Original Article

Domestic Cooking Fuel Exposure and Tuberculosis in Indian Women

Digambar Behera and Gaurav Aggarwal

L.R.S. Institute of Tuberculosis and Respiratory Diseases, New Delhi, India

ABSTRACT

Background. A case-controlled study was undertaken to find out the possible relationship of biomass fuel and pulmonary tuberculosis.

Methods. Ninety-five non-smoking females with sputum positive tuberculosis (TB) and 109 healthy controls were interviewed using a questionnaire to obtain detailed information on type of fuel used in homes, duration of cooking, passive smoking, location of kitchen, socio-economic status, adequacy of ventilation, number of people per room and respiratory symptoms occurring during cooking. Odds ratio (OR) was ascertained by logistic regression analysis.

Results. The cases were from a low socio-economic status and the kitchens used by them were inadequately ventilated. Controls had less smoke accumulation in the rooms while cooking and cases had associated respiratory symptoms more often. Logistic regression analysis revealed that TB was significantly influenced by the location of the kitchen (OR 0.201, 95% confidence interval [CI] 0.08-0.51) and the presence of respiratory symptoms while cooking (OR 10.70, 95% CI 2.90-39.56). The odds of having TB did not differ significantly among various fuel types either on univariate (OR 0.99, 95% CI 0.45- 2.22) or multivariate analysis (OR 0.60, 95% CI 0.22-1.63).

Conclusions. No association was found between type of fuel used and TB. However, low socio-economic status, smoky rooms, location of the kitchen, ventilation and associated respiratory symptoms during cooking are likely to be important contributors. **[Indian J Chest Dis Allied Sci 2010;52:139-143]**

Key words: Biomass fuels, Tuberculosis, Case-control, Respiratory problem.

INTRODUCTION

Domestic cooking fuels are one of the important causes of indoor air pollution particularly in developing countries.[1] About 50% of all households in the world and 90% of rural households use solid fuel as the main domestic source of energy, thus, exposing approximately 50% of the world population to the adverse health effects of these combustion products. Traditionally, cooking is one of the important tasks of an Indian woman and on an average, she spends about 6-8 hours per day for this purpose starting quite early in life. Mainly four types of fuels are used for this purpose. These include biomass fuels (cow/buffalo dung cake, wood, agricultural residues, dried leaves, etc) coal, liquefied petroleum gas (LPG), kerosene and a mixture of two or more of these fuels. Indoor air pollution due to these fuels is associated with a number of respiratory problems.[2-11] Indoor air pollution is considered to be an important factor for the development of tuberculosis (TB).[12-18] A recent meta-analysis of five studies reported a positive association between biomass fuel use and TB, but there was a significant heterogeneity among the studies.[19] We carried out a study on the possible association of different domestic fuels and pulmonary TB among female patients.

MATERIAL AND METHODS

This was a case-controlled study in which 95 non-smoking female patients who were sputum smear-positive for acid-fast bacilli (AFB) attending the LRS Institute of Tuberculosis and Respiratory Diseases, a tertiary care TB hospital in North India, were included as cases. These were consecutive patients and enrolled in the study from July 2007 to March 2008. One hundred and nine healthy females who were attendants of patients admitted in the hospital constituted the control group. All the study subjects were screened and interviewed by a respiratory physician. A detailed interview was carried out using a questionnaire.

The questionnaire elicited information regarding the demographic data, lifetime exposure to smoking, use of domestic fuels, marital status, crowding in the

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Correspondence and reprint requests: Dr D. Behera, Director, L.R.S. Institute of Tuberculosis and Respiratory Diseases, Sri Aurobindo Marg, New Delhi-110 030, India; Phone: 91-11-26963335; Fax: 91-11-26568227; E-mail: dirlrsi@bol.net.in

house, use of separate kitchen and respiratory symptoms during cooking. Classification of socio-economic status was done into three categories (very low, low and fair), based on income per dependent and educational status, modified from that described by Aggarwal *et al*[20] for Indian population. An exposure index was calculated as the average duration of cooking multiplied by the number of years of cooking. Exposure to passive smoking was calculated in pack-years expressed as average number of cigarettes/*bidis* smoked per day (20 number of such products is taken as one pack) by a household person living in the same house multiplied by the number of years. The extent of radiological disease was classified as minimal, moderately advanced and far-advanced as per the classification of the National Tuberculosis Association of the United States of America (USA).[21] Three or more persons residing per room in the household was considered as over-crowding. Adequacy of ventilation was assessed subjectively according to the provision of windows or exhaust for the kitchen. Effects of individual variables were assessed using logistic regression analysis. The odds ratio (OR) and 95% confidence interval (CI) were calculated. Statistical analysis was done using SPSS software programme. Potential confounding variables, such as the place of residence, passive smoking, crowding, use of separate kitchen and adequacy of ventilation, were taken into account.

