Effect of Biomass Smoke on Respiratory Symptoms and Lung Functions in Rural Non-Smoking Indian Women

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Abstracts: **Background:** Majority of women living in rural areas use biomass fuels for production of domestic energy. Biomass fuels are an enormous source of indoor pollution when burned in closed space with no ventilation. Combustion products have deleterious effect on lung functions. **Aim:** To Study the effect of biomass smoke on respiratory symptoms and lung functions in rural non-smoking Indian woman. **Materials and Methods:** A comparative study was conducted among women visiting hospital ›18 years of age belonging to rural areas of Bareilly, to study the effect of biomass smoke on respiratory symptoms and lung functions. The study group comprised of 100 subjects who were exposed to biomass smoke and 100 aged matched subjects who were not exposed to biomass served as controls. A standardized respiratory questionnaire was administered to all subjects and pulmonary function tests were evaluated by MIR SPIROLAB 3. **Results:** The lung functions (FVC, FEV1, FEV1/FVC, PEFR) were significantly lesser in the study group, exposed to biomass fuel than the controls. **Conclusion:** Women cooking with biomass fuels have increased respiratory symptoms and have marked reduction in lung functions compared with those cooking with gas.[Tiwari V NJIRM 2014; 5(6) :7-10]

Key Words: Biomass, lung functions, rural women

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Introduction: COPD is the 4th leading cause of death and expected to be 3rd by 2030 [1]. It is the result of cumulative exposures over decades. Often the prevalence of tobacco smoking, although in many countries, outdoor, occupational and indoor air pollution- the latter resulting from burning of wood and other biomass fuels are the major risk factors for COPD [2]. The World Health Organization (WHO) estimates that around 1.1 billion people worldwide use tobacco, constituting one third of the entire population aged 15 years and above. Indoor air pollution is ranked as the 10thof preventable risk factors, contributing to the global burden of a disease, while in developing countries; it ranks 4th most important preventable risk factor. Around 1.5-2 million deaths/year are attributed to indoor air pollution, mainly affecting the children under 5 years due to acute respiratory infection (ARI), COPD and lung cancer among women. India registers 6, 00,000 premature deaths /year due to biomass fuel combustion exposure [3]. 50% of the world's population and up to 90% of rural households in developing countries and approximately 80% rural households in India still rely on unprocessed biomass fuels such as wood, dung, crop residues and coal for production of domestic energy for cooking and heating. Almost 3 billion people worldwide use biomass and coal as their main source of energy for cooking, heating and other household needs, so the population at risk worldwide is very large [4,5]. The biomass fuels when burned in inefficient stoves and in closed space with no ventilation, forms an enormous source of indoor pollution. Biomass combustion produces complex mixture of volatile organic compounds: Suspended particulate matter of respirable size (PM‹10µ), carbon monoxide, nitrous oxides, SO2, aldehydes,polyaromatic hydrocarbons (carcinogenic)[6]. Women in the developing countries spend 4-6 hours daily in kitchen, thus are exposed to the biomass fuel for 30-40 years equivalent to 60,000 hours of exposure and inhaling 25 million litres of polluted air during lifetime[7]. Health hazards due to biomass exposure: Chronic obstructive pulmonary disease, cor pulmonale caused by pulmonary damage, acute respiratory infections, low birth weight due to maternal exposure, malignancy, perinatal and infant ill health [8,9,10].

A survey conducted by National sample survey organization during 2006 to 2007 on the percentage of rural households across states in India using different fuel types for cooking source showed the use of the biomass fuels i.e., use of approximately 75-80% (fire wood and chips), 10%

(dung cake) among rural population in Uttar Pradesh India (fuel wood report, 2012)[11]. Only 3.1% LPG users and 0.1% kerosene was used by rural households of Uttar Pradesh.

