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Association of Second Hand Smoke and Biomass Cooking Fuel with the Tuberculosis: A Case-Control Study from Southern Haryana, India

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Abstract:

Background: Cooking smoke is a known risk factor for a number of respiratory diseases. It is essential to delineate the role of these environmental factors in the etiology and epidemiology of Tuberculosis (TB). *Aim and Objectives*: The present study was conducted with an aim to assess the association of TB among the study subjects using biomass fuels for cooking or exposed to Second Hand Smoke (SHS). *Material and Methods*: The present case control study was conducted in the Department of Chest and TB for a duration of one-year and included 100 cases (new pulmonary TB) subjects and 300 controls as non-TB subjects who attended outpatient clinic. Data were collected as a structured questionnaire. Categorical data were presented as percentages (%) and bivariable logistic regression analysis was done to find out the strength of association between dependent variable and independent variables and an association was considered significant if the p value was less than 0.05. *Results:* There was more representation of male participants (53.6%) compared to females and (63.9%) of participants were residing in the rural area. On comparative analysis for occurrence of TB among cases and controls, the statistically significant difference was observed for the variables such as age, overcrowding, biomass as cooking fuel, second hand smoke, socioeconomic status, and previous history of TB ($p<0.05$). *Conclusion:* Improvement in the standard of living brought about by economic development will lead to more people using cleaner fuels for cooking than biomass fuel which in turn will lead to a reduction in the occurrence of pulmonary TB in the community.

Keywords: Second Hand Smoke, Indoor Air Pollution, Tuberculosis, Biomass Cooking Fuel

Introduction:

Inhaling smoke, whether this is active (when an individual smokes) or passive (when an individual is exposed to cigarette smoke in their environment) has also been associated with Tuberculosis (TB). Second Hand Smoke (SHS) and biomass cooking fuel are persistent or growing exposures in regions where TB poses a major health risk [1]. Many cross-sectional studies have evaluated various risk factors for development of TB, however; very few studies are available in Indian context, which determine the causal role of passive smoking and use of biomass fuel (wood or dung) for cooking on development of pulmonary TB [2-3]. In developing

countries, such as India, daily air pollution exposures from cooking with biomass typically exceed relevant health-based guidelines by factors of 20 or more [4]. SHS which resembles biomass smoke in several aspects, can reduce several defense mechanisms that may be important against TB.

There is related evidence that smoke from cigarettes, which are also a form of biomass, is a risk factor for pulmonary TB, and that cigarette smoking renders the treatment of TB less effective [1]. Cooking smoke is a known risk factor for a number of respiratory diseases [5-7]. However, the evidence of a causal relation between cooking smoke and TB is tenuous. It is essential to delineate the role of these environmental factors in the etiology and epidemiology of TB, so the present study was conducted with an aim to assess the association of TB among the study subjects using biomass fuels for cooking or exposed to SHS in underprivileged population of Mewat (Nuh) including the evaluation of other socio-demographic and environmental factors associated with the development of TB.

Material and Methods:

Study Design and Participants:

The present quantitative retrospective case control study was cross-sectional in design, conducted under the Department of Chest and TB of the Shaheed Hasan Khan Mewati Government Medical College (SHKM GMC), Nalhar for a duration of one-year i.e. from 1st January 2019 to 31st December 2019. The study included subjects seeking care at Chest and TB Department, SHKM GMC, Nalhar. Only residents of Mewat were considered as a part of eligible target population from whom sampling was done. Sample size was calculated using online Open Epi software ver.3.1 for case control studies; considering confidence level of 95%, power 95%, ratio of cases to controls 1:3 and Odds ratio of 2.37 for development of TB in case of second hand smoking came out to be 400 (cases:100, controls: 300) [8]. The cases were 100 new pulmonary TB (Newly diagnosed Category I) subjects diagnosed at the Department of Chest and TB and the controls were age-sex matched 300 non-TB subjects who attended hospital at the outpatient clinic, from 1st Jan 2019 onwards and were considered till the sample size was met i.e. 31st December 2019. Subjects with HIV-infection, diabetes mellitus and suffering with other known lung diseases were excluded from the study.

