

# Study on respiratory problems and respiratory function amongst females exposed to biomass fuel and gas/electricity fuel in a district of Bangladesh

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## Abstract

Indoor air pollution from biomass smoke is now regarded as public health hazard in the developing world causing different respiratory diseases. A cross-sectional study was conducted to see the prevalence of respiratory disease and status of respiratory function among female biomass fuel users and gas/electricity fuel users in a selective area of Bangladesh. A total of 103 females from Madla, a rural area under Bogra District of Bangladesh, which having good communication facilities, meeting the defined enrollment criteria for biomass fuel group were selected purposively as cases, while 101 females from the urban households from Thanthania in the same district, meeting the defined eligibility criteria for controls were included in gas/electricity fuel group. The participants were interviewed on a semi-structured questionnaire from March to June 2007. Moreover, peak expiratory flow rate (PEFR) of 98 participants from each group was measured as a lung function parameter. In the biomass group, majority (61.6%) used open type of kitchen, 21.2% partially closed kitchen, 11.1% closed and 6.1% closed non-ventilated kitchen. Nearly three-quarter (73%) of the gas/electricity group used closed ventilated type of kitchen, 26% used partially closed kitchen and only 1 case used open kitchen. Nearly one-quarter (24%) of the biomass group had habit of taking beetle-nut compared to only 3% of the gas/electricity group and chewing tobacco was also revealed to be proportionately higher in the former group (22.8%) than that in the latter group (4%) ( $p < 0.001$ ). The biomass group exhibited a significantly higher frequency of respiratory problem (16.5%) compared to their gas/electricity counterpart (5%). 30.4% of the participants of biomass group suffered from allergic rhinitis as opposed to 13% of the gas/electricity group. Coughing was also significantly higher in the biomass group (13.7%) than that in the gas/electricity group (1%). Coughing in the early morning and cough with productive sputum also demonstrated their significant presence in the former group than that in the latter group. Peak expiratory flow rate (PEFR) shows that it was significantly lower in the biomass fuel user group ( $225.0 \pm 38.6$  L/min.) than that of the gas/electricity user group ( $247.5 \pm 34.4$  L/min.) ( $p < 0.001$ ). It was found that smoke generated from biomass fuel combustion is a significant risk factor for respiratory problems among the female household members who, by tradition, are associated with cooking activities.

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**Key words:** Health hazards, respiratory disease, respiratory function, biomass fuel, gas/electricity fuel.

## Introduction

Indoor air pollution from biomass smoke is now regarded as public health hazard in the developing world, where more than two billion people still rely on the use of solid biomass fuels such as, dung, wood, crop residue and coal for cooking daily meals and heating homes. About half of the world's households still use unprocessed solid fuels, ranging near zero in developed countries to more than 80% in the regions such as China, Indian sub-continent and Sub-Saharan Africa<sup>1</sup>. Studies conducted of indoor air-pollution and its health effects in developing countries have provided evidence of associations between indoor air pollution by solid biomass fuel burning and health problems like acute lower respiratory infection (ALRI) in children, chronic obstructive

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pulmonary disease (COPD), asthma, tuberculosis, etc<sup>2</sup>. In rural areas of Bangladesh, a vast majority of women in rural households use biomass fuel for daily cooking and heating purposes (particularly in winter season) and are at risk of developing diseases associated with unprocessed fuels. However, excepting a few small scale studies, no national level study has yet been conducted in Bangladesh to ascertain the risk associated with exposure to biomass smoke and development of diseases particularly respiratory illness. The researchers, donors and policy makers have failed to comprehend the significance of relationship of exposure to indoor air pollution and increased risk of acute respiratory tract infection in childhood, chronic obstructive pulmonary diseases in adults<sup>3-5</sup>. Hence, their adverse effects on health have been somewhat neglected. Bangladesh is a poor, developing country, situated in the tropical zone with monsoon and high humidity which plays a vital role to keep the population indoor. Almost two-thirds of the population of Bangladesh is in rural areas and almost half of them are female. Most of them have poor living conditions and almost all of them use poorly ventilated kitchens or cooking space.

They do not have access to cleaner forms of fuel such as Natural Gas/LPG or electricity and only few can afford to have kerosene for cooking and heating purpose; instead they stick to their age old tradition of using biomass fuel for cooking and heating purposes as such biomass fuel has become the part and parcel of their lives<sup>5</sup>.

