Indoor solid fuel combustion and tuberculosis: is there an association?

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OBJECTIVES: To assess the strength of evidence in published articles for an association between indoor solid fuel combustion and tuberculosis.

METHODS: PubMed, a private database and Google Scholar were searched up to May 2008, as was the Cochrane Library (2008, issue 4), to identify articles on the association between indoor air pollution and tuberculosis infection, tuberculosis disease and tuberculosis mortality. Each article initially chosen as acceptable for inclusion was reviewed for data extraction by three different reviewers using a standard format. Strength of evidence was determined by pre-determined criteria.

RESULTS: The full texts of 994 articles were examined for a final selection of 10 possible articles, of which six met the inclusion criteria. All articles investigated the association between exposure to solid fuel (coal and biomass) smoke and tuberculosis disease. Three (50%) of the six studies included in the systematic review showed a significant effect of exposure to solid fuel combustion and tuberculosis disease—one high-quality case-control study and two cross-sectional studies.

CONCLUSION: Despite the plausibility of an association, available original studies looking at this issue do not provide sufficient evidence of an excess risk of tuberculosis due to exposure to indoor coal or biomass combustion. Because the number of studies identified was small, new studies are needed before more definitive conclusions can be reached.

KEY WORDS: tuberculosis; indoor air pollution; solid fuels; review

EMISSIONS from the burning of fossil fuels include greenhouse gases and make up the single largest source of anthropogenic pollutant emissions into the ambient air. Indoor smoke from solid fuels, in turn, is probably the single largest source of human exposure to air pollution. Indoor smoke from solid fuels includes many carcinogens and toxic substances, including polyaromatic hydrocarbons, volatile organic compounds, carbon monoxide and fine particulate matter. Furthermore, biomass and coal combustion produces nitrogen oxides, and coal combustion also produces sulfur dioxide. Exposure to these compounds indoors, because of the relatively high concentrations and long periods of exposure, would be expected to cause greater effects on health than outdoor exposure. There is good evidence that exposure to smoke from indoor solid fuel burning causes acute lower respiratory tract infection (ALRI) in children aged under 5 years.
and chronic obstructive pulmonary disease (COPD) in adults,\textsuperscript{6} and that exposure to coal smoke causes lung cancer.\textsuperscript{7} There is reason to suspect that such exposures also influence the risk of tuberculosis, but evidence for this is much less clear.

A correlation between respiratory tuberculosis and the use of industrial or domestic fuels was reported in an ecological study in 1959 of the populations of several cities in the United Kingdom.\textsuperscript{8} Since that time, there has been a suspicion that air quality related to tuberculosis. However, few studies have investigated this association. Areas with poor indoor air quality due to the burning of solid fuels indoors are often areas of high rates of tuberculosis,\textsuperscript{9} but the evidence for a causal association has not been well established. Lin and colleagues recently published a systematic review on tobacco smoke, indoor air pollution (IAP) and tuberculosis.\textsuperscript{10} They searched PubMed and EMBase, and found only five articles investigating the association between IAP and tuberculosis. Of the five articles reviewed, three reported a positive association between biomass use and tuberculosis disease and two found no such association. As there was significant heterogeneity among the studies, meta-analysis was not performed. The present study was undertaken by searching databases that had not been searched by Lin et al. to further systematically examine the evidence available from published original studies on the relationship between tuberculosis and exposure to solid fuel smoke.

**METHODOLOGY FOR THE SYSTEMATIC REVIEW**

**Selection of articles**

To identify relevant articles, a non-public database on tuberculosis literature (courtesy of Hans Rieder of the International Union Against Tuberculosis and Lung Disease) was searched using the key words of the database: ‘biomass’, ‘indoor pollution’, ‘risk factors’, ‘predictors’, ‘indicators’, ‘epidemiology’. Any potentially interesting articles were then scanned for the words ‘biomass’, ‘smoke’, ‘indoor air pollution’, ‘solid fuel’ and ‘coal’. Titles of published articles in PubMed were examined for all years up to May 2008, using the following key word combinations: ‘tuberculosis’ and ‘solid fuels’, ‘tuberculosis’ and ‘indoor air pollution’, and ‘tuberculosis’ and ‘biomass’. Google Scholar was consulted under the terms ‘tuberculosis and indoor air pollution’, ‘tuberculosis and solid fuels’, ‘tuberculosis and traditional fuels’, ‘tuberculosis and biomass’ and ‘tuberculosis and domestic fuels’. The Cochrane Library (2008, issue 4)\textsuperscript{11} was also searched. Identified references were then more fully examined if the title or abstract indicated possible relevance. Article reference lists were examined for other titles. A final list of references was selected according to the inclusion criteria detailed below.