Study Definition:

Case: A new pulmonary TB case, diagnosed by physician, aged ⩾ 15 years who attended the outpatient clinic of the Chest and TB Department, and/or never had previous treatment for TB (new patients who had taken anti-TB drugs for less than 4 weeks were included). The TB criteria were: at least two sputum specimens positive for Acid-Fast Bacilli (AFB) by microscopy; or with at least one sputum specimen positive for AFB and radiographic abnormalities relevant with pulmonary TB and free from HIV infection and Diabetes.

Control: Non-TB case, aged ⩾15 years attending the outpatient and having no evidence of lung disease. Controls were matched for sex and age (15-24 years, 25-34 years, 35-44 years, 45-54 years and ⩾ 55 years), and with no history of TB and free from HIV infection and diabetes.

Smoking habits:

1. Non-smoker: any person that has never smoked (non-active smoker) or who has never or

less than 3 times/week been exposed to tobacco smoked by others at home, work, or in public places (non-passive smoker).

2. Active smoker: any person who smoked a tobacco product at the time of the study or persons who used to smoke but had stopped smoking <6 months before the interview (current active smoker) or any person who used to smoke and had stopped smoking ⩾ 6 months before the interview (ex-active smoker).

3. Passive smoker: any non-smoker who was exposed to tobacco smoke >3 times/week, either at home, work, or in public places (current passive smoker) or any non-smoker who was exposed to tobacco smoke who had terminated such exposure ⩾ 6 months before the interview (ex-passive smoker).

Study Tools:

A 23-elements structured questionnaire with both open and close ended responses was developed which covered the domains of subject's demographic and household. The questionnaire was first prepared in English. Then, it was translated into Hindi by an expert in that language keeping semantic equivalence. To check the translation, it was back translated into English by two independent researchers who were unaware of the first English version. The questionnaire was piloted among a small number (n = 20) of subjects and the average time taken to complete the survey was around 30 minutes. The presentation and validity of the questionnaire were undertaken by 15 randomly selected faculty members for clarity, relevance, and acceptability. All efforts were made to keep the questions simple and unambiguous according to the objectives of the study. Refinements were made as required to facilitate better comprehension and to organize the questions before initiation of study. The study questionnaire comprised of two sections. Section one covered the detailed demographic characteristics of cases and control such as age, gender, education, occupation, religion, type of family, place of residence, socioeconomic status and history of TB among households in past ten years. Section two comprised of household characteristics such as type of house, ownership of house, windows in the rooms, overcrowding, dampening and mold growth, primary or secondary cooking fuels type, duration of current cooking fuel usage, separate kitchen, exhaust fan in kitchen, smoking habits, second hand smoking and smoke in house. The cases and controls address and contact numbers were noted down. They were contacted telephonically for their availability to conduct this study. Written consent was obtained from study subjects after they were explained about purpose of this study and were requested to participate. The sociodemographic and household characteristics component of questionnaire for subjects was administered by the investigator himself by face to face interview technique and direct observation. The questionnaire required 30-35 minutes per subjects to be completed. Also, the filled questionnaires were then checked for the completeness. The subjects suspected of symptoms of TB were directed to the nearest health facility for testing and all possible attempts were made to keep the information pertaining to subjects as anonymous and confidential. Being elective and not requite were the properties for participating in study. The study was initiated after obtaining the ethical approval from Institutional Ethics Committee, SHKM GMC, Nalhar.

Statistical Analysis:

Collected data were entered in the MS Excel spreadsheet, coded appropriately and later cleaned for any possible errors. Analysis was carried out using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp. Armonk, NY, USA). During data cleaning, more variables were created so as to facilitate association of variables. Clear values for various outcomes were determined before running frequency tests. Categorical data were presented as percentages (%). Bivariable logistic regression had been done to find out the strength of association between dependent variable and independent variables. All tests were performed at a 5% level of significance; thus, an association was significant if the p value was less than 0.05.

Results:

The present study included total 397 participants including 99 cases and 298 controls. During the defined study period a total of 3 participants (1 case and 2 controls) were dropped from the study after inability to communicate with them by making strenuous attempts via multiple calls or three home visits. Table 1 shows that overall, there was more representation of male participants (53.6%) compared to females and (63.9%) of participants were residing in the rural area. The nearly two third of participants (63.9%) belonged to 30-44 years (30.9%) and 35-59 years (32.9%) of age groups. More than two fifth of participants (43.3%) were illiterate and 50.1% of participants had belonged to lower SES. More than four fifths of participants (82.1%) belonged to Muslim religion and more than half of participants (57.6%) were staying in joint families. More than one tenth of participants (12.8%) provided previous history of household TB among family members over the past 10 years. On comparative analysis for occurrence of TB among cases and controls, the statistically significant difference was observed for the variables such as gender, age, education, occupation, type of family, SES, and previous history of TB ($p<0.05$).

