Original Article

# Clinical characteristics of tobacco smoke-induced versus biomass fuel-induced chronic obstructive pulmonary disease

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## ABSTRACT

**Objective:** To investigate differences in clinical features between tobacco smoke-induced and biomass fuel-induced chronic obstructive pulmonary disease (COPD). **Methods:** We retrospectively analyzed 206 patients with COPD caused by exposure to tobacco smoke and 81 cases of COPD caused by exposure to biomass fuels who received treatment in our hospital between 2011 March and 2014 March. Difference in general health status, clinical symptoms, the dyspnea score, and comorbidities between the two groups were compared. In addition, pulmonary function, grading, and acute exacerbations were also compared. **Results:** (1) Difference in general health status: Male and female patients with COPD caused by exposure to tobacco smoke were 83.5 and 16.5%, respectively. Male and female patients with COPD caused by exposure to smoke from biomass fuels were 14.8 and 85.2% ($\chi^2 = 27.2$, $P < 0.05$), respectively. Tobacco smoke-induced COPD was more prevalent in men, and COPD caused by exposure to smoke from biomass fuels was more prevalent in women. After gender adjustment, body mass index (BMI) was lower in women with COPD caused by exposure to smoke from biomass fuels than those by tobacco smoke. There was no statistically significant difference in other indicators, such as age. (2): Difference in clinical symptoms: No statistically significant difference in the modified British Medical Research Counsel (mMRC) Questionnaire, a measure of breathlessness, was observed between the two groups. Dyspnea was more common in COPD patients that was caused by exposure to biomass fuels (38.3%) than by tobacco smoke (11.1%) ($\chi^2 = 17.9$, $P < 0.05$). The comorbidities of allergic diseases (such as allergic rhinitis, bronchial asthma) were more prevalent in COPD patients that was caused by exposure to smoke from biomass fuels (43.2%) than by tobacco smoke (18%) ($\chi^2 = 16.1$, $P < 0.05$). However, COPD comorbid with lung cancer was more prevalent in those cases that were caused by exposure to tobacco smoke (7.77%) than in cases caused by exposure to smoke from biomass fuels (3.7%) ($\chi^2 = 9.7$, $P < 0.05$). (3) Differences in grading of pulmonary function: After gender adjustment, patients with COPD caused by exposure to biomass fuels were mostly in grade B or D. (4) Exacerbations: No significant difference in exacerbations per year was noted between the two groups. **Conclusions:** Marked differences exist between patients with COPD caused by exposure to tobacco smoke and smoke from biomass fuels. Patients with COPD caused by exposure to biofuels are mostly females with lower BMI and often with many clinical symptoms and complications, such as allergic rhinitis and bronchial asthma. Such patients are often in stage B or D. Tobacco smoke-induced COPD is more prevalent in male patients, often with complications in the form of lung cancer.

**Key words**: chronic obstructive pulmonary disease; smoking; biomass fuels; clinical characteristics

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## INTRODUCTION

Cigarette smoking is the most dangerous risk factor for chronic obstructive pulmonary disease (COPD)[1] and appropriately 90% of COPD patients are smokers or ex-smokers[2–4]. However, some people who develop COPD are non-smokers [5–7]. In recent years, in rural areas, the impacts and role of biomass fuels in the pathogenesis of COPD have received increasing attention. Biomass fuels refer to firewood, woods, charcoal, crop residues, and animal dung. The main harmful components of such smoke are oxycarbide, oxynitride, oxysulfide, incompletely burned hydrocarbon particles, and multicyclic organic compounds[8]. Evidence-based medicine indicates that exposure to smoke from biomass fuels is also an important risk factor for the pathogenesis of COPD. Currently, the clinical features of biomass fuel-induced COPD, especially the difference between COPD caused by exposure to smoke from biomass fuels and COPD by cigarette smoking in particular, is not clear. Our research discusses in detail the clinical characteristics of tobacco smoke-induced versus biomass fuel-induced COPD.

## PATIENTS AND METHODS

### *Clinical data*

We gathered 287 COPD patients at Guangzhou Respiratory Disease Research Institution from 2011 March to 2013 March. Among them, there were 206 smoke-induced COPD patients (hereafter Group A) with an average age of 59 ± 7 and 81 biomass fuel-induced COPD patients (hereafter Group B) with an average age of 63 ± 9. The inclusion criteria for Group A included both a history of 20 or more pack-years of smoking and the diagnostic criteria of 2011 COPD guide. The inclusion criteria for Group B included a history of exposure to smoke from biomass fuels for an average of at least 30 minutes per day for more than 5 years, and the diagnostic criteria of 2011 COPD guide. According to the guide, after the administration of bronchodilators, diagnostic criteria of 2011 COPD guide were the $FEV_1/FVC < 70\%$ and $FEV_1$/predicted value < 80%. Both groups excluded patients with a history of exposure to both smoke and smoke from biomass fuels. All patients provided written informed consent. The study was approved by the relevant ethics.

