ORIGINAL ARTICLE

Comparative study of respiratory symptoms and lung functions in patients with chronic obstructive pulmonary disease associated with biomass smoke and tobacco smoke exposure

V. K. Tiwari, Rajat Agarwal, Ankit Khurana, Nadeem Akbar, Prashant Chowdhary, Deepti Badwe

Department of Pulmonary Medicine, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India

Corresponding Author:
Dr. Rajat Agarwal,
Department of Pulmonary Medicine, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India. E-mail: drrajatchest@yahoo.com.sg

Received: 02/07/2017
Accepted: 18/07/2017
Published: 05/04/2020

How to cite this article:
Tiwari VK, Agarwal R, Khurana A, Akbar N, Chowdhary P, Badwe D. Comparative study of respiratory symptoms and lung functions in patients with chronic obstructive pulmonary disease associated with biomass smoke and tobacco smoke exposure. Int J Adv Integ Med Sci 2020;X(X):1-5.

Source of Support: Nil,
Conflicts of Interest: None declared.

Background: Chronic obstructive pulmonary disease (COPD) is the leading cause of morbidity and mortality worldwide. It is the result of cumulative exposures over decades. Tobacco smoking, occupational, outdoor, and indoor air pollution (burning of wood and other biomass fuels) are the major risk factors for COPD. Objective: The objective of the study was to compare the respiratory symptoms and lung functions in patients with COPD associated with biomass and tobacco exposure. **Materials and Methods:** We retrospectively evaluated symptoms and spirometry data of 512 patients who underwent spirometry at the pulmonary function laboratory of our institute. Clinical data were collected from a standardized respiratory questionnaire recommended as per American Thoracic Society guidelines. From the total of 512 patients, we selected 188 patients who had COPD as per gold guidelines. **Results:** There was no difference in respiratory symptoms, lung functions, and severity of disease in biomass and tobacco group ($P > 0.05$). **Conclusion:** Biomass smoke is an important risk factor for COPD. Biomass and tobacco smoke have a similar type of deleterious effect on lung functions.

KEY WORDS: Biomass smoke, chronic obstructive pulmonary disease, tobacco smoke

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide and results in an economic and social burden that is both substantial and increasing.[1,2] It is the 4th leading cause of death and expected to be 3rd by 2030.[2] It is the result of cumulative exposures over decades. Tobacco smoking, occupational, outdoor, and indoor air pollution (burning of wood and other biomass fuels) are the major risk factors for COPD.[3] The prevalence and burden of COPD are projected to increase in the coming decades due to continued exposure to COPD risk factors and changing age structure of the world's population.[2] The World Health Organization estimates that around 1.1 billion people worldwide use tobacco, constituting one-third of the entire population aged 15 years and above. About 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 the 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

Access this article online	
Website: www.ijaims.net	Quick Response code

population at risk worldwide is very large.[4,5] The biomass fuels when burned in inefficient stoves and in closed space with no ventilation form an enormous source of indoor pollution.

While there are large numbers of studies on tobacco smoke and COPD, there is a paucity of data on biomass smoke and COPD. It is not clear whether this phenotype of COPD is different or similar to COPD caused by tobacco smoke.

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.[6] There is also a study indicating an association of lung cancer with wood smoke exposure.[7] 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 patients with COPD associated with biomass smoke and tobacco smoke exposure.

MATERIALS AND METHODS

We retrospectively evaluated the symptoms and spirometry data of 512 patients who underwent spirometry at the pulmonary function laboratory of our institute. Clinical data were collected from a standardized respiratory questionnaire recommended as per American Thoracic Society Guidelines.

Pulmonary function tests were performed according to ATS guidelines using MIR Spirolab 3 machine. Severe exercise, eating large meals, and wearing tight clothes were avoided before performing the test. The subject's age (years), height measured in standing position without shoes in centimeters, and weight measured in kilograms were taken as continuous variables. The entire forced vital capacity (FVC) procedure was demonstrated satisfactorily to the subjects. The nose clip was attached. The patients were then asked to take maximal inspiration and blow into the mouthpiece as rapidly, forcefully, and completely as possible for about at least 3 s. The subjects were verbally encouraged to continue to exhale the air at the end of maneuver to obtain optimal effort. A minimum of three acceptable FVC maneuvers were performed with nose pinched and best maneuver was selected and accepted. The parameters measured were FVC, forced expiratory volume in 1 s (FEV1), and FEV1/FVC ratio. After salbutamol administration, post-bronchodilator pulmonary function parameters were measured.

