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## Impact of improved biomass stove on health of rural families

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### Abstract

Inefficient combustion of solid fuels emits high concentrations of particulate matter (PM) and other harmful emissions. A strong association has been shown between household air pollution (HAP) and acute lower respiratory infections (ALRI) in children, and chronic obstructive lung disease (COPD) and lung cancer in adults. As a result of the magnitude of these adverse health impacts, household air pollution from burning solid fuels in primitive cook stoves is the primary environmental cause of death. The 2014 Global Burden of Disease Report (GBDR) found household air pollution to be the third most deadly global risk factor, accounting for about 4.3 million deaths annually (mainly due to cardiovascular and respiratory illnesses), and the second greatest risk factor in India (Improved biomass cook stove, 2014). Exploratory and experimental Study was conducted during the year 2016-17 Dharwad and Vijayapur districts of Karnataka state. Keeping this in view a study was conducted in two villages namely Timmapur Village of Dharwad district and Bhaganager village of Vijayapur district. From each village 60 households were selected randomly. Interview schedule was used. More than 90 percent of the respondents in both the villages were illiterate and majority of the respondents had breathing problems. The highly significant difference was found between improved biomass stove and traditional stove and also among women of both villages. This indicates that the benefits were more effective while using improved biomass stove as compared to traditional stove.

**Keywords:** Biomass, health, health problems, women, carbon emission, improved biomass cook stove

### Introduction

The use of bio mass fuels for heating and cooking is too old concept, occurring from the early stage of human evolution. About 40 per cent of the global population (Amounting to three billion people) relies completely on solid biomass fuels including fuel wood, crop residues, charcoal and cow dung etc. for preparing food and heating water. People in India also heavily dependent on solid biomass fuels for cooking food. Biomass fuels emit lot of carbon monoxide (CO) and particulate matters (PM). This emission causes various health problems because traditional stoves have less thermal efficiency.

Inefficient combustion of solid fuels emits high concentrations of particulate matter (PM) and other harmful emissions. A strong association has been shown between household air pollution (HAP) and acute lower respiratory infections (ALRI) in children, and chronic obstructive lung disease (COPD) and lung cancer in adults. As a result of the magnitude of these adverse health impacts, household air pollution from burning solid fuels in primitive cook stoves is the primary environmental cause of death. The 2014 Global Burden of Disease Report (GBDR) found household air pollution to be the third most deadly global risk factor, accounting for about 4.3 million deaths annually (Mainly due to cardiovascular and respiratory illnesses), and the second greatest risk factor in India (Improved biomass cook stove, 2014).

It is evident that the collection of fuel wood for burning and cooking is one of the major activities in rural area mostly done by rural women. The young girls alone or accompanied by mothers or most of the time young girls are being asked to collect the wood for cooking. This affects their schooling and ultimately affects their education. Half of the rural population consisting of women can be empowered to contribute to the growth and well-being of the society by utilizing their time in more productive work. From the study we conclude that improved biomass stove has better thermal efficiency and lesser emission as well as low health risk as compared to traditional stove.

Hence, the present study was carried out to know the impact of improved biomass stoves on health of the users with the following objectives.

1. To estimate the Co<sub>2</sub> and Co while cooking with different fuel wood.

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- To study the impact of biomass stove on health status of the family members

### Material and Methods

The research study on “Impact of Improved Biomass Stove on Health of Rural Families” was conducted in Dharwad and Vijayapur districts of Karnataka state. Out of seven districts two districts were selected for the study, two villages namely Timmapur and Bhaganagar from Dharwad and Vijayapur districts respectively were selected from each village 60 households were selected randomly in total 120 households were selected for the study. Exploratory research design was used for the study. Interview questionnaire was used to elicit the required information from the respondents.