### *Clinical observation*

A clinical observation was conducted for (1) shortness of breath and dyspnea, which were assessed by using the Modified Britain Medical Research Counsel Questionnaire(mMRC) (2) other respiratory symptoms, such as coughing and panting (3) cardiovascular symptoms or signs (coronary heart disease and pulmonary heart disease) such as precordial squeezing pain, edema affecting lower extremities, and bulbar conjunctiva (4) assessment of comorbid conditions: comorbid with other respiratory diseases, that is, bronchial asthma, allergic rhinitis, bronchiectasis, and other cardiovascular diseases. Diagnostic criteria of COPD comorbid with bronchial asthma (also bronchial asthma-COPD overlapping syndrome) required that: (1) the patient had paroxysmal panting and wheezing of both lungs during expiratory phase (2) the patient was a long-term smoker (3) the patient's lung function was tested at entry and after 1-week anti-asthma treatment of anti-inflammatory spasmolysis. Both lung functions were $FEV_1/FVC < 70\%$ and the improvement of after-treatment was ≥ 12% and the absolute value was ≥ 200 ml.

### *Pulmonary function test and COPD classification*

We used the MasterScreen lung function tester (Germany Jaeger) to test vital capacity (VC), FVC, $FEV_1/FVC$, peak expiratory flow (PEF), maximum mid-expiratory flow (MMEF75/25), total lung capacity (TLC), and residual volume (RV). All the measuring indices were repeatedly measured three times and only the maximums were used. Based on the 2011 edition GOLD guide and according to the following three factors: dyspnea ratings, lung function classification, and acute exacerbation risk, we classified all COPD patients into grades A, B, C, and D.

### *Acute exacerbations*

Acute exacerbations were defined as acute worsening of symptoms, that is, coughing, expectoration, shortness of breath, or panting and consequently, required altered treatment plan. The acute exacerbations of both groups within the previous year were recorded.

### *Statistical analysis*

All the measurement data accorded with the normal distribution was expressed as Mean ± Standard deviation. Comparison between groups used *t* test. The difference was statistically significant when $P < 0.05$.

## RESULTS

### *General health status*

Differences in general health status between two groups: subjects in Group A were mostly male (83.5%, 172/206), while subjects in Group B were mostly female (85.2%, 69/81). The gender difference was statistically significant ($\chi^2 = 27.2$, $P < 0.05$). After gender adjustment, the body mass index (BMI) of Group B patients was lower than that of Group A. No statistically significant differences in other indices were observed between the two groups, such as age and baseline lung function (Table 1).

**Table1: General condition of smoke-induced vs. biomass fuel-induced COPD**

| | age | BMI | $FEV_1$/predicted |
|---|---|---|---|
| Smoke-induced COPD (206) | | | |
| Male(172) | 60 ± 7 | 19.4 ± 5.6 | 52.6 ± 9.3 |
| Female (34) | 58 ± 9 | 16.6 ± 4.8 | 50.4 ± 7.9 |
| Biomass fuel-induced COPD (81) | | | |
| Male (12) | 61 ± 11 | 16.1 ± 3.6* | 50.9 ± 4.8 |
| Female (69) | 64 ± 7 | 13.7 ± 5.2* | 47.8 ± 6.7 |

*Note: Compared with biomass fuel-induced COPD of the same gender. BMI: body mass index.

### *Clinical symptoms*

As for the difference in clinical symptoms between the two groups, after gender adjustment, the difference in mMRC between the two groups was not statistically significant. In this regard, men in Group A scored 3.2 ± 1.3 and women scored 2.7 ± 0.6 while men in Group B scored 3.7 ± 0.9 and women scored 2.9 ± 1.1. Patients in Group B showed more panting than those in Group A, which were 38.3% (31/81) and 11.1% (23/206), respectively ($\chi^2 = 17.9$, $P < 0.05$). However, the incidence of coughing was similar for both groups (72.8 *vs.* 79.6%). The difference in comorbidities of cardiovascular events (coronary heart disease, arrhythmia, left heart failure, etc.) between Group A and Group B was not statistically significant, (14.8 *vs.* 12.6%, $\chi^2 = 1.4$, $P > 0.05$). The ratio of patients comorbid with allergic diseases (such as allergic rhinitis and bronchial asthma) in Group B was higher than that of Group A, which were 43.2 and 18% ($\chi^2 = 16.1$, $P < 0.05$), respectively. However, the ratio of the patients comorbid with lung cancer in Group A was higher than that of Group B, which were 7.77 and 3.7% ($\chi^2 = 9.7$, $P < 0.05$), respectively. No significant difference in comorbidities of bronchiectasis and chronic pulmonary heart diseases between Group A and B was observed (5.83 *vs.* 6.17%; 36.9 *vs.* 39.5%).

