

Association Of Biomass Fuel Smoke Exposure And COPD In Women Of Rural India – A Cross Sectional Hospital Based Study

Anand Agrawal*, Uma Garg**, Chandermani Madan***, Shikha goel****

* Assistant professor & Head, Department of Respiratory Medicine., **Professor & Head , Department of ENT,
Junior Resident ,Department of Respiratory Medicine., * Demonstrator Department of Microbiology, , BPSGMCW Khanpur Kalan
Sonepat ,(PBDSUHS,Rohtak) Haryana

Abstract : Background and Objectives: Commonly used biomass fuel in developing world is equally harmful for lung health as tobacco smoke and unfortunately it is increasing the prevalence of chronic respiratory diseases like COPD specially among women of rural India. Study conducted to find out the prevalence of COPD among biomass users and epidemiological factors associated with excess use of biomass fuel in our country. **Methods:** A cross sectional questionnaire based epidemiological hospital based study . A study was conducted among hospital visited women >18 years of age belonging to rural areas of Haryana. Questionnaire was filled to get the relevant information and complete clinical examination and pulmonary function test was done to make the diagnosis. Collected data was compiled and analysed by using standard statistical methods as Chi square test, $p < .05$ consider as significant, RR risk with 95% CI also calculated. **Results:** 560 subjects were included in the study, out of them 494 (88.21%) were biomass users, literacy rate was very poor among biomass users 105 (21.26%), than non users .COPD was observed as commonest chronic respiratory problem in biomass users 75.40% than non users , RR was 1.43 (95%CI 1.31-1.55) and it was in more severe form in subjects who were exposed for prolonged period of biomass smoke. **Conclusion:** Study shows that risk of COPD increases by the constant exposure of biomass smoke in under ventilated houses and it was also found that the severity of diseases also increase with duration of exposure. [Agrawal A et al NJIRM 2013; 4(4) : 11- 17]

Key Words: COPD, Biomass Smoke, Lung health, Rural.

Author for correspondence: Dr. Ananad Agrawal, Assistant professor & Head, Department of Respiratory Medicine , BPSGMCW Khanpur Kalan Sonepat Haryana .Email. ashidocbps@yahoo.com

Introduction: Around 1/3 of the world population is exposed to high concentration of solid fuel smoke , generated by the inefficient burning of biomass fuel, predominantly in the rural areas of developing world¹. Although the evidence of using biomass fuel by our ancestors was found 5,00,000 years ago in China, but still in 21st century, 90% of developing world is using wood, cow dung, and agricultural residue as prime source of energy². Biomass smoke is equally harmful as tobacco smoke in under ventilated houses and causes COPD^{3,4}. According to WHO report indoor air pollution is considered as 10th preventable risk factor in the world and 4th in the developing countries, as contributing to global burden of diseases⁵. Beside this, 1.5 to 2 million deaths are attributed to biomass smoke worldwide. Out of them 0.6 million deaths /year in our country. It is projected that by 2020 COPD will rank fifth for burden of diseases and third with respect to mortality^{6,7}. Unfortunately the indoor air pollution is not much highlighted as a factor for respiratory problem like COPD, but for last two decades the increasing number of women having respiratory ailment drag the interest of researchers