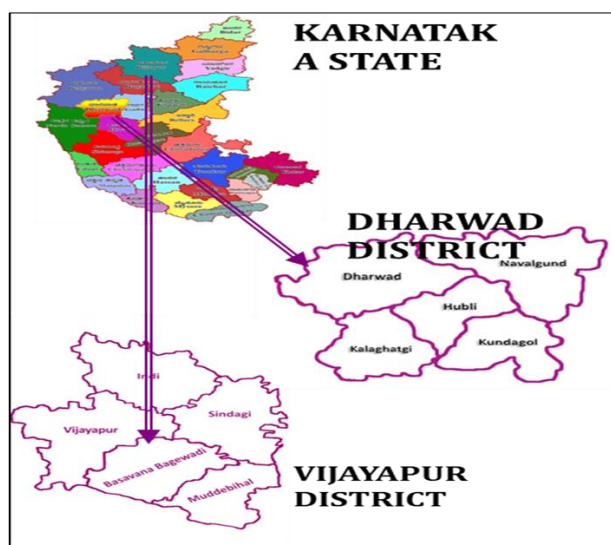


Fig 1: Map showing study area

The research study on “Impact of Improved Biomass Stove on Health of Rural Families” was conducted in Dharwad and Vijayapur districts of Karnataka state. Out of seven districts two districts were selected for the study, two villages namely

Timmapur and Bhaganagar from Dharwad and Vijayapur districts respectively were selected from each village 60 households were selected randomly in total 120 households were selected for the study. Exploratory research design was used for the study. Interview questionnaire was used to elicit the required information from the respondents

### Results and Discussion

The data in table 1 shows that Socio economic status of the rural women in the selected households. In Timmapur village majority (51.70%) of the rural women were belonged to middle age group (< 30 years) followed by 33.3 per cent of them were belonged to old age group. While in Bhaganagar village majority (56.70%) of the women were belonged to middle age group (< 30 years) followed by (28.30%) of them belonged to young age group (31 to 50 years). With respect to education, in Timmapur village majority of them were illiterate (80.00%) followed by 11.70 per cent of the women had an education up to primary level school (1-4) and 8.30 per cent of them had studied middle level school (5-7). In Bhaganagar village about 11.66 per cent of them had studied primary level school (1-4), 10 per cent of them had studied middle level school (5-7). The results are similar to the results of study conducted by Komala *et al.*, (2016) [3].

#### Occupation

In Timmapur village majority of the women belonged to agricultural laborers (98.30%) and few per cent of the respondents belonged to agriculture (1.70%). In Bhaganagar village, majority of the women occupation was agriculture (76.70%) followed by agricultural laborers (23.30%). With respect to the family type majority of the women in Timmapur village were belonged to nuclear family (61.70%) where as about 38.30 per cent of them belonged to joint family. While in Bhaganagar majority of the women belonged to nuclear family (58.33%) followed by joint family (41.66%). The contradictory findings of Komala and Girirajanna (2014) [2].

Table 1: Socio economic profile of the rural women of Timmapur and Bhaganagar villages N=120

