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Research Paper

Domestic Combustion of Biomass Fuels and Respiratory Symptoms Among Women of Sonatti Village, Belagavi – A Cross Sectional Study

Medical Science

KEYWORDS : Biomass fuel, Domestic combustion, Exposure, Respiratory symptoms, Women

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ABSTRACT

Background: Exposure to indoor air pollution from the combustion of biomass fuels (wood, charcoal, animal dung, and crop wastes) and coal is a significant public health hazard predominantly affecting poor rural and urban communities in developing countries.

Objectives: To assess the association between socio-economic status, type of biomass fuel used and exposure rate to biomass generated smoke and respiratory morbidity among women involved in cooking.

Material and Methods: A cross sectional study was conducted in Sonatti village of Belagavi district. Non-smoking women aged 20 years and above who were involved in cooking were included as subjects and were interviewed using a pretested questionnaire. Observations were made on housing characteristics especially about kitchen and the cooking stove.

Results:A total of 320 non-smoking women aged 20 years and above were included in the study that revealed a significant association between respiratory symptoms in women exposed to biomass smoke and age as well as the amount of exposure to the biomass smoke.

Conclusion: The study revealed a strong association existing between age of the women and the duration of exposure to the occurrence of respiratory symptoms among women.

INTRODUCTION

Biomass fuels are the human earliest source of energy with their invention history dating back to the adoption of fire, thousands of years ago.[1] Exposure to indoor air pollution from the combustion of traditional biomass fuels (wood, charcoal, animal dung, and crop wastes) and coal is a significant public health hazard predominantly affecting the poor communities of rural and semi-urban areas in developing countries. Large numbers of people are exposed on a daily basis to harmful emissions and other health risks from biomass combustion, which typically takes place in open fires or low efficiency stoves with inadequate venting.[2]

About half of the world's households still use unprocessed solid fuels, ranging near zero in developed countries to more than 80% in the countries such as China, India and Sub-Saharan Africa.[3] Burning of biomass fuel has emerged as one of the top ten global threats to public health, as it accounts for 2.7 % of the global burden of disease. The levels of exposure to polluted air is reported to be higher in women and children since they spent most of their time indoors during cooking.[4] Indoor Air Pollution is the second largest global environmental contributor to morbidity, and it causes 2.2–2.8 million deaths annually.[5]

India has the largest burden of disease due to the use of dirty household fuels and 28% of all deaths due to indoor air pollution in developing countries occur in India as compared to other countries.[6] In rural India, nearly 90% of the primary energy is derived from biomass (wood-56%, crop residues-16%, dung-21%). 82% of the Indian population use solid fuels which attributes to 3.5% of national burden of the disease. 407,100 deaths are attributed to solid fuel use in our country every year. 106,46,500 DALYs are attributable to solid fuel use in India.[7]

Burning biomass in traditional stove (open fire, three stone stoves) of low efficiency and often with little ventilation emits smoke containing large quantities of particulate matter and gaseous pollutants such as carbon monoxide, nitrogen dioxide, sulphur dioxide, formaldehyde and dozens of toxic poly aromatic hydrocarbons such as benzopyrene. These substances have serious health consequences on the exposed population.[8]

More than 200 chemicals and compound groups have been identified in wood some, which are almost all (90%) in the inhalable size range with mean aerodynamic particulate matter diameters less than 10 mm (PM_{10}). A significant number of these wood smoke constituents are known to be toxic or irritants for the respiratory system, including respirable PM (PM_{10}), carbon monoxide (CO), nitrogen and sulfur oxides (NO_2, SO_2), aldehydes, polycyclic aromatic hydrocarbons, volatile organic compounds, chlorinated dioxins, and free radicals. Many substances can act as primary pollutants, irritants, and carcinogenic or co-carcinogenic compounds.[9]

Women and young children are most commonly affected by the noxious effects of indoor air pollution. In poor households, women typically do most of the cooking and spend most time indoors, thus they are subject to high levels of pollution both from being close to the fire, and spending longer periods of exposure in the indoor environment. Evidences from scientific studies prove that women who cook in the households, exhibit greater symptoms of respiratory illness, as do the young children they supervise. It is common to see that women handle the responsibility of collection and storing of biomass fuels in majority of the communities in the developing world. Collection of biomass fuels is associated with a variety of mechanical injuries from felling, carrying and splitting wood, encounters with animals such as snakes and scorpions, violence, and exposure to vectors of a number of infectious diseases.[10]

Domestic cooking is one of the important functions of the average Indian house wife. On an average, an Indian housewife spends about six hours each day in the kitchen for cooking food and other purposes. She is exposed to the fuel at an early age of

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about 15 years or less which means during her lifetime, she is exposed for 30 to 40 years equivalent to 60,000 hours.[11] Moreover, fires from biomass fuels require more or less continual feeding, resulting in extended exposure to their smoke.