**Inclusion criteria**

Published or internet-accessible cohort, case-control or cross-sectional studies that included effect estimates of exposure to solid fuel smoke in relation to tuberculosis were included. All selected articles were initially examined for information on the country of study, sample size, and age and sex distributions in the study population. Because of the small number of articles found, the lack of this information did not lead to exclusion, but was noted as a possible indicator of lower quality.

**Definitions**

**Exposure to solid fuel smoke**

The most complete measures of exposure, considered ‘best’ measures, included those with information on type of fuel, type of stove, duration of exposure and degree of ventilation, or a measure of indoor fine particulate matter concentration in micrograms per cubic meter (\(\mu g/m^3\)) over several days. Less complete but adequate measures included information only on type of fuel and degree of ventilation or type of stove. The least complete but acceptable measures consisted of information on the type of fuel.

**Outcome measures**

Tuberculin skin test reaction at a specified cut-off of induration size was considered the best measure of tuberculous infection. Sputum smear-positive for acid-fast bacilli and/or culture-positive for *Mycobacterium tuberculosis* was considered the best measure of tuberculosis. Acceptable measures included clinical, radiological or histological diagnosis in addition to appropriate response to anti-tuberculosis treatment. Studies that identified people with tuberculosis without making use of these measures were also included, but were considered to be of lesser quality. Classification of cause of death as being due to tuberculosis during or after treatment was defined as dying with tuberculosis.

**Procedures**

The review protocol included systematically identifying and screening evidence, selecting studies according to research design, culling the most pertinent data and assessing the quality of included studies according to quality assessment criteria based on previous studies.\textsuperscript{12-14} Guidelines from the QUOROM statement\textsuperscript{15} and the Checklist for refereeing systematic reviews from the Cochrane Reviewers’ Handbook 4.2.6\textsuperscript{16} were utilised.

Experts in tuberculosis control and in indoor air pollution from solid fuel combustion were invited to participate as members of a steering committee\textsuperscript{8} to


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Indoor air pollution and tuberculosis
<table>
<thead>
<tr>
<th>Population source</th>
<th>Gupta et al., 1997</th>
<th>Mishra et al., 1999</th>
<th>Perez-Padilla et al., 2001</th>
<th>Hazra et al., after 2001</th>
<th>Crampin et al., 2004</th>
<th>Shetty et al., 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural and urban areas, Lucknow, India</td>
<td>1992–1993 National Family Health Survey, India</td>
<td>Ear/nose/throat vs. TB patients at a chest referral hospital, Mexico</td>
<td>1998–1999 National Family Health Survey, India</td>
<td>Northeastern states from 1998–1999 National Family Health Survey, India</td>
<td>Hospital-detected TB cases, population controls, Karonga District, Malawi</td>
<td>TB patients and out-patients at a hospital in Bangalore, India</td>
</tr>
</tbody>
</table>

| Case ascertainment | Did not specify how subjects were enrolled. History, general examination, chest radiograph and sputum examination were done to identify cases | A nationally representative probability sample. Cases identified by asking ‘does anyone listed suffer from tuberculosis?’ | A database of interviews of patients registered in 1998–1999. Cases diagnosed by sputum examination | A nationally representative sample. Cases identified by asking questions | TB cases identified using enhanced passive surveillance and diagnosed by sputum examination and biopsies or fine needle aspiration on enlarged lymph nodes. Controls randomly selected in the population | Cases were all newly diagnosed PTB patients recruited over 2 years. Age- and sex-matched controls recruited concurrently among relatives accompanying non-TB in-patients in the hospital |

| Population number | 707: 543 rural, 164 urban | 260162 | 833: 288 cases 545 controls | Total sample 92486 households; this sample, number not given | 1590: 598 cases 992 controls | 378: 189 cases 189 controls |

| Age range | 16–60 years | ≥20 years | Not specified; mean ages, years: Controls, 36.4; Active TB, 41.6; Old TB, 49.6 | ≥15 years | 15–50 + years | 15–83 years |