Variables	Cateagory	Timmapur (n <sub>1</sub> =60)	Bhaganagar (n <sub>2</sub> =60)	Total (N=120)
Age	Young (<30 years)	9 (15.00)	17 (28.30)	26 (21.66)
	Middle (31to50 years)	31 (51.70)	34 (56.70)	65 (54.16)
	Old (> 51years)	20 (33.30)	9 (15.00)	29 (24.16)
Education	Illiterate	48 (80)	46 (76.70)	94 (78.33)
	Primary school (1-4)	7 (11.70)	7 (11.70)	14 (11.66)
	Middle school (5-7)	5 (8.30)	6 (10.00)	11 (9.16)
	High school (8-10)	-	1 (1.70)	1 (0.83)
Occupation	Agriculture labour	59 (98.30)	14 (23.30)	73 (60.83)
	Agriculture	1 (1.70)	46 (76.70)	47 (39.16)
	Subsidiary	-	-	
	Salaried job	-	-	
Family Type	Nuclear	37 (61.70)	33 (55.00)	70 (58.33)
	Joint	23 (38.30)	27 (45.00)	50 (41.66)
Family size	Small (< 3)	13 (21.70)	22 (36.70)	35 (29.16)
	Medium (4-6)	34 (56.60)	28 (46.60)	62 (51.66)
	Large (> 6)	13 (21.70)	10 (16.70)	23 (19.16)
Annual income of the Family (Rs)	Low income (<60,000)	30 (50.00)	4 (6.66)	34 (28.33)
	Medium (60,000 to 1,20,000)	27 (45.00)	40 (66.66)	67 (55.83)
	High (> 1,20,000)	3 (5.00)	16 (26.70)	19 (15.83)
Land holding category	Land less	31 (51.70)	12 (20.00)	43 (35.83)
	Small farmer (<5acre)	25 (41.70)	21 (35.00)	46 (38.33)
	Medium farmer (5-10acre)	4 (6.70)	23 (38.30)	27 (22.50)

Type of House	Big farmer (>10acre)	-	4 (6.70)	4 (3.33)
	Kachha	26 (43.30)	3 (5.00)	29 (24.16)
	Pucca	25 (41.70)	41 (68.30)	66 (55.00)
	RCC	9 (15.00)	16 (26.70)	25 (20.83)

Note:-Numbers in the parenthesis indicate percentage

Family Size: Majority of (56.60%) the respondents belonged medium family size (4-6 members) followed by equal per cent (21.70%) of the women had small family size (< 3). While in Bhaganagar village majority (46.60%) of the women belonged to medium family size (4-6 members) followed by 36.70 per cent of women had small family size (< 3). The results are in line with Somnath *et al.*, (2014). With respect to the annual family income, in Timmapur village fifty percent of the women had low annual income (< 60,000) followed by 45 per cent of the women were in the medium annual income (Rs. 60,000 to 1,20,000), while in Bhaganagar majority (66.66%) of the women were in the medium income (Rs. 60,000 to 1, 20,000) group. It can be observed that, majority (51.70%) of the women belonged to landless category followed by 41.70 per cent of the women were small farmers (< 5 acres), and few 6.70 per cent of them were belonged medium farmers category (5-10 acres) in Timmapur village. While in Bhaganagar, majority (38.30%) of the women respondents belonged to medium farmers (5-10 acres) categories.

Data in the Table 2 revealed that usage pattern of the improved biomass stove by the selected families, cent per cent

of the women respondents were used the improved biomass stove in the morning and night to cook food. With respect to quantity of fuel wood most of the women (53.30%) had used 3 to 4.5 kg of fuel wood during morning cooking followed by 35 per cent of them had used 1 to 2.5 kg, 10 per cent of them had used 5 to 6.5 kg and few per cent of them (1.70%) had used 7 kg and above.

The data on ash generated by cooking was specified and it was assumed that regarding ash quantity majority (60.00%) of the women had expressed that ash quantity was more in the morning followed by medium ash quantity (40.00%). Most of the women had expressed that ash quantity was medium in the night (63.30%) followed by less (35.00%) and few (1.70%) of them told that ash quantity was more.

The data on charcoal quantity generated by cooking specified and it was assumed that, about 58.30 per cent of the women had expressed that charcoal quantity was medium in the morning, followed by more (36.70%).

With respect to time taken to cook food majority (95.00%) of the women had taken 2 to 3 ½ hour time in the morning followed by ½ an hour to 1 ½ hour (5.00%). During night 50 per cent of them had taken 2 to 3 ½ hour.