RESULTS

Clinical and radiological characteristics of cases are presented in table 1. Out of the 95 cases, 35 (36.8%) were under category I (CAT-I) directly observed treatment, shortcourse (DOTS), 49 (51.6%) were on CAT-II DOTS while 11 (11.6%) were cases of multidrug-resistant (MDR) pulmonary TB. Twenty-four (25.3%) had mild disease, 37 (38.9%) were with moderately advanced disease and 34 (35.8%) had far-advanced disease as per the radiological assessment. Duration of disease varied from one month to eight years.

Table 1. Clinical and radiological characteristics of cases

Characteristics	Cases (%)
Sputum smear AFB status	
Scanty	2 (2.1)
1+	41 (43.2)
2+	27 (28.4)
3+	25 (26.3)
Treatment status	
CAT-1	35 (36.8)
CAT-2	49 (51.6)
MDR-TB	11 (11.6)
Extent of disease	
Minimal	24 (25.3)
Moderately advanced	37 (38.9)
Far-advanced	34 (35.8)

AFB=Acid-fast bacilli; CAT=WHO category of treatment; MDR-TB=Multidrug-resistant tuberculosis

Detailed demographic data of cases and controls and possible confounding variables are presented in tables 2 and 3. Cases were mainly from low socio-economic status and had a working area that was inadequately ventilated. Controls had less smoke accumulation in the room while cooking and also fewer number had any respiratory symptoms (cough, breathlessness, etc) while cooking.

Table 2. Characteristics of cases and controls

Characteristics	Controls (n=109)	Cases (n=95)
Age (years)	36.7 (±12.8)	34.3 (±13.1)
Total passive smoking exposure (pack-years)	17 (±17.6)	17.6 (±15.3)
Liquefied petroleum gas		
Number	22	23
Exposure index	35.4 (±33.1)	24.2 (±20.9)
Biomass		
Number	25	26
Exposure index	61.3 (±53.5)	49.6 (±51.8)
Kerosene		
Number	4	2
Exposure index	40.2 (±36.6)	38 (±2.8)
Mixed fuels		
Number	58	44
Exposure index	57.8 (±40.2)	63.2 (±48.2)

Data shown as mean ± (SD)

Table 3. Demographic characteristics of cases and controls

	Controls (n=109)	Cases (n=95)	P value
Place of residence			
Rural	46 (42.2%)	44 (46.3%)	0.684
Urban	63 (57.8%)	51 (53.7%)	
Socio-economic status			
Very Low	2 (1.8%)	3 (3.2%)	0.021
Low	65 (59.6%)	73 (76.8%)	
Fair	42 (38.5%)	19 (20%)	
Marital status			
Unmarried	11 (10.1%)	15 (15.8%)	0.067
Married	98 (89.9%)	80 (84.2%)	
Type of house			
Kuttcha	22 (20.2%)	29 (30.5%)	0.101
Pucca	87 (79.8%)	66 (69.5%)	
Persons per room			
>3	30 (27.5%)	25 (26.3%)	0.804
<3	79 (72.2%)	70 (73.7%)	
Status of kitchen			
Inside room	10 (9.2%)	11 (11.6%)	0.013
Open area	31 (28.4%)	12 (12.6%)	
Separate	68 (62.4%)	72 (75.8%)	
Adequacy of ventilation			
No	11 (10.1%)	23 (24.2%)	0.013
Yes	98 (89.9%)	72 (75.8%)	
Smoke in room while cooking			
No	93 (85.3%)	66 (69.5%)	0.012
Yes	16 (14.7%)	29 (30.5%)	
Respiratory symptoms while cooking			
No	102 (93.6%)	68 (71.6%)	0.00
Yes	7 (6.4%)	27 (28.4%)	

The mean age was 36.7 (±12.8) years for the controls and 34.3 (±13.1) years for the patients. The total passive smoking exposure was 17 pack years for the controls and 17.6 pack years for the patients. Exposure index was not found to be significantly different in the two groups.

On univariate analysis, odds of having TB were low (OR 0.40) in those with fair socio-economic status (as compared to those with very low or low status, Table 4). With regard to cooking practices, women cooking in an open area or in kitchens with adequate ventilation had significantly lesser odds (OR 0.39) of having TB, while those having greater smoke accumulation in room while cooking (OR 2.55) or those reporting respiratory symptoms while cooking had significantly higher odds (OR 8.26, Table 4).

