ORIGINAL ARTICLE

EFFECT OF BIOMASS FUEL BURNING ON LUNG FUNCTIONS IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT:

Objective: To determine the effects of biomass fuel burning on lung functions in patients with COPD in relation to duration of Biomass fuel (BMF) exposure and type of BMF.

Methodology: This descriptive correlational study was conducted at Pulmonology department lady Reading hospital Peshawar from October 23, 2009 to October 22, 2010. Data was collected by non-probability convenience sampling technique. COPD Patients presenting with symptoms of cough, sputum production or breathlessness and exposed to biomass fuel smoke were interviewed for type of biomass fuel and duration of exposure. Duration of cumulative exposure to biomass smoke was quantified in hour-years(H-Y). All of patients were subjected to pulmonary function testing before and after 15 minutes of 1 ml Salbutamol (bronchodilator) nebulization, to measure the Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV_1). Severity of air flow limitation (% FEV_1) was categorized as mild, moderate, severe and very severe. Spearman's rank correlation test was applied to see the relationship between "Severity of air flow limitation" and "type of BMF and duration of exposure".

Results: Out of 204 cases, 15 (7.4%) were males and 189 (92.6%) were females. Mean age of patients was 58.12 years +9.82 SD. Most common biomass fuel used was "Wood" followed by mixed fuel consisting of wood, animal dung and Crops residues. The mean duration of exposure to Biomass fuel smoke was 245.67 H-Ys (+95.90 SD). Mean base line FEV_1 was 1.25 liters (+ 0.56 SD) while the mean percent predicted FEV_1 was 54.25 % (+ 18.13). The relation between the type of BMF used and the severity of airflow limitation was statistically not significant (p 0.080) with Spearman's rank correlation coefficient (Spearman's rho) of 0.123. Similarly the relation between the duration of BMF and severity of air flow limitation was statistically not significant (p = 0.811) with Correlation Co-efficient of 0.017.

Conclusion: The duration of biomass fuel exposure and type of biomass fuel has no significant effect on Lung functions in patients with COPD.

Key Words: Biomass fuel, COPD, Lung functions, Air flow limitation.

INTRODUCTION

Chronic Obstructive Pulmonary Diseases (COPD) is common clinical problem in both developed and developing countries and is increasing[1] in the developing countries. A significant fraction of COPD, especially in women, occurs in never-smokers, and could be attributed predominantly to biomass fuel (BMF) burned for cooking and heating[1,2]. BMF refers to animal dung, crop residues, wood and charcoal used for cooking lighting and heating. Studies have reported biomass smoke as cause of COPD[2,3], lung cancer[4] and pulmonary tuberculosis.[5]

Annual Prevalence of COPD in our population using BMF is 7.01%[3]. About 50% of world population and 90% of rural communities in developing countries are using BMF mainly wood, dung, and crop residues, for cooking and heating[6].

Different studies have reported chronic exposure to biomass fuel smoke as cause of increase in respiratory symptoms (cough and phlegm), airflow limitation and impairment of pulmonary functions[7]. Mild to moderate reductions of force vital capacity (FVC) and force expiratory volume in one second (FEV_1) have been associated with the exposure to indoor biomass burning in both community[7] and hospital based studies[8]. Though mineral particles are not commonly found in BMF and only traces of silicon have been discribed[9]. Chronic exposure to BMF can also causes interstitial inflammation and fibrosis leading to interstitial lung disease called "wood smoke pneumoconiosis[10].

In Pakistan still majority of households in rural communities use biomass fuel for cooking and room heating. The association between biomass smoke and chronic bronchitis with respiratory symptoms gains further significance when cooking is done in living room, which is a common practice in winter.

The Rationale of this study was to know about the severity of pulmonary functions impairments in COPD patients exposed to BMF in relation to duration of BMF exposure and type of BMF. But as local data is scarce on this subject, so this study was planned to help understand the relationship between the severity of lung functions and different type of biomass fuel used for cooking, lighting and heating in patients with COPD.

METHODOLOGY:

This hospital based descriptive correlational study was conducted at Pulmonology department post graduate medical institute lady reading hospital Peshawar October 23, 2009 to October 22, 2010. Data was collected by non-probability convenience sampling technique. Sample size was calculated to be 204 using 7.01% prevalence of COPD[3] due to BMF exposure, with 95% confidence interval and 3.5% margin of error under WHO software for sample size determination. All Patients fulfilling the operational definition of COPD (Patient with symptoms of cough, sputum production or breathlessness, exposed to biomass fuel smoke and having a post bronchodilator value of FEV_1 80 % predicted or less in combination with an FEV_1 / FVC ratio of 70% that was not fully reversible) were enrolled in the study. Informed written consent was taken from all the patients with ethical approval from the ethical committee of Postgraduate Medical Institute, Lady Reading Hospital Peshawar.