**Table 2:** Usage pattern of the improved biomass stove by selected families N=120

Sl. No.	Particulars	Timmapur (n1=60)		Bhaganagar (n2=60)		Total N=120		
		Morning	Night	Morning	Night	Morning	Night	
1.	Type of wood	Wood pieces	12 (20.00)	15 (25.00)	24 (40.00)	22 (36.70)	36 (30.00)	37 (30.83)
		Twigs	7 (11.70)	8 (13.30)	-	-	7 (5.83)	8 (6.66)
		Both wood pieces twigs & cow dung	41 (68.30)	37 (61.70)	19 (31.70)	24 (40.00)	60 (50.00)	61 (50.83)
		Wood pieces & maize cob & cow dung	-	-	17 (28.30)	14 (23.30)	17 (14.16)	14 (11.66)
2.	Quantity of fuel wood	1 kg-2.5 kg	21 (35.00)	47 (78.30)	45 (75.00)	53 (88.30)	67 (55.83)	100 (83.33)
		3 kg-4.5 kg	32 (53.30)	12 (20.00)	13 (21.70)	6 (10.00)	45 (37.5)	18 (15.00)
		5 kg-6.5 kg	6 (10.00)	1 (1.70)	1 (1.70)	1 (1.70)	7 (5.83)	2 (1.66)
		7 and above	1 (1.70)	-	1 (1.70)	-	2 (1.66)	-
4.	Ash Quantity	Less	-	21 (35.00)	7 (11.60)	32 (53.30)	7 (5.83)	53 (44.16)
		Medium	24 (40.00)	38 (63.30)	31 (51.70)	27 (45.00)	55 (45.83)	65 (54.16)
		More	36 (60.00)	1 (1.70)	22 (36.70)	1 (1.70)	58 (48.33)	2 (1.66)
5.	Charcoal Quantity	Less	3 (5.00)	29 (48.30)	1 (1.70)	25 (41.70)	4 (3.33)	54 (45.00)
		Medium	35 (58.30)	31 (51.70)	30 (50.00)	33 (55.00)	65 (54.16)	64 (53.33)
		More	22 (36.70)	-	29 (48.30)	2 (3.30)	51 (42.5)	2 (1.66)
6.	Time taken for cook (min)	½ hour to 1 ½ hour	3 (5.00)	27 (45.00)	14 (23.30)	46 (76.70)	17 (14.16)	73 (60.83)
		2hour to 3 ½ hour	57 (95.00)	33 (55.00)	46 (76.70)	14 (23.30)	103 (85.83)	47 (39.16)

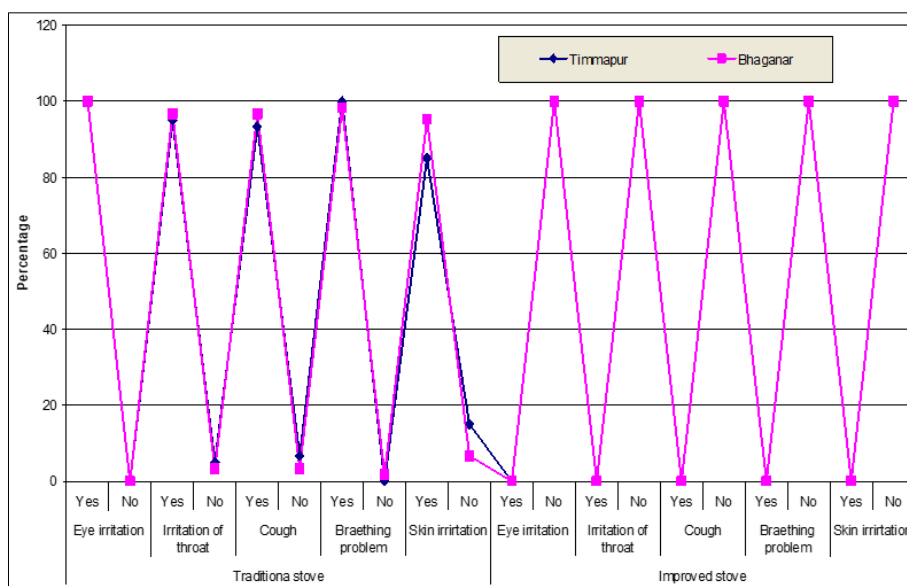
Note:-Numbers in the parenthesis indicate percentage

While in Bhaganagar most of the women respondents were used the wood pieces for morning cooking followed by combination of wood pieces, twigs and cow dung (31.70%), combination of wood pieces, maize cobs and cow dung (28.30%), during the night cooking majority of the women respondents were used the combination of wood pieces, twigs and cow dung (40.00%).