From ATS questionnaire, we obtained information on personal details, symptoms (cough, sputum, and wheezing), the intensity of dyspnea using the modified Medical Research Council scale, and quantification of the exposure to tobacco smoke and to biomass smoke including other inhaled substances, such as dust and chemicals reported by the patient.

The exposure to tobacco smoke was calculated using pack-years, and 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.

We considered the following as diagnostic criteria for COPD (as per GOLD Guidelines): Patients aged 40 years or older; post-bronchodilator ratio between FEV_1/FVC <70% of the predicted value; and history of dyspnea or cough. The classification in levels of severity was based on FEV_1.

We used the following as exclusion criteria: Variation of FEV_1 after bronchodilator use >10%, bronchial asthma, pulmonary tuberculosis or other pulmonary diseases other than COPD, and cardiac diseases.

From the total of 512 patients, we selected 188 patients who met the inclusion/exclusion criteria and whose data were complete. The selected group was divided into two subgroups according to the type of exposure: (1) Exposed only to biomass smoke; (2) exposed only to tobacco smoke.

Statistical Analysis

Significance among two groups was compared using Chi-square test.

The significance of mean values was compared using Student's *t*-test.

RESULTS

A total of 188 patients were selected for analysis, out of which 56 patients had COPD due to biomass exposure and 132 patients had COPD due to tobacco smoke. Mean age in biomass smoke and tobacco smoke was 51.44 and 50.47 years, respectively, as shown in Figure 1 and Table 1. This difference was not significant statistically ($P > 0.05$). Female patients predominated in the biomass group (94.6%) and male patients predominate in the tobacco group (96.6%), as shown in Figure 2. This difference in gender was statistically significant ($P < 0.05$). Mean BMI in biomass and tobacco smoke group was 20.83 and 20.69 kg/

Table 1: Distribution of patients according to gender, age, BMI and type of exposure

Parameters	Biomass smoke (*n*=56)	Tobacco smoke (*n*=132)	*P* value
Female	53 (94.6%)	4 (3.03%)	<0.05
Male	3 (5.35%)	128 (96.6%)	<0.05
Age (mean±SD)	51.44±6.77	50.47±6.82	>0.05
Pack-years (mean±SD)		59.3±37.6	
Hours-years (mean±SD)	175.6±80.2		
BMI (kg/m²)	20.83±4.02	20.69±3.64	p>0.05

m², respectively. This difference in BMI was not statistically significant ($P > 0.05$).

All the respiratory symptoms including cough, sputum, wheezing, and dyspnea have shown no statistically significant difference in both biomass and tobacco smoke group ($P > 0.05$) [Table 2]. In both the groups, dyspnea observed was most often in Grade 2, that is, 46.4% and 51.5% in biomass and tobacco group, respectively. No significant difference in the frequency of dyspnea regardless of grades was observed in both the groups ($P > 0.05$).Lung function parameters including FVC, FEV1, and FEV1/FVC in both the groups are shown in Table 3. Lung function parameters have shown no statistically significant difference in both the groups ($P > 0.05$).

On analyzing the severity of disease, we found no difference in both the groups, as shown in Table 4. In patients who were exposed to biomass smoke, 18 (32.14%) patients had mild-to-moderate disease and 38 (67.85%) patients had severe-to-very severe disease. The patients exposed to tobacco group, 57 (43.18%) had mild-to-moderate disease and 75 (56.8%) patients had severe-to-very severe disease.

DISCUSSION

The present study was conducted to compare the respiratory symptoms and lung functions in patients with COPD associated with tobacco and biomass exposure. The study shows no statistical difference in respiratory symptoms, lung functions, and severity of disease in both tobacco and biomass groups.