| Men | 87.8% | 51.4% | 49.6% | 48.9% | 46% | 58% |
| Research design | Cross-sectional | Cross-sectional | Case-control; cases and controls were selected from the same setting | Cross-sectional | Case-control | Case-control |
| Measurement of PTB | Unspecified PTB by clinical diagnosis or X-ray | Interviewer report of history of TB | Bacteriologically proven PTB + retreated PTB | Not clearly reported, (presumably interviewer report of history of TB) | Bacteriologically confirmed TB | Bacteriology or chest X-ray |
| Measurement of IAP | Type of fuel: (dung or wood vs. coal) | Type of fuel: (dung, wood vs. coal, kerosene, LPG, biogas, electricity); kitchen type | Wood stoves vs. other cooking source; duration of exposure in number of years | Traditional ‘unclean’ fuels (agricultural wastes, dung, wood, coal vs. ‘modern’ fuels) | Type of fuel (wood vs. other) | Type of stove: biomass (dung, wood, coal, kerosene) vs. gas, electricity; type of kitchen |

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Table 1 Overview of articles included in the systematic review
Indoor air pollution and tuberculosis

Unadjusted OR (95% CI) for TB

Active TB: current wood stove use 5.2 (3.1–8.8)
Past TB: current wood stove use 9.3 (5.0–17.4)
Unclean fuel 1.14 (—) kerosene for light

Adjusted OR (95% CI) for TB

Active TB: 2.2 (1.1–4.2)
Past TB: 1.6 (0.6–4.3)

Adjusted OR (95% CI) for TB

Unadjusted OR (95% CI) for TB

Active TB: current wood stove use 3.56 (2.82–4.50)
Past TB: current wood stove use 5.2 (3.1–8.8)
Unclean fuel 1.21 (CI not given)

Adjusted for age, sex and area; a protective effect was found for low exposure OR 0.6 (0.3–0.9) and moderate exposure OR 0.8 (0.5–1.3). Not significant if also adjusted for HIV status.

Adjusted OR (95% CI) for TB

Sex, age, area, HIV status

Factors in analysis

Age, sex, kitchen type, housing, crowding, education level, smoking, income

Sex, age, urban or rural, crowding, education, income level, smoking, income

Age, sex, area, HIV status

Sex and age matched, adjusted for education, income, persons per room, smoking, chronic diseases

Sample size was small

Strength of evidence for each tuberculosis outcome was determined according to the following criteria, which have been used in a previous systematic review on the association between tobacco and tuberculosis:17

**Strong evidence:** generally consistent findings in at least two high-quality cohort and three high-quality case-control studies.

**Moderate evidence:** generally consistent findings in one high-quality cohort and two high-quality case-control studies, or three or more high-quality case-control studies.

**Limited evidence:** generally consistent findings in a single cohort study or two case-control studies or three cross-sectional studies.

**Not enough evidence:** none of the above conditions were met.

**Conflicting evidence:** less than 75% of the studies reported consistent findings.

RESULTS

Articles identified that assessed risk factors for tuberculosis in the private database, in PubMed for all years from 1954 to May 2008, in Google Scholar up to May 2008, in the Cochrane database of 2008, and...
in reference lists from published articles with possibly relevant titles and abstracts, were investigated. The full texts of 994 articles were scanned for key words, for a final selection of only 10 possible articles,18–27 of which six provided sufficient information to measure the relationship between exposure to solid fuel smoke and tuberculosis.18–23 In all articles, the association with tuberculosis disease was investigated. No studies were found that included outcomes of tuberculous infection or tuberculosis mortality. The flow chart of the selection of articles is shown in the Figure.

Associations
In three (50%) of the six studies included in the systematic review, a significant effect of exposure to solid fuel combustion on tuberculosis disease was reported: one high-quality case-control study and two cross-sectional studies. A summary of all of the studies, including the research question, covariates and adjusted effect estimates for solid fuel smoke exposure, is presented in Table 1. A detailed assessment of study quality is presented in Table 2.

Strength of evidence
The articles included in this review were assessed against the strength of evidence classification as currently providing ‘not enough evidence’ to support a claim of an association between exposure to smoke from solid fuel combustion and tuberculosis disease.

DISCUSSION
This study identified only six articles on the association between indoor air pollution and tuberculosis by searching a private database of 19,353 articles about tuberculosis, PubMed, Google Scholar and the Cochrane Library. Of the six articles, five had already been identified by Lin et al.,10 who had searched PubMed and EMBase. Although we did not search other databases, such as Web of Science and BIOSIS, and did not perform comprehensive searches of languages other than English, given the size of the literature databases we did use it is unlikely that other research on the association between indoor air pollution and tuberculosis was overlooked by both this study and that of Lin et al.

