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The Assessment of Indoor Air Pollution associated with household fuel use in Bagalkot District, Karnataka, India.

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ABSTRACT

India is one of the developing countries with high incidence of traditional fuel use in the rural areas such as Wood, Dung cakes, Agricultural residues and so on. The available literature shows the traditional fuels as a major contributor for increased levels of indoor air pollution in the developing countries. Aim: To estimate the prevalence of traditional fuel use and the exposure time among people in Bagalkot District, Karnataka, India. Settings and Design: Sirur Village, Bagalkot District. A Cross-Sectional Study. Methods and Material: The sample size N=185 was calculated according to the prevalence of traditional fuel use in rural India, Prevalence=86% shown by National Sample Survey report in 2001. The total households surveyed were 215. Statistical analysis used :Data collected was analyzed using SPSS (version 16.0) package. Results: The total population in 215 houses was 1,177. The prevalence of traditional fuel use was 100%. None of the kitchen had improved stoves with the presence of outlet pipeline (flue). The average cooking hours for a day was 5.6 hours divided into three sessions (Morning- 2.5 hours, Afternoon- 1 hour and Evening- 2.1 hours). There was a significant difference found between the prevalence of tuberculosis among adults and the type of the house. (Fisher's exact test, at 0.05 level of significance). Conclusions: Women primarily cook in the rural houses using the traditional fuel and children in the age group of 0-15 years accounted for more than half of total people who were present in kitchen while cooking.

Key-words: Indoor Air Pollution, Rural fuel use, Exposure to pollution, House type, Kitchen type.

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Introduction

Indoor air pollution (IAP) is found to be a cause for various health risks to exposed population. The major sources of indoor air pollution worldwide include combustion of fuels, ventilation systems, smoking tobacco, coal, furnishings, material that builds the house and so on. The pollutant released indoors can be one thousand times more likely to affect people's lung than a pollutant released outdoors. [1]

The source of IAP varies from the developed to the developing countries. About half the population in the world still depends on biomass fuel.[2] This prevalence can go up to nearly 90% among the rural households in developing countries.[2] As far as the rural sectors of the developing country like India is concerned, the most significant cause for harmful levels of indoor air pollution is the combustion of traditional solid fuel such as wood, dung, and crop residues with poor ventilation system in the house. [3] Most of the people in the rural households depend on these traditional fuels and burn them in inefficient earthen stoves or use open pits. [3] The ventilation systems in the rural houses are poorly constructed. This also adds to the increased levels of IAP as the smoke containing various harmful contaminant gases and the dust particles don't pass out easily from the house. These levels are very important to be measured to maintain the indoor air quality according to the World Health Organization (WHO) guidelines for indoor air quality: selected pollutants 2010.

When the people in the rural villages use biomass fuels on a daily basis in their house for cooking or heating, the exposure to indoor air pollution happens together. This exposure is chronic and will have serious health consequences for household members, especially for the women who are culturally involved in cooking in the house for her family members and also the young children including infants who are usually present with their mothers.[4] The studies have shown strong associations between biomass fuel combustion and increased incidence of chronic bronchitis in women and acute respiratory infections in children in developing countries. The evidence is now emerging of links with a number of other conditions, including low birth weight, respiratory infections like asthma, tuberculosis, eye problems like cataracts, long/short sightedness and cancer of the upper airways. [5]

India has the highest burden of diseases in the World due to negative effects of indoor air pollution in the household. [6] IAP is responsible for nearly half a million women and children deaths each year in India.[6] Statistically, India alone accounts for 28% of all deaths among developing countries due to IAP. [6]

Economic status of the family plays a major role in determining the type of fuel use in the house. There can be various other factors that could determine the household fuel use and living conditions. The traditional fuel like wood, agricultural residues, dung cakes and so on are available easily and cheap so it is most popular in the rural Indian community. Other cleaner fuels like LPG, Electricity and Solar-energy are expensive. These cleaner fuels don't remain popular or used by the rural sectors in India as it's not affordable. The National Census of India surveyed about the household fuel use for the first time in 1991 and found out that 90% of the rural population used traditional biomass fuels. [7]

If we see the recent National Family Health Survey, NFHS-3 report, it has found the overall traditional fuel use to be still the same (above 90%) in the rural areas whereas it has been reduced from 78 percent in 1991 to 31 percent in 2005 among Urban Indian households.[8]

There is a need for more studies to find out the validated information on parameters such as housing type, type of fuel need and usage, exposure levels and so on which can be associated with various disease outcomes. This would help for evidence-based policy making to prevent from these avoidable exposures and to save lives of people in terms of Morbidity and Mortality caused directly or indirectly by IAP.

The present study of assessment of household fuel use in one of the rural villages in Karnataka, India, aims to document the actual fuel practices in the rural setting.