Patients were admitted to Pulmonology Department Lady Reading Hospital Peshawar from Out Patient Department and casualty. All patients were interviewed to obtain clinical data like age, sex, occupation, clinical symptoms, drugs history particularly, beta blockers, angiotensin converting enzyme inhibiters and history of tobacco use. Patients with active smoking, ex-smoker or exposure to occupational dust were excluded. Duration of BMF exposure, types of current and past cooking fuels were enquired and entered in the proforma. The duration of cumulative exposure to biomass smoke was calculated and expressed in hour-years. Possible confounders in the study were tobacco smoking, occupational dusts, drugs (beta blockers, angiotensin converting enzyme inhibiters) and outdoor air pollution and were excluded. All patients were then subjected to pulmonary function testing before and after 15 minutes of 1 ml Salbutamol (bronchodilator) nebulization, to measure the Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV_1). FVC and FEV_1 were expressed in liters and as well as percent predicted, and the ratio of FEV_1 and FVC expressed in percentage. Severity of air flow limitation was categorized as mild, moderate, sever and very severe as per GOLD guidelines classification of air flow limitation.Pulmonary functions values (FEV_1) were studied in relation to duration of BMF exposure and the type of fuel used. Data were analyzed by using SPSS version 15.0.

Frequencies/Percentages were calculated for qualitative variables, while Mean+ standard deviation was calculated for quantitative variables. Spearman's rank correlation test was applied to see the relationship between "Severity of air flow limitation" and "type of BMF". Spearman's rank correlation test was also applied to see the relationship of "Severity of air flow limitation" and "duration of exposure to BMF". P-value of 0.05 or less than 0.05 were considered as significant.

RESULTS:

This study was conducted in Pulmonology Department Post Graduate Medical Institute, Lady Reading Hospital, Peshawar for one year (from March 26, 2009 to March 25, 2010). The study included 204 cases. There were 15 males and 189 females, with male to female ratio of 1:12.6. The age of patients ranged from 40-81 years with a mean age of 58.12 years and standard deviation of +9.82 SD.

Mean duration of the symptoms at presentation was 7.14 (+4.41 SD) years ranging from 1 to 20 years. Patients presented from all districts of Khyber Pakhtunkhwa including Federally Administered Tribal Areas (FATA). Most of the patients belonged to district Peshawar followed by Charsadda, Afghanistan and Dir districts (Graph I).

Most common biomass fuel used for cooking was Wood. (Table I). In this study the duration of exposure to biomass smoke was calculated and expressed in Hour-Years (the product of number of years of exposure, and average hours per day of exposure). The mean duration of exposure to Biomass fuel smoke was 245.67 + 95.90 SD ranging from 100-430 Hours-Years. Regarding the severity of air flow limitation most patients presented (41.7%) with severe air flow limitation. While only 5.4 percent patient presented with very severe air flow limitation (Table II). Mean FEV_1 was 1.25 (+ 0.56 SD) liters while the mean percent predicted FEV_1 was 54.25 % (+ 18.13 SD). Spearman's rank correlation test was applied to determine the relationship between "Severity of air flow limitation" and "type of BMF". The same test was also used to determine the relationship of "Severity of air flow limitation" and "duration of exposure to BMF". In our study the correlation between the type of BMF used and the severity of airflow limitation, as Spearman's rank correlation coefficient (Spearman's rho) revealed, was statistically not significant ($p > 0.080$) with correlation coefficient of 0.123. Similarly Correlation between the duration of BMF and severity of air flow limitation was also statistically not significant (p 0.811) with Spearman's rank correlation coefficient of 0.017.

Graph I: District-Wise Distribution of Patients (n=204)

