Study of Effects of Kerosene and LPG on Pulmonary Function Tests in Rural Women of Punjab.

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ABSTRACT

Background: The unhealthy effects of indoor air pollution by cooking fuels is great concern for good respiratory health. Present study was conducted to study and compare the effects of two major fuels used in developing countries like India, Kerosene and Liquefied Petroleum Gas (LPG) in rural women of Amritsar, India. **Methods**: Study was conducted on 800 rural women out of which 400 using Kerosene as cooking fuel and rest 400 using LPG. Subjects of chronic and recent respiratory illness even if treated were excluded Ventilatory functions of lungs were done on computerized spirometer, MED-SPIRER. **Results**: There was statistically significant decline in FEV1 in Kerosene using women (0.98±0.47) when compared with LPG using women (1.86±0.37). Other parameters FEV3, PEFR, FEF 25-75%, FEF2-12, FEF 25%, FEF 50% FEF 75% and MVV showed similar significant decline in women using Kerosene as fuel. **Conclusion**: There is significant decline in ventilator function od lungs in women using Kerosene as cooking fuel, which is still used in developing country like India. Reduced values indicate small airway obstruction.

Keywords: Cooking fuel, Pollution, COPD, FEV, Kerosene, LPG.

Abbreviations: LPG: Liquefied petroleum gas; FVC: Forced vital capacity; FEF: Forced Expiratory Flow; MVV: Maximum Voluntary Ventilation.

INTRODUCTION

The health effects of air pollution have been a great concern for mankind since several decades. Air pollution, both outdoor and indoor is major causes of chronic obstructive lung disease.[1] Administrative efforts to control air pollution are focused on outdoor air, e.g. regularization of activity of roadside vehicular traffic. Elevated contaminant concentrations are common in indoor environment also which is often ignored in official data. There are four principal sources of indoor air pollution

a) Cooking fuel Combustion
b) Low cost building materials used in wooden joinery and walls
c) Non cemented flooring
d) Biological agents such as moulds, mildew and mites.

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Evolution of combustion devices in human history can be described as energy ladder. Raw biomass fuel (animal dung, crop residues, wood etc.) is at the lowest end of the ladder followed by biomass fuels such as coal, coke, kerosene and gas. Electricity at the top of the ladder is the cleanest but most expensive form of energy. [Figure 1]

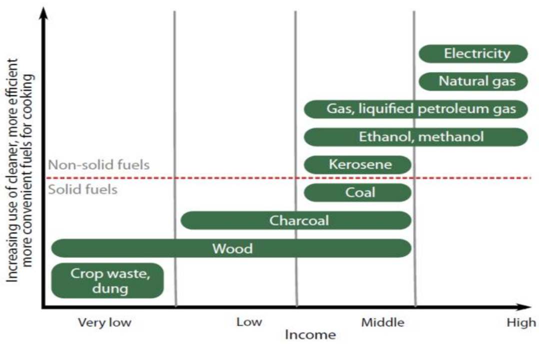

Figure 1: Energy Ladder (Reddy1995) 2

More than half of the world's households cook daily use unprocessed solid fuels that release at least 50 times more gaseous and particle noxious pollutants.[3]

The location of the kitchen, type of ventilation, type of cooking device and type of fuel are the main determinants of the level of pollution.

A number of studies from India and other countries have described lung function abnormalities attributable to exposure to domestic cooking and indoor air pollution.

Reduction in ventilator functions is reported with use of biomass fuel.[4,5] Use of gas stove also has effect on lung functions.[6,7]

LPG mainly produces two oxides of nitrogen- nitric-oxide, nitrogen-dioxide.[8] though emissions of LPG have negligible amounts of particulate matter.