Many studies have proven that biomass fuel combustion deteriorates lung function in rural women mainly producing acute and chronic pulmonary disease. There are also studies explaining no adverse effects of biomass combustion on lung functions [12]. There is also a study indicating association of lung cancer with wood smoke exposure [13]. Hence more studies are needed for stronger evidence.

Many studies on the effect of biomass fuel combustion on lung functions were performed worldwide but very few studies have been conducted in north India. Hence this study was performed to compare the respiratory symptoms and lung functions in women exposed to biomass smoke and LPG.

Materials and Methods:
This study was conducted in the Department of Pulmonary Medicine, Rohilkhand Medical College and Hospital, Bareilly. Rohilkhand Medical College is tertiary care teaching hospital with well-equipped state of the art infrastructure and well-trained human resources. It caters mainly to the population of district Bareilly and adjoining areas.

Sample size of 200 subjects was taken. The study group comprised of 100 subjects who were exposed to biomass smoke and 100 aged matched subjects who were not exposed to biomass (LPG users) served as controls. Clinical data were collected from a standardized respiratory questionnaire recommended as per American Thoracic Society Guidelines.

Study group comprised of non-smoking Indian women of › 18 years of age using biomass fuel and LPG (control) for cooking purposes with a minimum period of 5 years of exposure with their respective fuels. Subjects with a history of pulmonary tuberculosis, bronchial asthma, pregnancy, cardiac diseases, cancer, subjects using mixed fuel and male population were excluded from the study. Ethical clearance was obtained from institutional ethical committee. Informed written consent was obtained from all subjects.
From ATS questionnaire, we obtained information on personal details, symptoms (cough, sputum, wheezing), intensity of dyspnea using the modified Medical Research Council scale, and quantification of the exposure to biomass smoke and to other inhaled substances, such as dust and chemicals reported by the patient.

Exposure to biomass smoke was expressed in hour-years, calculated as the number of years cooking with a biomass multiplied by the mean number of hours, the patient reported to spend, daily in this activity.

Pulmonary function tests were performed according to ATS guidelines using MIR Spirolab 3 machine. Severe exercise, eating large meals, wearing tight clothes was avoided before performing the test. The subject's age (years), height measured in standing position without shoes in centimetres and weight measured in kilograms was taken as continuous variables. PFT was carried out in the afternoon hours. The entire FVC procedure was demonstrated satisfactorily to the subjects. Nose clip was attached. Patients were asked to take maximal inspiration and blow into the mouthpiece as rapidly, forcefully and completely as possible for about at least 3 seconds. The subjects were verbally encouraged to continue to exhale the air at the end of maneuver to obtain optimal effort. A minimum of 3 acceptable forced vital capacity (FVC) manoeuvers were performed in the standing position with nose pinched and best manoeuver was selected and accepted. The parameters measured were Forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio and Peak expiratory flow rate (PEFR).

Statistical Analysis: Student't' test was used for Significance among two groups and for the analysis of pulmonary functions.

Results: There was no significant difference in mean age, height among biomass fuel exposed women compared to women using LPG. Both the groups were within normal range of BMI. Mean BMI for women using biomass were 18.88 kg/m2 and LPG were 20.82 kg/m2.(Table 1) The normal

range of BMI was 18.5-24.9 kg/m2 as per WHO classification. The study showed that exposure index among women using biomass fuel as compared to LPG group was not significant. The difference may be due to long duration required for cooking food with biomass fuel.

Table 1: Distribution of Patients According To Age, BMI And Type Of Exposure.

Parameters	Biomass group (n=100)	LPG group (n=100)
Age (years)	37.15 ± 13.04	38.37 ± 13.29
Height (cms)	162.20 ± 7.20	163.69 ± 7.30
Weight (cms)	49.57 ± 8.50	55.73 ± 8.28
BMI (Kg/m2)	18.88 ± 3.14	20.82 ± 3.05
Exposure index	52.15 ± 25.20	20.57 ± 12.36

The educational status of the subjects was divided into illiterate, primary school education, secondary school and graduate education. Illiteracy was considered as a significant factor in biomass group. There was significant difference in educational status between two groups.

