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RESEARCH ARTICLE

STUDY ON TYPES OF FUEL CONSUMPTION IN TRADITIONAL CHULHAS AND ITS IMPACT ON HEALTH IN VILLAGE BANDE OF DISTRICT BANDA

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ABSTRACT

Biomass fuel refers to burned plant or animal material, wood, charcoal, dung and crop residues. In developing countries more than half of domestic energy as much as 95% in low income countries use biomass fuel for cooking and heating purposes. Indoor air pollution is potentially a large health threat in rural regions and is also responsible for the deaths and illness of millions of young children. This paper reports the results of a survey of types of fuel consumption and health among the 150 households in village Bande of Banda district. Firewood, dung cake following by Coal, Kerosene, Agricultural waste, were found to be the major fuels consumed by the villagers. In comparison to the other fuels dry leaves, shreds of cloth, plastic, etc are also consumed as fuels but comparatively in a very less proportion. Wood of *Acacia nilotica* was found to be consumed the maximum followed by the wood of *Zizyphus mauritiana*. Wood of *Ipomoea carnea* which produce highly toxic pollutants was also found to be used in good proportion in village Bande. The wood of *Mangifera indica* was found to be consumed the minimum in this village. Approximately 27.58 % people were reported to be lung infected and 24.13% were found to suffer from the eye problems among all the other diseased people. 6.89% people were having both the eye as well as lung related problems. As a result of the detrimental impact of biomass fuel consumption on health and mortality, many governmental, non–governmental organization and international organizations have started developing strategies aiming to reduce indoor air pollution. These strategies include subsidization of clean fuel technologies, promotion and subsidization of improved cook stoves, use of solar thermal cookers and solar water heaters. To reduce pollutants level from biomass fuel, behavioural changes like processing biomass fuel to make them cleaner and improving household design should also be adopted on personal aspects.

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INTRODUCTION

Indoor air pollutants mean different harmful chemical, physical and biological factors, which come from building materials, decoration materials, furniture and living discharges emitting from the fuels used for cooking food. Biomass fuel on combustion produce different harmful chemical pollutants and increase the contents of certain toxic and hazardous substances that decrease indoor air quality and threat human health. In many rural areas indoor air pollution is even more serious problem approximately 2.5 to 3 billion people worldwide rely on traditional cooking methods to meet their household energy needs. Rural people burn fire wood, dung cake, agricultural waste, kerosene, coal and other biomass fuels which contribute to respiratory illness, lung cancer and cataract. Dependence on traditional fuel leads to higher risk of child mortality and the poverty conditions are also worsened. According to the World Health Organization (WHO, 2004), in high mortality developing countries indoor air pollution causes approximately 3.7 percent of the overall disease burden, fourth in impact after malnutrition, unsafe sex, lack of sanitation and safe water. Traditional biomass fuel effects the health and quality of life impacts. It has both direct and indirect effects in our lives. Direct effects include burns to children falling into fires, household fires and respiratory illness from indoor air pollution. Indirect effects include the opportunity cost of time spent by women and children in collection of fuel, injuries from carrying large amounts of wood, restriction on economic and educational activity due to poor air quality. These biomass fuels contains several fuel contaminants such as Sulphur / metal which also effect the health, moreover fuel wood demand contributes to greater environmental stress and in localized cases such as sub Saharan Africa thus contribute to

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forest depletion (Holdren and Smith, 2001, Schirinding *et al.*, 2002). The harmful and toxic gases released from biomass fuel combustion effects health. People may suffer from throat infection, dizziness and discomfort etc. Evidences from health records in Kericho District Hospital, prove that children over and under five most commonly suffer from respiratory tract infections (International Energy Agency 2010). Infant and child deaths are therefore substantial health impacts attributable to indoor air pollution. In fact, (Smith and Mehta, 2000) estimate 1.8 million annual deaths results from global exposure to indoor air pollution, with approximately 1 million due to ALRI in children under 5 years. Complex and unstable mixture of particulate matter, CO, Hydrocarbons, Nitrogen oxides, HCHO and C_6H_6 often greatly exceeds the standards for indoor air pollutants, set by U.S. Environmental protection agency (USEPA) (Schrinding *et al.*, 2002) due to incomplete combustion. Research has also shown that the indoor level of pollutants such as carbon dioxide, benzene etc range from 2 to 50 times higher than outdoor levels. (EPA, 1990, WHO, 1987, Hoskins, 2011). Studies have linked ventilation, kitchen location and permeability of roof and walls to smoke exposure (Duflo *et al.*, 2008). Government of India initiated several household programs focusing on improved stove, biogas plants kerosene and energy supply, which were aimed at reducing the dependence on biomass fuels and removing smoke from the kitchens. The (CPCB, 2012) recommended principal measures or action plan for controlling the release of air pollution. Although these programs had varying levels of success. Now different initiatives have been undertaken at the grassroots level and extensive infrastructure for implementing projects to overcome the problems related to indoor air pollution and health problems.

