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CO-RELATION OF PULMONARY FUNCTION TEST AND CHEST X- RAYS IN BIOMASS FUEL USER IN RURAL AREA OF SOUTH INDIA

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ABSTRACT

Indoor air pollution from burning of traditional biomass fuel such as wood, dung, and agricultural wastes for daily household cooking is a major problem in rural India. Although it is known that biomass smoke contains a wide spectrum of potentially toxic compounds, its effect on public health is relatively unexplored. In view of this, the health impact of biomass fuel use in rural India has been evaluated in this study. To investigate Co-relation of Pulmonary Function Test and Chest x- rays in women who cook regularly with biomass fuels and compared with group of control women who cook relatively liquefied petroleum gas (LPG). Respiratory health was evaluated from Questionnaire survey, Clinical examination, Spirometry and chest x-rays are investigated in biomass and control users. A total of 150 women were approached, of which only 70 non-smoking women without any history of any major chronic illness in the past were selected for this study. Pulmonary function is one of the indicators of obstructive lung disease hereby indicates high risk of developing obstructive disease in biomass users as compared to LPG users. From our study it is clear that with increasing duration of exposure to biomass fuel combustion, the pulmonary functions reduced significantly in biomass users compared to LPG users.

INTRODUCTION

Air pollution collectively describes the presence of a diverse and complex mixture of chemicals, particulate matter (PM), or biological material in the ambient air which can cause harm to humans. Humans have always been exposed to ambient air pollutants and have therefore adapted cellular defense mechanisms to protect against agents that may cause disease. Urbanization, industrialization and fossil fuel based transportation led to significant increase in air pollution in urban areas. World health organization considers air pollution as a major public health threat that requires efforts in the areas of research and policy making. An estimated number of 120,600 deaths are attributed to outdoor air pollution per year in India (Balakrishnan *et al*., 2002).On the other hand, indoor air pollution also poses a significant health threat in rural India.

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Around 3 million people worldwide are exposed to smoke who smoke might be the most important global risk factor for chronic obstructive pulmonary disease (COPD). In developing countries nearly 50% of deaths from COPD are attributable to biomass smoke, of which about 75% are of women (Salvi and Barnes, 2009).Inflammatory diseases in respiratory system, susceptibility to respiratory tract infections and cardio-vascular diseases are linked to air pollution induced mortality and morbidity. Chronic obstructive pulmonary disease, lower respiratory tract infections and asthma are important lung diseases linked to air pollution. Air pollution is commonly perceived as an urban problem associated with automobiles and industries. But indoor air pollution emitted from fuels in rural areas of the developing countries is exposed to highest levels of air pollution from burning the fuels for household cooking purpose. About 74% biomass using rural household in India still rely on firewood or cow dung as their primary cooking fuel and large no. of household in urban areas depend on LPG (65%), Kerosene (7.5%) and coal (2.9%) for cooking purpose.

Exposure to air pollution due to combustion of biomass fuels remains one of the significant risk factor for chronic respiratory diseases in the developing countries. It is estimated that an average women in India may be subjected to 60,000hrs of exposure to smoke due to combustion of biomass fuels in her life time. The growing awareness of COPD being a complex disease involving several organs with a clearly established low grade systemic inflammation, biomarkers have been more focus of interest in clarifying the pathogenesis and progression of COPD as well as designing new therapeutic targets for the disease (Agustí, 2007).The National Ambient Air Quality Standards of the U.S Environmental Protection Agency requires the daily average concentration of PM_{10} (Particulate matter less than 10µm in diameter) to be less than 150µg/m^3 and annual average to be less than 50µg/m^3. In contrast, concentration of PM_{10} ranged above the average level during cooking Indian households (The World Health Report, 2002). Our study to investigate the Co-relation of Pulmonary Function Test and Chest x- rays in biomass fuel user in rural area who cook regularly with biomass fuels and have compared the results obtained from a group of control women who cook relatively cleaner fuel, liquefied petroleum gas (LPG).

MATERIALS AND METHODS

SUBJECTS

A total number of 50- 100 women participated in this study. The biomass user group was represented by 46 women from Gangawara, Bangalore rural. They were in the age group of 25-79 years and used to cook regularly with wood, and agricultural refuge such as bamboo, jute stick etc. Another group of 24 women from Gangawara who use LPG as cooking fuel, aged 25-69 years, was enrolled as controls. Women in the study population and control groups were selected randomly. All of them were non- smokers and they used to cook 3-5 hr/day regularly. The study protocol was approved by the Ethical Committee of SDS- TRC and Rajiv Gandhi Institute of Chest Diseases Institute.