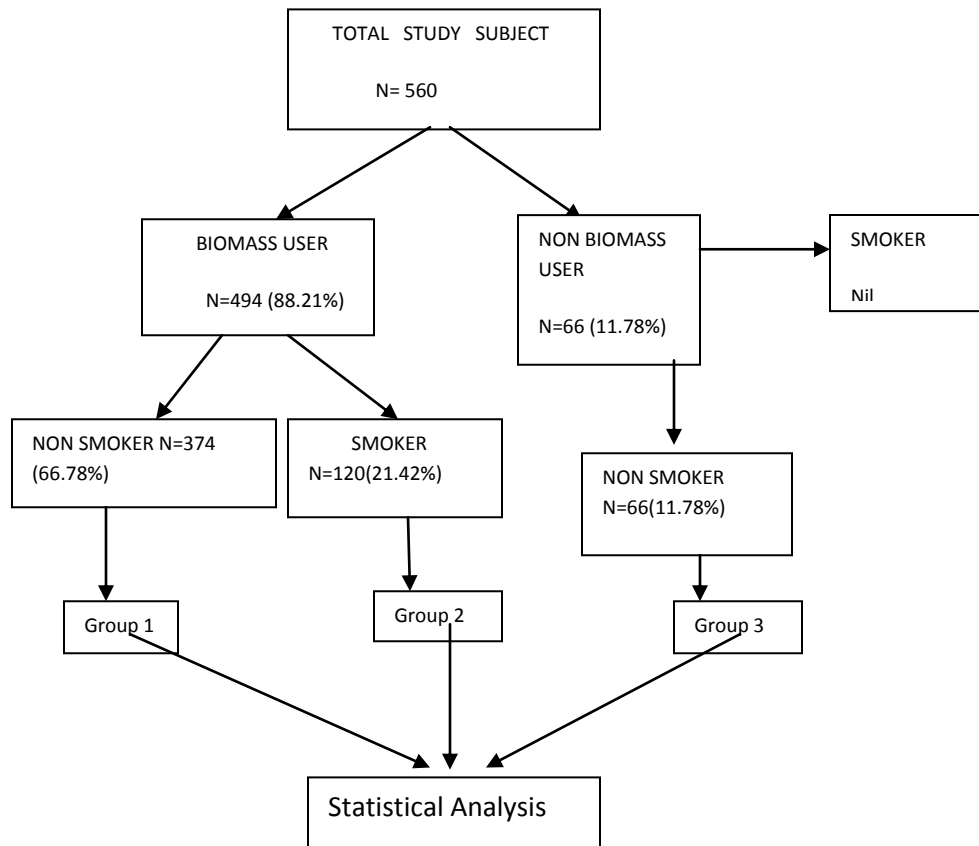
to explore the impact of hazardous biomass smoke on lung.

Material & Methods: A questionnaire based cross sectional study was designed in the Department of Respiratory Medicine, after the approval taken by ethical committee of our institute to find out the Hospital based prevalence of chronic Respiratory diseases among biomass fuel users and its impact on lung function. Only the female patients belonging to rural as well as urban areas visited to various OPD s like Respiratory medicine, General Medicine ,ENT, Dental, Gynaecology, Surgery, having age more than 18 years, during September 2012 to February 2013 were included randomly with written consent . Complete predesigned and pretested per forma was filled including the information regarding the personal profile with duration of exposure of biomass fuel, type of fuel, position of kitchen , no. of members in one room, common symptoms and detailed smoking history was also taken, if she has any respiratory problem detailed Clinical examination and Pulmonary function test was performed only once by Trained Resident doctor in the Department of Respiratory

Medicine by using pulmonary function equipment (BTL -08 spiro PC ,manufactured by Health and Medical Industry, United Kingdom, calibration 03-jun-13/003-0031080) ,with pre and post broncho dilation to confirm the diagnosis and staging

based on the criteria of global initiative for chronic obstructive lung diseases 2010 guideline (<http://www.goldcopd.org/>) in required subjects and minimum two visits of the patients were needed to collect complete information .

STUDY DESIGN



Data collected, compiled and analysed by using software SPSS version 20. , we computed the percentage of patients of each group and compared difference in proportion of biomass users and non users by using the χ^2 (Chi square test) . $p < 0.05$ consider as statistically significant. Relative risk with 95% confidence interval calculated.