MATERIALS AND METHODS

To study and gain knowledge and information of the types of fuel consumed by the residents of village Bande of Banda district by burning biomass fuel and its adverse effects on health, a survey was conducted in 150 families of the village. The information was collected by means of the questionnaire prepared which consisted the questions related to the types of fuel and its amount consumed by a particular family, percentage of people using different cook stoves for food preparation, from where the fuel is brought or purchased, which type of wood is consumed more as a fuel, nearly how much distance (in km) is covered to collect the fuel. Finally questions related to the types of diseases with which people are infected were asked. One questionnaire was used to fill the details of one family including questions about the age, profession, education level, occupation etc which are directly or indirectly related to the health or disease from which a person is suffering. Generally all the fuel related information was taken from the lady of the house who usually cooks food for the other family members.

RESULTS

In this paper focus had been given on what types of fuel are used by the villagers and their amount used in APL and BPL families per person per day. Queries of which type of fuel is consumed the maximum is also included. Information about the percentage of people suffering from different diseases due to traditional cooking methods or any other reason regarding indoor air pollution had been summarised. The fuels that were found to be used by the villagers in cooking food are wood, dung cake, coal, kerosene, agricultural waste and other (includes plastic, scrap papers, dry leaves, shreds of cloth etc). Consumption of biomass fuel weekly in 150 families of Bande village is 5052 Kg. The following table will reveal the amount of particular fuel consumed in Kg/litre weekly by the residents of Bande and also answers the question which fuel is used mainly in cooking food by the residents of this village.

Table 1. The amount of particular fuel consumed weekly

SNo.	Fuel type	Amount consumed in Kg/litre
1	Firewood	2658.5Kg
2	Dungcake	1378Kg
3	Coal	34Kg
4	Kerosene	210 litre
5	Agricultural waste	767Kg
6	Others	5Kg

The graphical representation given below clearly reveals which type of fuel is used the maximum.

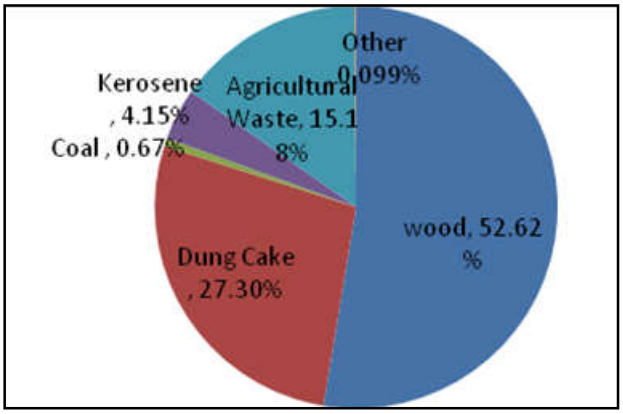

Figure 1. Graph Showing total consumption percentage of different Fuels

On the basis of economic condition or the income earned yearly the families were categorized into Above poverty line and Below poverty line in 150 families in which the survey was conducted. Among them 12 families i.e. 45 people were found to be in BPL and 138 families i.e. 865 people among the total families surveyed lie in APL category. That means 8% people are of BPL and 92% people are of APL category. The amount of fuel consumed by these people per person per day (in Kg) is given in the Table 2.

Table 2 shows that maximum proportion of all types of fuel is consumed by the APL population and also shows that the condition is so critical that inspite of lying above poverty line people still use traditional cooking fuels instead of using LPG, biogas which are the other clean and safe methods of cooking. According to the calculation, it has been found that among all the fuels, wood is consumed the maximum, but which wood is consumed the most in Bande is still a matter of concern. Table 3 shows the minimum and maximum consumption of different woods used as fuel in this village.

