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EFFECT OF BIOMASS FUEL AND LPG ON PULMONARY FUNCTION IN RURAL WOMEN

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ABSTRACT

The study was to compare the pulmonary functions in healthy ,nonsmoking women who used either biomass or liquefied petroleum gas (LPG) as cooking fuel. The effects of biomass fuel, type of ventilation, economic status and cooking index were also taken. The study of the effect of pulmonary function was investigated during the period of Jan 2007. Sixty healthy, non-smoking women were included 30 cooked solely with biomass and 30 cooked with LPG. A standardized respiratory symptoms questionnaire was administered to all the subjects and spirometry was carried out. Passive smoking showed significant difference between the two groups. Statistically significant differences were found in lung functions between two groups FVC, FEV_1, FEV_1% pred which was significantly lower ($P<0.05$) in study group, but FEV_1%, $FEF_{25-75\%}$ & $FEF_{25-75\%}$ % pred no significantly difference but the value is less in women using biomass. The step-wise student't' test analysis showed no correlation between cooking fuel and the pulmonary functions. The absence of the expected adverse effects of biomass on pulmonary functions was possibly due to better ventilation in the kitchens of subjects in the biomass group compared to previous studies.

KEYWORDS: Cooking fuel, Pulmonary function, Non-smoking women, Biomass, Liquefied petroleum gas.

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INTRODUCTION

People have been cooking with wood for thousands of years. More than half of the world population relies on biomass fuels such as cow dung, coal and wood and crop residue as the primary source of domestic energy like cooking, heating and lighting. In India, nearly 90% biomass fuels used for cooking and other purpose[1]. Biomass fuels are used mostly by very poor people. It is being used predominately in rural area of kuppam because it is cheap and easily available from the local environment or from agriculture residue than other fuels such as LPG, kerosene stoves. Biomass combustion produces fine and ultra fine particles and a large number of mixture of semi volatile & non volatile organic compound which are respiratory irritants like suspended particles of respirable size[2], Polycyclic aromatic hydrocarbon[2,3], Carbon monoxide, oxides of nitrogen and sulphur[4], others such as benzene, aldehyde 1,3- butadiene.Domestic cooking is one of the important functions for the average Indian housewife. In rural area houses, most of the cooking is carried out in an enclosed space with poor ventilation. On an average the Indian housewife spends about six hours in the kitchen daily for cooking and it's depend on the burden of extra work. During her life period she is exposed to the fuel at an early age of about 15yrs therefore she is exposed for 30 to 40 yrs equivalent to 60,000hrs[5].the health hazards associated with high exposure to biomass combustion products are obstructive lung disease, peri natal condition and low birth weight, acute respiratory infection and otitis media infection, Disease of eye such as cataract[4], Respiratory failure & cor pulmonale[6], Increase risk of cancer & genetic mutation.The LPG used for cooking is associated with lowest prevalence of abnormal respiratory finding in non smoking women when compared to smoking women[2], who used biomass fuel for cooking. Expose to biomass combustion products may well play an important role in the etiology of both chronic and acute respiratory diseases leading to respiratory morbidity[7].

AIM AND OBJECTIVE

To evaluate the PFT in rural women in & around Kuppam near Chittoor District, exposed to biomass fuel combustion. To compare the PFT of rural women exposed to biomass fuel & with those not exposed to biomass fuel.

METHODOLOGY

SOURCE OF DATA

Female attendants of patients in PESIMSR and also workers in hotels during the period 2007-2008 were recruited for the study.

SAMPLE SIZE PFT was evaluated in 30 healthy non smoking rural women using biomass fuel for cooking and compared with that of 30 healthy non smoking rural women using LPG as controls. The subjects were selected on the basis of inclusion and exclusion criteria.