As mentioned earlier, biomass fuel comprises of wood, charcoal, dry cow-dung and crop residues, which when burnt, emits smoke having high concentration of pollutants including gases like carbon monoxide, nitrogen oxide, sulfur dioxide, phenols, acetaldehyde and also considerable amount of particulate matters causing serious indoor air pollution. Majority of our rural people and to some extent urban people as well, exposed to such pollutants, are at risk of developing respiratory problem<sup>2-5</sup>.

There are reports from a number of studies in Mexico<sup>6,7</sup>, Bolivia<sup>8</sup>, China<sup>9</sup>, Turkey<sup>10</sup>, India<sup>11-13</sup> and Nepal<sup>14,15</sup> stating representative levels of

air pollution in rural households for use of biomass fuels and respiratory problems due to its exposure in their countries. However, there is no data available from Bangladesh which can relate smoke exposure from biomass fuel combustion to the prevalence of respiratory diseases. Faced with this backcloth, a study on the subject in context to rural Bangladesh is imperative which might have policy implication in the days ahead. Therefore, the present study was aimed to see and compare the prevalence of respiratory disease and status of the respiratory function among female biomass fuel users and gas/electricity fuel users in a Bangladeshi population.

### Methods

The present study was a cross-sectional comparative study, conducted from March to June 2007, in Madla, a rural area under Bogra District, which is approximately 5 km far from Bogra city and in Thanthania, an urban area having good communication facilities. There were no industries in the surrounding area and as such the areas were devoid of industrial pollution. The place was purposely chosen considering the convenience of communication facilities. The rural community was generally poor and was dependent on biomass fuel for cooking and heating purposes. The urban community was mostly middle class and rich and was dependent upon gas/electricity for cooking and heating purposes. The study population was divided into two groups:

*Biomass fuel group:* Adult female household members residing in rural area, associated with daily cooking using biomass fuel at least for the last 3 years were included in biomass group.

*Gas/electricity fuel group:* Adult female household members residing in urban areas, associated with daily cooking using either gas or electricity at least for the last 3 years were assigned to gas/electricity group. A total of 103 females from the rural households meeting the defined enrollment criteria for biomass fuel group were selected purposively as cases, while 101 females from the urban households meeting the defined eligibility criteria for controls were included in gas/electricity fuel group.

Ideally sample size should have been determined by simple random sampling procedure the prerequisite of which is construction of a sampling frame with all the sampling units of defined study area. But it was not feasible to construct a sampling frame because of time and financial constraints. Therefore, all respondents of both groups were selected purposively. A structured questionnaire addressing all the variables of interest was developed. The questionnaire was pre-tested and modified and finalized according to the feedbacks received from field-testing. Before collecting data necessary permission was obtained from the local Union Parishad Chairman and Health Administration (Civil Surgeon and UH&FPO). Data was collected on variables of interest by house to house interview of the respondents with their voluntary verbal consent and conducted by 8 trained data collectors. Time for interview was agreed upon so that the respondents could spend sufficient time. Moreover, peak expiratory flow rate (PEFR) of 98 participants from each group was measured as a lung function parameter. Collected data were checked and compiled and statistical analyses were done by using SPSS version 11.0. Both descriptive and inferential statistics were used in the process of data analysis. Chi-square ( $\chi^2$ ) test and Student's 't' test were done and the level of significance was set at 0.05.

## Results

Of the 204 female respondents, the age categories were almost identically distributed between gas/electricity and biomass fuel groups with 25-30 years category occupying over one-quarter (25%) of the total in each group. Majority (87.1%) of the gas electricity group and 60.2% of the biomass group were Muslims ( $p < 0.001$ ). The groups did not differ in terms of number of family members, although, frequency 2-4 membered families were a bit higher in the biomass group (70.9%) compared to that in the gas/electricity group ( $p = 0.063$ ) (Table-I).