Table 2. Per person per day consumption of different fuels in APL and BPL families

S.No	Types of fuel	Fuel Consumption	BPL Consumption	APL Consumption
1	Wood	Fuel wood weekly	214 Kg	2245 Kg
		% of fuel wood consumption	64.85%	51.77%
		Wood consumption per day	30.57 Kg	349.2 Kg
		Consumption per person per day	0.67 Kg	0.4 Kg
2	Dung Cake	Dung cake weekly	71 Kg	1307 Kg
		% of Dung Cake consumption	21.51%	27.68%
		Dung Cake consumption / day	10.14Kg	186.71Kg
		Consumption per person per day	0.22Kg	0.21Kg
3	Coal	Coal weekly	NIL	84Kg
		% of Coal consumption	-	0.72%
		Coal consumption / day	-	4.85Kg
		Consumption per person per day	-	0.006Kg
4	Kerosene	Kerosene weekly	9Kg	200.5Kg
		% of Kerosene consumption	2.73%	4.25%
		Kerosene consumption / day	1.28Kg	28.64Kg
		Consumption per person per day	0.028Kg	0.033Kg
5	Ag.Waste	Agricultural Waste weekly	36Kg	731Kg
		% of Agricultural Waste consumption	10.91%	15.48%
		Agricultural Waste consumption / day	5.14Kg	104.4Kg
		Consumption per person per day	0.114Kg	0.121Kg
6	Other	Other fuel weekly	NIL	5Kg
		% of Other fuel consumption	-	0.11%
		Other fuel consumption / day	-	0.714Kg
		Consumption per person per day	-	0.00083Kg
7	Total	Total weekly	330Kg	4722Kg
		% of Total fuel consumed	6.53%	93.46%
		Total consumption / day	47.1Kg	675Kg
		Total consumption per person per day	1.05Kg	0.78Kg

Table 3. Total consumption of types of wood

S.No	Wood type	Amount consumed (Kg)	Percentage
1	*Mangifera indica*	186	7%
2	*Azadirachta indica*	227.5	8.55%
3	*Ipomoea carnea*	505	18.99%
4	*Zizyphus mauritiana*	613	23.10%
5	*Madhuca longifolia*	287	10.79%
6	*Acacia nilotica*	840	31.59%
7	Other	nil	nil
	Total	2658.5	

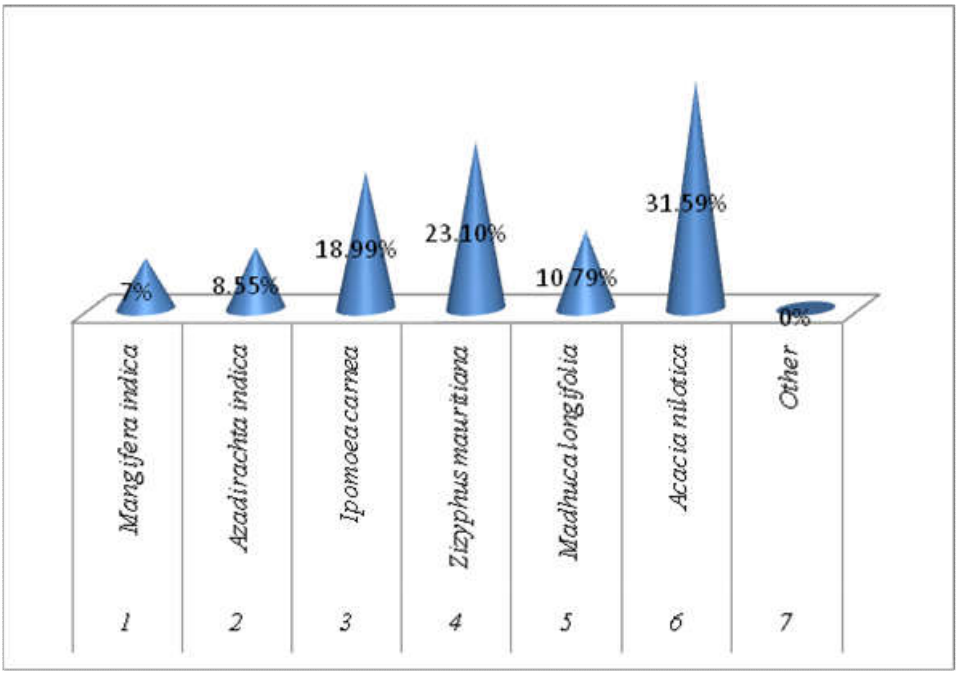

Figure 2. Graph showing percentage consumption of different wood

The graph clearly reveals that *Acacia nilotica* is consumed maximum and *Mangifera indica* is consumed the least in village Bande, as the surroundings have most of the Acacia trees.

They have low thermal efficiency i.e. poor extraction of energy contained in the fuel and significant emissions of pollutants which have negative impacts on human health in the households, regional air pollution and climate.

