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IS THE DERANGEMENT OF PULMONARY FUNCTION DUE TO BIOMASS FUEL SMOKE MORE THAN THAT OF TOBACCO SMOKE?

Physiology

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ABSTRACT

It is a known fact for a long time now that tobacco smoke having ample harmful effects on the lung function, but biomass fuel being one of the cheapest mode of fuel available for cooking and domestic purposes, especially in the rural areas also having near or even more ill effects on the lung function health. Does the biomass fuel smoke impact on the lung function health being concealed, due to the fact of over impression of effects by the tobacco smoke? So, exposure indexes been formulated to assess how much impact been created by these different kinds of smoke on the lung function indices.

KEYWORDS

Biomass fuel exposure index, tobacco smoking index, lung function test, environmental pollution.

Biomass fuels, mainly of wood, agricultural waste, cow dung is a cheaper alternative to liquefied petroleum gas (LPG) or electricity[1] and easily accessible for rural dwellers[2], especially in developing countries[3] in comparison to developed countries. And the persistent rise in cost of energy has urged, especially the rural dwellers to use wood or any other biomass product. 75% of the households in rural India are using firewood as their primary cooking fuel as compared to only 22% of the urban population.[4]

Disadvantage is that biomass fuel usage is associated with higher levels of indoor air pollution[5] as well as leading to environmental pollution. Here the concern is due to inefficient burning[6], improper ventilation facilities[7], and illiteracy specially among the rural population.[8]

Biomass fuel is accounting for 5-6% of the national burden of disease[9], registering 0.6 million premature deaths per year. Indoor air pollution, ranked the 10th preventable risk factor[10] and solid fuel smoke being responsible for almost 1.5 to 2 million premature death, with more than 99% of these occurring in the developing countries.[11]

Smoking causes decrease in pulmonary functions, a known preventable risk factor for the development of chronic obstructive pulmonary disease (COPD), cardiovascular diseases and cancer with increased mortality.[12] 7 million annual deaths with 86% of them from direct tobacco use.[13] Among 1.1 billion smokers, the majority were living in low- and middle-income countries, where the morbidity and mortality is high.[14]

Lung function tests are designated to identify and quantify the abnormalities in lung function. It includes several tests like spirometry, static lung volume measurement, diffusing capacity for carbon monoxide, airway resistance studies, respiratory muscle strength, and arterial blood gases etc., In our study, pulmonary functions were measured by a forced vital capacity (FVC) manoeuvre on a computed spirometer with automated quality checks- BTL-08 Spiro PC, manufactured by Health and Medical Industry, United Kingdom.

To quantify the effects of biomass fuel smoke and tobacco smoke on the lung function, two different exposure indexes were used. Biomass exposure index[15] was calculated by multiplying the average hours spent on cooking per day and the number of years spent in cooking. Smoking index[16] was calculated by multiplying the average number of cigarettes/bidis smoked per day and the number of years the person had smoked.

Data has been collected after obtaining informed written consent from all the included subjects and prior approval from the institutional ethical committee. Then the parameters like age, sex, height, weight, body mass index (BMI), type and duration of exposure (biomass fuel smoke or tobacco smoke), blood pressure (BP), pulse rate (PR), temperature, and pulmonary function test (PFT) indices were obtained and recorded.

The present study was conducted in the Department of Physiology in collaboration with Department of Respiratory Medicine, Bhagat Phool Singh Government Medical College for Women and associated hospital, Khanpur Kalan, Sonepat. The study was carried out on 200 subjects between the age group of 18 - 45 years, and were divided into two case groups with 50 subjects in biomass smoke exposed (persons using biomass as the fuel for cooking) group and 50 subjects in tobacco smokers' (active current smoker[17] who had smoked 100 cigarettes/bidis in his lifetime) group with 50 controls in each group, and PFT indices were obtained before and after giving bronchodilator and others who were not willing and having end stage diseased subjects were excluded. The obtained p-value < 0.05 was considered as statistically significant. All the statistical analysis was carried out by using Microsoft excel and standard statistical software (IBM Statistical Package for the Social Sciences (SPSS), Statistics for Windows, Version 20.0. Armonk, NY: USA).

