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

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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 4\(^{th}\) leading cause of death and expected to be 3\(^{rd}\) 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.

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

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population at risk worldwide is very large.\textsuperscript{[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.\textsuperscript{[6]} There is also a study indicating an association of biomass smoke on pulmonary functions.\textsuperscript{[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 (FEV\textsubscript{1}), and FEV\textsubscript{1}/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\textsubscript{1}/FVC <70\% of the predicted value; and history of dyspnea or cough. The classification in levels of severity was based on FEV\textsubscript{1}.

We used the following as exclusion criteria: Variation of FEV\textsubscript{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 Student’s \textit{t}-test.

The significance of mean values was compared using Student’s \textit{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 (\textit{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 (\textit{P} < 0.05). Mean BMI in biomass and tobacco smoke group was 20.83 and 20.69 kg/m\textsuperscript{2}.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Biomass smoke (n=56)</th>
<th>Tobacco smoke (n=132)</th>
<th>\textit{P} value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>53 (94.6%)</td>
<td>4 (3.03%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Male</td>
<td>3 (5.35%)</td>
<td>128 (96.6%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Age (mean±SD)</td>
<td>51.44±6.77</td>
<td>50.47±6.82</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Pack-years (mean±SD)</td>
<td>59.3±37.6</td>
<td>59.3±37.6</td>
<td></td>
</tr>
<tr>
<td>Hours-years (mean±SD)</td>
<td>175.6±80.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m\textsuperscript{2})</td>
<td>20.83±4.02</td>
<td>20.69±3.64</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>
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.

The female preponderance in the biomass group has been observed in various studies. 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**

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

*Modified medical research council scale

**Table 3: Spirometeric parameters in both groups**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Biomass smoke ( (n=56) )</th>
<th>Tobacco smoke ( (n=132) )</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC% ( (pre-BD) )</td>
<td>85.73±14.71</td>
<td>86.28±12.04</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>FEV1% ( (post-BD) )</td>
<td>44.17±9.56</td>
<td>47.07±10.34</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>FEV1/FVC% ( (post-BD) )</td>
<td>45.78±10.48</td>
<td>47.68±7.74</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>FEV1 ( (post-BD) )</th>
<th>Biomass smoke ( (n=56) )</th>
<th>Tobacco smoke ( (n=132) )</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50% (mild and moderate)</td>
<td>18 (32.14%)</td>
<td>57 (43.18%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>&lt;50% (severe and very severe)</td>
<td>38 (67.85%)</td>
<td>75 (56.8%)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>
The common symptoms which were observed by various workers in the biomass group are cough, expectoration, dyspnea, and wheeze. The dyspnea was observed to be the predominant symptom with moderate severity in the groups studied by Moreira et al. 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. However, Regalado et al. 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.

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. Behera and Jindal 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. 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. 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. observed a significant decline in airflow limitation based on reduced PEFR. Kurmi et al. observed that FVC, FEV1, and FEF25-75 of FVC were significantly impaired in biomass and tobacco exposed COPD.

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. 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.

The common risk factors attributing the development of respiratory sicknesses in rural population have been studied such as (1) domestic smoke pollution, (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, SO2, nitrogen oxide, particulate matter, polycyclic aromatic hydrocarbon, benzopyrene, and formaldehyde causing injury to respiratory system, (6) insufficient indoor ventilation, (7) elderly people, (8) low socioeconomic status, (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.

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 chulla 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