Table 1: Demographic Characteristics of Cases and Controls (N=397)

Variables	Cases (n=99)	Controls (n=298)	Test of significance
Gender			
Male (n=213)	66 (66.7%)	147 (49.3%)	$\chi2=8.983$, df=1, p=0.003
Female (n=184)	33 (33.3%)	151 (50.7%)	
Age (in years)			
15-29 (n=67)	11 (11.1%)	56 (18.8%)	$\chi2=100.979$, df=3, p=0.000
30-44 (n=123)	17 (17.2%)	106 (35.6%)	
45-59 (n=131)	18 (18.2%)	113 (37.9%)	
60 or more (n=76)	53 (53.5%)	23 (7.7%)	

Continued...

Variables	Cases (n=99)	Controls (n=298)	Test of significance
Education			
Illiterate (n=172)	68 (68.7%)	104 (34.9%)	$\chi2$=34.677, df=3, p=0.000
Primary or middle school (n=88)	11 (11.1%)	77 (25.8%)	
High school or senior secondary (n= 76)	11 (11.1%)	65 (21.8%)	
Graduate or diploma or above (n=61)	9 (9.1%)	52 (17.5%)	
Occupation			
Working (n=222)	70 (70.7%)	152 (51.0%)	$\chi2$=11.704, df=2, p=0.003
Housewife (n=144)	24 (24.2%)	120 (40.3%)	
Student (n=31)	5 (5.1%)	26 (8.7%)	
Religion			
Hindu (n=71)	14 (14.1%)	57 (19.1%)	$\chi2$=1.258, df=1, p=0.262
Muslim (n=326)	85 (85.9%)	241 (80.9%)	
Type of family			
Nuclear (n=136)	17 (17.2%)	119 (39.9%)	$\chi2$=20.221, df=2, p=0.000
Joint (n=229)	76 (76.7%)	153 (51.4%)	
Extended (n=32)	6 (6.1%)	26 (8.7%)	
Place of residence			
Urban (n=143)	28 (28.3%)	115 (38.6%)	$\chi2$=3.426, df=1, p=0.064
Rural (n=254)	71 (71.7%)	183 (61.4%)	
Socioeconomic status[$]			
Class I (n=43)	5 (5.1%)	38 (12.8%)	$\chi2$=30.204, df=4, p=0.000
Class II (n=64)	9 (9.1%)	55 (18.5%)	
Class III (n=91)	14 (14.1%)	77 (25.8%)	
Class IV (n=123)	37 (37.4%)	86 (28.9%)	
Class V (n=76)	34 (34.3%)	42 (14.1%)	
History of Household TB in past 10 years			
Yes (n=51)	24 (24.2%)	27 (9.1%)	$\chi2$=15.299, df=1, p=0.000
No (n=346)	75 (75.8%)	271 (90.9%)	

[$]*Modified B.G Prasad SES Classification*

Table 2 shows that around one third of participants (30.9%) were staying in kutcha houses, and nearly four fifths of participants (79.6%) owned their houses. On close observation of homes, it was noticed that 36.5% of the houses were not having windows in any room, visible dampness or mold growth was noticed in more than two fifths of the houses. There was no separate kitchen in 43.3% of homes and non-availability of exhaust fan in 48.6% of homes. When participants were enquired about the primary cooking fuel, surprisingly one third of them were still dependent on biomass or kerosene and among them 22.1% were using biomass or kerosene as cooking fuel over 5 years of duration. The SHS was observed among nearly one tenth of participants (8.5%). On comparative analysis for occurrence of TB among cases and controls, the statistically significant difference was observed for the variables such as house ownership, windows in rooms, overcrowding, visible dampness or mold growth, smoke inside house and SHS ($p<0.05$).

