

Effect of Indoor Air Pollution During Cooking in Women Belonging to Rural, Urban and Slum Areas of Delhi

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Abstract: A study was undertaken to investigate the effect of indoor air pollution caused by different cooking fuels on the lung functions in the women of East Delhi. The cross sectional study was performed in 140 females aged 12-60 years belonging to rural, urban and slum areas of East Delhi. Data was collected by questionnaire and lung functions were measured by spirometric tests. Multiple regression analysis was performed taking functional parameters FVC, FEV₁, PEFR as the dependent variable whereas BMI, per capita household living area, kitchen area, number of ventilators, total cooking exposure, cooking fuel and smoking as independent variable. Significantly lower values of FVC & FEV₁ in population from slum samples and better results of these in rural samples were observed. However in the same group females using cowdung as cooking fuel exhibited lower values of FVC.

Introduction

Several epidemiological studies have revealed inter-relationship of poor nutritional status, repeated pregnancies and workload in making women's life quite arduous¹, especially in lower and middle socio-economic class of India. Literature survey indicates that women do spend most of their time in household mainly for cooking purposes. Various fuels used for cooking have been shown to be the major cause of indoor air pollution and the exposure of women to such hazardous environment raises grave concern². These days, use of safer modern fuels are increasing, however, a large majority of rural population still depends on traditional biomass fuels for cooking². Emission of noxious gases from incomplete combustion of these fuels, more so in poorly ventilated conditions can result in accumulation of hazardous pollutants most notably being nitrogen dioxide^{3,4} and carbon monoxide⁵ (CO) to unacceptable levels. Nitrogen dioxide tends to increase respiratory illness and CO forms carboxyhaemoglobin which even in the low concentration of 0.8% is harmful specially for people having cardiorespiratory disability by accentuating exercise induced angina. Biomass fuel has deleterious effect on pulmonary function and structure leading to obstructive and restrictive pathologies (ref). Carbo et al⁶ in their study on the effect of gas cooking on lung functions concluded that cooking gas has harmful effect on the lung functions of adolescent girls with high serum level of IgE. Similar reports suggest that subjects using gas for cooking has a significantly reduced FEV₁, compared to those using electricity for cooking. Behra D et al⁷ in their study concluded that exposure to biomass fuel and LPG affect PEFR in asthmatics and both types of fuels affect airway function and causes respiratory symptoms. Reports have also indicated increasing incidence of chronic bronchitis and cor pulmonale in nonsmoking rural women engaged in cooking⁸.

Biomass fuels are used widely in developing countries mostly in rural and poor urban areas. They are composed of complete organic matter, vegetable protein and carbohydrates incorporating carbon, nitrogen, oxygen, hydrogen and certain other elements in trace amounts². Exposure to different fuels for cooking causes high incidence of cough with expectoration, dyspnoea, lung abnormalities, chronic bronchitis, cor pulmonale and decreased lung

functions⁹⁻¹⁴. Gas stove exposure is a significant risk factor for respiratory symptoms and atopic children tended to have a greater risk of respiratory symptoms compared with non-atopic children with exposure to gas stove or nitrogen dioxide. Similarly in one of the study undetected pneumoconiosis in rural women was found to be caused by a combination of dust from maize grinding and smoke from biomass fuel¹³. In Chinese women higher lung cancer rates could be attributed to the combined effects of passive smoking and domestic use of poor quality coal¹⁴. All these findings are pointing towards one common fact that lung diseases associated with indoor smoke exposure may be asymptomatic for a prolonged period masking the extent of ill health from this cause and contributing to under-reporting with particular implication for women. Viewing all above facts we planned the present study.

Material and Methods

The study was conducted on 140 females in the age range of 12-60 years old drawn from rural slums and urban areas of East Delhi. Among these 40 were from Dilshad Garden area which is inhabited by middle socio-economic group, 50 from rural area of Gazipur with lower middle socio-economic population residing in about 2000 houses and remaining 50 from slum of Kalander Colony representing lower socioeconomic group. Out of 140 study participants 55, 51, 29, 5 and 1 were using cooking fuels such as kerosene oil, cowdung cakes, firewood and heaters respectively. Detailed questionnaire was completed on each subject to document age, sex, body mass index, smoking history and other relevant informations. Pulmonary functions such as FEC, FEV₁, and PEFR were assessed using PK Morgan portable pocket spirometer. Each subject was explained about the procedure. Measurements were made with the subject comfortably seated. After application of nose clip the subject was asked to perform appropriate respiratory maneuver and maximum of 3 observations was recorded. Body Mass Index (BMI) was calculated using following formula

$$\text{BMI} = \text{Weight} / \text{Height}^2$$

Results

Regression equation of PET against Body Mass Index (BMI) in all three groups did not show any statistical significant relationship (Table 1), on comparison of PFTs in all three groups (Table 2), significantly lower values of FVC and FEV₁ in slum sample and

Table 1 : Regression of PFTs against BMI in total sample (N= 140).

