the evidence for the GBD 2010 study

Supplementary information file

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Contents

1. SELECTION OF ELIGIBLE STUDIES .................................................................................................................. 2
2. ANALYSIS OF PUBLICATION BIAS ................................................................................................................. 2
  2.1 FUNNEL PLOT ..................................................................................................................................................... 2
  2.2 STATISTICAL TESTS OF FUNNEL PLOT ASYMMETRY .................................................................................. 2
3. SENSITIVITY ANALYSIS .................................................................................................................................. 3
  3.1 WOMEN ............................................................................................................................................................ 3
  3.2 HEATING AND MIXED USE OF BIOMASS FUEL ......................................................................................... 3
4. EXPOSURE-RESPONSE EVIDENCE .................................................................................................................. 4
5. REFERENCES ....................................................................................................................................................... 5
1. Selection of eligible studies

During the study selection process, it was found that, of the 21 manuscripts with information on biomass use, seven combined biomass and other solid fuels into one category such as ‘traditional’ or ‘solid fuels’. Since these studies would not allow an assessment of the health risks of biomass fuel per se, these were excluded.\(^1\)

2. Analysis of publication bias

2.1 Funnel plot

**Figure S1**: Funnel plot of 14 studies (25 estimates) of biomass and lung cancer, stratified by sex. See main text for statistical tests of funnel plot asymmetry.

2.2 Statistical tests of funnel plot asymmetry

- All studies: Begg’s test \( p = 0.398 \); Egger’s test \( p = 0.48 \)
- Women: Begg’s test \( p=0.59 \); Egger’s test \( p=0.46 \)
- Men: Begg’s test \( p=0.46 \); Egger’s test \( p=0.59 \).
3. Sensitivity analysis

3.1 Women
Nine of the studies used hospital controls, so there was little opportunity to study the effect of this aspect of design. Studies using population (n=2) and mixed (n=1 report, pooling 4 studies) controls did have lower ORs, but differences were small.

The majority (n=10) had strong or moderate adjustment for confounding, with a summary OR of 1.25 (0.98, 1.61). Restriction to studies with a clean fuel reference group resulted in an OR of 1.95 (1.16, 3.27) (sub-analysis #2, Table 3 in main text), further increasing to 2.33 (1.23, 4.42) on exclusion of the one study with kerosene in the reference group.

There was some evidence of a larger effect in studies from less-developed countries, consistent with higher exposure, but only apparent when restricted to studies reporting a clean fuel reference group. In studies with a clean reference group, those from Asia had an OR of 2.33 (1.46, 3.72), p<0.001, compared to an OR of 1.19 (0.94, 1.51), p=0.15 for the pooled study carried out in Europe and North America.

Four studies with results for non-smoking women had an OR of 1.14 (0.78, 1.67), p=0.5, but only one of these reported a clean fuel comparison with an OR of 2.75 (0.85, 8.86), p=0.09.

Table S1: Results for meta-analysis of studies reporting estimates for cooking with biomass fuel, stratified by sex.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of studies</th>
<th>Heterogeneity (I²; p-value)</th>
<th>OR (95% CI) FE=Fixed Effects</th>
<th>p-value</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>All (men and women)</td>
<td>12</td>
<td>41% (0.02)</td>
<td>1.15 (0.97, 1.37)</td>
<td>0.10</td>
<td>^8-19; IARC (personal communication)</td>
</tr>
<tr>
<td>Women</td>
<td>All</td>
<td>12</td>
<td>50% (0.009)</td>
<td>1.20 (0.93, 1.54)</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>At least moderate adjustment and clean fuel reference group</td>
<td>5*</td>
<td>52% (p=0.06)</td>
<td>1.95 (1.14, 3.34)</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>At least moderate adjustment and clean fuel reference group, excluding one study with kerosene in the reference group</td>
<td>4</td>
<td>57% (p=0.06)</td>
<td>2.30 (1.22, 4.36)</td>
<td>0.01</td>
</tr>
<tr>
<td>Men</td>
<td>All</td>
<td>4</td>
<td>0%</td>
<td>1.15 (0.98, 1.35) FE</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>At least moderate adjustment and clean fuel reference group</td>
<td>2*</td>
<td>0%</td>
<td>1.26 (1.04, 1.52) FE</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*One of these studies includes kerosene in the reference group