Material and Methods

All the households in Sirur Village, Bagalkot District were enumerated as eligible subjects and Simple random sampling technique was employed to select the houses. The data was collected after obtaining formal administrative permission from the Head of department, Department of Public Health, Manipal University and from the District Health Officer, Bagalkot District. The data collection was done in June-July 2011. The obtained data was tabulated and analysed using the statistical package SPSS 16.0 version for windows. Findings were described using percentages and Chi-square distribution statistics to check the association of fuel use with various associated health outcomes due to IAP.

Results

Table I : Socio-demographic Characteristics of sampled households, N=215.

Characteristics		Number	Percent
SEX	Male	599	50.9
	Female	578	49.1
AGE (years)	0-15	2	.5
	16-25	110	27.1
	26-35	110	27.1
	36-45	70	17.2
	46-55	44	10.8
	56-65	45	11.1
	66-100	25	6.2
OCCUPATION	Professional	149	12.6
	Agriculture	613	52.1
	Unemployed	254	21.6
	House wife	97	8.2
	Tailoring	62	5.3
	Blacksmith	2	.2
Literacy	Can Read or Write	Nil	
	910 (77.4%)	267 (22.6%)	
Mean household size	5.5 people per household (Range: 1 to 18 people)		
Socioeconomic Status	Above Poverty line: 76 (35.45)	Below Poverty line: 139 (64.6%)	

Table -I shows the total population in the total 215 households surveyed was 1177. The sex ratio in the population was 1036 males per 1,000 females. The total percent that can read and write was about 77.4%.

The mean household size was about 5.48 persons per household. The proportion of nuclear households was 44.2% followed by equal proportions (sharing 27.9 % each) of Joint family type and Three generation family type. The majority of houses were Semi-pucca houses 87.4% followed by Pucca houses 9.8% and Traditional mud houses 2.8%.
The prevalence of households living under Below Poverty Line (BPL) was 64.6%.

Table II: Type of Kitchen and type of House.

		N (%)
Type of Kitchen, N=215	Indoor Kitchen without partition	21 (9.8)
	Indoor Kitchen with partition	193 (90%)
	Open air kitchen outside the house	1 (0.2%)
	Separate kitchen outside the house	0 (0%)
Traditional Fuel Use	100%	
Type of House, N=215	Traditional Mud House	6 (2.8%)
	Semi pucca house	188 (87.4%)
	Pucca house	21 (9.8%)

*Adapted from NFHS 3 survey questionnaire on assessment of household and Kitchen characteristics: Houses made from mud, thatch, or other low-quality materials are called *kachha* houses, houses that use partly low-quality and partly high-quality materials are called semi-*pucca* houses, and houses made with high quality materials throughout, including the floor, roof, and exterior walls, are called *pucca* houses. Traditional fuel includes coal/lignite, charcoal, wood, straw/shrubs/grass, agricultural crop waste, and dung cakes.

Houses marked as Below Poverty Line (BPL) are those who have a BPL card issued by the Government of India.

Table II shows that the majority of the kitchens were indoor kitchen with partition which accounted for 90% of the households. Indoor kitchen without partition accounted for 10% of the households. There was one open air kitchen outside the house. The prevalence of traditional fuel use in the houses surveyed in the village was 100%. All the kitchens had at least one outlet as ventilation on the ceiling right above the stove. But none of the houses had improved stoves with the presence of outlet pipeline (flue). About 82.8% of the houses gathered traditional fuel from forests or garden. About 3.3% partly gathered and partly bought the fuel. About 15% bought it all. The mean amount paid for traditional fuel in one month was 362.43 Indian Rupees. Fuels were used for cooking food for the family and the cattle if they had any. About 50% of the households had at least one cattle (cow, buffalo or ox). The cooking hours for one day is divided into three sessions. The average cooking session in the morning was about 2.5 hours. The average cooking session in the afternoon was about an hour. The average cooking session in the evening was about 2.1 hours. Involvement of women in cooking as a main cook in the family was about 92.6%. Men involvement in cooking was 7.4%. The age group mainly helps or present in the kitchen while the head cook is cooking was between 0-15 years that accounts for 53.6% among those present in the kitchen. The prevalence of traditional fuel use in the village was 100%. 56 (26%) of the houses had cleaner fuel like LPG (Liquefied Petroleum Gas) along with the traditional fuel in their kitchen. LPG wasn't used for cooking major meals like lunch or dinner.