Result: A total number of 560 female subjects were included in the study who visited in various OPDs , Out of them 494 (88.21%) were biomass users and only 66 (11.78%) were non biomass users. Subjects having smoking habit 120(21.42%) were all biomass users also , only 374 (66.78%)

were non smoker, smoking considered as confounding factor for COPD hence only non smoker biomass users compared with non smoker non biomass users subjects to calculate the relative risk among biomass users and non users. The prevalence of COPD in biomass users was 75.40% (282) ,and only 27.27 % (18) were found in non biomass users RR 1.43 (95% CI 1.31 to 1.55)other diseases like URTI, LRTI, Bronchial Asthma were more prevalent in non biomass users. After thorough analysis it was found that the subjects who were exposed less than 10 years of biomass fuel having mild grade (GOLD 1) of obstruction in majority 93.48% , none having severe obstruction(GOLD4) Contrary to this in the

Table1. Distribution of patient on basis of health outcome in Biomass users and non users

SN	Health outcome	Biomass user Group 1, N=374	Non biomass user Group 3, N=66	RR with 95% CI
1	COPD	282 (75.40%)	18 (27.27%)	1.43 (1.31-1.55)
2	LRTI	32 (8.55%)	19 (28.78%)	0.70(0.50-0.92)
4	URTI	45 (12.03%)	17 (25.75%)	0.84(0.69-0.99)
5.	Bronchial Asthma	15(4.01%)	12 (18.18%)	0.64(.47-.81)
6	History of Tuberculosis	80 (21.39%)	7 (10.60%)	1.10(1.02-1.18)

subjects exposed to prolonged biomass smoke having more severe obstruction 25% than others shown in Table 2.

Table2. COPD severity categorised on basis of biomass smoke exposure

SN	Duration of exposure (Yrs)	No. Of subject	Mild COPD(GOLD 1) (FEV 1 >80%, fev1/fvc<.70)	Moderate COPD (GOLD 2) (FEV 1 50-80%)	Severe COPD (GOLD 3) (FEV1 30-50%)	Very Severe COPD (GOLD4) (FEV1 <30%)
1.	≤10	46	43(93.48%)	3 (6.52%)	-	-
2.	11-20	43	24 (55.81%)	18 (41.86%)	1 (2.32%)	-
3.	21-30	98	48 (48.98%)	25 (25.5%)	20 (20.41)	5(5.10%)
4.	31-40	49	27 (55.10%)	12 (24.49%)	6 (12.24%)	4 (8.16%)
5.	41-50	38	6 (15.79%)	28 (73.68%)	1 (2.63%)	3 (7.89%)
6.	>50	8	-	6 (75%)	-	2 (25%)
	Total	282	148 (52.48%)	92(32.62%)	28 (9.92%)	14 (4.96%)

Cough , dyspnoea and chest tightness were more commonly found in biomass users than non users, demographic data comprises in three groups as per their biomass exposure and smoking habit, as biomass users 374 (66.78%) Group 1 , biomass users with smoking habit 120 (21.42%) Group 2 and non biomass users and non smokers 66(11.78%) Group3 . Group 2 subjects having age more than 50 years (55.83%) were more frequent and it was found that young females were not commonly associated with smoking habit in our study. In group 3 all the subjects in various age group were equally distributed. Most of the biomass users either non smokers or smokers were residing in rural areas (91.44%) and (86.66%),contrary to this non biomass users were mostly residing in urban areas (72.72%). It was also found that the subjects who were using biomass fuel were more illiterate 80.75% than non biomass users 21.21%,besides this only 27.5% literate subjects indulge in various type of smoking, rest

were illiterate. The trend of using biomass fuel was observed in low socioeconomic strata and only 25.75% using safe fuel p<.05.shown in Table 3.

Wood and cow dung was most commonly used fuel type in all biomass users in this region and wood coal least commonly used fuel type as shown in Table 3. About 49.80% subject having their kitchen outside in separate room, and 23.28% of kitchen was inside the living area . Smoking habit in women is also very significant around 120 (21.42%) ,Bidi 37.5% , as well as Hookah 37.5% commonly used by middle age female , the commonest reason for starting smoking was found as Peers pressure , other factors like advised by local quack ,and starting out of curiosity was also significant as shown in Table 3. Usual age of starting of smoking was >30 years in 64.16%.