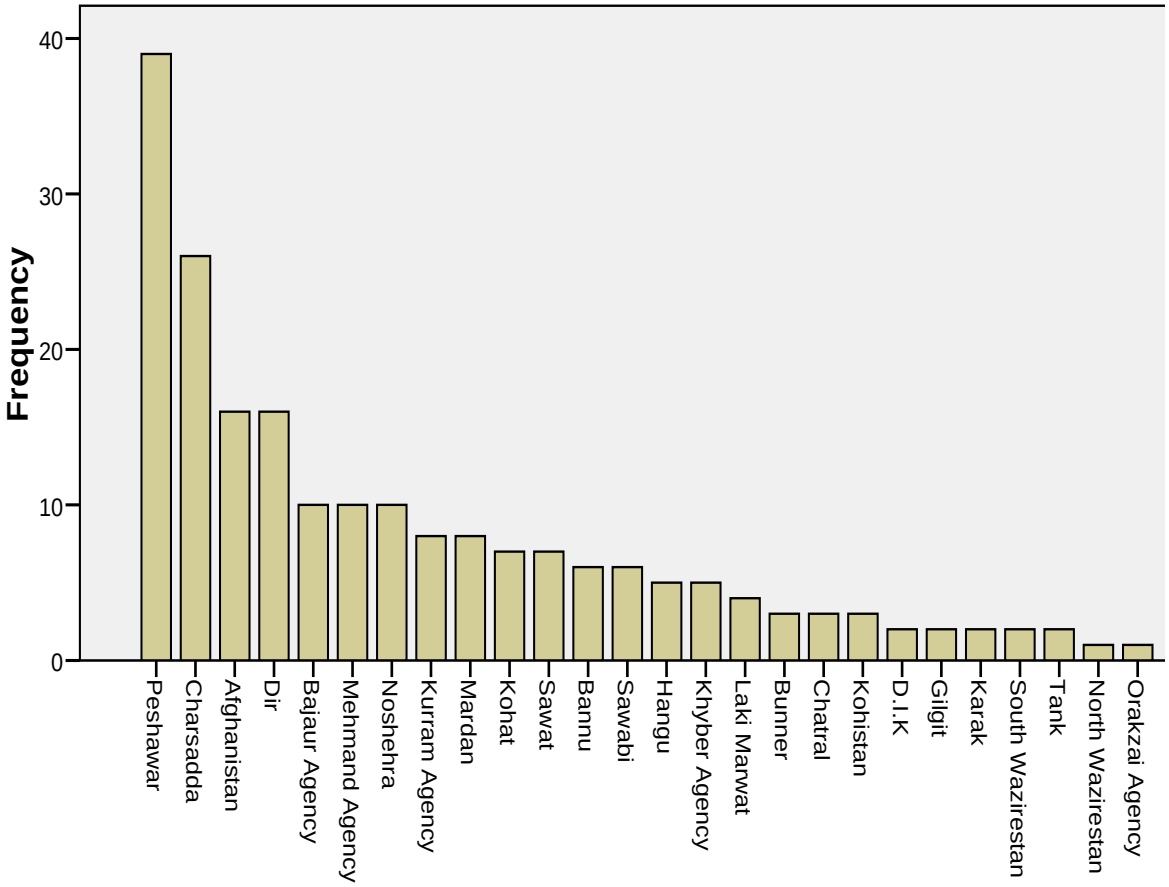

Table 1: Type of Biomass Fuels Used (n=204)

Type of biomass fuel	Frequency	Percentage
Wood	81	39.7
Wood and animal dung	79	38.7
Wood, animal dung and crops residues	22	10.8
Animal dung	9	4.4
Animal dung and crops residues	6	2.9
Wood and crops residues	5	2.5
Charcoal	2	1.0
Total	204	100.0

Table II: Severity of Airflow Limitation (n=204)

Severity of air flow limitation	% Predicted FEV_1	Frequency	Percentage
Severe	30 % - 50 %	85	41.7
Moderate	50 % - 80 %	75	36.8
Mild	More than 80%	33	16.2
Very severe	Less than 30 %	11	5.4
Total		204	100.0

DISCUSSION:

COPD is an important public health problem worldwide, despite the fact that it is potentially a preventable disease[1,2, 11]. In developed countries the prevalence of chronic bronchitis ranges from 3% to 17% while in developing countries the rates are higher, ranging from 13% to 27% [12]. In developed countries smoking is one of the primary risk factors for the development of chronic bronchitis[13]. This explains much higher prevalence rates in men than in women because men are more likely to smoke. In rural areas of developing countries, on the other hand, where smoking is uncommon among women, studies have shown similar rates of chronic bronchitis between men and women [14, 15]. This high prevalence of COPD in female may be explained by another potential risk factor that is smoke from domestic biomass fuel combustion. Most of these people live in rural areas of developing countries where about 90% of households rely on biomass fuels as their major or only source of domestic energy for cooking and sometimes room heating.[6] Since people in rural areas of developing countries spend many hours a day in cooking, exposure to BMF smoke is considerable, especially among women and children[2]. Despite the high exposure to indoor air pollution on a global basis and its association with respiratory symptoms and air flow limitation, few local studies have examined it as a risk factor in the development of COPD especially chronic bronchitis and to our knowledge no local study exist to determine the effect of different types of biomass fuels on respiratory symptoms and lung functions directly. We have therefore examined the relationship between the respiratory symptoms and lung functions and "different types of biomass fuels" and "duration of exposure.