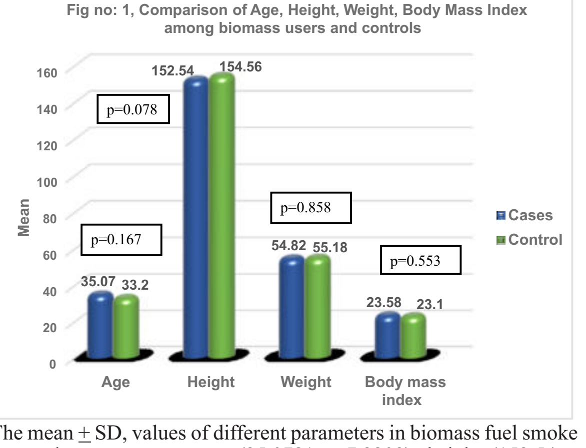
OBSERVATION:

Table no-1

Comparison of Age, Height, Weight, Body Mass Index among biomass users and controls

S. No	Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
1	Age (years)	35.0781 ± 7.3209	33.2031 ± 7.9525	0.167
2	Height (cm)	152.5468 ± 6.2384	154.5625 ± 6.6377	0.078
3	Weight (kg)	54.8281 ± 12.2507	55.1875 ± 0.5075	0.858
4	Body Mass Index (kg/m^2)	23.5859 ± 5.0108	23.1 ± 4.221	0.553

(*p<0.05 – Significant; p>0.05 – not significant)



The mean ± SD, values of different parameters in biomass fuel smoke exposed women were, age (35.0781 ± 7.3209), height (152.54 ± 6.2384), weight (54.82 ± 12.2507) and body mass index (23.5859 ±

5.0108). And, in control women using other types of fuels their mean ± SD values were age (33.2031 ± 7.9525), height (154.5625 ± 6.6377), weight (55.1875 ± 0.5075) and body mass index (23.1 ± 4.221) - (table and fig no: 1).

The mean value of biomass exposure index was 96.2031 ± 44.5792.

Fig no: 2, Comparison of predicted FEV_1 among biomass users and controls

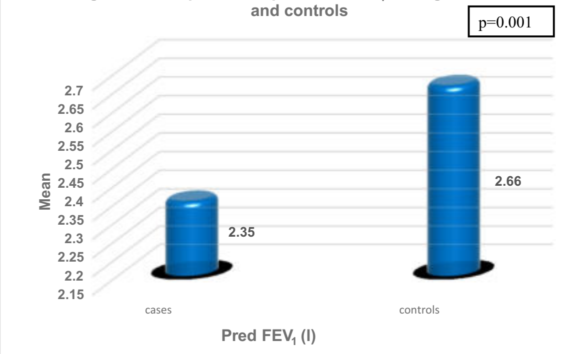


Fig no: 3, Comparison of predicted FEV_1 % (post bronchodilator) among biomass users and controls

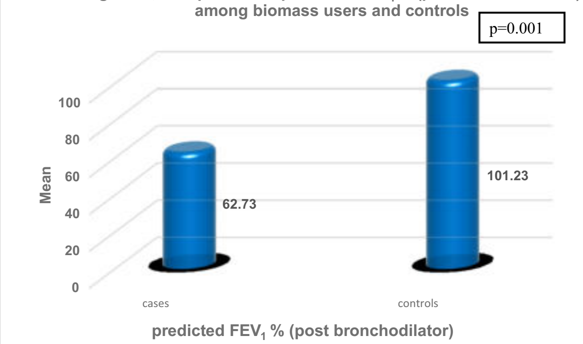


Table no: 2
Comparison of predicted FEV_1 and predicted FEV_1 % (post bronchodilator) among biomass users and controls

S. No	Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
1	Predicted FEV_1 (l)	2.3553 ± 0.3471	2.6641 ± 0.5215	0.001*
2	Predicted FEV_1 % (postbronchodilator)	62.7345 ± 24.4931	101.2313 ± 8.1611	0.001*

(*p<0.05 – Significant; p>0.05 – not significant)

The mean ± S.D, values of predicted FEV_1 in biomass fuel users and in controls were (2.3553 ± 0.3471) & (2.6641 ± 0.5215) respectively (table and fig no: 2). On comparison between them, statistically significant difference (p<0.05) was found.