Most of people are exposed for three to seven hours daily, and even longer in winter months when houses must also be heated. The elderly and expectant women are also more susceptible. Susceptibility is exacerbated by malnutrition, poor living standards, overcrowding and exposure to disease through poor sanitation in rural areas.[12]

The present study was designed to know the association between socio-economic status, type of biomass fuel and exposure rate to biomass generated smoke and respiratory symptoms among women involved in cooking.

MATERIALS AND METHODS

The present study is a community based cross sectionalstudy which was primarily conducted to assess the association between exposure to biomass smoke and adverse respiratory symptoms among non-smoking women in Sonatti village, Belagavi district, Karnataka. The study was approved by JNMC Institutional Ethics Committee on Human Subjects Research.Universal sampling was used to achieve at a sample size 320 women. All non-smoking women aged 20 years and above involved in cooking were included in the population.

Care was taken to avoid the confounding effects of tobacco smoking on the respiratory health of women in the initial stages of designing the study. Women having history of Bronchial asthma, systemic and immune compromised diseases like HIV/AIDS and chest abnormalities like scoliosis were excluded from the study since these conditions were expected to have a confounding effect on the outcome variable.

A standard pretested questionnaire was used which was designed and adapted from National Family health Survey-3 and United Kingdom Medical Research Council (UKMRC). The data was collected through the interview and observation of the house made by the investigator at the time of the survey. An informed written consent was obtained from all the participants before collecting the data. SPSS software version 13.0 was used to measure and assess the association using chi-square test. p-value of 0.05 was fixed to ascertain the significance of the associations at 95% confidence interval.

RESULTS

Table.1 suggests that the maximum number of study subjects i.e. 101 women (31.56%) were in the youngest age group i.e. 20-25 years followed by the women above 50 years who were 61 in number (19.06%). The range was from 20 – 70 years. Nearly 91% of the study subjects were married whereas 9% were unmarried. All the 320 women were living their lives below the poverty line (BPL) and belonged to Class V of socio-economic status. Majority of the women i.e. 62.81% of them were living in joint families and 37.18% lived in the nuclear families. 91.56% of all the study subjects were illiterate and there was only one woman who had studied after her secondary education. 90.3% of subjects were house wives and there was only one woman who was employed in a factory nearby whereas about 9% remained unemployed.

TABLE.1: SOCIO-DEMOGRAPHIC PROFILE OF STUDY SUBJECTS

VARIABLE	NUMBER	PERCENTAGE (%)
AGE IN YEARS		
20 – 25	101	31.56
26 – 30	45	14.06
31 – 35	36	11.25
36 – 40	34	10.62
41 – 45	18	5.62
46 – 50	25	7.81
> 50	61	19.06
MARITAL STATUS		
Married	291	90.93
Unmarried	29	9.06
SOCIO-ECONOMIC STATUS		
Class V	320	100
TYPE OF FAMILY		
Nuclear	119	37.18
Joint	201	62.81
EDUCATION		
Illiterate	293	91.56
Primary school	22	6.87
High school	4	1.25
Post SSLC	1	0.3125
OCCUPATION		
Housewife	289	90.31
Factory worker	1	0.31
Unemployed	30	9.37
TOTAL	320	

Table.2 suggests that barring one woman, all women i.e. 319 women (99.7%) were using wood as cooking fuel. The other single woman was using dung cakes for cooking food.

TABLE.2: TYPE OF BIOMASS FUEL

VARIABLE	NUMBER	PERCENTAGE (%)
TYPE OF FUEL		
Wood	319	99.70
Dung cakes	1	0.30
TOTAL	**320**	

Table.3 clearly reveals that there is a statistically significant association between age of the women and adverse respiratory symptoms on exposure to biomass smoke. More number of women in the older age groups experienced respiratory symptoms as compared to the younger group. 45.9% of women in the age group of above 50 years had respiratory symptoms whereas only 8.91% of women the age group of 20 – 25 years. The next highest percentage of women with respiratory symptoms was found in the age group of 46 – 50, where 36% of women showed respiratory symptoms.

TABLE.3: ASSOCIATION BETWEEN AGE AND ADVERSE RESPIRATORY SYMPTOMS

AGE IN YEARS	SUBJECTS WITHOUT RESPIRATORY SYMPTOMS	SUBJECTS WITH RESPIRATORY SYMPTOMS	TOTAL (n = 320)	PERCENTAGE (%)
20-25	92	9	101	8.91
26-30	39	6	45	13.3
31-35	32	4	36	11.11
36-40	28	6	34	17.64
41-45	15	3	18	16.66
46-50	16	9	25	36.00
> 50	33	28	61	45.9
TOTAL	255	65	320	

p* = 0.0001

*** = Statistically significant**

Table.4 clearly represents statistically significant association existing between years involved in cooking and the occurrences of adverse respiratory symptoms among women. The proportion of women with respiratory symptoms increased along with a in-

crease in the total number of years spent in cooking. Of the total 136 women who were involved in cooking for more than fifteen years, 49 of them (36.02%) had respiratory symptoms.