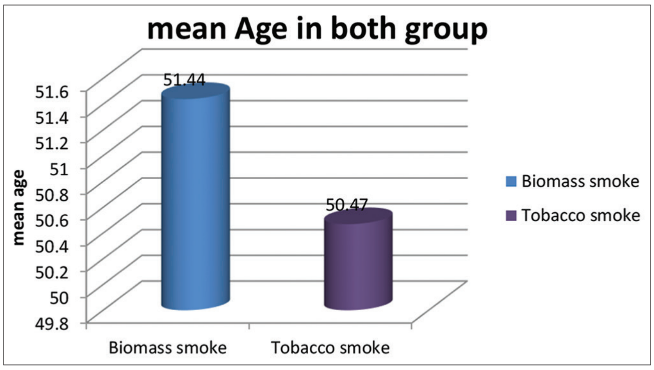

Figure 1: Mean age in both group

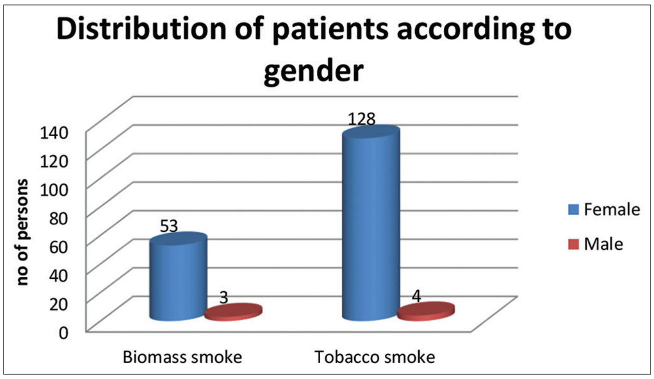

Figure 2: Distribution of patients according to gender

The female preponderance in the biomass group has been observed in various studies.[3,8,9] The domestic biomass exposure takes place, especially during cooking and heating purposes, a task traditionally related to females, is a known fact. The habit of tobacco consumption in the form of smoking and non-smoking tobacco use predominates in the male population. In this study, 53 (94.7%) of the females were exposed to biomass smoke and 128 (96.6%) males to tobacco use.

There was no statistically significant difference in BMI in both biomass and tobacco groups, thereby showing proper matching of both the groups. Both the groups had mean BMI within normal range. In this study, the mean BMI for the biomass group was 20.83 kg/m² and tobacco group was 20.67 kg/m² showing no significant difference in BMI among both the groups.

Table 2: Frequency of respiratory symptoms according to type of exposure

Symptoms	Biomass smoke (*n*=56)	Tobacco smoke (*n*=132)	*P* value
Cough	41 (73.21%)	98 (74.24%)	>0.05
Sputum	35 (62.5%)	84 (63.6%)	>0.05
Wheezing	28 (50%)	72 (54.5%)	>0.05
Dyspnea *			>0.05
0	2 (3.5%)	4 (3.03%)	
1	8 (14.2%)	18 (13.6%)	
2	26 (46.4%)	68 (51.5%)	
3	14 (25%)	32 (24.24%)	
4	6 (10.7%)	10 (7.57%)	

*Modified medical research council scale

Table 3: Spirometeric parameters in both groups

Variables	Biomass smoke (*n*=56) Mean ± SD	Tobacco smoke (*n*=132) Mean ± SD	*P* value
FVC% (pre-BD)	85.73±14.71	86.28±12.04	>0.05
FEV1% (post-BD)	44.17±9.56	47.07±10.34	>0.05
FEV1/FVC% (post-BD)	45.78±10.48	47.68±7.74	>0.05

Table 4: Severity of Chronic obstructive pulmonary disease and type of exposure

FEV1 (post-BD)	Biomass smoke (*n*=56)	Tobacco smoke (*n*=132)	*P* value
>50% (mild and moderate)	18 (32.14%)	57 (43.18%)	>0.05
<50% (severe and very severe)	38 (67.85%)	75 (56.8%)	>0.05

The common symptoms which were observed by various workers in the biomass group are cough, expectoration, dyspnea, and wheeze.[8,9] The dyspnea was observed to be the predominant symptom with moderate severity in the groups studied by Moreira *et al*.[9] No difference in the severity of dyspnea was noted in our study [Table 2]. The percentage of sputum production, cough, and wheezing on higher side among women exposed to biomass fuel was also observed by Gonzalez *et al*.,[10] Behera and Jindal,[11] and Regalado *et al*.[12] However, Regalado *et al*.[12] did not find any difference among the studied group in terms of sputum production. Overall respiratory symptoms were observed in 13%, while 12.6% of biomass group had respiratory symptoms. The smoking women who are exposed to cooking fuels experienced more respiratory symptoms more often than the non-smoker (33.3% vs. 13%). Shrestha IL (2005) in Nepalese households observed more respiratory disorders in biomass group than cleaner fuel groups. There is a significant association in between biomass groups and respiratory symptoms such as cough, phlegm, breathlessness, wheezing, and chronic respiratory diseases, COPD and asthma.[11]