Tuberculosis has been included among the outcomes listed as a possible effect of exposure to indoor air pollution.28–30 The evidence for such an effect has previously been described as ‘not yet definitive’31,32 or ‘moderate’, taking into account the available evidence on tobacco smoking (a form of biomass), animal studies, and plausible mechanisms.33 While Lin et al. came to the conclusion that there was evidence of an association between exposure to solid fuel smoke and tuberculosis,10 we find, as a result of this extended search, that such a conclusion is not supportable at the present time and that further study is needed. Based on this systematic review, we conclude that there are currently not enough studies to support a conclusion of an association between exposure to indoor pollution from biomass or coal smoke and tuberculosis disease. We identified no study of the association between exposure to biomass smoke and outcomes of tuberculous infection or tuberculosis mortality. As the number of studies identified was small, the determination of high-quality studies was problematic. The conclusions reached are thus highly modifiable if new findings are released of case-control or cohort studies.

There are several reasons why one might expect an association between exposure to smoke from biomass fuels and tuberculosis. First, ecological studies suggest an association between tuberculosis and exposure to coal smoke or other combustion pollutants.8,34–37 However, because solid fuel use commonly occurs together with poverty, there is legitimate concern that the ecological association between solid fuel use and tuberculosis is confounded by poverty.38–40 Thus, an ecological assessment of exposure to biomass fuel smoke is likely not adequate. Second, exposure to tobacco smoke has been shown to be causally related to tuberculosis.17 In a number of countries where tuberculosis is a large problem, few attempts have been made to differentiate between the effects of concurrent

Figure  Flow chart of the article selection process. TB = tuberculosis; IAP = indoor air pollution.
exposure to tobacco (through smoking or from second-hand smoke) and biomass fuel smoke in the populations studied. Of the six studies included in this review, only two adjusted for smoking. Third, smoke from biomass fuel combustion contains many of the chemical components contained in both first-hand and second-hand cigarette smoke. Finally, studies using animal models suggest plausible biological mechanisms whereby exposure to biomass smoke could increase susceptibility to tuberculosis.

Limitations of the studies and of this systematic review

The studies currently available for determining the strength of evidence for an association between exposure to solid fuel smoke and risk of tuberculosis suffer from many weaknesses. Most do not measure exposure to other sources of indoor air pollution, and others, like the widely cited study by Mishra et al., although presenting separate results for males and females, did not specifically control for tobacco smoking. While the type of fuel used is often identified in these studies, information on type of stove, separate kitchen and ventilation are also needed to provide better estimates of exposure. Combustion of many different types of fuel can release pollutants into indoor air, but information on other combustion sources is often lacking. In these studies it has been difficult to assess variability in exposure among those exposed, and pollutant concentrations have not been taken within homes of study subjects in these specific studies. Furthermore, none provide data on personal exposure. We found no studies that examined fuel sources for heating. Ambient levels of outdoor pollution not only from outdoor but also from neighbouring indoor pollution sources may result in misclassification of

Table 2  Quality scores

<table>
<thead>
<tr>
<th>Study population</th>
<th>Gupta et al. 18</th>
<th>Mishra et al. 19</th>
<th>Perez-Padilla et al. 20*</th>
<th>Hazra et al. 21</th>
<th>Crampin et al. 22*</th>
<th>Shetty et al. 23*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed and non-exposed cohorts or cases/controls were drawn from the same population</td>
<td>NA</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Covariates were designated</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Eligibility criteria were specified</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Attrition rate similar in each group (cohorts only)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Assessment of exposure to smoke from biomass fuels</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Type of fuel specified</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>—</td>
</tr>
<tr>
<td>Type or room used for cooking specified</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Type of stove used for cooking specified</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Ventilation of room used for cooking specified</td>
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<td>—</td>
<td>—</td>
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<td>—</td>
</tr>
<tr>
<td>Hours of daily exposure measured</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Duration of daily exposure measured</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Assessment of air quality performed</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Baseline of presence of pollutants in control homes determined</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>—</td>
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<tr>
<td>Assessment of exposure to tobacco smoke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active smoking in household measured</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A valid measurement was used to determine smoking</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Passive tobacco smoke exposure was defined</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>A valid measurement was used to determine passive exposure</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Exposed cases were unlikely to be misclassified</td>
<td>—</td>
<td>NA</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Assessment of tuberculosis outcome (infection, disease, treatment outcome variable, mortality)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A valid definition of the tuberculosis outcome was used</td>
<td>X</td>
<td>X</td>
<td>—</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Assessment of the outcome measured was reproducible</td>
<td>X</td>
<td>X</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>A valid measurement was used to assess the tuberculosis outcome</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Study design</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The design was adequate to measure an association</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Information was given about those lost to follow-up</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Effect of covariables was measured</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Follow-up was long enough for outcomes to occur</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Results are consistent with data</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Analysis and presentation of data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate analysis was performed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dose-effect calculations were made</td>
<td>—</td>
<td>—</td>
<td>X</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Adjustment for confounders was presented</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>The importance (or not) of loss to follow-up was described</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Total score (presence of item/number possible × 100) 41.6 (10/24) 37.5 (9/24) 64 (16/25)* 20 (5/25) 64 (16/25)* 56 (14/25)*