INCLUSION CRITERIA

STUDY GROUP

- 25 – 50 yrs age
- Using biomass as fuel
- Exposed to cooking for minimum 5yrs

CONTROL GROUP

- 25 – 50 yrs age
- Using LPG / electricity for cooking

EXCLUSION CRITERIA

STUDY GROUP

- Below 25 & above 50 yrs of age
- Smokers
- Pregnant women
- Cardiopulmonary disease
- Symptoms such as cough,wheezing, sputum production
- Chest deformities, kyphosis etc

CONTROL GROUP

- Below 25 & above 50 yrs
- Using biomass
- Smokers
- Pregnant women
- Cardiopulmonary disease

Information about the place of cooking & ventilation of room, number of windows, type of ventilation, presence or absence of chimney, type of cooking fuel used etc. Informed consent was taken. A standard respiratory questionnaire was used for this study. Before testing – physical & systemic examination was done. Height was measured in standing position without shoes in centimeters and weight was

measured in kilograms. The educational status of the subject and the socioeconomic status[8] of the family were noted. PFT were performed using medsprior, which is a PC based spirometer with flow transducer.

PC based spirometer

FLOW TRANSDUCER

It is bi-directional for both exhale and inhale maneuver. Mouth piece is pushed on the transducer while removing it is to be pulled out without rotating it. Hand/ finger was avoided on backside mesh while doing the maneuver. It is plug and go computer based spirometry. Test was performed in sitting position. Reference values for spirometry were based on age, sex and height provided in the software. Before testing, the whole procedure was explained & demonstrated to the subject. Later the subject was asked to perform the FVC maneuver. FVC was recorded after a maximal inspiration when the subject expires forcefully with maximum expiration into the mouthpiece. A minimum of 3 acceptable FVC maneuvers was performed and the best maneuvers were selected and accepted. Acceptability criteria were full inhalation before of test, satisfactory start of exhalation, no cough during the first second of maneuver, no early termination of exhalation, maximum exhalation time of 6 seconds is recommended. For FVC and FEV the difference of two largest values should be within 200ml. For PEFR the difference of two largest values should be within 10%. When this criteria were not met, the testing was continued for 8 trials, even after 8 trials when the criteria were not met, the testing was stopped and the 3 best acceptable tests were taken and interpreted. Calibration was done from time to time for accuracy. After scrutinizing the flow volume curve and time volume curve the parameters derived were FVC, FEV1, FEV1/FVC and FEF (25- 75%) Results of maneuvers were based on American thoracic society & European thoracic society standards[9]. PFT was considered normal when the FEV1/FVC was > 70% predicted values. Obstructive ventilator defect was diagnosed when FVC is normal and FEV1/FVC is > 70% predicted.In restrictive ventilator defect the FVC is less than the 80% predicted and FEV1/FVC is normal or > 80% predicted values.The data were analyzed statistically and the results were obtained. A 'p' value of less than 0.05 was accepted as indicating statistical significance.

RESULTS AND ANALYSIS

PFT was evaluated in rural women to study the effect of biomass fuel on pulmonary function and compare with the control groups. Student't' test was used to compare the means of PFT parameter between study and control groups.

TABLE 1
Profile of Study and Control Group

VARIABLES	STUDY GROUP	CONTROL GROUP
NUMBER	30	30
AGE	33.6 ± 6.43	32.33 ± 6.03
HEIGHT (cms)	154.7 ± 3.03	154.07 ± 3.66
WEIGHT (kgs)	51.96 ± 7.22	52.86 ± 4.93
BMI	21.81 ± 2.83	21.96 ± 1.77