In this study, all the PFT parameters such as FVC, FEV1, and FEV1/FVC have not shown a statistically significant difference between biomass and tobacco exposure groups ($P > 0.05$). The study comparing biomass fuel and tobacco exposure was carried out by Moreira *et al*.[9] Behera and Jindal[11] observed FVC value <75% predicted in biomass fuel users. The absolute values of the parameters of PFT were the lowest in biomass and mixed fuel users. A study by Regalado *et al*.[12] had revealed that women who cooked with biomass fuel had lower FEV1/FVC ratio than the women cooking with cleaner fuels and severity was observed as a mild type of pulmonary function impairment. Revathi *et al*.[13] also observed, the lung function parameters to be significantly lower in the study group exposed to biomass fuel (FVC [$P < 0.01$], FEV1 [$P < 0.001$], and FEV1/FVC [$P > 0.05$]) and analysis showed both restrictive and small airway type of pulmonary disease. Bihari *et al*.[14] observed a significant decline in airflow limitation based on reduced PEFR. Kurmi *et al*.[15] observed that FVC, FEV1, and FEF_{25-75} of FVC were significantly reduced in biomass fuel users compared to non-biomass using population in all age groups. The airflow obstruction was twice as common among biomass users compared with LPG users (81% vs. 3.6%, $P < 0.001$), with similar patterns for males (7.4% vs. 3.3%, $P = 0.022$) and females (10.8% vs. 3.8%; $P < 0.001$) based as a lower limit of normal. However, the studies by Behera and Jindal,[11] Bihari *et al*.,[14] and Kurmi *et al*.[15] were the comparative study among women exposed to biomass fuel and cleaner fuels. However, the PFT changes in biomass group were significantly impaired.

In this study, out of 56 patients in the biomass group, 18 (32.14%) had mild-to-moderate disease and 38 (67.85%) had severe-to-very severe disease. Similarly, out of 132 patients in the tobacco group, 57 (43.8%) had mild-to-moderate disease and 75 (56.8%) had severe-to-very severe disease [Table 4]. Thus, there was no difference in the severity of disease in both the groups. Regalado *et al*.[12] observed a mild type of lung function impairment in the women cooking with biomass fuel.

The diverse respiratory sickness associated with biomass fuel exposure has been observed by the various workers in India and outside such as COPD, bronchial asthma, lung cancer, tuberculosis, interstitial fibrosis of various degrees, cor pulmonale, obstructive, restrictive or mixed disorders, and low birth weight.[8,11,13,16-19] The women exposed to biomass fuel develop COPD with clinical characteristics, quality of life, and increased mortality similar in degree to that of a tobacco smoker. In Nepal, 12.5% of cases of chronic bronchitis in non-smoker were related to domestic pollution due to biomass burning.[11]

The common risk factors attributing the development of respiratory sicknesses in rural population have been studied such as (1) domestic smoke pollution,[20] (2) acute respiratory infections in children, (3) asthma, (4) environmental tobacco smoke, (5) wood combustion for more than 10 years or >200 h years leading to the production of mixture of volatile organic compounds such as CO, SO_2, nitrogen oxide, particulate matter, polycyclic aromatic hydrocarbon, benzopyrene, and formaldehyde causing injury to respiratory system,[8,11,16] (6) insufficient indoor ventilation, (7) elderly people, (8) low socioeconomic status,[1,21,22] (9) urban outdoor air pollution, (10) mud and brick houses, and (11) smoking.

Kurmi *et al*. observed smoking as a major risk factor for airflow obstruction but biomass exposure added to the risk.[15]

With regard to the precaution, the health hazards of the biomass fuel usage can be minimized or avoided, if the proper safety measures are observed such as better housing, improving stove design, lowering exposure to smoke emissions, provision of chimney over the stove, adequate ventilation of room, putting exhaust fans near roof of the kitchen, keeping chulha in open courtyard or any open space, and use of smokeless devices. These measures will provide considerable protection for the exposed persons from the respiratory hazards.

CONCLUSION

Biomass fuel is also an important risk factor of COPD as tobacco smoke. Biomass smoke has a similar type of deleterious effects on our lungs as tobacco smoke. There was no difference in respiratory symptoms, lung functions, and severity of disease in biomass and tobacco exposed COPD.