The mean ± S.D, values of predicted percentage of post bronchodilator FEV_1 in biomass cases and controls were (62.7345 ± 24.4931) & (101.2313 ± 8.1611) respectively (table no: 2, and fig no: 3). On comparison between them, statistically significant difference (p<0.05) was found.

Table no: 3
Comparison of predicted FVC and predicted FVC % (post bronchodilator) among biomass users and controls

S. No	Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
1	Predicted FVC (l)	2.6927 ± 0.3598	2.7706 ± 0.4873	0.305
2	Predicted FVC % (postbronchodilator)	93.3754 ± 25.7915	99.0780 ± 9.3571	0.098

(*p<0.05 – Significant; p>0.05 – not significant)

The mean ± S.D, values of predicted FVC in biomass fuel users and in controls were (2.6927 ± 0.3598) & (2.7706 ± 0.4873) respectively (table no: 3, and fig no: 4). On comparison between them, no significant difference (p>0.05) was found.

The mean ± S.D, values of predicted percentage of post bronchodilator FVC in biomass cases and controls were (93.3754 ± 25.7915) & (99.0780 ± 9.3571) respectively (table no: 3, and fig no: 5). On comparison between them, no significant difference (p>0.05) was found.

Fig no: 4, Comparison of predicted FVC among biomass users and controls

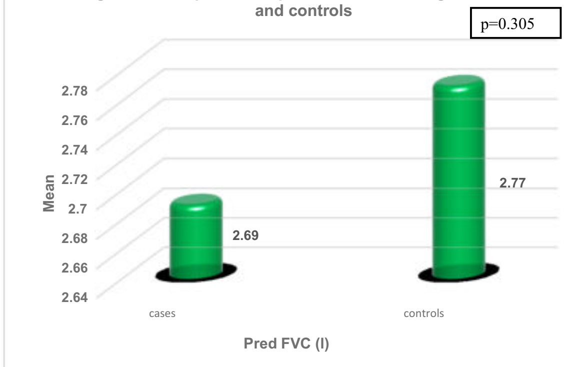


Fig no: 5, Comparison of predicted FVC % (post bronchodilator) among biomass users and controls

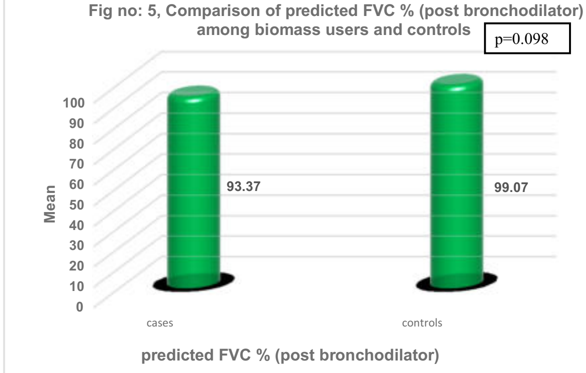


Table no: 4
Comparison of predicted FEV_1/ FVC and predicted FEV_1/FVC % (post bronchodilator) among biomass users and controls

S. No	Parameter	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
1	Predicted FEV_1/ FVC (%)	82.2045 ± 1.4967	83.0502 ± 2.1150	0.010*
2	Predicted FEV_1/FVC % (postbronchodilator)	67.1852 ± 13.4924	102.2309 ± 5.2750	0.001*

(*p<0.05 – Significant; p>0.05 – not significant)

The mean ± S.D, values of predicted FEV_1/FVC in biomass fuel users and in controls were (82.2045 ± 1.4967) & (83.0502 ± 2.1150) respectively (table no: 4, and fig no: 6). On comparison between them, statistically significant difference (p<0.05) was found.