Table 4. Per person per day consumption of different woods in APL & BPL families

S.No	Types of wood	Wood consumption	BPL Consumption	APL consumption
1	*Mangifera indica*	*Mangifera indica* consumed weekly	7 Kg	179 Kg
		% of *Mangifera indica* consumption	3.27%	7.32%
		Mangifera indica consumption per day	1 Kg	25.57 Kg
		Consumption per person per day	0.022 Kg	0.03 Kg
2	*Azadirachta indica*	*Azadirachta indica* consumed weekly	25 Kg	202.5 Kg
		% of *Azadirachta indica* consumption	11.68%	8.28%
		Azadirachta indica consumption / day	3.571 Kg	28.93 Kg
		Consumption per person per day	0.079 Kg	0.033 Kg
3	*Ipomoea carnea*	*Ipomoea carnea* consumed weekly	44 Kg	461 Kg
		% of *Ipomoea carnea* consumption	20.56 %	18.85%
		Ipomoea carnea consumption / day	6.28 Kg	65.85 Kg
		Consumption per person per day	0.13 Kg	0.076 Kg
4	*Zizyphus mauritiana*	*Zizyphus mauritiana* consumed weekly	63 Kg	550 Kg
		% of *Zizyphus mauritiana* consumption	29.43%	22.50%
		Zizyphus mauritiana consumption / day	9 Kg	78.57 Kg
		Consumption per person per day	0.2 Kg	0.091 Kg
5	*Madhuca longifolia*	*Madhuca longifolia* consumed weekly	18 Kg	269 Kg
		% of *Madhuca longifolia* consumption	8.41%	11.00%
		Madhuca longifolia consumption / day	2.57 Kg	38.429 Kg
		Consumption per person per day	0.057 Kg	0.044 Kg
5	*Acacia nilotica*	*Acacia nilotica* consumed weekly	57 Kg	783 Kg
		% of *Acacia nilotica* consumption	26.63%	32.03%
		Acacia nilotica consumption / day	8.142 Kg	111.86 Kg
		Consumption per person per day	0.18 Kg	0.129 Kg
	Total	Total wood consumed weekly	214 Kg	2445 Kg
		% of Total wood consumption	8.04%	91.96%
		Total wood consumption / day	30.57 Kg	349 Kg
		Total wood Consumption per person per day	0.67 Kg	0.4 Kg

Table 4 shows per person per day consumption of *Mangifera indica* by BPL category is 0.022Kg which is less than the APL consumption ie 0.03Kg, *Azadirachta indica* is consumed more among BPL i.e. 0.079Kg than that of APL i.e. 0.033Kg.Consumption of *Ipomoea carnea* among BPL is more i.e. 0.13Kg than among APL i.e. 0.076Kg.Again *Zizyphus mauritiana* is consumed 0.2Kg and 0.091Kg among BPL and APL respectively. Similarly *Madhuca longifolia* and *Acacia nilotica* are also consumed more i.e. 0.057Kg and 0.18 Kg respectively by the BPL families in comparison to APL families using 0.044Kg and 0.129Kg per day per person respectively. Regarding *Mangifera indica* nearly all types of woods are consumed more by BPL people than APL people. Total consumption of all types of wood is also calculated to be 0.67Kg by BPL in comparison to 0.9Kg by APL. More consumption of firewood by BPL category reveals the truth that people lying in BPL category are more dependent on biomass fuel instead of clean and safer methods of cooking.

Health outcomes

Since a long time period, biomass fuels in the form of wood, crop residues, animal dung cake continue to be the dominant source of cooking energy in India according to the National family health survey for 2005 -06 NFHS (IIPS 2007). Mostly the biomass energy technologies for cooking in households and institutions are largely traditional chulhas i.e. mud, stove along with some metal, cement and pottery normally with no operating chimneys or hoods for venting the smoke outdoors. Even stoves with working chimneys, however do not completely eliminate indoor air pollution, as there is often substantial leakage into the room. India's stove programme are now focusing in reducing fuel wood consumption and secondarily smoke reduction in Kitchens through chimneys. Despite the imprecision of the measure, health effects of several sorts have repeatedly been found for households that use biomass fuels, which in most cases include or consist entirely of wood fuel. The effects include: acute infections of the lower respiratory tract (pneumonia) in young children and chronic obstructive pulmonary disease, such as chronic bronchitis and emphysema in adult women who have cooked over unvented solid fuel stoves for many years. WHO, in a risk assessment that combined the results of many published studies (Ezzati *et al*., 2002), compared the burden of illness and premature death from solid fuel use with other major risk factors, including outdoor air pollution, tobacco smoking and hypertension. The results indicate that solid fuel use may be responsible for 800000 to 2.4 million premature deaths each year (Smith, Mehta and Maeusezhal-Fuez, 2004) (Smith *et al.*, 2000) writes that the case – control study in Nigeria showed that children with ALRI who came from homes that burnt wood were 12.2 times more likely to die than those from homes that burn Kerosene / Gas.