Kerosene combustion produces mainly carbon-monooxide, sulfur-oxide and nitrogen dioxide.[9]

Acute and chronic respiratory effects of domestic fuel combustion include chronic obstructive pulmonary disease,[10] Asthma,[11] Cor-pulmonale and bronchiectasis,[12] nasopharyngeal cancer,[13] acute lower respiratory illness (ALRI) in children and exacerbations of asthma.[14,15] There are increased levels of carbon monoxide in nonsmoking women using different cooking fuels.[16] Nitrogen dioxide damages lung directly through its oxidant properties or indirectly by increasing its susceptibility to infections.[17]

Lung volume measurement as a function of time is more informative than static lung volumes.[18]

Ventilatory functions are influenced by number of factors like race, age, sex and weight. These are also influenced by environmental, genetic, socio-economic and technical variations.[19]

MATERIAL AND METHODS

Present study was conducted in the villages nearby Amritsar (India). 800 nonsmoker rural female subjects in the age group of 18-45 years, consisting of 400 women using LPG and 400 using Kerosene. Persons having existing respiratory diseases like asthma, persistent cough, Tb, COPD and also those treated recently for any respiratory illness were excluded.

Parameters:

The following parameters were studied

1. Body surface area (B.S.A.)
2. Forced vital capacity (F.V.C.)
3. Forced expiratory volumes (FEV1, FEV2, FEV3 over fixed time intervals(T=0.5,1&3 seconds)
4. Maximum mid expiratory flow rate FEF (25-75%)
5. Peak expiratory flow rate (PEFR)
6. Maximum voluntary ventilation(MVV)
7. Forced expiratory flow after 25% FVC has been expired (FEF 25%)
8. Forced expiratory flow after 50% FVC has been expired (FEF 50%)
9. Forced expiratory flow after 75% FVC has been expired (FEF 75%)

RESULTS

Table 1: Showing Mean, standard deviation and 'p' value with statistical significance of expiratory parameters in rural women using LPG &Kerosene fuel.

Parameters	Lpg-Users	Kerosene Users	P Value	Significance
FVC	1.91±0.37	1.02±0.47	<0.001	HS
FEV0.5(L)	1.72±O.40	0.90±0.15	<0.001	HS
FEV1(L)	1.86±0.37	0.98±0.47	<0.001	HS
FEV3(L)	1.90±0.37	1.00±0.47	<0.001	HS
PEFR(L/sec)	4.42±0.94	2.27±0.46	<0.001	HS
FEF25-75(L/sec)	3.24±0.76	1.96±0.50	<0.001	HS
FEF2-12(L/sec)	3.48±O.89	1.56±0.38	<0.001	HS
FEF25%(L/sec)	3.69±0.94	1.98±0.45	<0.001	HS
FEF50%(L/sec)	3.32±0.77	1.99±0.51	<0.001	HS
FEF75%(L/sec)	2.87±0.72	1.80±0.47	<0.001	HS
FEV0.5/FVC %	90.45±15.47	88.58±12.10	<0.001	HS
FEV1/FVC %	97.54±8.15	96.28±5.39	<0.001	HS
FEV3/FVC %	99.68±0.32	98.18±3.96	<0.001	HS
MVV(L/min)	77.21±7.60	27.14±6.24	<0.001	HS

DISCUSSION

The present study was done to collect more information about lung functions in rural women of Punjab using LPG &kerosene. The lung functions were done with help of a computerized spirometer 'MED-SPIROR'. The sample studies in the investigation is presumed to represent a cross section of rural women of Punjab. Each parameter has been dealt with separately explaining the changes in these two types of fuel users. It also showed changes in these parameters with number of years of exposure. The conclusion reached at by present study has been compared with those derived from other studies in the past.

FVC(Forced vital capacity in litres): [Table 1] In the present study mean FVC was 1.91 in LPG fuel users and 1.02 in kerosene fuel users.This showed that difference in FVC between two groups was highly significant.FVC declined by46.6% in kerosene fuel users when compared with LPG fuel users.Similar changes in FVC due to smoke have been reported in earlier studies.[20]

FEV0.5(Forced expiratory volume in 0.5 second in litres): In present study FEV0.5 in LPG fuel users was 1.72 & in kerosene fuel users was 0.90.It was decreased by 48% in kerosene fuel users when compared with LPG fuel users.

FEV1(Forced expiratory volume in one second in litres): In the present study FEV1 was 1.86±0.37 in LPG fuel users and 0.98±0.47 in kerosene fuel users.Thus FEV1 was decreased by 47% in kerosene fuel users when compared with LPG fuel users. Findings in our study are concurrent with earlier studies.[21,22] Decrease in FEV1 reflects obstructive pattern of impairment as a result of mucosal edema and superimposed infection,bronchoconstriction substances.