The mean ± S.D, values of predicted percentage of post bronchodilator FEV_1/FVC in biomass cases and controls were (67.1852 ± 13.4924) & (102.2309 ± 5.2750) respectively (table no: 4, and fig no: 7). On comparison between them, statistically significant difference (p<0.05) was found.

Fig no: 6, Comparison of predicted FEV_1 /FVC among biomass users and controls

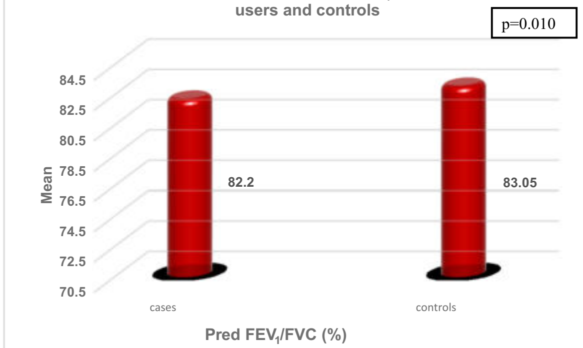


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Fig no: 7, Comparison of predicted FEV_1/FVC % (post bronchodilator) among biomass users and controls

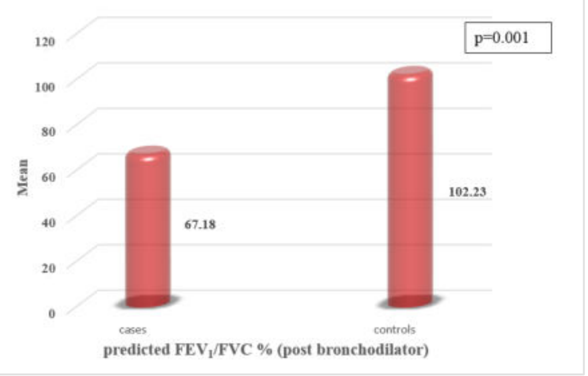

Table no: 5
Comparison of Age, Height, Weight, Body Mass Index among tobacco smokers' and controls

S. No	Parameter	Cases (Mean + SD)	Controls (Mean + SD)	p-value
1	Age (years)	37.9375 + 7.5758	35.8401 + 7.90834	0.127
2	Height (cm)	166.4063 + 6.6301	167.9531 + 5.7388	0.160
3	Weight (kg)	58.0625 + 11.7809	60.7500 + 10.23892	0.169
4	Body Mass Index (kg/m^2)	20.9000 + 3.6738	22.0491 + 3.3239	0.064

(*p<0.05 – Significant; p>0.05 – not significant)

The mean + SD, values of different parameters in tobacco smokers' were, age (37.9375 + 7.5758), height (166.4063 + 6.6301), weight (58.0625 + 11.7809) and body mass index (20.9000 + 3.6738). And, in controls their mean + SD values were age (35.8401 + 7.90834), height (167.9531 + 5.7388), weight (60.7500 + 10.23892) and body mass index (22.0491 + 3.3239) - (table no: 5 and fig no: 8).

The mean value of smoking index was 503.97 + 241.741.

On comparison, there was no significant difference (p>0.05) found in age, height, weight and body mass index, between tobacco smokers' and controls.

Fig no: 8, Comparison of Age, Height, Weight, Body Mass Index among tobacco smokers' and controls