**Table-I: Socio-demographic characteristics of the respondents**

Socio-demographic variables	Group		p-value
	Gas/Electricity (n=101)	Biomass fuel (n=103)	
<b>Age (years)</b>			0.178
<25	13(12.9)	25(24.3)	
25 – 30	24(23.8)	27(26.2)	
30 – 35	20(19.8)	12(11.7)	
35 – 40	18(17.8)	15(14.6)	
≥ 40	26(25.7)	24(23.3)	
<b>Religion</b>			<0.001
Muslim	88(87.1)	62(60.2)	
Hindu	13(12.9)	41(39.8)	
<b>Family member</b>			0.063
2 to 4	59(58.4)	73(70.9)	
>4	42(41.6)	30(29.1)	
<b>Education</b>			<0.001
Illiterate	3(3.0)	45(43.7)	
Primary	7(6.9)	23(22.3)	
Secondary & higher	77(76.2)	33(32.0)	
Graduate/post graduate	14(13.9)	2(1.9)	
<b>Respondent's occupation</b>			0.001
House wife	85(84.2)	95(92.2)	
Small business	00	4(3.9)	
Farming	00	2(1.9)	
Service	16(15.8)	2(1.9)	
<b>Husband's occupation</b>			0.001
Agriculture work	4(4.0)	44(43.1)	
Service	49(49.0)	18(17.6)	
Small business	42(42.0)	33(32.4)	
Others	5(5.0)	7(6.9)	
<b>Family income (BD Taka)</b>			<0.001
<5000	3(3.0)	49(47.6)	
5000-10000	98(97.0)	54(52.4)	
<b>Housing condition</b>			<0.001
Pacca	84(83.2)	9(8.9)	
Semi pacca	16(15.8)	42(41.6)	
Thatch	1(1.0)	50(49.5)	

Data was analyzed using Chi-square ( $\chi^2$ ) test; figures in the parentheses denote percentage.

A significantly higher proportion of the respondents in the biomass group (43.7%) were found to be illiterate, where as secondary and higher secondary educated formed the main bulk in Gas/electricity group (76.2%) ( $p < 0.001$ ). Distribution of occupation shows that respondents were predominantly housewife in both groups. However, service-holders were much higher (15.8%) in the gas/electricity group than that in the biomass group (1.9%) ( $p = 0.001$ ). Agriculture work was the prime occupation of the respondents' husbands in the biomass group (43.1%), while service was the main job in the gas/electricity group (49%) ( $p < 0.001$ ). Majority of the gas/electricity group (97%) had a monthly income 5-10 thousand Bangladeshi Taka compared to 52.4% of the biomass group ( $p < 0.001$ ). In terms of housing too the groups were found to differ with 83.3% of the former group occupying a pacca house compared to only 8.9% of the latter group ( $p < 0.001$ ) (Table-I). In the biomass group, majority (61.6%) used open type of kitchen, 21.2% partially closed kitchen, 11.1% closed and 6.1% closed non-ventilated kitchen. Nearly three-quarter (73%) of the gas/electricity group used closed ventilated type of kitchen, 26% used partially closed kitchen and only 1 case used open kitchen (Fig. 1). Besides, nearly one-quarter (24%) of the biomass group had habit of taking beetle-nut

compared to only 3% of the gas/electricity group ( $p < 0.001$ ). Chewing tobacco was also revealed to be proportionately higher in the former group (22.8%) than that in the latter group (4%) ( $p < 0.001$ ) (Table-II).

**Table-II: Distribution of risk behaviors between groups**

Risk behaviors	Group		p-value
	Gas/Electricity	Biomass fuel	
Taking beetle nut	3(3.0)	24(24.0)	<0.001
Chewing tobacco	4(4.0)	23(22.8)	<0.001
Smoking habit	1(1.0)	1(1.0)	0.994

Data was analyzed using Chi-square ( $\chi^2$ ) test; figures in the parentheses denoted corresponding percentage.

The biomass group exhibited a significantly higher frequency of respiratory problem (16.5%) compared to their gas/electricity counterpart (5%) ( $p = 0.008$ ). Table-III compares the experience of respiratory symptoms between the groups in the previous year of the present study. The symptoms intended to be compared between the groups were wheezing in the chest, wheezing with breathlessness, wheezing without cold, woken up due to tightness of chest, woken up with an attack of coughing and attacked with asthma. All the symptoms, except an asthmatic attack, were observed to be significantly higher in the bio-mass group than those in the gas/electricity group. The data of usual sufferings from respiratory problem depicts that 30.4% of the biomass group suffered from allergic rhinitis as opposed to 13% of the gas/electricity group ( $p = 0.003$ ). Complain of coughing was also significantly higher in the biomass group (13.7%) than that in the gas/electricity group (1%) ( $p = 0.001$ ). Coughing in the early morning and cough with productive sputum also demonstrated their significant presence in the former group than that in the latter group (Table-IV). Peak expiratory flow rate (PEFR) shows that it was significantly lower in the biomass fuel user group ( $225.0 \pm 38.6$  L/minute) than that of the gas/electricity user group ( $247.5 \pm 34.4$  L/minute) ( $p < 0.001$ ) (Table-V).