(Bloom and Zaidi, 2002) found that use of traditional biomass fuel is positively and significantly associated with infant mortality, child mortality, crude birth rate, total fertility population growth rate. They show that 10% point reduction in

biomass fuel use would decrease the child mortality rate by 4.9 deaths / 10000 live births. The poor air quality leads to poor health outcomes for both adults and children. The mechanisms by which air quality affects health is usually thought to be through reduced pulmonary functioning leading to acute respiratory symptoms (Bruce *et al.*, 2000). The data collected from village Bande by means of a questionnaire reveals that the number of disease reported are due to indoor air pollution while other diseases may or may not be directly related to the effects of biomass fuel combustion. They have been categorized into lung diseases, eye diseases, people having both types of diseases, other diseases (e.g. normal cough and cold, headache, fits, viral fever) etc. While visiting , it has been found that though people are suffering from these diseases since a long time , but even then most of them have not consulted the doctor for their treatment. Majority 96.81% of the population were recorded healthy as per their information and only 3.18% were found unhealthy. This may be due to their unawareness or carelessness about their health condition. Among all 910 people only 29 people were reported diseased. 96.55% of the diseased people consulted the doctor whereas 3.44% never went for their health checkups even when they are physically unfit and suffering from either of the above mentioned diseases.

Table 5. Percentage of healthy, unhealthy, treated, untreated population

S.No		Percentage
1	Percentage of healthy people	96.81
2	Percentage of unhealthy people	3.18
3	Total no of diseased people	29/910
4	People taking treatment	96.55
5	People not taking treatment	3.44

Table 6. Number of people infected with different types of diseases

S.No	Types of diseases	No of people	Percentage
1	Lung diseases	8	27.58
2	Eye diseases	7	24.13
3	Both	2	6.89
4	Other	12	41.37
	Total	29	

Lung disease includes lung cancer, asthma, tuberculosis, acute respiratory diseases etc and eye diseases noticed are cataract, hypermetropia, myopia, running tears from eyes, itching of eyes. Some people are suffering from both eye and lung infections and something strange but true that many of them have one or the other physical problem yet they are not conscious of their health. Regarding this researchers have also found a strong relationship between indoor air pollution and pre-term delivery (Xu *et al.*, 1995) and low birth weight (Wang *et al.*, 1997). Low birth weight was also found to be associated with household exposure to biomass smoke in Guatemala (Boy *et al.*, 2002)

Conclusion

Consistent evidences from the previous studies have shown that indoor air pollution from traditional biomass fuel sometimes become so severe that they also badly affect the person's health ultimately leading to death. Indoor air pollution caused by burning traditional biomass fuel not only affects women making food at home but also the small children / infants around them while cooking food. People have informed during this survey about the problems faced by the person cooking food as well as those who are around the cooking place or kitchen. Vomiting in infants due to heat in the kitchen and eye or lung diseases are the common problems faced by the women involved in kitchen work. The lung and eye problems were more prominent among women in comparison to the men who are generally not involved in cooking in the kitchen. Asthma and other respiratory disorders in men are mostly due to use of Cigarette or smoking habits. The sex ratio in Bande village is found to be 864 women:1000 men i.e. women are less in comparison to men. The observations in this village have revealed that very few nearly negligible families use LPG or biogas for cooking inspite of the fact that with the use of LPG or biogas people have better health (Related to eye / lung diseases) in comparison to the women using traditional biomass fuel. Cataract was found to be very common among the adult women using biomass fuel for cooking from many years. During the survey, efforts to make people aware of the adverse effects of biomass fuel and to use improved chulhas and LPG and kerosene etc which are less harmful in comparison to biomass fuel were taken. For a country like Kenya in which roughly three – fourths of total energy consumption is supplied by biomass fuels, the implication is that switching completely to non – biomass fuel would definitely lower its child mortality rate by 38% and prevents 54,000 deaths to children before the age of 5 or above 5 years.

Excess use of biomass traditional fuel is not only affecting our health and environment but also indirectly responsible for cutting trees, shrubs etc. The wood demand for cooking only is very high. We can say that if the demand for cooking wood is lowered by adopting any other substitute of fuel, we can conserve our forest also. Near to Banda district a district named Manikpur has dense vegetation where everyday many quintals of wood is cut down from the forest and sold by them for cooking as well as other purposes which directly or indirectly affects our atmosphere and is a serious threat for our health.

Many households were found to use multiple cooking devices like Kerosene, LPG, stoves in addition to biomass fuel in village Bande. Till now no current surveys adequately capture this information, leading to uncertainty of fuel – use estimates.

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