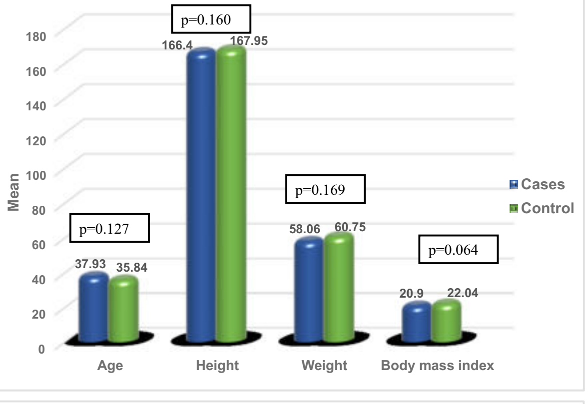

Fig no: 9, Comparison of predicted FEV_1 among tobacco smokers' and controls

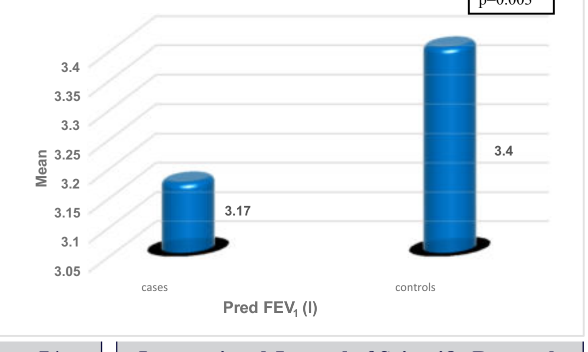

Fig no: 10, Comparison of predicted FEV_1% (post bronchodilator) among tobacco smokers' and controls

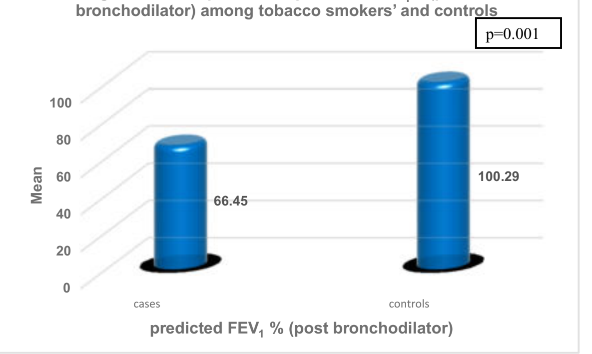

Table no: 6
Comparison of predicted FEV_1 and predicted FEV_1 % (post bronchodilator) among tobacco smokers' and controls

S. No	Parameter	Cases (Mean + SD)	Controls (Mean + SD)	p-value
1	Predicted FEV_1 (l)	3.1777 + 0.39001	3.4011 + 0.4305	0.003*
2	Predicted FEV_1 % (postbronchodilator)	66.4526 + 16.4829	100.2967 + 8.3496	0.001*

(*p<0.05 – Significant; p>0.05 – not significant)

The mean + S.D, values of predicted FEV_1 in tobacco smokers' and in controls were (3.1777 + 0.39001) & (3.4011 + 0.4305) respectively (table no: 6, and fig no: 9). On comparison between them, statistically significant difference (p<0.05) was found.

The mean + S.D, values of predicted percentage of post bronchodilator FEV_1 in tobacco smokers' and controls were (66.4526 + 16.4829) & (100.2967 + 8.3496) respectively (table no: 6, and fig no: 10). On comparison between them, statistically significant difference (p<0.05) was found.

Table no: 7
Comparison of predicted FVC and predicted FVC % (post bronchodilator) among tobacco smokers' and controls

S. No	Parameter	Cases (Mean + SD)	Controls (Mean + SD)	p-value
1	Predicted FVC (l)	3.7905 + 0.4584	3.9442 + 0.4133	0.048*
2	Predicted FVC % (postbronchodilator)	96.1285 + 18.2176	98.2523 + 9.5359	0.410

(*p<0.05 – Significant; p>0.05 – not significant)

The mean + S.D, values of predicted FVC in tobacco smokers' and in controls were (3.7905 + 0.4584) & (3.9442 + 0.4133) respectively (table no: 7, and fig no: 11). On comparison between them, statistically significant difference (p<0.05) was found.

The mean + S.D, values of predicted percentage of post bronchodilator FVC in tobacco smokers' and controls were (96.1285 + 18.2176) & (98.2523 + 9.5359) respectively (table no: 7, and fig no: 12). On comparison between them, no significant difference (p>0.05) was found.