Discussion: Globally rising the number of COPD patients not only among smokers but also in the female who were never exposed to tobacco **Table**

3. Demographic characteristic of study subjects in different Group.

S.N.	Parameter	Category	Group 1 (G1) (Biomass user n=374)	Group 2 (G2) (Biomass user with smoking habit N=120)	Total Biomass User G1+G2 N=494	Group 3 (G3) (Non biomass users N=66)	P Value	Total Study subject G1+G2+G3 N=560
1.	Age	<30 30-50 51-70 >70	104 (27.80%) 166(44.38%) 99(26.47%) 5 (4.16%)	Nil 43(35.83%) 67(55.83%) 10(8.33%)	104(21.05%) 209(42.30%) 166(33.60%) 15(3.04%)	25(37.87%) 24(36.36%) 17(25.75%) Nil	P>.05	129(23.03%) 233(41.60%) 183(32.67%) 15 (32.67%)
2.	Marital status	Married Unmarried	351(93.85%) 23 (6.14%)	120 (100%) nil	471(95.34%) 23(4.66%)	58(87.87%) 8 (12.12%)	P>.05	529(94.46%) 31(5.53%)
3.	Habitat	Rural Urban	342(91.44%) 32 (8.55%)	104 (86.66%) 16 (13.33%)	446(90.28%) 48(9.72%)	18 (27.27%) 48 (72.72%)	P<.05	464(82.85%) 96(17.4%)
4.	Education	Literate Illiterate	72 (19.25%) 302 (80.75%)	33(27.5%) 87(72.5%)	105(21.26%) 389(78.74%)	52 (78.78%) 14 (21.21%)	P<.05	157(28.03%) 403(71.96%)
5.	Socioeconomic status	Very low Low Fair	264 (70.58%) 97 (25.93%) 13 (3.47%)	82 (68.33%) 34 (28.33%) 4 (3.33%)	346(70.04%) 131(26.52%) 17(3.44%)	17 (25.75%) 49 (74.24%) NIL	P<.05	363(64.82%) 180(32.14%) 17 (3.03%)
7.	Type of house	Kaccha Pakka	289 (77.27%) 85 (22.72%)	59(49.16%) 61 (50.83%)	348(70.45%) 146(29.55%)	18 (27.27%) 48 (72.72%)	P<.05	366 (65.36%) 194 (34.64%)
8.	Position of kitchen	Inside Separate room Outside	93 (24.87%) 211 (56.42%) 70 (18.72%)	22(18.33%) 54 (45%) 44 (36.67%)	115(23.28%) 265(53.64%) 114(23.08%)	17(25.76%) 49(74.24%) NIL		132(23.57%) 314(56.07%) 114(20.36%)
9.	Person per room	>3 <3	306 (81.81%) 68 (18.18%)	74 (61.67%) 46 (38.33%)	380(76.92%) 114(23.08%)	37 (56.06%) 29 (43.93%)		417(74.46%) 143 (25.53%)
10.	Type of fuel	Wood Cow dung Both Agricultural residue Wood coal	40 (10.69%) 26 (6.95%) 293(78.34%) 14 (3.74%) 1 (0.26%)	15 (12.5%) 18 (15%) 80 (66.66%) 5 (4.16%) 2 (1.66%)	55(11.13%) 44(8.91%) 373(75.51%) 19(3.85%) 3(0.60%)	- - - -		

Table4: Detail of various study on exposure of biomass smoke and health outcome⁹

S.N	Outcome	Study references	Exposure	Reported range of OR/RR
1.	COPD	Behera et al , Descriptive study. Qureshi et al , Case control study Kurmi et al ,review and meta analysis June Y.T Po , review and metaanalysis	Cooking with solid fuels	3.04 (2.15-4.31) 2.10 (1.50-2.94) 2.80 (1.85-4) 2.40(1.47-3.93)

smoke, specially in developing countries due to heavy exposure of noxious biomass smoke responsible for the damaging lung defence. Frequent use of biomass fuel generally related to areas like rural side where the availability of such type of substances is rather common and they don't have other option may be due to poverty which is very high among biomass users as well as lack of knowledge about the injurious impact of it, as literacy rate in study subjects was also very low. It was found that 88.21% subjects were using biomass fuel in this region, close to national data which was 90% for rural areas⁷, wood and cow dung 75.50% was commonly used fuel type ,probably due to its frequent availability in this region. Among all the subjects 71.25% were suffering from COPD, in which 68.03% were using biomass fuel, the relative risk after exclusion of smokers subject was 1.43 (95%CI 1.31-1.55). Kiraz K. et al⁸ also reported that COPD was more prevalent in rural women although this figure is quite less than our study because it was field study contrary to this our study was hospital based and included only the diseased female population .Salvi SS.et al.⁴ Significantly reported that 25-45% of patients with COPD have never smoked and biomass smoke is biggest risk factor for COPD. Relative risk was near to other studies conducted in various parts of the world as shown in Table 4.