QUESTIONNAIRE SURVEY

The women were interviewed, clinically examined by a Pulmonologist who will fill up validated respiratory symptoms. Respiratory symptoms ascertained from questionnaire responses and clinical examination are grouped into upper respiratory symptoms like cold, fever and lower respiratory symptoms like Dry/productive cough, chest pain and wheezing.

PULMONARY FUNCTION TEST BY SPIROMETRY

Lung function test was performed in a sitting position with nose closed by nose clips following the recommendations of the American Thoracic Society (American Thoracic Society, 1995) using Portable spirometer. Forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), and mild expiratory volume (FEF 25-75%) values were recorded.

The data were compared with individual predictive values based on age, sex, body weight etc.

CHEST X-RAYS: The group of women who exposure to biomass fuels and LPG users, who did not smoke had not suffered from Tuberculosis and had chest x rays for abnormal investigation.

STATISTICAL ANALYSIS: Statistical analysis of the collected data was analysed by mean, percentages and correlation analysis by using Microsoft excel and statistical tool.

RESULTS

A total of 150 women were approached from the village for the study out of which 70 women gave consent for the investigations such as pulmonary function test and Chest X-rays. Further two groups were formed, biomass users and LPG users consisting of 46 and 24 women each of the group of 25-79 years (3-5hr/day exposure).

Changes in Lung Function

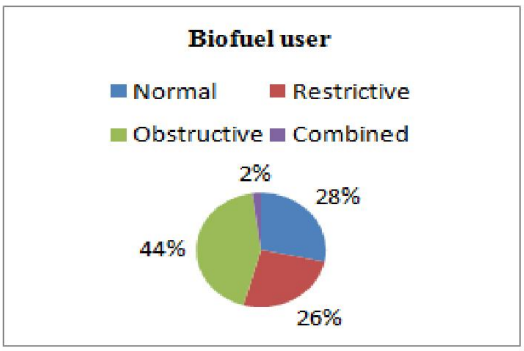
The pulmonary function status of the overall population is shown in Fig1 & 2. Here, the analysis compared total pulmonary impaired cases found in respective fuel users and total impaired cases from LPG users. Lung function was significantly reduced 44 % of biomass users as compared with controls. Restrictive type of lung function deflect (FVC less than 80% predicated) was predominant in both the groups, but the prevalence was more in biomass users (26.0 vs. 37.0%). Similarly, obstructive type of lung deficit (FEV1/ FVC less than 70% predicted) was more than doubled in women who cook with biomass (44.0 vs. 21.0% in control). A combination of both types of deficits was several- fold increased in biomass users.

Among biomass fuel exposed people, few percentages had ventilator abnormalities. In addition, the percent of obstruction was significantly higher among biomass fuel users than LPG users. The results further state the adverse effect of bio fuels by categorizing it into mild, moderate and severe obstruction; mild and moderate levels of obstruction were only predominant in biomass users. These results further discriminate and substantiate the deleterious nature of fuels and the consequences of impaired pulmonary effects of exposed groups. COPD diagnosis was done based on symptoms of breathlessness more than three years with PFT showing obstructive pattern (FEV1/FVC < 0.7), and chest x rays showing hyper inflated lung fields.

Table 1. Comparison of PFT values of biomass exposed women and LPG users exposed

Parameters	Biomass users (%)	LPG users (%)
Normal	28	42
Restrictive	26	37
Obstructive	44	21
Combined	2	0

*P<0.42 compared with control



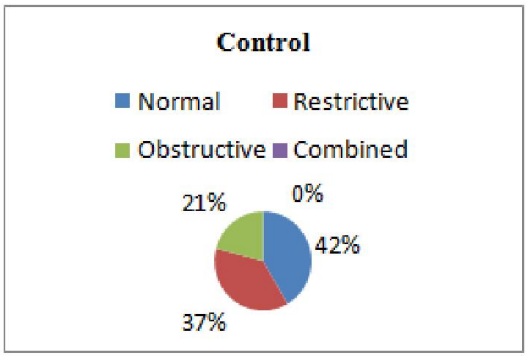
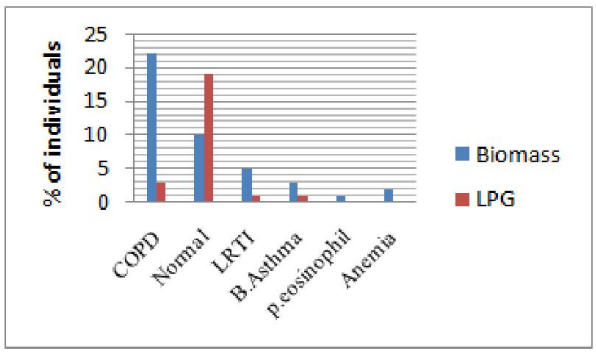