Fig no: 11, Comparison of predicted FVC among tobacco smokers' and controls

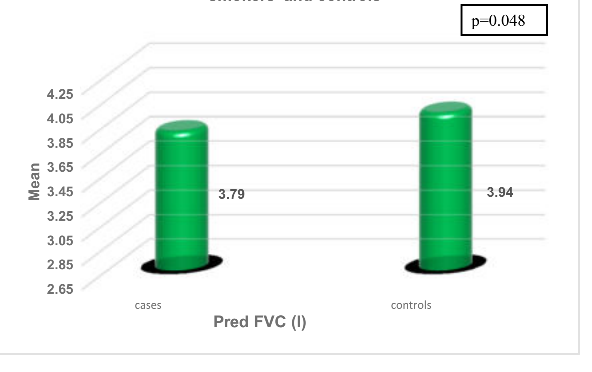

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Fig no: 12, Comparison of predicted FVC % (post bronchodilator) among tobacco smokers' and controls

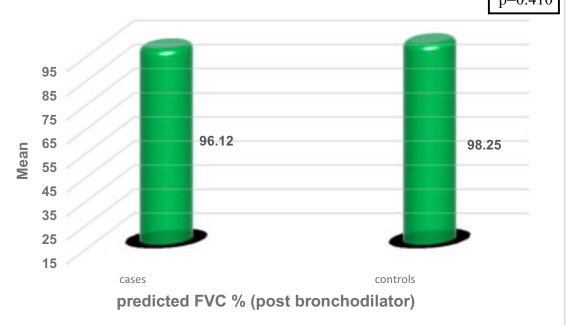


Table no: 8
Comparison of predicted FEV_1/ FVC and predicted FEV_1/FVC% (post bronchodilator) among tobacco smokers' and controls

S. No	Parameter	Cases	Controls	p-value
1	Predicted FEV_1/ FVC (%)	80.3484 ± 1.5070	80.5783 ± 1.3173	0.360
2	Predicted FEV_1/FVC % (postbronchodilator)	69.1289 ± 9.6093	103.0150 ± 5.7404	0.001*

(*$p<0.05$ – Significant; $p>0.05$ – not significant)

The mean ± S.D, values of predicted FEV_1/FVC in tobacco smokers' and in controls were (80.3484 ± 1.5070) & (80.5783 ± 1.3173) respectively (table no: 8, and fig no: 13). On comparison between them, no significant difference ($p>0.05$) was found.

The mean ± S.D, values of predicted percentage of post bronchodilator FEV_1/FVC in tobacco smokers' and controls were (69.1289 ± 9.6093) & (103.0150 ± 5.7404) respectively (table no: 8, and fig no: 14). On comparison between them, statistically significant difference ($p<0.05$) was found.

Fig no: 13, Comparison of predicted FEV_1/FVC among tobacco smokers' and controls

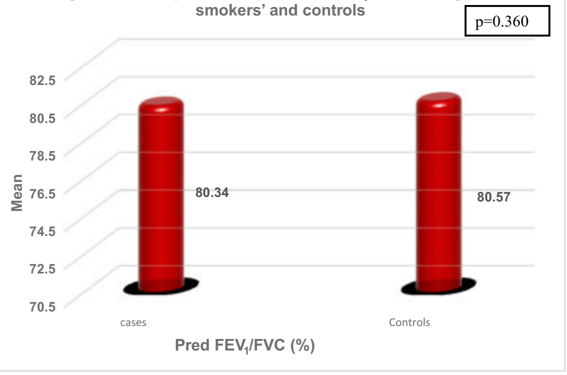
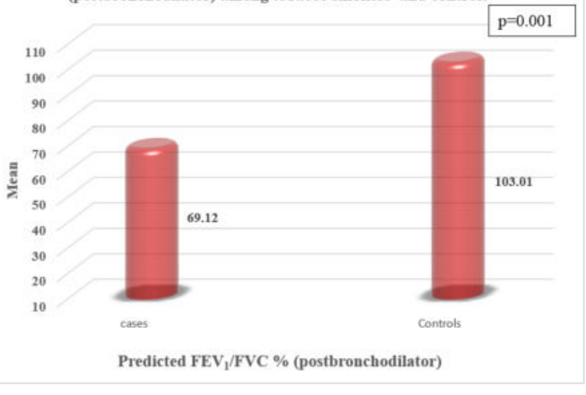


