



Measuring Association of biomass fuel smoke exposure and pulmonary tuberculosis among female in rural areas of Bangladesh

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Abstract

Background: Despite the severe burden of tuberculosis (TB) on national economy in Bangladesh very little information is known about the relationship between biomass fuel smoke exposure and pulmonary TB. Hence a case-control study was conducted among female in rural areas of Bangladesh.

Purpose: To determine whether biomass fuel smoke as an exposure increases the risk for pulmonary TB among female of Ullahpara and Shahzadpur Upazilla (Subdistrict) north western region of Bangladesh.

Methods: Physician-diagnosed cases of sputum positive pulmonary TB (n=114) and healthy controls (n=147) a total of 261 were enrolled from different DOTS centers in those two specific sub-districts of Sirajgong districts. Interviews were conducted in the DOTS centers using a pretested questionnaire to collect information on type of cooking fuel, education, occupation, socio-economic status, type of kitchen, ventilation of kitchen etc. The conditional logistic regression model was used for control of confounding.

Results: The study population was predominantly in the 20-40 year-old age group (49.1%) and lived in rural areas (90.4%). Majorities were illiterate (47.3%) and housewives (69.2%) and almost 98.2% had a monthly family income of no more than 20,000 Tk. Among the cases 50.9%, 46.5%, and 2.6% used tree, cowdung (biomass fuel) and liquid or supply (L/S) gas respectively, whereas among controls the respective figures were 55.8%, 38.8% and 5.4%. The unadjusted Odds Ratio (OR) for biomass fuel compared with L/S gas was 2.480 (p=0.197). Adjustment for confounding factors (education, type of kitchen, type of oven, in touch of TB patients, and smokers in the family) and interaction between cooking fuel and smoker in family revealed an OR of 7.319 (p=0.009) for biomass fuel in compared with L/S gas.

Conclusion: Cooking with biomass fuel increases the risk of pulmonary TB.

Keywords: Biomass fuel, exposure, pulmonary tuberculosis, female, rural

Introduction

Air pollution has been commonly perceived as an urban problem associated with motor vehicles and industries. However, in developing countries, air pollution tends to be highest indoors, where biomass fuels, such as wood, animal dung, crop residues and grasses, are burned by many households for cooking and space heating^[1,2]. Approximately half the world's population and up to 90% of rural households in developing countries still rely on unprocessed biomass fuels in the form of wood, dung and crop residues^[3]. Biomass fuels are at the high end of the fuel ladder in terms of pollution emissions and at the low end in terms of combustion efficiency^[4]. Biomass smoke consists of many noxious components, including respirable suspended particulates, carbon monoxide, nitrogen oxides, formaldehyde and polyaromatic hydrocarbons, such as benzo (a) pyrene^[5]. Many of the substances in biomass smoke can damage human health. Particles with diameter of <10 μm and particularly those <2.5 μm in diameter can penetrate deeply into the lungs and appear to have the greatest potential for damaging health^[6]. Thus high exposures to air pollutants can cause serious health problems. It has been estimated that indoor air pollution

from solid-fuel use in a developing countries accounted for about 1.6 million deaths annually in 2004^[7]. Also in developing countries like Bangladesh, daily air pollution exposure from cooking with biomass typically exceeds relevant health-based guidelines by a factor of 25 or more.⁸ Such exposure to cooking smoke may lead to greater susceptibility to infection and increased risk of progression to active pulmonary tuberculosis (TB) in those who are already infected.

According to WHO global report tuberculosis is a major public health problem in Bangladesh and the country ranks sixth among 22 highest burdens TB countries in the world. Despite existing successful NTP program and DOTs strategy, every year 70,000 people die due to TB in our country (care2). Most of the epidemiological studies did not adequately take into account the influence of multiple, potentially confounding, exposure variables, such as the type and location of kitchens, type of oven, and type of fuel with fuel preference to measure the association between biomass fuel smoke exposure and pulmonary TB among female in rural areas of Bangladesh. We, therefore conducted a case-control study to measure such kind of relationship. This was part of a series of

studies with similar design, the first of which, done in Pokhara, Nepal, found effects from both biomass and kerosene smoke [9].

Methodology

Patients were recruited from Ullahpara and Shahjadpur Upazilla (subdistrict), Sirajganj District, Bangladesh from April 2012 to May 2012. This two sub-districts cover approximately 0.9 million people [BBS]. Total 261 pulmonary tuberculosis patients were enrolled to evaluate the association between biomass fuel and pulmonary TB. Trained public health specialists and data collectors administered a semi structured questionnaire, through a face to face interview. This interview schedule was written in Bangla language, developed through a process of peer review and pre testing. All ethical aspects were strictly adhered to in the study. This research was funded by Ministry of Science and Information & Communication Technology (MSICT), Government of People's Republic of Bangladesh and conducted by Department of Statistics, Jahangirnagar University, Savar, Dhaka, Bangladesh.