TABLE.4: ASSOCIATION BETWEEN YEARS INVOLVED IN COOKING AND ADVERSE RESPIRATORY SYMPTOMS

YEARS INVOLVED IN COOKING	WITHOUT ANY RESPIRATORY SYMPTOMS	WITH RESPIRATORY SYMPTOMS	TOTAL (n=320)	PERCENTAGE (%)
< **2** years	6	0	6	00
2 – 5 years	47	3	50	6.00
6 – 15 years	115	13	128	10.15
> **15** years	87	49	136	36.02
TOTAL	**255**	**65**	**320**	

***p*=0.0001** *
***=Statistically significant**

Table.5 shows a statistically significant association existing between total number of hours spent in cooking per day and occurrence of respiratory symptoms. Highest proportion of women with respiratory symptoms was seen in the group which spent the maximum hours per day i.e. 4-6 hours as well as least hours per day i.e. less than 2 hours.

TABLE.5: ASSOCIATION BETWEEN HOURS INVOLVED IN COOKING PER DAY AND OCCURANCE OF RESPIRATORY SYMPTOMS

HOURS SPENT IN COOKING	WITHOUT ANY RESPIRATORY SYMPTOMS	WITH RESPIRATORY SYMPTOMS	TOTAL (n=320)	PERCENTAGE (%)
< 2 Hours	27	12	39	30.76
2-3 Hours	70	12	82	14.63
3-4 Hours	105	18	123	14.63
4-6 Hours	53	23	76	30.26
TOTAL	**255**	**65**	**320**	

p*=0.0099
***=Statistically significant**

DISCUSSION

In our study, the age of the subjects ranged from 20-70 years, with the mean age being 34.9 years and a standard deviation of 13.8 years. All the 320 women belonged to the lowest class of socio economic status. 91.5% of the women were illiterates and only 6.8% of women had completed their primary education. Almost all the women were housewives. In a similar study undertaken in Gwanda, Zimbabwe, the age of 48 subjects ranged from 16-60 years with the median age being 35 years. The study had 62.5% of married women as the subjects among whom 50% had completed their primary education and 18.7% had completed their secondary education and 27% had completed their high school.[13] In a household survey undertaken in Nepal, the mean age of the women was 36.1 years with a standard deviation of 16.7 years. 80.4% of the subjects were married and 52.4% were illiterate.[14]

Women aged 20 years and above were considered for the inclusion of subjects in order to have women in all the age groups who indulge in cooking. 320 women were almost equally represented in all the age groups with an exception of highest representation of 31.5% in 20-25 years and 19% in the above 50 years group. Sample size of 48 women in the study conducted in Gwanda, Zimbabwe was too small to assess an association between biomass fuels and respiratory symptoms. A sample size of 320 women was thought appropriate to find significant association in our study. Generally, populations with low economic status resort to biomass fuels for cooking owing to the factor of affordability and availability. Households adopting less polluted stoves and/or behavior generally do so following improvements in their socio economic circumstances–factors that are known to strongly influence many of the health outcomes studied.

Most of the women were using wood as a cooking fuel 319 (99.7%) and only one used dung cakes 1(0.30%) for cooking food. Similar results were found in a study done in Nepal of respiratory symptoms (2.5 to 4 times) using unprocessed fuels.[15]In the Mexico study, 778 women used biomass fuels and 67 women cooked with gas. The results revealed that the group of women currently using biomass fuels reported more frequent respiratory symptoms.[16]

The study showed a statistically significant association between age of the women and adverse respiratory symptoms on exposure to biomass smoke. More number of women in the older age groups experienced respiratory symptoms as compared to the younger group. 45.9% of women in the age group of above 50 years had respiratory symptoms whereas only 8.91% of women had respiratory symptoms in the age group of 20–25 years. The next highest percentage of women with respiratory symptoms was found in the age group of 46–50, where 36% of women showed respiratory symptoms. This association was in line with the results from the study conducted in India based on NFHS-II data, where in a positive effect of age on the asthmatic symptoms was found in women exposed to biomass fuels.[17] In a study conducted in Northern India, the prevalence of bronchitis symptoms was also found to be increasing with the age.[18]

Of the total 136 women who were involved in cooking for more than fifteen years, 49 of them (36.02%) had respiratory symptoms. Highest proportion (30.26%) of women with respiratory symptoms were seen in the group which spent the maximum hours per day i.e. 4-6 hours as well as 30.76% in least hours spent per day i.e. less than 2 hours. The differences were found to be statistically significant. The results of the study are in agreement with the Pakistan study on chronic bronchitis, where majority of women had cooked in the kitchen for 11-20 years.[19] The same association was found in a study conducted in Northern India, where the prevalence of asthmatic symptoms was significantly higher in females who had used biomass fuels for cooking for more than 20 years than for 1-20 years usage.[18]

CONCLUSION

The study has revealed a strong association existing between age of the women and the duration of exposure to the occurrence of respiratory symptoms among women. There is substantial baseline information on usage of biomass fuels and associated kitchen characteristics in southern India.

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