VariableName	Dependent	(P-Value)	Significance
BMI	FVC	0.7513	Not Significant
BMI	FEV ₁	0.469	Not Significant
BMI	PEFR	0.8449	Not Significant

Table 2 : FVC, FEV₁ & PEFR in rural, slum and urban samples

PFT	Rural(n=50)		SLUM(n=50)		Uran(n=40)		(P-Value)	Significance At 5:6levelTukey'sTEST
	Mean	SD	Mean	SD	Mean	SD		
FVC	2.431	0.78	1.691	0.382	2.150	0.519	<0.0001*	Group 2 is significantly different from Group 1,3
FEV ₁	1.980	0.695	1.532	0.298	1.797	0.485	0.0002*	Group 2 is significantly different from Group 1,3
PEFR	173.980	83.403	161.820	42.063	169.050	72.132	0.6673	Not significant

*Significant p value <0.05

better results for rural samples were observed. While considering BMI<25 (normal) comparison of PFTs in three groups revealed maximum values of FVC and FEV₁ in rural females. This significance was however not noticed when BMI>25 (abnormal) is taken (Table 3). Further analyzing the rural sample, for finding a relationship between PFTs and other variables such as total household area (Table 4), kitchen area (Table 5), number of ventilators (Table 6) and total cooking exposure (Table 7), no statistical significant association was obtained. However, in the same group, the females using cowdung as cooking fuel (Table 8) exhibited lower values of FVC (Table 9) indicates that there was difference in values of PFTs in smoker as well as non-smoker (Kalander Colony females found to be smoking biri and consuming alcohol) but females in the household were the total number of smokers exceeded 3, showed decrement in their values of FVC thus reflecting the effect of passive smoking (Table 10) also.

Table 3 : PFT in normal and abnormal rural, slum and urban samples.

PFT	Rural(n=50)		SLUM(n=50)		Uran(n=40)		(P-Value)	Significance At 5:6levelTukey'sTEST
	Mean	SD	Mean	SD	Mean	SD		
For BMI < 25 (Normal)								
FVC	2.443	0.804	1.711	0.382	2.218	0.573	<0.0001*	Group 2 is Significantly different from Group 1,3
FEV ₁	2.033	0.681	1.544	0.681	1.544	0.295	0.0001*	Group 2 is significantly different from Group 1
PEFR	179.630	83.746	161.467	43.370	172.889	80.233	0.456	Not significant
For BMI > 25 (Abnormal)								
FVC	2.293	0.456	1.508	0.375	2.095	0.478	0.0286	Not significant
FEV ₁	1.370	0.622	1.424	0.340	1.761	0.422	0.1303	Not significant
PEFR	109.000	47.924	165.000	31.129	165.909	66.549	0.2376	Not significant

*Significant p value <0.05

Table 4 : Per capita household living area (square feet) and PFT in rural sample (n=60).

PFT	<50sqft		<50-99sqft		100sqft		100sq.ft		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
	(n=36)		(n=9)		(n=2)		(n=3)			
FVC	2.5564	0.7623	2.151	0.886	2.425	0.488	1.7633	0.4114	0.7297	Not significant
FEV ₁	2.081	0.681	1.704	0.829	1.935	0.134	1.62	0.4709	0.9141	Not significant
PEFR	173.980	83.403	181.167	84.157	173.00	95.089	125	25.4558	0.5271	Not significant

Table 5 : Kitchen area (sq.ft) and PFT in rural sample (n=50)

PFT	<10sq.ft		<10-19sq.ft		20-49sq.ft		50sq.ft		No Kitchen*		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
	(n=1)		(n=5)		(n=4)		(n=6)		(n=34)			
FVC	1.640	0.000	2.300	0.798	1.945	0.451	2.2067	0.73	2.49	0.80	0.1081	Not Significant
FEV ₁	1.510	0.000	2.024	0.846	1.768	0.602	1.8067	0.65	2.04	0.71	0.8011	Not Significant
PEFR	102.000	0.000	198.600	97.961	201.250	88.323	142.1667	96.64	17.4	81.42	0.5593	Not significant