3.2 Heating and mixed use of biomass fuel
Lissowska et al^11 reported a non-significant effect for risk of lung cancer in both men and women who used wood for heating compared to those who had never used solid fuels; men OR 1.2 (0.97,
However most subjects were Eastern Europeans whose exposure to HAP will have been very different to those in developing country homes using open fires and traditional stoves. Gupta\textsuperscript{10} also examined biomass fuel for heating in a case control study from Chandigarh, India, but the observed effects were non-significant for men and women.

Malats et al\textsuperscript{20} reported an increased risk for lung cancer among men and women (combined) associated with biomass use for either heating or cooking after adjustment for age, sex, ETS, residential history and coal use among non-smokers with an OR of 2.5 (1.0, 6.2). The pooled analysis of four European and North American studies\textsuperscript{21} found an elevated odds ratio among men and women of 1.21 (1.06, 1.38) for wood use for heating and/or cooking.

4. Exposure-response evidence

Five studies included information on exposure duration, which can be used a proxy for lifetime dose, and the evidence relating to exposure-response relationships for biomass fuel use and risk of lung cancer is considered here.

One Japanese study\textsuperscript{18} retrospectively asked non-smoking women if they had used wood/straw for cooking at ages of 15 and 30 years. Use of wood/straw at age 30 was associated with an unadjusted OR for lung cancer of 1.89 (1.16-3.06) when compared with those who did not use biomass. Use of wood/straw at age 15 was associated with an odds ratio of 1.24 (0.86, 1.81). Ninety percent of women who were using wood at age 30 had also been using wood for cooking when they were 15 years old, implying a longer duration of use and consistent with a dose-response effect. These effect estimates were not adjusted, however, and the higher effect seen at age 30 might be accounted for by confounding from other factors, including ETS.

A study from Taiwan\textsuperscript{22} investigated the risk of lifetime exposure to wood or charcoal by analysing fuel use in three discrete periods of life; before 20 years of age, ages from 20 to 40 and after the age of 40. The ORs (age-matched, and adjusted for socio-demographic variables) for the first two periods were 2.5 (1.3, 50.1) and 2.5 (1.1, 5.7), when compared to matched controls who did no cooking or used gas for cooking. Only four women cooked with wood beyond the age of 40 and this was not associated with an increased risk of lung cancer. Further interpretation of these results is difficult as the women lived through each of the cooking-period categories (each includes the full sample of cases and controls), and information is not given on the total number of years each woman cooked with biomass.

Three studies constructed the exposure variable to take into account the duration of exposure. A multi-centre case-control study from India\textsuperscript{9} categorised subjects into those who had always used modern fuels and those who had used wood for fuel for <30, 30-50 and >50 years; although the <30 year group had the lowest OR, there was no evidence of a significant trend in risk ($P_{\text{trend}} = 0.86$). It is worth noting that 88\% of the subjects in this study were men who may have had lower exposures to cooking smoke than women.

A study of women in Chandigarh India\textsuperscript{10} reported a higher risk of lung cancer associated with wood used for cooking for more than 45 years (OR 1.11 (0.34, 3.60)), compared to use for less than 45 years (OR 0.74 (0.2, 2.65)). Although adjusted for age, education and cumulative tobacco smoking, the numbers of female cases was small (n=30) and the results non-significant. Larger numbers of cases were available for men, but analysis by duration of exposure to wood for cooking showed no evidence of a trend.
The case-control study from Mexico City with 113 female lung adenocarcinoma cases divided exposure to cooking with wood into four categories; none, 1-20 years, 21-50 years and >50 years of cooking. An increased risk was only found in women who had used wood for cooking for > 50 years (adjusted OR 1.9, 1.1, 3.5)(Table 2).

See main text for discussion on the contributions to evidence on exposure-response relationships of findings from (i) re-analysis of Lissowska et al (2005), and (ii) geographical variations in risk.

5. References