Fig. 1 and 2 Lung function in biofuel users and control women

COPD in biomass using women

Biomass fuel user were more symptomatic with abnormal finding when compared to control users (Fig 3)



*P<0.73 compared with control

Fig. 3. Showing the symptoms at the time of presentation in biomass fuel and control user

RADIOLOGICAL ABNORMALITIES: Hyper inflated lung fields were commonest finding in the chest X- rays.

Table 2. Radiological changes in biomass fuel users

	Biomass	Control
Hyper inflated lung fields	20	9
Normal lung fields	12	9
Bilateral reticular shadows	7	3
Cardiac enlargement & Hyper inflated lung fields with enlarged right pulmonary artery	6	2
Left lung fibrosis	1	1

*P< 0.02 compared with control

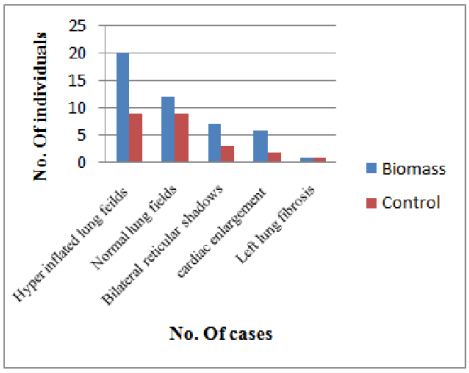
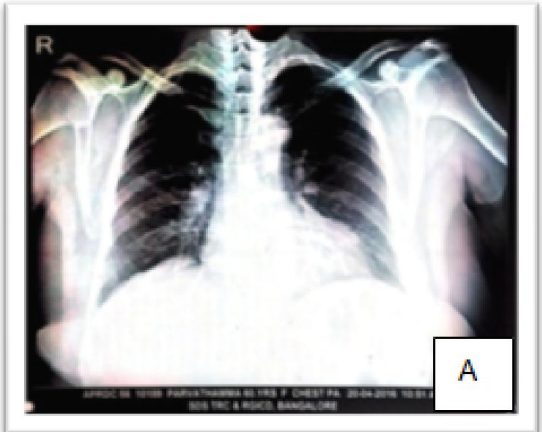
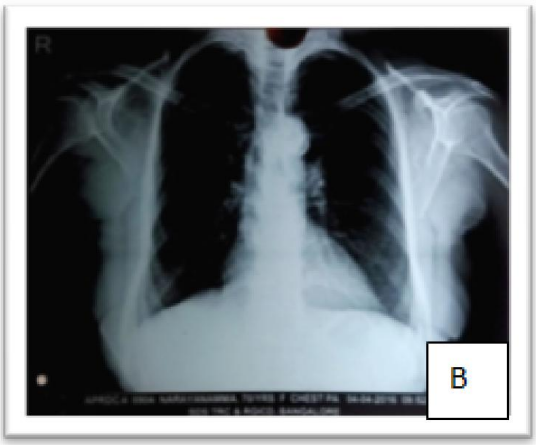
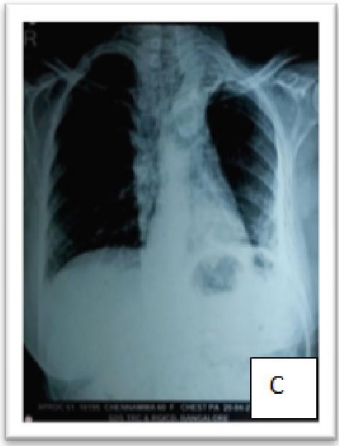