The respiratory symptoms were significantly high in women exposed to biomass group as compared to LPG group. History of passive smoking had no significant difference in both groups.(Table 2)

Table 2: Frequency of Respiratory Symptoms According To Type of Exposure

Variables	Biomass group (n=100)	LPG group (n=100)
Cough or phlegm all day	30 (30%)	11(11%)
Cough all day lasting more than 3 months/yr	12 (12%)	06 (6%)
Phlegm all day lasting more than 3 months/yr	05 (5%)	00(0%)
Shortness of breath at rest	12 (12%)	01(1%)
Shortness of breath during physical activities	46 (46%)	06 (6%)
Chest tightness	28 (28%)	04 (4%)
Wheeze	18 (18%)	02 (2%)
Passive smoking	32 (32%)	30 (30%)

A significant decline was observed in lung functions parameters (FVC, FEV1, FEV1/FVC and PEFR) in women exposed to biomass group as compared to LPG exposed women. This difference in lung function parameters was statistically significant (p value ‹0.05). (Table 3)

Table 3: Spirometeric parameters in both groups

PARAMETERS	Biomass group (n=100)	LPG group (n=100)	pvalue
FVC	1.49 ± 0.75	3.25 ± 0.86	‹ 0.05
FEV1	1.22 ± 0.68	2.74 ± 0.75	‹ 0.05
FEV1/FVC	80.09 ± 13.24	83.14 ± 7.89	‹ 0.05
PEFR	2.31 ± 1.49	4.69 ± 2.09	‹ 0.05

Values are mean ± SD

Discussion: The present study was conducted to evaluate the effect of biomass smoke on respiratory symptoms and lung functions in rural non-smoking Indian women. The study showed a significant relation between biomass fuel combustion and decrease in lung functions. Respiratory symptoms were significantly high in women exposed to biomass group as compared to women using LPG as a cooking fuel. The commonest respiratory symptoms among biomass group are breathlessness, cough, phlegm followed by chest tightness and wheeze (table 2). Lung function parameters (FVC, FEV1, FEV1/FVC and PEFR) were significantly reduced in women exposed to biomass as compared to LPG group (p‹0.05). This decrease in lung functions may be due to chronic inhalation of particulate matter and toxic gases emitted during biomass combustion.

Our study showed a significant deterioration of lung functions in rural non-smoking Indian women using biomass fuel as compared to LPG users. Our observation supports the earlier study on women exposed to biomass fuels in rural Mexican women [14,15,12,16]. Regalado et. al.(2006) concluded in their study that women exposed to biomass smoke reported more cough and phlegm than did women cooking with gas, with minimal average adverse changes in lung functions[14]. Kirazet. al. (2003) found that the pulmonary functions were within normal limits, FEV1 values in rural women were found to be relatively low compared with those of urban women. Rural women exposed to biomass

fumes are more likely to suffer from Chronic bronchitis and COPD than urban women[15].

Reddy et. al.(2004) observed no statistically different lung functions in two groups except for PEFR which was significantly lower in women exposed to biomass[12]. Ekiciet. al. (2005) found that the prevalence of chronic airway disease in exposed women was found to be higher than that of LPG group[16].

Our study shows a significant relation between biomass fuel combustion and decrease in lung functions. This decrease in lung functions may be due to exposure to high concentration of respiratory irritants emitted during biomass fuel combustion.

Conclusion: Women cooking with biomass fuel have increased respiratory symptoms and have marked reduction in lung functions as compared to LPG users. The adverse effects of biomass smoke on lung functions can be due to exposure of high concentration of pollutants liberated by biomass fuel combustion. Hence educating women, improved ventilation and by using clean fuels may prevent the deleterious effect of biomass fuel on lungs.

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