Gupta A . et al. reported that bronchial anthracofibrosis was observed in elderly housewives in rural areas with prolonged exposure to biomass fuel and was associated with respiratory diseases like tuberculosis, chronic obstructive pulmonary diseases, pneumonia and malignancy¹⁰. Desalu O O et al also observed that

the women using biomass fuel having more chances of chronic bronchitis as well as more vigorous presentation with cough ,wheeze, chest tightness and breathlessness like in our study¹¹. Women living in rural areas were using biomass fuel more frequently than those who were living in urban areas . Majority of biomass fuel users belong to very low socioeconomic strata in comparison to non biomass users shown in Table 3. Fullerton D.G. et al. also observe the association of poverty with the use of biomass fuel¹².

It was also found that literacy rate among biomass users was very less than non biomass users, besides this over all literacy rate in all study subjects was also very less than average national figure 65.5% according to census report 2011¹³ and obviously lack of knowledge about the hazardous impact of biomass fuel may be one of the factor behind the large scale use of biomass fuel in rural areas. Smoking habit was also common in poorly literate population and most of them using Bidi as well as hookah , Although peers pressure was found the most common reason to start the smoking but another important and surprising factor comes in light as advised by local quack to alleviate the problem of flatulence after pregnancy behind the starting of smoking in females of rural Haryana. Among all study subjects 1/5 were smokers, and this figure is quite high from national prevalence of smoking in female which is 1.4% mentioned in census 2011 report¹³.and 2% reported by Jindal et al in 2006¹⁴.Smoking in women was not very much supported by the society in our country and it was the probable reason of under estimation of this habit in various field studies as they hesitated to

reveal about their bad habit in front of family members.

Our study shows that the impact of biomass smoke depend on the duration of exposure as mild case of COPD found maximally in those subjects whose exposure was less than 10 years and severity increase with duration of exposure as very severe case of COPD were reported maximally in those females who were exposed >50 years to biomass smoke shown in Table 2.

Biomass smoke as well as tobacco smoke recognised as the Important factor for the precipitation of COPD because biomass smoke having all the noxious substance as found in tobacco smoke except nicotine, Particulate matter with a diameter less than 2.5μ , which is main culprit present in both type of smoke, it was also reported that approximately 76% of particulate matter air pollution occur indoor in the developing world¹, and when it enter in tracheo bronchial tree, causes mucosal inflammation resultantly narrowing of small airway and airflow limitation¹⁵, it may also cause fibrosis of mucosa and scar formation that is responsible for airway remodelling, Particulate matter also affects the immunity of the lung by killing the alveolar macrophages and decrease the clearance of mucus by affecting mucocilliary blanket^{16,17}. It was also reported that carboxyhaemoglobin concentration was two to five times higher in the blood among non-smoking biomass users female than non biomass users and it was also a major factor for other systemic cardiovascular diseases.^{18,19} Using biogas as well as natural gas significantly reduce the burden of chronic respiratory as well as other diseases and it need more further studies to prove it.

Conclusion: Biomass fuel exposure contribute substantially to the burden of diseases in India as a part of developing world. Implementing strategies to reduce or eliminate exposure is very challenging because it must consider the level of individual exposure as well as cultural and economic aspects at the individual and local levels, including the level of development, resources, technical capacity, domestic energy needs and protection of the

environment. Hence concerted effort in improving stove design and switching over to cleaner fuels or other high efficiency low emission fuels for cooking, possibly helpful in alleviating the great risk posed by biomass fuel in rural India.

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