**Table-III: Experience of asthma-like symptoms in the previous year**

Usual sufferings	Group		p-value
	Gas/Electricity (n=100)	Biomass fuel (n=102)	
Allergic rhinitis	13(13.0)	31(30.4)	0.003
Chronic cough	1(1.0)	14(13.7)	0.001
Coughing in the early morning	1(1.0)	14(13.9)	0.001
Cough with productive sputum	00	9(8.9)	< 0.001

Data was analyzed using Chi-square (2) test; figures in the parentheses denoted corresponding percentage.

**Table-IV: Different respiratory problems between groups**

Usual sufferings	Group		p-value
	Gas/Electricity (n=100)	Biomass fuel (n=102)	
Allergic rhinitis	13(13.0)	31(30.4)	0.003
Chronic cough	1(1.0)	14(13.7)	0.001
Coughing in the early morning	1(1.0)	14(13.9)	0.001
Cough with productive sputum	00	9(8.9)	< 0.001

Data was analyzed using Chi-square (2) test; figures in the parentheses denoted corresponding percentage.

**Table-V: Comparison of peak expiratory flow rate (in L/min.)**

Peak expiratory flow rate (PEFR)	Group		p-value
	Gas/Electricity (n=98)	Biomass fuel (n=98)	
1 <sup>st</sup>	256.8±34.8	234.9±39.9	<0.001
2 <sup>nd</sup>	246.8±34.5	225.1±39.3	<0.001
3 <sup>rd</sup>	238.9±38.3	214.9±40.8	<0.001
Average	247.5±34.4	225.0±38.6	<0.001

Data was analyzed using Student's 't' test and was presented as mean±SD.