GRAPH 1
Profile of Study Group and Control Group

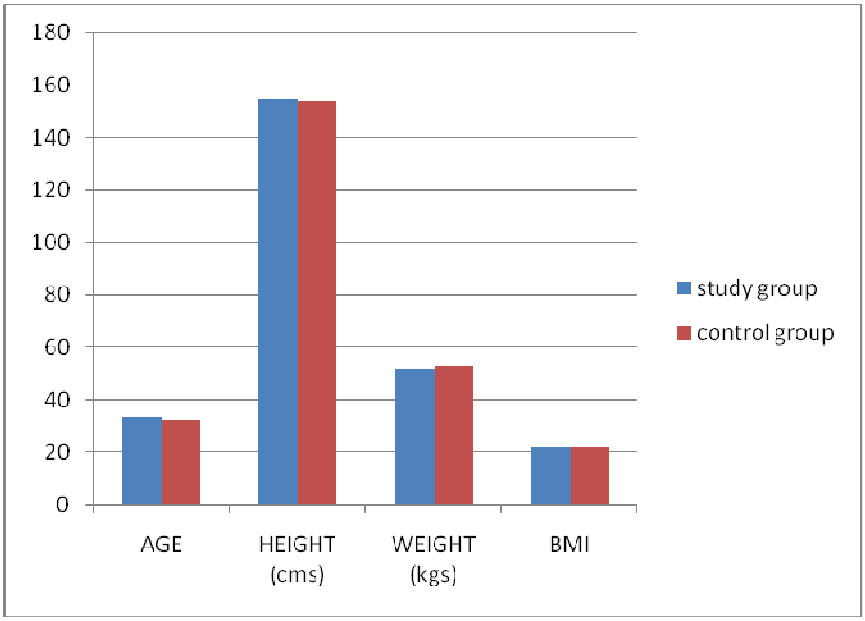


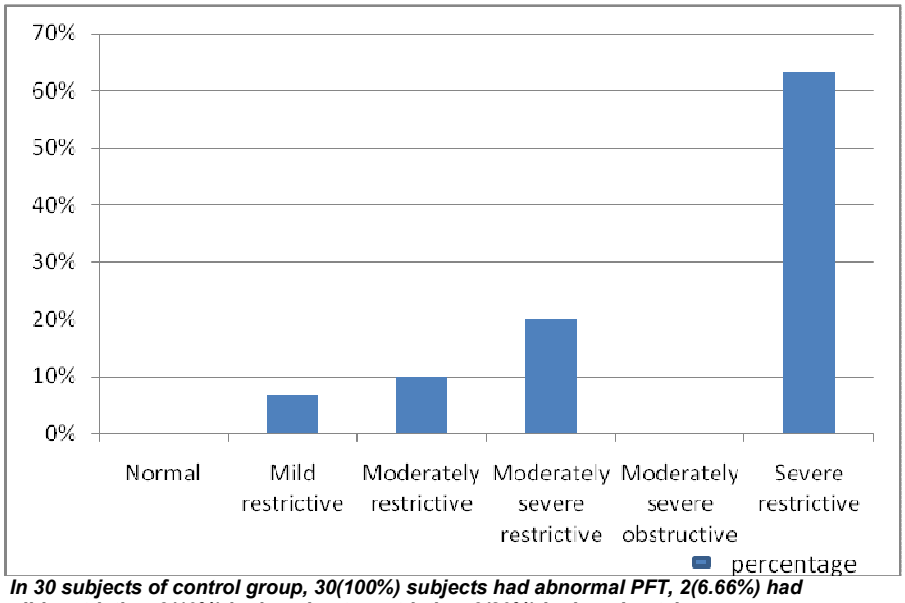
TABLE 2
Distribution of Ventilation for Study Group

VENTILATION PROFILE	NUMBER
Both window & chimney	6
Only chimney	6
Only window	13
Absence of both window & chimney	4
Cooked in open space	1

TABLE 3
Results of PFT in Control Group

S.NO	PFT	TOTAL NUMBER	PERCENTAGE
1	Normal	-	-
2	Mild restrictive	2	6.66%
3	Moderately restrictive	3	10%
4	Moderately severe restrictive	6	20%
5	Moderately severe obstructive	-	-
6	Severe restrictive	19	63.3%