The questionnaire addressed factors suspected to be involved with health-seeking behaviour based on clinical experience. All patients who gave informed oral consent were consecutively enrolled in the study until the sample size was achieved. The participation rate was almost 100%.

The interview included questions regarding the patient's sociodemographic factors e.g. age, gender, educational status, occupation, family types, religion, environmental factors e.g. main cooking fuel used, time in touch of oven, type of kitchens, type of oven, smokers in the family, in touch of TB patients, tobacco smoking and the ventilation of the place of cooking.

Statistical analysis

Data were analyzed using SPSS v. 22. Cooking using cow dung, wood grass, crop residue or coal was considered as exposure to biomass fuel. The level of education, socio economic status, passive smoking, alcohol intake, type of kitchen, type of oven, ventilation process in cooking place were investigated as potential confounding factors. The type of kitchen was grouped in two groups: a) cooking outside or separate kitchen inside or outside the house (low exposure) and b) kitchen inside the house but not separate from other rooms (high exposure). Risk factors found significant in univariate matched analysis, that is, type of kitchen, in touch of TB patients, tobacco smoking and ventilation process of cooking place were considered for the multivariate analysis using conditional logistic regression. The difference between the models was tested by the likelihood ratio (LR) test and the best fitting model was selected.

Results

The study population was predominantly in the 20-40 year-old age group (49.1%) and lived in rural areas (90.4%). Majorities were illiterate (47.3%) and housewives (69.2%) and almost

98.2% had a monthly family income of no more than 20,000 Tk. The socio-economic characteristics of the study participants are presented in table 1. Literacy was significantly higher among controls (52.6%) compared with the cases (47.3%).

The distribution of cases and controls according to exposure to environmental factors is presented in table 2. In a univariate analysis the risk of pulmonary tuberculosis among female using biomass fuel (cowdung) was twice as high as that in female who cooked with liquid or supplied petroleum gas with Odds Ratio (OR) 2.480. The risk of pulmonary tuberculosis was also significantly higher among female in the high biomass exposure group, that is, who had cooked inside the house but not separate from other rooms, having the in touch of TB patients and with a tobacco smoking characteristics. Moreover, ventilation process of the cooking place had also a significant effect of getting higher risk in TB patients.

Conditional logistic regression was used to evaluate significant confounding and or interaction. The LR test was used to test whether the model having only main cooking fuel fits better than the model having both main cooking fuel and education, or type of kitchen or in touch of TB patients, or smokers in the family. The final model with the interaction term for main cooking fuel and in touch of TB patients had the best fit. The adjusted OR of biomass fuel compared with liquid/supply petroleum gas was found to be 7.319 with a p-value 0.009 (table 3).

Discussion

Indoor air pollution from biomass, which disproportionately affects female and children, is a significant cause of global mortality and morbidity. This is a neglected area of global disease that affects a large proportion of the world's population.¹⁰ This study provides evidence that female who cook with biomass fuel have an increased risk for pulmonary tuberculosis (table 3). Possible socio-demographic, economic and environmental factors, such as age, area of residence, religion, type of house and income, that might confound the relationship between biomass fuels and tuberculosis were similarly distributed in cases and controls (table 1). Restricting the study to female group helped to some extent control confounding due to smoking as most female did not smoke, but environmental factors was quite common in this area, as in touch of TB patients in a family occurred. In the multivariate analysis a strong interaction between environmental factor and biomass fuel smoke was evident (Table 3).

Studies have implied a causal role of biomass fuel smoke exposure and the development of TB [11]. (lakshmi). A case-control study in three countries in West Africa shows that TB is multifactorial disorder, in which the environment interacts with host-related factors [12]. (lakshmi). This study supports the fact that irrespective of the type of fuel use, the risk of having the pulmonary tuberculosis is twofold higher among those who use the kitchen inside the living room that those who use a separate kitchen or cook in the open.

Table 1: Distribution of Socio-demographic characteristic of the study population, North-Western region of Bangladesh.

Characteristics	Categories	Cases N=114	Cases in (%)	Controls N=147	Controls in %
Religion	Islam	106	92.98246	139	94.55782
	Hindu	8	7.017544	8	5.442177
Education	Illiterate	54	47.36842	50	34.01361
	Primary	25	21.92982	43	29.2517
	Secondary	26	22.80702	33	22.44898
	Graduate	2	1.754386	9	6.122449
Occupation	Others	7	6.140351	12	8.163265
	Housewives	79	69.29825	100	68.02721
	Service	1	0.877193	2	1.360544
	Day labor	3	2.631579	3	2.040816
House Type	Others	31	27.19298	42	28.57143
	Pucca	17	14.91228	20	13.60544
	Semi pucca	1	0.877193	1	0.680272
Monthly Income	Kuccha	96	84.21053	126	85.71429
	<=20000	112	98.24561	143	97.27891
	20000 from <=40000	2	1.754386	3	2.040816
Land ownership	>40000	0	0	1	0.680272
	Own a house	108	94.73684	138	93.87755
	Rented house	2	1.754386	5	3.401361
Relative house	Relative house	1	0.877193	1	0.680272
	Others	3	2.631579	3	2.040816