Table 4. Logistic regression analysis

	Univariate Odds Ratio	(95% CI)	Multivariate Odds Ratio	(95% CI)
Marital status				
Unmarried*	1.0			
Married	0.6	(0.3-1.4)		
Type of house				
*Kuttcha**	1.0			
Pucca	0.6	(0.3-1.1)		
Over-crowding				
<3 Persons per room*	1.0			
>3 Persons per room	1.0	(0.5-1.8)		
Socio-economic status				
Poor/low*	1.0		1.0	
Fair	0.4	(0.2-0.8)	0.4	(0.2-0.8)
Status of kitchen in house				
Separate*	1.0		1.0	
Inside room	1.0	(0.4-2.6)	0.7	(0.2-2.0)
Open area	0.4	(0.2-0.8)	0.2	(0.1-0.5)
Adequacy of ventilation				
No*	1.0		1.0	
Yes	0.4	(0.2-0.8)	0.5	(0.2-1.1)
Smoke in room while cooking				
No*	1.0		1.0	
Yes	2.6	(1.3-5.1)	1.2	(0.4-3.3)
Respiratory symptoms while cooking				
No*	1.0		1.0	
Yes	8.3	(3.0-22.5)	10.7	(2.9-39.6)
Fuel type for cooking				
LPG*	1.0		1.0	
Biomass	1.0	(0.5-2.2)	0.6	(0.2-1.6)
Kerosene	0.5	(0.1-2.9)	0.1	(0.0-1.3)
Mixed	0.7	(0.4-1.5)	0.5	(0.2-1.1)

*=Reference category; CI=Confidence interval; LPG=Liquefied petroleum gas

After adjustment through a multivariate logistic regression model, odds of having TB were significantly influenced only by the location of the kitchen in house and by the presence of respiratory symptoms while cooking (Table 4). The odds of having TB did not differ significantly among the various fuel types used for cooking, either on univariate, or on multivariate analysis (Table 4).

DISCUSSION

In the present study we did not observe any association between the type of domestic fuel used and TB. There are reports[19-27] suggesting that indoor air pollution increases the risk of TB, but the association is not strongly supported by the available evidence. A cross-sectional study from India reported that persons living in households that primarily use biomass fuel have substantially higher prevalence of active TB as compared to persons living in households using cleaner fuels.[22,23] Two other studies[24, 25] had also reported an increased risk of TB (OR 2.20-2.58). However, other studies from India[26] and Malawi[27] showed a decreased risk of TB. A recent meta-analysis[19] revealed that although three of these studies reported a positive association between biomass fuel use and TB, there was remarkable heterogeneity. Recent reviews reported indoor air pollution from biomass fuel smoke to be a major health concern in the developing world including TB.[11,13] It is possibly due to impairment of alveolar macrophage function.[28-30] While the above studies from India, Malawi and Mexico had fairly a large sample size, these included both men and women. While women in these countries are the main users of domestic cooking fuels, and are thus, exposed to indoor air pollution, men are much less actively exposed. Further, no quantification was made in terms of duration or intensity of exposure. In the study by Shetty *et al*,[26] only 42% were women. In the present study, the subjects studied were all women and we have tried to quantify the exposure in the form of exposure index.

Our results are in contrast to those of Mishra *et al*.[22] The possible reasons could be that our cases had confirmed TB and the questionnaire was applied by respiratory physician in contrast to that study.[22] Biomass fuel use was three times higher in the rural areas as compared to urban areas whereas the prevalence of TB was higher in urban areas for which the appropriate reasons were not given.

The type of house, over-crowding, socio-economic status, use of separate kitchen and adequacy of ventilation were considered potential confounders in the present study. Persons living in *pucca* house (house constructed using bricks and cement as building material) had a lower risk of TB than persons living in *kuttcha* house (house constructed using bamboo, dried leaves, thatch, etc). Over-crowding within the house did not show an increased risk of TB. Women having better socio-economic status had less chance of having TB. The possible reasons may be a better access and use of medical services. Women having kitchen in an open area had lesser odds of having the disease in comparison to women cooking inside the room or even with those cooking in a separate kitchen. Respirable particulate matter concentrations in the kitchen and living areas of household using various fuels have been found significantly higher.[31]

Adequate ventilation and less smoke accumulation in the room while cooking had less odds of having TB in our study. The likely reason may be the dispersion through windows or ventilators in adequately ventilated kitchens. A limitation in the present study was the information about adequacy of ventilation and kitchen size, etc, that were assessed subjectively. These could not be assessed more objectively and may have affected the results. Females having respiratory symptoms, such as cough and breathlessness had higher odds of having TB. These respiratory symptoms are related to exposure to domestic fuels. Marital status was taken into account as exposure to indoor air pollution might be different in these subjects. But we did not find any difference. Another limitation of the study is the inclusion of Cat I and Cat II and MDR TB in the sample as different sets of patients may have different pre-morbid situations that may confound the results.

In conclusion, the association of TB and use of biomass fuel needs additional corroboration from studies that have better indicators for exposure and control for confounders, such as household characteristics including the type of construction material, stove type, number of rooms and windows, etc. This is important as establishment of an association will be an important step in TB control measures. It has been projected[14] that complete cessation of solid fuel use by the year 2033 would reduce the annual TB incidence by 14 percent to 52 percent.

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