REFERENCES

1. Lopez AD, Shibuya K, Rao C, Mathers CD, Hansell AL, Held LS, *et al*. Chronic obstructive pulmonary disease: Current burden and future projections. Eur Respir J 2006;27:397-412.
2. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;3:e442.
3. Salvi SS, Barnes PJ. Chronic obstructive pulmonary disease in non-smokers. Lancet 2009;374:733-43.
4. Oroczo-levi M, Garcia-Aymerich J, Villar J, Ramirez-Sarmiento A, Anto JM, Gea J. Wood smoke exposure and risk of chronic obstructive pulmonary disease. Eur Respir J

2006;27:542-6.
5. Torres-Duque C, Maldonado D, Perez-Padilla R, Ezzati M, Viegi G. Biomass fuels and respiratory diseases: A review of the evidence. Proc Am Thorac Soc 2008;5:577-90.
6. Reddy TS, Guleria R, Sinha S, Sharma SK, Pande JN. Domestic cooking fuel and lung functions in healthy non-smoking women. Indian J Chest Dis Allied Sci 2004;46:85-90.
7. Ramanakumar AV, Parent ME, Siemiatycki J. Risk of lung cancer from residential heating and cooking fuels in Montreal, Canada. Am J Epidemiol 2007;165:634-42.
8. Ramírez-Venegas A, Sansores RH, Pérez-Padilla R, Regalado J, Velázquez A, Sánchez C, *et al*. Survival of patients with chronic obstructive pulmonary disease due to biomass smoke and tobacco. Am J Respir Crit Care Med 2006;173:393-7.
9. Moreira MA, Moraes MR, Silva DG, Pinheiro TF, Vasconcelos HM, Maia LF, *et al*. Comparative study of respiratory symptoms and lung function alterations in patients with chronic obstructive pulmonary disease related to the exposure to wood and tobacco smoke. J Bras Pneumol 2008;34:667-74.
10. Gonzalez M, Paez S, Jaramillo C, Barrero M, Maldonado D. Chronic Obstructive Pulmonary Disease (COPD) produced by woodsmoke in women. Comparison with COPD due to cigarette smoking. Acta Med Colomb 2004;29:17-25.
11. Behera D, Jindal SK. Respiratory symptoms in Indian women using domestic cooking fuels. Chest 1991;100:385-8.
12. Regalado J, Perez-Padilla R, Sansores R, Ramirez JP, Brauer M, Pare P, *et al*. The effect of biomass smoke on respiratory symptoms and lung functions in rural Mexican women. Am J Respir Crit Care Med 2006;174:901-5.
13. Revathi M, Kutty TK, Annamalai N. Pulmonary function in rural women exposed to biomass fuel. J Pulm Respir Med 2012;2:133.
14. Bihari V, Iqbal SM, Srivastava LP, Kesavachandran C, Siddique MJ. Lung function impairment in women exposed to biomass fuels during cooking compared to cleaner fuels in Uttar Pradesh, India. J Environ Biol 2013;34:971-4.
15. Kurmi OP, Devereux GS, Smith WC, Semple S, Steiner MF, Simkhada P, *et al*. Reduced lung function due to biomass smoke exposure in young adults in Rural Nepal. Eur Respir J 2013;41:25-30.
16. Parez-Padilla R, Regalado J, Vedal S, Pere P, Chapela R, Sansores R, *et al*. Exposure to biomass smoke and chronic airway disease in Mexican Women. A case-control study. Am J Respir Crit Care Med 1996;154:701-6.
17. Delegado J, Martinez M, Sanchez TT, Ramirez A, Iturria C, González-Avila G. Lung cancer pathogenesis associated with wood smoke exposure. Chest 2005;128:124-31.
18. Misra VK, Retherford RD, Smith KR. Cooking with biomass fuels increases the risk of tuberculosis. Natl Fam Health Surv Bull 1999;13:1-4.
19. Rinne ST, Rodas EJ, Bender BS, Rinne ML, Simpson JM, Galer-Unti R, *et al*. Relationship of pulmonary function among women and children to indoor air pollution from biomass use in Rural Ecuador. Respir Med 2006;100:1208-15.
20. Pandey MR. Domestic smoke pollution and chronic bronchitis in a rural community of the hill region of Nepal. Thorax 1984;39:337-9.
21. Desai M, Mehta S, Smith K. Indoor Smoke from Solid Fuels: Assessing the Environmental Burden of Disease at National and Local Levels. Geneva, Switzerland: World Health Organization; 2004.
22. Rodolfo JD, Maldonado D, Norman S, Baena E, Martinez G. Woodsmoke exposure and risk for obstructive airways disease among women. Chest 1996;109:115-9.