Table 2: Household Characteristics between Cases and Controls (N=397)

Variables	Cases (n=99)	Controls (n=298)	Level of significance
Type of house			
Kutcha (n=123)	35 (35.4%)	88 (29.6%)	$\chi2=1.313$, df=2, p=0.519
Pukka (n=231)	53 (53.5%)	178 (59.7%)	
Mixed (n=43)	11 (11.1%)	32 (10.7%)	
Ownership of house			
Yes (n=316)	64 (64.6%)	252 (84.6%)	$\chi2=18.152$, df=1, p=0.000
No (n=81)	35 (35.4%)	46 (15.4%)	
Presence of window in all or some rooms in use			
Yes (n=252)	42 (42.4%)	210 (70.5%)	$\chi2=25.212$, df=1, p=0.000
No (n=145)	57 (57.6%)	88 (29.5%)	
Presence of Overcrowding			
Yes (n=236)	76 (76.8%)	160 (53.7%)	$\chi2=16.415$, df=1, p=0.000
No (n=161)	23 (23.2%)	138 (46.3%)	
Visible dampness in all or some rooms in use			
Yes (n=186)	61 (61.6%)	125 (41.9%)	$\chi2=11.546$, df=1, p=0.001
No (n=211)	38 (38.4%)	173 (58.1%)	

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Variables	Cases (n=99)	Controls (n=298)	Level of significance
Visible mold growth in all or some rooms in use			
Yes (n=178)	60 (60.6%)	124 (41.6%)	$\chi2$=10.783, df=1, p=0.001
No (n=219)	39 (39.4%)	174 (58.4%)	
Primary cooking fuel			
LPG (n=261)	59 (59.6%)	202 (67.8%)	$\chi2$=4.197, df=2, p=0.123
Biomass fuel*(n=87)	29 (29.3%)	58 (19.4%)	
Kerosene/Others (n=49)	11 (11.1%)	38 (12.8%)	
Secondary cooking fuel			
LPG/Not applicable (n=198)	40 (40.4%)	158 (53.0%)	$\chi2$=6.199, df=2, p=0.045
Biomass fuel* (n=144)	46 (46.5%)	98 (32.9%)	
Kerosene/Others (n=55)	13 (13.1%)	42 (14.1%)	
Duration (in years) of cooking fuel usage			
LPG (n=261)			
< 5 (68)	16 (27.1%)	52 (25.7%)	$\chi2$=0.045, df=1, p=0.832
5 or more (193)	43 (72.9%)	150 (74.3%)	
Biomass fuel (n=87)			
< 5 (n=21)	6 (20.7%)	15 (25.9%)	$\chi2$=0.282, df=1, p=0.595
5 or more (n=66)	23 (79.3%)	43 (74.1%)	
Kerosene/Others (n=49)			
< 5 (27)	5 (45.4%)	22 (57.9%)	$\chi2$=0.534, df=1, p=0.465
5 or more (22)	6 (54.6%)	16 (42.1%)	
Smoke inside house			
No/Not applicable (n=226)	38 (38.4%)	188 (63.1%)	$\chi2$=18.495, df=1, p=0.000
Yes (daily/occasionally) (n=171)	61 (61.6%)	110 (36.9%)	
Separate kitchen			
Yes (n=142)	36 (36.4%)	106 (35.6%)	$\chi2$=8.643, df=2, p=0.013
No (n=172)	52 (52.5%)	120 (40.3%)	
Kitchen in open area (n=83)	11 (11.1%)	72 (24.1%)	

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Variables	Cases (n=99)	Controls (n=298)	Level of significance
Kitchen with exhaust			
Yes/Not applicable (n=204)	45 (45.5%)	159 (53.4%)	$\chi2$=1.857, df=1, p=0.173
No (n=193)	54 (54.5%)	139 (46.6%)	
Smoker			
Yes (n=36)	17 (17.2%)	19 (6.4%)	$\chi2$=10.504, df=1, p=0.001
No (n=361)	82 (82.8%)	279 (93.6%)	
Secondhand smoke			
Yes (n=34)	15 (15.2%)	19 (6.4%)	$\chi2$=8.852, df=1, p=0.003
No/Not applicable (n=363)	84 (84.8%)	279 (93.6%)	

**Biomass fuel includes wood, dung, charcoal, coal/coke/lignite, crop residues*

The independent variables which were found to have significant association with occurrence with TB among cases and controls were put into bivariate logistic regression model (Table 3) and it observed that odds of TB among cases for old age was 1.01 (CI: 0.49-2.05) whereas for males it was 2.05 (CI: 1.27-3.30). Higher education was found to be protective as odds among cases with higher education was 0.21 (CI: 0.10-0.44). Households with overcrowding, visible dampness or mold growth had an odds ratio among cases as 2.85 (CI: 1.69-4.78), 2.22 (CI: 1.39-3.54) and 2.15 (1.35-3.43). Odds of TB among cases with SHS status was 2.83 (CI: 1.39-5.75).