Fig no: 14, Comparison of predicted FEV_1/FVC % (postbronchodilator) among tobacco smokers' and controls



Discussion: Inefficient combustion of biomass fuels[18] being major responsible for generating a higher concentration of solid indoor particle.[19] A biomass exposure index[15] and Smoking index[16] were calculated to see the effect of duration of biomass fuel exposure and tobacco smoke on lung function parameters respectively by comparing the pre and post bronchodilator values between the cases and controls.

Our study revealed that the values of predicted FEV_1 and predicted percentage of post bronchodilator FEV_1 was significantly ($p<0.05$) reduced in biomass fuel smoke exposed group and strong negative correlation was found between biomass exposure index[15] and predicted FEV_1, FVC in comparison to the controls and a significant reduction in predicted FEV_1/FVC and predicted percentage of post bronchodilator FEV_1/FVC in biomass fuel exposed groups. Our findings corroborate with, Regaldo[18] et al., and Filip Mejza[20] et al., where they found FEV_1/FVC ratio was lower in women cooking with wood stoves than in those cooking with gas stoves.

The values of predicted FEV_1, predicted percentage of post bronchodilator FEV_1 and FEV_1/FVC has been significantly reduced ($p<0.05$) in tobacco smokers' and predicted $FEV_1$and FEV_1/ FVC has significant weak negative correlation with smoking index.[16]

We found that predicted FVC, predicted percentage of post bronchodilator FVC did not show any significant difference ($p>0.05$) between tobacco smokers' and controls.

The present study is in agreement with some of the earlier studies by Rubeena Bano[10] et al., and Hani[21] et al., and found significant statistical difference between FEV_1, FEV_1/FEV%, PEFR among smokers.

On comparison between biomass fuel users and tobacco smokers', we found that the values of predicted FEV_1, FVC, and FEV_1/FVC was significantly lesser ($p<0.05$) in biomass fuel users than tobacco smokers'.

The airway obstruction causing gradual deterioration of lung function is due to histopathological lung changes like septal enlargement, fibrosis, bronchitis, glandular hyperplasia, and goblet cell metaplasia.[22] Reduction of the forced expiratory lung function parameters indicates an obstructive type of lung disease. The higher mean biofuels exposure index attribute to reduced lung function in rural women.[23] The gases evolved from the biomass fuels which contain toxic materials can be another reason for deteriorated lung capacities.[24,25]

Our study reveals that biomass fuel smoke is more hazardous than tobacco smoke due to its prolonged exposure in biomass fuel users. Perhaps, it may be due to humongous exposure of soot particles as well as smoke in biomass smoke exposed population in comparison to tobacco smokers' in terms of hours of exposure.

Conclusion and Result: Our research shows that biomass fuel not only affecting the airway in the form of reduced FEV_1; but also affecting the lung parenchyma in the form of decreased FVC in comparison to tobacco smokers'.

And so, it seems that the biomass fuel smoke impact on the lung function is more hazardous than that of the tobacco smoke from our study.

It also suggests parenchymal lung disease, which may be due to initial fibrosis, similar to the earlier studies by Bunyamin Sertogullarindan[26] et al., and RM Rivera[27] et al., needs further evaluation.

We have taken the reproductive age group to conclude that the quality of life also been compromised in the form of lung diseases, due to the exposure of either type of smoke, and the major portion of women spending their life on household activities especially for cooking making them to be exposed to biomass fuel smoke in terms of hours was more in comparison to men, vastly who are all tobacco smokers and as well having an outside job.

So, in future policies can be formulated in such a way, as to decrease the dependency on biomass fuel by making policies and welfare schemes, as well as have to improve the education system to make them understand about the ill effects, and we medical fraternities can give a hand to the law makers to come out with a solution to culminate the exposure of both the smoke.

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