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Effect of chronic exposure to indoor air pollutants on lung function

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Abstract: Background: *A significant number of women living in rural areas use biomass fuel like wood, dung or crop residues for cooking. They are exposed to the smoke produced by combustion of these materials, which can cause harmful effects to the respiratory system.*
Objective*: The present study was done to evaluate the effect of chronic exposure to biomass fuel smoke on the lung functions of rural women.*
Methods*: The case control study included 150 female subjects of comparable age group. 75 of them were biomass fuel users and 75 were liquefied petroleum gas (LPG) users. Both the groups had been exposed to the respective fuel during cooking for over 15 years. After detailed questionnaire the Peak expiratory flow rate (PEFR) were assessed by computerized spirometry and statistical comparisons was done by using student t-test.*
Results: *The percentage predicted value of the lung parameters of the biomass fuel users PEFR ($p<0.01$) were reduced significantly in biomass fuel users as compared to those using LPG.*
Conclusion: *The results of this study suggest that exposure to biomass fuel smoke for chronic period can lead to reduction in lung function.*
Keywords: *Biomass fuel users, Liquefied petroleum gas users peak expiratory flow rate (PEFR), decreased lung functions*

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I. Introduction

Domestic cooking in rural areas involves usage of biomass fuel as primary source of energy. This solid fuel includes firewood, animal dung , charcoal and crop residues[1].

In India, the rural women undertake routine cooking over long periods, often many hours per day. They are exposed to high levels of indoor air pollutants which is increased by the poor ventilation [2].

Biomass fuel generates suspended particles of respirable size and toxic chemicals when burnt[3]. This may lead to acute respiratory infections, Bronchitis, Chronic obstructive lung disease etc. Long term exposure to these particles has been strongly linked to reduction in pulmonary function parameters including peak expiratory flow rate (PEFR) suggestive of airway obstruction[4,5].

Studies on effects of indoor air pollution have observed that the use of solid fuel increases the risk of acquiring pulmonary disorders. There was mild to moderate reduction in the spirometric variables suggestive of obstructive airway disease[6.7].

To measure the intensity of health hazards of biomass fuel on lung function the present study was conducted by measuring the pulmonary function test in females using this fuel. And this was compared with that of the results from a group of control women who were using Liquefied Petroleum Gas (LPG).

II. Aims and Objectives

- To measure the peak expiratory flow rate (PEFR) in women exposed to biomass fuel. They were chosen as cases.
- To measure the PEFR in women using LPG. They were chosen as controls.
- To compare the PEFR in women using biomass for cooking to those using LPG.

III. Material And Methods

The study was conducted in rural women in and around the area of the Medical college hospital. After obtaining clearance from Institutional Ethical Committee, 75 female subjects who use biomass fuel and 75 female subjects who use LPG as fuel, ranging between 25-45 years of age were chosen for the study. Informed consent was obtained and the subjects were interviewed with a standard respiratory questionnaire[8].

Subjects who were pregnant ,or those with the history of any major illness or recent surgery or those who were less than 25 years and more than 45 years of age were excluded from the study.

After clinical examination which included height and weight, Pulmonary Function Test using "MEDICAID SPIRO EXCEL PC" based Pulmonary function system was done on all subjects [9]. The entire procedure was explained and demonstrated satisfactorily to the subjects. After attaching nose clips, the subjects were asked to take maximal inspiration and blow into the mouthpiece as rapidly, forcefully and completely as possible for about at least 4 seconds. A minimum of 3 acceptable Forced expiratory manoeuvres was performed in the standing position with nose pinched and the best was selected and accepted. The peak expiratory flow rate [PEFR] was measured in litres/second on all subjects.

Data was collected and statistical analysis was performed with the SPSS software. Student 't' test was used for comparing the results between the groups.

IV. Result

The mean of age and Body Mass Index (BMI) of the cases and controls were comparable. Most of the biomass users were living in kutcha houses using common kitchen and a significant number of them had no proper ventilation. Both case and controls have been exposed to their respective fuels while cooking, for the past 15 years at an average of 2-3 hours per day.

The mean and the percentage (%) predicted values of the peak expiratory flow rate [PEFR] values of biomass users and controls are shown in table 1.

Table 1: Pulmonary Peak Expiratory Flow Rate parameter of the subjects

Parameter	Biomass users (n=75)			LPG users (n=75)			
	Reference value (Mean ±SD)	Test value (Mean ±SD)	%Predicted value (Mean ±SD)	Reference value (Mean ±SD)	Test value (Mean ±SD)	%Predicted value (Mean ±SD)	Student 't' test p value
PEFR (litres/sec)	5.66± 0.27	5.05± 0.28	89.15±2.1	5.67± 0.32	5.45±0.33	96.11±2.89	p<0.01 (S)

The Percentage (%) predicted values of the PEFR values ($p<0.01$) of the biomass group was lesser than the LPG group. A significant number of the biomass users were reported to have episodes of lacrimation, rhinitis, cough and expectoration.

V. Discussion

The present case control study was undertaken to determine the effect of biomass fuel on Lung functions. In this study the % predicted values of PEFR of the biomass users were found to be significantly lower than the LPG users. Cross-sectional studies show a mild to moderate reduction of the PEFR with the exposure to indoor biomass combustion [4,10.]..

The decreased values of PEFR in biomass users suggest that there is narrowing of airways. Studies have reported that particulate matter $PM_{2.5}$ present in biomass smoke induce oxidative injury by forming free radicals leading to airway inflammation and obstruction.[11]**.** Ekici et al showed that prevalence of chronic airway disease was high in exposed group compared to control[12].

Respiratory symptoms especially phlegm and cough, has been consistently higher due to the inhalation of particulate matter in women cooking with biomass fuels in comparison with those using cleaner fuels like LPG [4]. The biomass users in the present study also had upper and lower respiratory symptoms.

Thus the results of the present study indicate that exposure to biomass smoke for prolonged periods causes impairment of lung functions leading to airway obstruction.

VI. Limitations

Confounding factors like cooking outdoors occasionally and time of cooking of the fuel users were the limitation of this study[10].

VII. Conclusion

The present study was undertaken to measure the effect of biomass smoke on lung functions by comparing them with a group of age matched female subjects using LPG. The association between the use of biomass fuel and the decrease in lung function parameters namely the PEFR were found to be significant compared to the controls.

The results of the present study show that chronic exposure to biomass fuel can have a detrimental effect on lung functions. This study shows the importance of interventions required to improve the standard of living conditions like usage of low smoke fuels.

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