Table 3: Logistic Regression Analysis of Variables for TB Cases

Variables	TB cases (N=99)		p-value
	Frequency (%)	aOR (95% CI.)	
Age group (in years)			
15-29 (n=67)	11 (16.4%)	Reference	
30-44 (n=123)	17 (13.8%)	0.70(0.34-0.14)	0.000
45-59 (n=131)	18 (13.7%)	0.81(0.35-1.86)	0.630
60 or more (n=76)	53 (69.7%)	1.01(0.49-2.05)	0.985
Gender			
Female (n=184)	33 (17.9%)	Reference	
Male (n=213)	66 (31.0%)	2.05 (1.27-3.30)	0.003

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Variables	TB cases (N=99)		p-value
	Frequency (%)	aOR (95% CI.)	
Education			
Illiterate (n=172)	68 (39.5%)	Reference	
Primary or middle school (n=88)	11 (12.5%)	0.82(0.32-2.13)	0.692
High school or senior secondary (n= 76)	11 (14.5%)	0.84(0.34-2.07)	0.712
Graduate or diploma or above (n=61)	9 (14.8%)	0.21(0.10-0.44)	0.000
Occupation			
Housewife (n=144)	24 (16.7%)	Reference	
Student (n=31)	5 (16.1%)	0.43(0.25-0.73)	0.002
Working (n=222)	70 (31.5%)	1.04(0.36-2.98)	0.942
Type of Family			
Extended (n=32)	6 (18.8%)	Reference	
Joint (n=229)	76 (33.2%)	1.61(0.58-4.49)	0.358
Nuclear (n=136)	17 (12.5%)	0.46(0.18-1.17)	0.106
Socioeconomic status			
Class I (n=43)	5 (11.6%)	Reference	
Class II (n=64)	9 (14.1%)	0.20(0.87-0.46)	0.000
Class III (n=91)	14 (15.4%)	0.38(0.17-0.84)	0.018
Class IV (n=123)	37 (30.1%)	1.24(0.38-4.00)	0.715
Class V (n=76)	34 (44.7%)	0.90(0.36-2.22)	0.820
History of Household TB in past 10 years			
Yes (n=51)	24 (47.1%)	Reference	
No (n=346)	75 (21.7%)	3.21(1.75-5.89)	0.000
Ownership of house			
Yes (n=316)	64 (20.3%)	Reference	
No (n=81)	35 (43.2%)	2.99(1.78-5.03)	0.000
Presence of window in all or some rooms in use			
Yes (n=252)	42 (16.7%)	Reference	
No (n=145)	57 (39.3%)	3.23(2.02-5.18)	0.000

Continued...

Variables	TB cases (N=99)		p-value
	Frequency (%)	aOR (95% CI.)	
Presence of Overcrowding			
No (n=161)	23 (14.3%)	Reference	
Yes (n=236)	76 (32.2%)	2.85(1.69-4.78)	0.000
Visible dampness in all or some rooms in use			
No (n=211)	38 (18.0%)	Reference	
Yes (n=186)	61 (36.8%)	2.22(1.39-3.54)	0.001
Visible mold growth in all or some rooms in use			
No (n=219)	39 (18.3%)	Reference	
Yes (n=178)	60 (32.6%)	2.15(1.35-3.43)	0.001
Secondary cooking fuel			
LPG/Not applicable (n=198)	40 (20.2%)	Reference	
Biomass fuel* (n=144)	46 (31.9%)	1.85(1.13-3.03)	0.014
Kerosene/Others (n=55)	13 (23.6%)	1.51(0.74-3.09)	0.253
Smoke inside house			
No/Not applicable (n=226)	38 (16.8%)	Reference	
Yes (daily/occasionally) (n=171)	61 (35.7%)	2.74(1.71-4.38)	0.000
Separate kitchen			
Yes (n=142)	36 (25.4%)	Reference	
No (n=172)	52 (30.2%)	2.23(1.06-4.65)	0.034
Kitchen in open area (n=83)	11 (13.3%)	0.78(0.47-1.29)	0.338
Smoker			
No (n=361)	82 (22.7%)	Reference	
Yes (n=36)	17 (47.2%)	3.04(1.51-6.12)	0.002
Secondhand smoke			
No/Not applicable (n=363)	84 (23.1%)	Reference	
Yes (n=34)	15 (44.1%)	2.83(1.39-5.75)	0.004

aOR- adjusted Odds Ratio

Discussion:

This case-control study sought to provide clear evidence of an association between household air pollution from biomass fuel use or second hand smoke and pulmonary TB. It was observed in present study that odds of pulmonary TB were higher among households using biomass (aOR: 1.85, CI: 1.13-3.03) and kerosene (aOR: 1.51, CI: 0.74-3.09) as cooking fuel was higher compared to those using Liquefied Petroleum Gas (LPG). There are studies by Patra *et al*., Jafta *et al*., Singh *et al*., and Bates *et al*., which reported that persons living in households that primarily use biomass fuel have substantially higher odds of pulmonary TB as compared to persons living in households using cleaner fuels but the association is not strongly supported by the available evidence [8-11]. It is possibly due to impairment of alveolar macrophage function. In the present study the odds (aOR: 1.01, CI: 0.49-2.05) of TB was higher among old age group when compared to younger age groups. The major contributing factor is the increased level of susceptibility to infectious diseases and weakened immune system amongst the elderly. Additionally, factors like tobacco use, low socioeconomic status, previous disease, longer delays in seeking medical attention and very high rates of adverse reactions during treatment exacerbates the likelihood of TB in the Indian elderly. Similar results were observed in studies by Negin *et al*., Byng *et al*., and Sterybo *et al*., where the old age have higher odds for developing TB [12-14]. Therefore, this group requires special attention which should include early screening and initiation of treatment, as well as proper nutritional supervision. The results also showed that the odds (OR: 2.05, CI: 1.27-3.30) of TB was higher among males than females. This may be due to contact with more people in society and habituation to tobacco smoking and alcohol use. Further, men are expected to be in greater contact with people who suffer from active TB than women. The higher occurrence of TB in males was also reported in studies by Singh *et al*., Jassal *et al*., and Singh *et al*., [15-17]. In the present study households with higher socio-economic status had less chance of having TB and the possible reasons may be a better access and use of medical services. Other studies by Bates *et al*., Bhat *et al*., Shezi *et al*., and Ratta *et al*., have also showed that impoverished class was more vulnerable to the disease [11, 18-20]. Smoke exposure may be caused by tobacco (from smoking or second-hand smoke), or from the burning of biomass. In the present study it was observed that odds of TB were higher among smokers (OR: 3.04, CI: 1.51-6.12), second hand smokers (OR: 2.83, CI: 1.39-5.75) and households with smoke inside house (OR: 2.74, CI: 1.71-4.38). Similar inferences are also drawn from the other studies done by Singh *et al*., Jindal *et al*., Lakshmi *et al*., and Lindsay *et al*., [17,21-23]. The type of house, over-crowding, use of separate kitchen and adequacy of ventilation were considered potential confounders in the present study. Persons living in pucca houses had a lower risk of TB than persons living in kuttcha house. Households having kitchen in an open area had lesser odds of having the disease in comparison to households 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 in studies done by Smith *et al*., Krall *et al*., Secrest *et al*., and Smith *et al*., [24-27]. Adequate ventilation while cooking had less odds of having TB in present study. The likely reason may be the dispersion through windows or ventilators in adequately ventilated kitchens which shown in studies by Elf *et al*., Patra *et al*. and Kan *et al*., [28-30].

There are two limitations. First, the exposure to cooking smoke was not quantitatively measured. Secondly, the study population did not include children up to the age of 14 years. The effect of biomass smoke on childhood TB, especially mother to child transmission of TB, could not be studied.

Conclusion:

This study showed that biomass used as a cooking fuel and second hand smoke is an independent risk factor for pulmonary TB. Usually people with a low or medium standard of living use biomass fuel. Standard of living included economic status, over-crowding, housing type and assets. Improvement in the standard of living brought about by economic development will lead to more people using cleaner fuels for cooking than biomass fuel which in turn will lead to a reduction in the occurrence of pulmonary TB in the community.

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