GRAPH 2
Result of PFT in Control Group

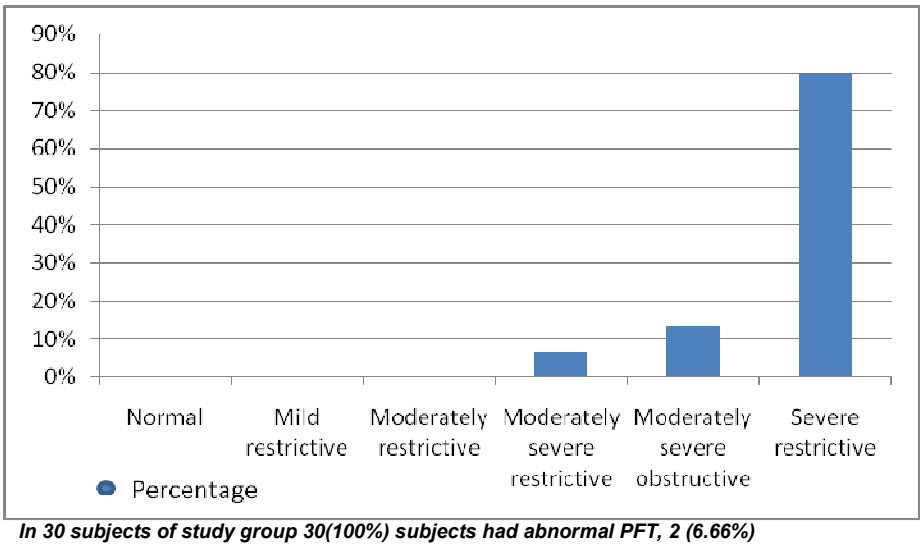


In 30 subjects of control group, 30(100%) subjects had abnormal PFT, 2(6.66%) had mild restrictive, 3(10%) had moderate restrictive, 6(20%) had moderately severe restrictive,19(63.3%) had severe restrictive condition.

TABLE 4
Results of PFT in Study Group

S.NO	PFT	TOTAL NUMBER	PERCENTAGE
1	Normal	-	-
2	Mild restrictive	-	-
3	Moderately restrictive	-	-
4	Moderately severe restrictive	2	6.66%
5	Moderately severe obstructive	4	13.33%
6	Severe restrictive	24	80%

GRAPH 3
Results of PFT in Study Group



In 30 subjects of study group 30(100%) subjects had abnormal PFT, 2 (6.66%) had moderately severe obstruction, 4(13.33%) had moderately severe restrictive, 24(80%) had severe restrictive condition. Among 30 subjects, normal PFT was not observed.

TABLE 5
FVC & FVC% Predicted Value of Study Group and Control Group

LUNG PARAMETER	STUDY GROUP	CONTROL GROUP	P VALUE
FVC (L)	1.26 ± 0.41	1.48 ± 0.32	0.0125
FVC % pred	40.72 ± 14.81	47.45 ± 11.82	0.0284

There was significantly decrease in FVC and FVC% predicted value in study group than the control group.

TABLE 6
FEV_1, FEV_1 % pred & FEV1% Value of Study Group and Control Group

LUNG PARAMETER	*STUDY GROUP*	*CONTROL GROUP*	*P VALUE*
FEV_1	1.21 ± 0.34	1.39 ± 0.27	0.0123
FEV_1 % PRED	44.56 ± 12.99	52.19 ± 10.88	0.0083
FEV_1 %	96.71 ± 9.04	96.27 ± 8.03	0.4227

The FEV1 and FEV1% predicted lung parameter showed significantly decline in study group. But the FEV1% value was no statistically significant in the study group as compared to control group.