*Cooking in open space

Significance p value <0.06

Table 6 : Number of ventilators in kitchen and PFT in rural sample (n=50)

PFT	No ventilator		One Ventilator		Two or more		No Kitchen*		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
	(n=11)		(n=3)		(n=2)		(n=34)			
FVC	2.457	0.684	1.530	0.141	2.520	1.103	2.496	0.803	0.2163	Not significant
FEV ₁	1.962	0.623	1.310	0.131	2.015	1.131	2.0429	0.7144	0.6149	Not significant
PEFR	174.000	84.175	147.333	94.368	198.500	173.241	174.3824	81.4288	0.9127	Not significant

*Cooking in open space

Table 7 : Total cooking exposure (hours) and PFT in rural sample (n=50).

PFT	One (Hr)		Two (HR)		Three (HR)		Four (HR)		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
FVC	2.784	0.814	2.466	0.798	2.647	0.826	1.9608	0.5006	0.0977	Not significant
FEV ₁	2.152	0.565	2.101	0.727	2.197	0.818	1.5308	0.4848	0.2007	Not significant
PEFR	207.400	95.931	205.167	73.097	173.111	72.757	105.6923	54.4187	0.0526	Not significant

*Significant P value <0.05

Table 8 : Main cooking fuel and PFT in rural sample (n=50)

PFT	LPG		Kerosene Oil		Cowdung/Cakes		Firewood		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
	Group-1		Group-2		Group-3		Group-4			
FVC	2.415	0.575	2.633	0.8884	2.0636	0.719	2.483	0.416	0.0032	Group 1 is significantly different from group-3
FEV ₁	1.922	0.603	2.222	0.777	1.751	0.685	1.9533	0.5689	0.5278	Not significant
PEFR	187.429	90.427	186.389	80.387	139.143	73.686	220.6667	102.9093	0.4254	Not significant

Table 9 : Smoking and PFT in rural sample (n=50)

PFT	Smoker		Non Smoker		(P-Value)	Significance At 5% level Tukey's TEST
	Mean	SD	Mean	SD		
FVC	2.590	0.825	2.590	0.752	0.0581	Not significant
FEV ₁	2.009	0.756	1.963	0.670	0.3872	Not Significant
PEFR	153.278	76.454	185.625	86.028	0.1847	Not Significant

*Significant p value <0.05

Discussion

With increasing attention focused on women's health, the need for more of gender specific data is being felt. Our work is one such attempt to fill the existing information gap and demonstrates the

Table 10 : Number of smokers in the household and PFT in rural sample (n=50).

PFT	None		One		Two		Three or more		(P-Value)	Significance At 5% level Tukeys TEST
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
	Group1		Group2		Group3		Group4			
FVC	2560	0.840	2256	0.707	2475	0.716	398	0	0.0254	Group Disignificantly different from group abc
FEV ₁	2139	0.696	1901	0.663	1910	0.839	1.72	0	0.742	Not significant
PFR	195.235	89.325	170.375	80.628	147.625	81.085	110	0	0.3246	Not significant

Significant p value <0.05

influence of contribution of indoor environment towards the health of women. As women are largely carry out most of the cooking, it is they who are maximally exposed to the hazardous indoor environment resulting mainly from the cooking fuel emission specially in under ventilated homes^{13,14}. Though LPG is commonly used fuel, but traditional biomass ones continued to be used in poor slum areas Besides this the jhuggi clusters in these slum areas contribute to poor ventilation. The reliance on biomass fuels coupled with poor ventilation is adequate to explain the low values of FVC and FEV₁ noticed in slum samples. The tobacco smoking which is quite prevalent in slum population may also contribute towards these results. The values of FVC and FEV₁ where maximum in rural women, may be attributed to cooking in open air or in well ventilated conditions. Another factor which appears to be adversely affecting the results, was passive smoking. Women in households having 3 or more smokers showed significant lower values of FVC. This reflects the combined effects of passive smoking¹⁵ and domestic cooking on reported decrement in the values of FVC. Our study strengthening the need for adequate control of environment, proper ventilation combined with health education of women as a move to remove the associated health risks.

Conclusion

The study of varied indoor environment prevailing in the rural, slum and urban areas due to use of different cooking fuels and its probable impact on lung functions was attempted by us in the present study. Pulmonary functions were measured using portable pocket spirometer and increased FEV₁ were observed in rural females as compared to urban population. Though we did not find any significant relationship between PFT and other variables such as total household area, kitchen area and smoking habits but lower values of FVC were seen amongst rural women using cowdung as cooking fuel.

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