Table 2: Association of environmental factors with pulmonary tuberculosis among female, North Western region of Bangladesh

Characteristics	Categories	Cases (%) N=114	Control (%) N=147	OR	P-value
Main Cooking fuel used	L/S gas	3 (2.6)	8 (5.4)	1.00	
	Biomass	53 (46.5)	57 (38.8)	2.48	0.19
	Tree	58 (50.9)	82 (55.8)	1.89	0.36
Type of Kitchen	Open Space	78 (68.4)	75 (51.0)	1.00	
	Others	36 (31.6)	72 (49.0)	0.48	0.005
Smokers in the family	0	65 (57.0)	76 (52.1)	1.00	
	1	44 (38.6)	62 (42.5)	1.28	0.78
	2	3 (2.6)	5 (3.4)	1.06	0.94
	3	2 (1.8)	3 (2.1)	0.90	0.92
Type of Oven	Open	51 (44.7)	53 (36.1)	1.00	
	Partially open	61 (53.5)	89 (60.5)	12562.8	0.99
	Developed	2 (1.8)	0 (0.0)	13567.9	0.99
	Gas oven	0 (0.0)	5 (3.4)	11324.5	0.99
In touch of TB members	Family Member	26 (22.8)	7 (4.8)	1.00	
	Not possible	70 (61.4)	24 (16.3)	0.78	0.62
	Non relative	9 (7.9)	43 (29.3)	0.05	0.00
Tobacco Smoking	Relative	9 (7.9)	73 (49.7)	0.03	0.00
	Yes	13 (11.4)	30 (20.4)	1.99	0.05
Ventilation Process	No	101 (88.6)	117 (79.6)	1.00	
	Close	0 (0.0)	4 (2.7)	1.00	
	Without Wall	50 (43.9)	53 (36.1)	0.00	0.99
	With door and Window	16 (14.0)	29 (19.7)	0.75	0.43
Others	Wall 2/3 with tinshed	23 (20.2)	41 (27.9)	0.44	0.05
	Others	25 (21.9)	20 (13.6)	0.45	0.04

Table 3: Association of biomass fuel exposure on pulmonary TB among female in North-Western region, Bangladesh: Conditional logistic regression model.

Variables	OR	p-Value
Main Cooking fuel		
L/S gas	1.00	
Biomass(Cowdung)	7.31	0.009
Tree	8.03	0.006
Education		
Illiterate	1.00	
Primary	2.62	0.026

Secondary	3.20	0.005
Graduate	1.56	0.301
Others	1.63	0.412
Type of Kitchen		
Open Space	1.00	
Others	0.84	0.112
In Touch of TB patients		
Family Member	1.00	
Not possible	1.62	0.203
Non relative	0.21	0.000
Relative	0.14	0.000
Main cooking fuel* In touch of TB patients		
L/S gas*Family Member	1.00	
Biomass* Family Member	7.319	0.009
Tree*Family Member	2.345	0.003

Conclusion

This study provides a scenario into the relationship of biomass fuel exposure and pulmonary TB patients among female in an area of North-Western Bangladesh. The use of biomass fuel for cooking is associated with pulmonary TB among female in north western region of Bangladesh.

Limitation of the study

The findings of this study need to be interpreted in the light of several limitations. Firstly, our study was assessment of the exposure by questionnaire, which is not an objective measurement for the quantity of exposure. Secondly, misclassification of the exposure is likely to be random in cases and controls, hence, the estimated OR is an underestimation of the true risk.

Abbreviations

TB: Tuberculosis, DOTS: Directly Observed Treatment, OR: Odds Ratio, L/S: Liquid/Supply, WHO: World Health Organization, NTP: National Tuberculosis Control Program, BBS: Bangladesh Bureau Of Statistics, MOSICT: Ministry of Science and Information & Communication Technology, LR: Likelihood Ratio.

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Availability of data and materials

The data used for this manuscript were collected from Ullahpara and Shahjadpur Upazilla, a sub-district of Sirajgong, DOTS centers through a face to face interview using pretested questionnaire.

Authors' contributions

MA conceived and designed the experiments. AR analyzed the data. MA also contributed in the interpretation of data, and AR wrote the paper. Both authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing of interests.

Consent for publication

Consent for publication is not applicable as authors are responsible for data source, that have been used for this study.

Ethics approval and consent to participant

All ethical aspects were strictly adhered to in this study. Moreover, participants from DOTS center were maintained with a scheduled time period. However, official permission was also taken form DOTS centers prior to collection of required data set.

Author Details

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