### *Pulmonary function*

As for the classification of pulmonary function, in Group A, 40 male patients were classified as Grade B and 49 as Grade D, taking up 51.7% of the male smoking group. Totally, 7 female patients were classified as Grade B and 9 as Grade D, taking up 47% of the female smoking group. In Group B, 5 male patients were classified as Grade B and 4 as Grade D, taking up 75% of the male smoking group. Totally, 27 female patients were classified as Grade B and 23 as Grade D, taking up 72.5% of the female smoking group. In terms of COPD classification, after gender adjustment, compared with Group A, patients in Group B were mostly Grade B and D and showed more symptoms.

### *Difference in acute exacerbations*

The acute exacerbation frequency of patients in Group B and Group A were 0.9 ± 0.3 and 1.2 ± 0.5, respectively, and no statistical difference was observed ($t = 2.4$, $P > 0.05$).

## DISCUSSION

COPD is a systemic and chronic inflammatory disease associated with lungs' abnormal inflammatory response to noxious gases or particles such as tobacco smoke[9].Currently, tobacco smoking is considered as the main pathogenic factor for COPD, while recently, the role of smoke from biomass fuels in the pathogenesis of COPD has been emphasized. Increasing evidence indicates that, in developing countries, smoke from biomass fuels is the main source of indoor air pollution and also an important risk factor for the pathogenesis of COPD. Our research investigated the differences in clinical features between COPD caused by exposure to tobacco smoke and smoke from biomass fuels. Our findings indicate that COPD caused by exposure to smoke from biomass fuels are mostly seen in women with the presence of lower BMI and more clinical symptoms, and the comorbidities are mostly allergic rhinitis and bronchial asthma and the COPD classification are mostly Grades B and D. In addition, COPD caused by tobacco smoke is mostly seen in men and its comorbidity is mostly lung cancer.

Incompletely burned biomass fuels release large amounts of polluted gases such as methanol, sulfur dioxide, and carbon monoxide, especially the sulfocompound[10–11]. Consequently, once such smoke is inhaled into the body, it will lead to airway inflammation, airway injury, and continuous non-specific bronchial hyper-responsiveness[12]. Previous researches have shown that biofuel smoke could lead to bronchial mucosa goblet cell metaplasia and excessive mucus secretion, as well as an obvious increase in the number of eosinophils in phlegm and neutrophils and eosinophils in bronchial walls and bronchoalveolar lavage fluid (BALF), resulting in an increased airway inflammatory response during acute exacerbations in COPD [13–18]. Clinically, coughing, expectoration, and panting are more likely to ensue. This also explains our findings that biofuel-induced COPD patients tend to have more cough, expectoration, and panting with comorbidities of mostly allergic rhinitis and bronchial asthma[19].

Cigarette smoke contains large amounts of cancerogenic substances such as tar, benzopyrene, nitrosamine, arsenic,

and cadmium. Research has shown that the degree of DNA injury was more severe in patients with COPD caused by exposure to cigarette smoke than by exposure to smoke from biomass fuels. Further research in this regard has shown that the DNA injury degree is positively associated with the concentration of malondialdehyde[19–20]. For patients with COPD caused by exposure to either cigarette smoke or biofuel smoke, oxidative stress markers and DNA injury degree in particular, are increased. Because DNA injury is directly related to cell canceration, it also, to some extent, explains why the rate of lung cancer is higher in patients with COPD caused by long-term smoking than COPD caused by exposure to smoke from biomass fuels[21].

Moreover, our research also observed that patients with COPD caused by exposure to biofuels are mostly women. Among the female COPD patients, the BMI was lower in the patients with COPD of the same age group caused by exposure to smoke from biomass fuels than those by exposure to tobacco smoke. This, possibly, is related to the fact that women in rural areas of our country have more chances and longer time of contact with biofuels than men do. COPD patients generally suffer from malnutrition and skeletal muscle atrophy of different degrees, and there are relatively worse economic and social conditions for patients living in rural areas. This might be the reason why patients with COPD caused by exposure to smoke from biomass fuels tend to have lower BMI[22–26].

To sum up, our research preliminarily observed the clinical feature difference between patients with COPD caused by exposure to tobacco smoke and smoke from biomass fuels and revealed the clinical feature of different COPD phenotypes (smoking-caused or biomass fuel-caused) and provided new theoretical basis for future prevention and clinical treatment of these subtypes pertinently.

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## Conflicts of Interest

None declared.

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