In our study most of the patients with COPD were female contrary to the trend in developed countries and urban areas of developing countries in which the prevalence of COPD is generally higher in men[12]. The reason is obvious as women spend many hours a day in cooking and thus exposure to BMF smoke is considerable and account for higher prevalence of COPD. A study by Norboo T et al, also show a higher prevalence of COPD in women as compared to men[16]. While the studies from Pandey MR and Anderson HR show a similar prevalence between the two[17,18]. Recently two meta-analyses also showed that biomass smoke is a significant risk factor for women for developing COPD[17-19].

We observed some effect on the male members of biomass using families especially patient from northern hilly areas of Pakistan. The reason for development of COPD in the males in these high landers is that the same room is used both for cooking and sleeping especially in winter season. Moreover most of the families being farmers, cooking is usually done in early morning or evening hours to enable both male and female members to go to field for agricultural activities. Cooking in such hours is the custom of most of the villages and there by both the male and female members of the families are exposed to the effects of cooking fuels because this is the time when all family members are setting together around the fire. However, direct involvement to the act of cooking is the reason for more exposure in females and explains the high prevalence of COPD in this group.

In our study the onset of symptoms in female was earlier (mean age 57.67) than males (mean age 63.80 years) and the prevalence of COPD increased till 60th decade and then decreased thereafter. The increase in prevalence with age is in agreement with studies from Nepal, [14]New Guinea [15]. However Studies from the United States,[18] and Canada,[20] are in contrast with our findings and have failed to show an increase with age. In our study most patients were in the 6th decade of life with decreasing prevalence before and after 6th decade. This is in agreement with another study from Peshawar by Akhtar et al[3]. The possible explanation for this could be that the involvement of women as chief cook after 40 years is reduced. This is due to the fact that daughters or daughters-in-law take over the responsibility of cooking in the family.

In this study the duration of exposure to biomass smoke was expressed in Hour-Years (the product of number of years of exposure, and average hours per day of exposure). Also in the correlation between the airflow limitation and the duration of exposure was not statistically significant (p 0.811). Although several studies have found a positive trend between the Duration of Biomass Smoke and the risk of COPD[2,8, 14, 21] none has examined the effect of increasing exposure on lung functions. There are variations in the assessment of biomass exposure in literature and most studies have not measured exposure directly, and instead has used proxy measurements such as the number of hours spent doing cooking or the presence or absence of room ventilation[17]. An accurate measurement of exposure is difficult because of spacial, temporal, biomass fuel difference and the presence or absence ventilation. These variations in the methods of exposure measurement may result in either overestimation or underestimation of effect. More over in our communities after the age 40 the act of cooking is taken over by daughter or daughter in law and thus exposure to biomass is decreased significantly[3]. Also once developed COPD is a progressive disease and deterioration in lung functions occur with time irrespective of further exposure to biomass[11]. Due to these reasons it is practically very difficult to access the accurate effect of increasing exposure to BMF on lung functions.

In our country the most common biomass fuels used are wood, crops residues, animal dung and occasionally charcoal. In this study the relationship between different biomass fuels and pulmonary functions were examined and included both the combination fuels as well as single fuel in the analysis but their effect on pulmonary functions was statistically not significant (p 0.08). Similar to our findings, a study from Mexico also found no significant relation between the type of biomass fuel and air flow limitation. While a study from India was in contrast to our findings and showed a significant association between type of biomass and the severity of lung functions especially in women[16]. Previously many studies have reported that the effect of different fuels on lung functions is different and only few have examined the effect of a single fuel on air flow obstruction [3,22-3]. In these studies the

prevalence of COPD was most commonly associated with wood followed by crops residues and then animal dung. As the chemical composition of different type of fuels is different therefore their effect of on lung functions may not be the same from practical point of view.

Limitation of the study: Because of poverty our rural communities rely on more than one biomass fuel for cooking and space heating and most of the time use mixed fuel rather than a single fuel. Therefore in these setting the effect of a single fuel on the lung function is difficult to establish. Secondly, most patients included in this study were uneducated and were not sure about the past and current fuel pattern they were using for cooking. This recall bias might have affected the results of the study. Moreover we included only those patients who were actually symptomatic and visiting chest OPD while missing asymptomatic patients exposed to biomass fuel. This can also impact the study's ability to identify the correlation between the duration of exposure and severity of lung function abnormality.

CONCLUSION:

The result of this study showed that the duration of biomass fuel exposure and type of biomass fuel had no significant effect on Lung functions in patients with COPD. Moreover the findings of high proportion of women exposed to biomass fuel smoke point towards an important environmental health problem involving mostly the poor women and indicate that the health consequences of exposure to biomass fuels in developing countries should not be ignored not only because the health burden is high but also because of the fact that such fuels will continue to be used by a large number of households in the foreseeable future because of economic reasons.

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