* High quality (score > 47.2).
X = presence of the item, — = not present, NA = not applicable.
exposure if controls are chosen from within the same neighbourhood. Moreover, most studies were carried out in rural areas, among poor people with 1) high use of and exposure to solid fuel smoke and 2) poor access to health care facilities. Factors determining access to care for TB and the selection of the control subjects may introduce bias.

Importantly, the concern over confounding by poverty has not been adequately addressed in these studies. Solid fuels are used in most poor countries by the poorest segment of the population, the same segment that is at highest risk of tuberculosis. Therefore, while new research may provide the evidence necessary to support a claim of an association between tuberculosis and exposure to indoor air pollution from solid fuel use, the evidence is currently not sufficient.

CONCLUSIONS

Currently there is not enough evidence to include tuberculosis among the diseases caused by indoor exposure to solid fuel combustion. This systematic review is limited by the paucity of relevant studies and by the inherent challenges in interpreting associations in observational studies, especially those using cross-sectional designs. As additional studies become available, the evidence base should be re-assessed. The known evidence of an association between pollutants from tobacco combustion lead us to recommend that, if reports of recently conducted (but not yet published) studies do not present clear conclusions, new research into risk factors for tuberculosis infection, disease, treatment variables and mortality should be carried out. New research should include better measures of exposure to solid fuel combustion and adequately account for confounding by socio-economic related factors, active smoking and second-hand tobacco smoke exposure.

References

OBJECTIFS: Evaluar la solidez de los datos publicados en artículos sobre la asociación entre la utilización de combustibles sólidos en interiores y la tuberculosis.

MÉTODOS: Se realizó una búsqueda en las bases de datos PubMed, una base privada y Google Scholar hasta mayo del 2008 y en la Cochrane Library (2008, número 4), con el propósito de detectar los artículos sobre la asociación entre la contaminación del aire interior y los beneficios asociados con la utilización de combustibles sólidos en interiores y la tuberculosis.

RESULTADOS: Se realizó una búsqueda en las bases de datos PubMed, una base privada y Google Scholar hasta mayo del 2008 y en la Cochrane Library (2008, número 4), con el propósito de detectar los artículos sobre la asociación entre la contaminación del aire interior y los beneficios asociados con la utilización de combustibles sólidos en interiores y la tuberculosis.
la infección, la enfermedad y la mortalidad por tuberculosis. Tres revisores diferentes extrajeron en formularios normalizados los datos de todos los artículos cuya inclusión se aceptaba inicialmente. La solidez de los datos se determinó de acuerdo con criterios definidos previamente.

**RESULTADOS:** Se examinó el texto completo de 994 artículos y se escogieron 10 artículos posibles, de los cuales seis cumplieron con todos los criterios de inclusión. En todos los artículos se investigó la asociación entre la exposición a los combustibles sólidos (carbón y de biomasa), el humo y la enfermedad tuberculosa. Tres de los seis estudios (50%) incluidos en la revisión sistemática mostraron un efecto significativo de la exposición a la combustión de materiales sólidos y la enfermedad tuberculosa: un estudio de casos y testigos de gran calidad y dos estudios transversales.

**CONCLUSIÓN:** Pese a la verosimilitud de una asociación, los estudios originales que han investigado este aspecto no aportan pruebas suficientes sobre un mayor riesgo de tuberculosis debido a la exposición a la combustión del carbón o de combustibles de biomasa en espacios interiores. Dado el pequeño número de artículos encontrados, se precisan nuevos estudios que permitan conclusiones más definitivas al respecto.