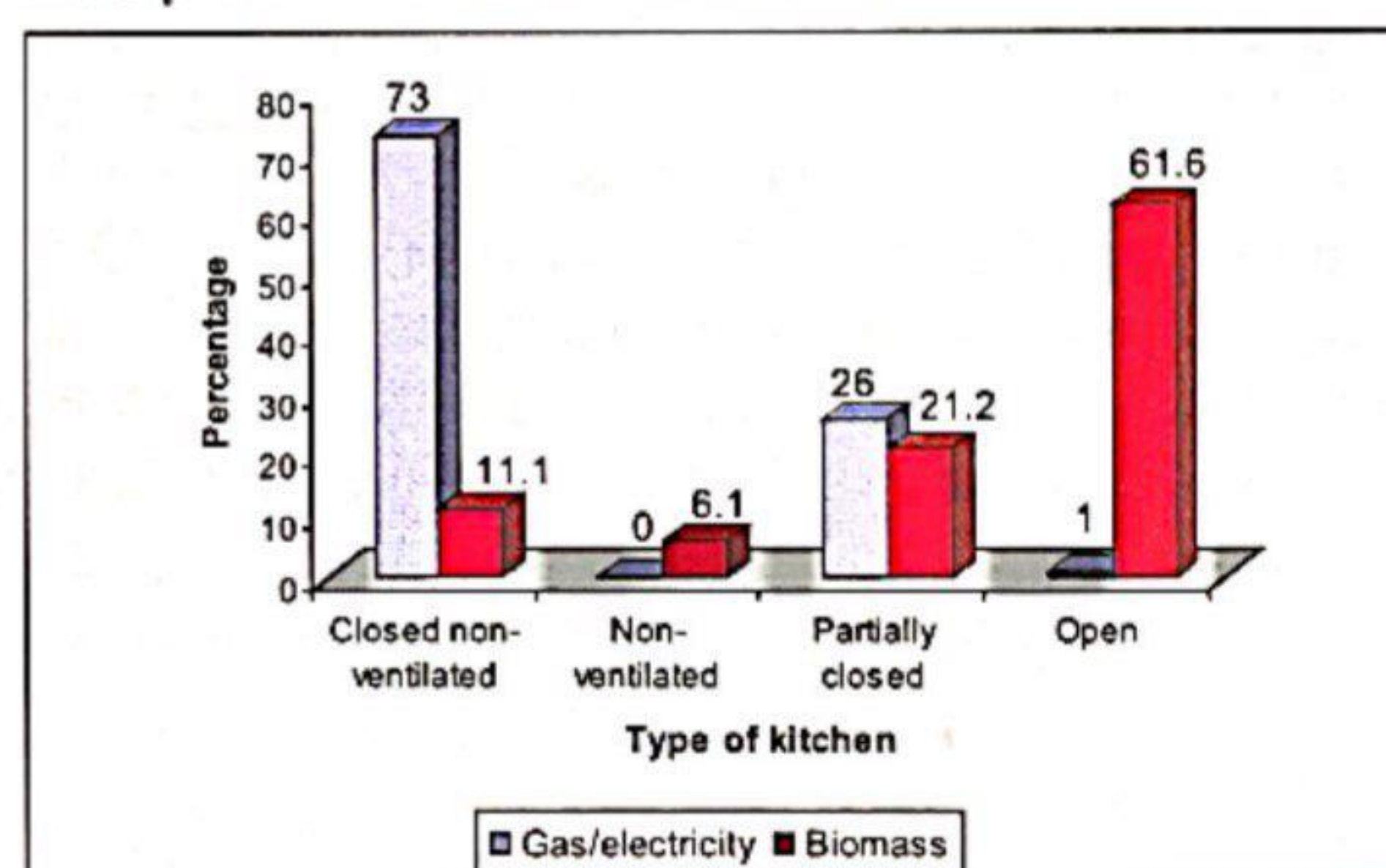


Fig. 1: Type of kitchen used by the study groups.

## Discussion

Similarly an association between indoor air pollution from Chinese-style cooking and lung cancer has been found among non-smoking women living in Sanghai, China<sup>9</sup>. Perez-Padilla et al.<sup>6</sup> investigated the relationship between older females (more than 40 years) with chronic bronchitis and chronic airway obstruction (CAO) and exposure to biomass fuels. They reported causal role of domestic wood smoke exposure for chronic bronchitis and CAO. Shrestha duo<sup>15</sup> demonstrated that Nepalese household kitchens using biomass fuels in traditional clay stoves for cooking were highly polluted with smoke. The mean smoke level (PM<sup>10</sup>) in kitchens was about three times higher than that in those using cleaner fuels (kerosene, LPG and biogas).

Biomass fuel caused significantly more respiratory disorders than did cleaner fuels. The prevalence of respiratory illness and symptoms were considerably higher in those living in mud and brick houses compared with concrete houses which is not consistent with the findings of the present study as expected. In rural Mexico, use of biomass was associated with 4% decrease in FEV/FVC, while an increase in kitchen particle concentration of 1000 microgram/m<sup>3</sup> was associated with a reduction of 2% in FEV<sub>6</sub>. In India, patients using biomass had lower FVC than those using kerosene gas and mixed fuels as Pandey<sup>14</sup> reported an exposure-response relationship with FEV<sub>1</sub> and FVC which decreased as reported hours of exposure increased. Besides, a study conducted in Jaracuaro, Mexico, that switching from unprocessed to cleaner fuels and from traditional stoves to those using improved fuels lowers respirable suspended particulate and carbon monoxide concentration reduces levels substantially and consequently respiratory ailments<sup>7</sup>. Albalak et al.<sup>8</sup> studied in two Bolivian villages and the result of the study suggests an association between chronic bronchitis and exposure to domestic biomass fuel combustion. Uzun et al.<sup>10</sup> investigated whether biomass fuel was a potential risk for chronic bronchitis and asthma among the females in five villages of Van, East Turkey, and found that over 60% of the biomass fuel users had asthmatic symptoms compared to only 12.9% of non-biomass fuel users. Biomass fuel users reported more cough symptoms than their counterparts.

### Conclusion

It was found that smoke generated from biomass fuel combustion is a significant risk factor for respiratory problems among the female household members who, by tradition, are associated with cooking activities. Public health awareness campaigns need to be designed by the health department and other concerned authorities to inform people about the risks of exposure to cooking smoke. Besides, where shifts to cleaner fuels are not feasible, programs to promote improved cook-stoves designed to reduce exposure to smoke by means of improved combustion and improved venting could be thought.

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