TABLE 7
$FEF_{25-75\%}$, $FEF_{25-75\%}$ % Pred Value of Study Group and Control Group

LUNG PARAMETER	STUDY GROUP	CONTROL GROUP	P VALUE
$FEF_{25-75\%}$	3.00 ± 1.28	3.12 ± 0.79	0.3243
$FEF_{25-75\%}$ % pred	74.65 ± 19.4	83.07 ± 20.92	0.0558

The FEF (25 -75%) and FEF (25-75%) %pred value was no significantly difference between two groups. But the value is less in study group than control group

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DISCUSSION

Cooking fuel produces irritants such as oxides of nitrogen, sulphur dioxide and burnt hydrocarbon. They lead to change in lung function. Among these fuels biomass combustion is more hazardous because it emits large amount of soot particles. These particles cause inflammatory reaction[10] in the mucous linings of the respiratory tract causing luminal narrowing by excess mucus, edema, cellular infiltration and smooth muscle hypertrophy. This leads to small airway obstruction. This particle also causes inflammation or scarring of lung tissue result in filling of air space with exudates & debris. This leads to restrictive lung disease and also accompanied by reduced gas transfer[11].PFT was evaluated in 30 women exposed to biomass fuel and compared with 30 women exposed to LPG. The data was analyzed and the results are discussed below. The data collected was age matched. FVC, FEV_1 & FEV_1 % pred value in study group were significantly decreased when compared to control (p value 0.0125, 0.0123, 0.0284) respectively. But FEV_1 % no significantly difference between two groups. Decrease in FVC & FEV_1 value in the study group is probably due to obstruction of air flow or restrictive lung disease. The obstruction is due to the chronic inflammation and the restrictive lung disease is due to scarring of the lung tissue caused by the respiratory irritants emitted by biomass fuel combustion. This finding was similar to the observation of Behera et al[12], Pandey et al[13], Asim saha et al[14], haldun summer et al[15].$FEF_{25-75\%}$ & $FEF_{25-75\%}$ % pred in the study group showed p value (p value 0.324). The difference between control and study group is not statistically significant. But the FEF 25-75% and FEF 25-75% pred are slightly less in study group than control group. These values indicate function of small airway. This finding was seen in a study conducted by Reddy TS et al[2], Saini V et al[16].All the subjects in the study group used wood for their domestic cooking purpose. Analyzing the type of ventilation in the kitchen of houses, it was found that almost all subject of study group had the ventilation in the form of window or chimney expect for four subjects who had no window or chimney it appeared that in this study ventilation of these household seem to influence the pulmonary function this may be because ventilation through present was inadequate.The present study shows association between biomass fuel combustion and decreases in lung function this could be due to exposed to high concentration of respiratory irritants emitted during biomass fuel combustion and poor ventilation. Thus decreased in lung function in biomass fuel exposed women can be avoided by better housing and use of smokeless device for cooking in the kitchen.Further studies in this aspect are required to come to the final conclusion.

CONCLUSION

The study group consists of 30 healthy non smoking women were selected and also in control group consists of 30 healthy non smoking women were selected at PESIMSR. The test group in inclusive and exclusive criteria was strictly followed.

1. FVC, FEV_1, FEV_1% pred were significantly decreased in the study group as compared to the control group, which indicate the effect of lung parenchyma and also the obstruction of airway. But FEV_1% no statistical difference between two groups.
2. $FEF_{25-75\%}$ & $FEF_{25-75\%}$ % pred which is an indicator of small airway function. There was no statistically significant between two groups. But the FEF 25-75% and FEF 25-75% pred values are slightly less in study group than control group indicating small airway obstruction.
3. This study shows that healthy non smoking women using biomass fuel for cooking had sub clinical respiratory impairment.
4. This could be identified by pulmonary function tests, which are sensitive and simple tests to identify early respiratory impairment as compared to history and physical examination.
5. The adverse effect of biomass fuel on lung function could be due to exposure of high concentration of pollutants emitted by biomass fuel combustion and inadequate ventilation. Hence improving ventilation and avoiding the biomass fuel may prevent the adverse effects of biomass fuel combustion prevent the adverse effects of biomass fuel combustion.

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