FEV3(Forced expiratory volume in 3 seconds in litres): In the present study there was highly significant decrease in FEV3 in kerosene fuel users (1.00±0.47) when compared with LPG users(1.90±0.37)

PEFR(Peak expiratory flow rate in litres/sec): In the present study PEFR decreased from 4.42±0.94 in LPG fuel users to 2.27±0.46 in kerosene fuel users. So PEFR decreased by 49% in case of kerosene fuel users when compared with that of LPG fuel users.Similar decrease in PEFR due to smoke and dust has been reported in previous studies.[23,24] PEFR is the better measure for large airways obstruction. Decrease in PEFR caused by irritant gases and particulate matter is due to hypertrophy of mucosal cells and superimposed infection due to ciliastasis.

FEF25-75%(Mean forced expiratory flow during middle half of FVC IN L/sec): In the present study FEF25-75% showed decline in kerosene fuel users(1.96±0.50) when decline was highly significant.FEF25-75% is a good index of early obstruction in small airways.

FEF2-12(Mean forced expiratory flow rate between 0.2-1.2 litres of volume change in litres/sec): In the present study FEF2-12 showed highly significant decrease in kerosene fuel users(1.56±0.38) when compared to LPG fuel users.

FEF25%(Forced expiratory flow rate after 25% of FVC has been expired in litres/second): In the present study FEF25% decreased from 3.64±0.94(in case of LPG fuel users)to 1.98±0.45(in case of kerosene fuel users)

FEF50%(Forced expiratory flow after 50% of FVC has been expired in litres/second): In the present study FEF50% decreased from 3.32±0.77(in LPG fuel users) to 1.99±0.51(in kerosene fuel users.

FEF75%(Forced expiratory flow after 75% of FVC has been expired in litres/second): In the present study FEF75% showed highly significant decline in kerosene fuel users(1.80±0.47) as compared to LPG fuel users(2.87±0.72).It is also important indicator of small airway obstruction.

FEV0.5/ FVC% Percentage ratio of forced expiratory volume in 0.5 second to forced vital capacity: In the present study showed that FEV0.5 /FVC% decreased from 90.45±15.47(in case of LPG fuel users) to 88.58±12.10.

FEV1/ FVC% (Percentage ratio of forced expiratory volume in 1 second to forced vital capacity: In the present study FEV1/FVC% decreased from 97.54±8.15(in LPG fuel users) to 96.28±39(in case of kerosene fuel users).It was significant decline($p>0.05$).It is better indicator of obstructive type of lung disease.

FEV3/FVC%(Percentage ratio of forced expiratory volume in 3 seconds to forced vital capacity: In the present study FEV3/FVC% ratio declined from 99.68±0.32 in LPG fuel users to 98.18±3.96 in kerosene fuel users.Decline was significant($p<0.05$).

MVV(Maximum voluntary ventilation in litres/minute): In the present study MVV decreased by 65% in kerosene fuel users(27.14±6.24) as compared to LPG fuel users(77.21±7.60).It was highly significant decline($p<0.001$) Decrease in MVV is in accordance to earlier study.25 MVV is good guideline of mechanical efficiency of lungs. Reduced MVV is indicator of obstructive insufficiency. Thus smoke emitted from kerosene decreased mechanical efficiency of lungs and obstructive impairment.

CONCLUSION

In our study there was decline in FVC in kerosene fuel users which indicate restrictive insufficiency. There was also decline in FEV1, FEV1/FVC%, MVV which indicated obstructive impairment. There was also decrease in PEFR which indicates large airway obstruction. Reduced values were also seen for FEF25-50% and FEF75% which indicates small airway obstruction. Thus in our study there are decline in all these parameters which indicates kerosene causes both restrictive and obstructive impairment. Obstruction was seen in both large and small airways. Kerosene combustion produces mainly carbon-monoxide, sulfur dioxide and nitrogen-dioxide.

Measures should be taken to minimize indoor air pollution:

1. Proper ventilation
2. Source substitution
3. Source modification
4. Air cleaning- gas adsorbers,air filters
5. Behavioral adjustment

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