Fig. 4. Radiological abnormalities in biomass fuel and control users







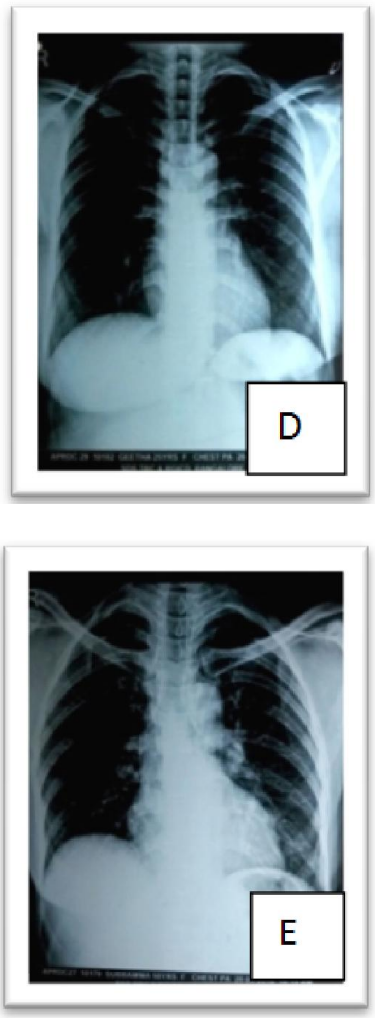


Fig. 5 Radiological abnormality images of biomass fuel and control users: (A) Cardiac enlargement & Hyper inflated lung fields, (B) Hyper inflated lung fields , (C)Left Lung Fibrosis, (D) Normal (E) Bilateral reticular shadows

DISCUSSION

The objective of this study was to assess the effect of biomass fuel and clean fuel smoke on respiratory parameters. We have shown that these women suffer from increased impaired lung function. In the earlier study in Indian women who used biomass for domestic cooking, lung function was impaired in a majority of cases, and the type of impairment was predominantly restrictive (Behera *et al*., 1994) but we found more obstructive cases as compared to earlier study. In our study risk of obstructive lung disease in biomass was 44% compared with LPG users were 21%, which indicates high risk of obstructive type of lung disorder, which was highly significant. Many earlier studies also showed association of exposure to biomass fuel (wood, crop residue and cow dung cake) with higher levels of indoor air pollution and with increased incidence of pulmonary diseases. In our study on pulmonary function test in rural women exposed to biomass fuel were significantly reduced in biomass fuel users as compared to LPG users. The female subjects taken in our study were of average age of presentation was 40 yrs with maximum number of patients in the 4^{th} & 5^{th} decade.

The mean exposure in our study was 3-5hrs/day with mean duration of exposure being 10 yrs. A study conducted in Kanchipuram it was observed that the lung function parameters (FEV1, FVC, FEV1/FVC%, FEF 25-75%, PEFR) were significantly lesser in the study group exposed to biomass fuel. The mean duration of cooking in the study was 3.5± 1.3 hrs/day with mean cooking years being 12.2 ± 5.2 years. (Revathi *et al*., 2012). Biomass fuel user were more symptomatic with abnormal finding when compared to control users COPD is the commonest lung disease in our study followed by Lower respiratory tract infections (LRTI)and Bronchial asthma.

The radiological evidence found from this study was those who produced an abnormal chest x ray had been exposed for longer to biomass fuels. Hyper inflated lung fields were commonest finding followed by normal chest X rays which were equal in both groups (Table 2 & Fig. 5). Bilateral reticular shadows were predominating in biomass users when compared to control. But it is better to evaluate functional impairment than radiological evidence. Spirometric results were compared with chest x rays had some form of spirometric abnormality. Patients with complications such as cor pulmonale showed cardiac enlargement with enlarged right pulmonary artery were predominating in biomass users when compared to control (Fig 5).

Conclusion

The present study showed a significant relationship between biomass fuel combustion & decrease in lung function. This could be due to exposure to high concentration of respiratory irritants emitted during biomass fuel combustion & poor ventilation. The healthy non smoking women using biomass fuel for cooking had clinical respiratory impairment, identified by PFT.

An indoor pollutant liberated from incomplete biomass fuel combustion has risk factor of pulmonary diseases like chronic obstructive Pulmonary Disease, Lower Respiratory tract infection, Asthma, peripheral eosinophil. Thus biomass exposed women can be avoided by adequate household ventilation, by improvement in stoves & change of the fuel type for cooking & heating. Hyper inflated lung fields were commonest finding which indicates COPD as confirmed by PFT although we observed few cases with normal chest X-rays showed significant obstruction. In summary, this study is done in one of the rural area where women exposed to biomass fuel showed significant obstructive lung diseases and radiological abnormities. In all rural areas where biomass fuel users are more prevalent needs research on inflammatory respiratory diseases and allergic manifestation. The development of biomarkers and field interventions trails that demonstrate the modification of exposure which prevent the further progression of the diseases.

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