Table III: Relation between type of house and morbid illness

Type	Disease	P-value, 0.05 level of significance
House	Asthma	0.654
Kitchen	Asthma	0.585
House	Tuberculosis	0.032 Fisher's Exact Test
Kitchen	Tuberculosis	0.585
House	Heart disease	0.529
Kitchen	Heart disease	0.057
LPG use	Asthma	0.415
LPG use	Tuberculosis	0.373
LPG use	Heart disease	0.291

The prevalence of Asthma, Tuberculosis and Heart Disease were 8.4%, 7% and 4.6% respectively. There was a significant difference found between the prevalence of Tuberculosis and the type of house. (Fisher's Exact Test, at 0.05 level of significance, P-value 0.032, when kuchha house and semi pucca house were clubbed together as one group and Pucca house as another group). Ref Table: III

Discussion:

There is growing scientific evidence in the last few years that air pollution indoors affects health more than the air pollution outside. Research also indicates that

people spend most of their times indoors. So, for many people, the risks to health may be greater due to IAP. In order to pin down the impacts of IAP for interventions, further research on this topic is very essential.

Though most of the studies have considered the use of traditional fuel use as the major contributing factor for the indoor air pollution, there are few studies from Bangladesh which has shown that the materials used to build the house and presence of chimney in the kitchen can be also a major contributing factor for IAP[9,10]. Thus, our focus should be both on fuel use and the housing characteristics if we are to reduce the indoor air pollution levels inside the house.

As far as the studies in India is concerned, the National Family Health Survey-3 data estimated the overall traditional fuel use to be above 90% in the rural areas that remained same like in 1991, whereas, it reduced from 78% to 31% in Urban Indian households.

Upon analyzing our data it was found that all of the rural houses in Bagalkot District were dependent on traditional fuel. The report from the study in the rural villages of three study districts in Andhra Pradesh (2004)[3] also shows that the traditional fuel was was prevalent in all the rural houses. The prevalence of clean fuel use was rare in the villages in Andhra Pradesh. There was only 1 house out of the 1032 surveyed which reported using an improved stove. In our study we found that there were 56(26%) houses which used LPG gas along with the traditional fuel in their kitchen. Only 13 (23.2%) houses gave health related reasons for bringing LPG gas in their kitchen. The other reasons were such as saving time or to show the improved status symbol in the society. This clearly shows the poor level of health awareness with regard to indoor air pollution.

Out of the total 215 houses, majority of houses were semi pucca houses 87.4% (N= 188) which were with concrete walls but without concrete ceilings. The ceilings were either made of wood with mud, or tiles. NFHS-3 report shows that 51.6% of the rural houses in India were semi pucca houses.[10] Our study shows the majority of the kitchen in the house were indoor kitchen with partition which accounted for 193(90%) households. Indoor kitchen without partition accounted for 10% of the households. The study from Andhra Pradesh shows the majority of kitchen being open-air kitchen which accounted for 50.4% of the houses (N=1032)[3] .The average cooking hours for a day was 5.6 hours divided into three sessions (Morning- 2.5 hours,

Afternoon- 1 hour and Evening- 2.1 hours). About 92.6% of main cook in the family were females. The study from rural Andhra Pradesh also showed women who stayed at home cooked one large meal over a period of 1.5–2 hours.[3] Among non-cooks, we found the age group of 0-15 experience the highest exposure as they accompany their mothers while she is cooking in the kitchen. So, women who cook and children under 15 years are the ones who are at greater risk of exposure to IAP due to fuel combustion and outcome of various morbid illnesses. The studies from different parts of the world have found that there is an emerging links of IAP with the outcome of conditions such as low birth weight, asthma, tuberculosis, cataracts and cancer of the upper airways.[11] Our study also assessed the prevalence of various morbid illness among adults that have been associated with the IAP such as Asthma (8.4%), tuberculosis (7%) and Heart disease (4.6%). There was also a significant association found between the prevalence of Tuberculosis and the type of the house. (Fisher's Exact Test P=0.032), at 0.05 level of significance).

The NFHS-3 report shows that 56% of the rural households in India now have electricity.[8] Our study found that electricity was accessible to all of the houses. About 8% of the houses couldn't afford electricity due to acute poverty. These houses are dependent on wicked kerosene lamps for lighting purpose which will also have an effect on increasing indoor air pollution levels. The inter-sect oral participation of health and electricity authority can help to bring subsidised electricity bill for the farmers living below Poverty line to help them enjoy the electricity facility.

The prevalence of traditional fuel use in rural India hasn't decreased since the first Nationwide survey (NFHS) in 1991 to NFHS-3 in 2006.[7,8] It has always remained to be above 90%. What can be possibly done to improve indoor air quality in these conditions is to improve the housing and kitchen characteristics. This can be done in the form of improving the building materials of the house or give more space for chimneys in Kitchen for better smoke outlet.

The study from Bangladesh focused on developing a set of structural options.[9, 10] The experimental houses were constructed which were identical to the structures used by poor families in the area. The outcome showed that the IAP readings in those model houses were generally lower than those of other studies in rural Bangladesh.[9,10]

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