With respect to quantity of fuel wood most of the women (75.00%) had used 1 to 2.5 kg of fuel wood during morning followed by 21.70 per cent of them had used 3 to 4.5 kg and less of them (1.70%) had used 5 to 6 kg. The data on ash

generated by cooking was specified and it was assumed that majority (51.70%) of the women had expressed that ash quantity was medium in the morning followed by more ash (36.70%), less ash (11.60%). Most of the women had expressed that ash was less quantity in the night (53.30%) followed by medium (45.00%), few of them expressed that ash quantity was more.

Fig. 2 shows that health problems experienced by women while cooking on improved biomass stove and traditional stove, in Timmapur village Bhaganagar village.



**Fig 2:** Health problems experienced by women while cooking on traditional and improved biomass stove

The data on charcoal generated by cooking was specified and it was assumed that 50 per cent of the women had expressed that charcoal quantity was medium in the morning, followed by more (48.30%) few per cent of them (1.07%) expressed that charcoal quantity was less. Most (55.0%) of the women had expressed that charcoal quantity was medium in the night followed by less (41.70%) and more (3.30%).

Regarding time taken for cooking majority (76.70%) of the women were had time taken 2 hour to 3 ½ hour in the morning cooking followed by ½ an hour to 1 ½ hour (23.30%). During night 76.70 per cent of the women had taken ½ hour to 1 ½ hour followed by 2 hour to 3 ½ hour. Fig. 2 shows that health problems experienced by women while cooking on improved biomass stove and traditional stove, in Timmapur village. Fig 2 shows that health problems experienced by the rural women on both traditional and improved stoves in both Timmapur and Bhaganagar villages. Cent per cent of the women were experienced that eye irritation and breathing problems by traditional stove due to smoke followed by irritation of throat (95.00%), cough (93.30%) and skin irritation (85.00%) and few women had no health problems with respect to skin irritation (15.00%) followed by cough (6.70%) and irritation of throat (5.00%). It is interesting to note that there was no health problems while

using improved biomass stove that was hundred per cent. While in Bhaganagar village cent per cent of the women were expressed that eye irritation problem due to traditional stove followed by breathing problem (98.30%), irritation of throat and cough (96.70%), skin irritation (93.30%) and very few percent of the women respondents had no health problems with respect to skin irritation (6.70%) followed by irritation of throat, cough (3.30%) and breathing problem (1.70%). Cent per cent of women respondents had expressed that there was no health problems while using improved biomass stove.

Data in the Table 3 shows satisfaction level of women while using improved biomass stove vs. traditional stove in Timmapur village and Bhaganagar villages. The five point scale was used to assess the benefits of both stoves (1-Extremely satisfied, 2-Dis satisfied, 3-Good, 4-Satisfied, 5-Extremely satisfied). The mean score were given to the benefits of stoves based on perception of stove users. In Timmapur village women respondents were given the high mean score to the statement of enables faster cooking (3.26) on traditional stove followed by suitable for all cooking vessels and overall satisfaction (3.0), low time consumption (2.28), easy to maintenance (2.26), free time for other activities (2.16), no fire coming out of the stove (2.11), no smoke

**Table 3:** Mean score towards satisfaction level of women while using improved biomass stove vs traditional stove

Sl. No	Benefits	Timmapur (n1=60)			Bhaganagar (n2=60)		
		Traditional stove	Improved Biomass Stove	t-value	Traditional stove	Improved Biomass Stove	t-value
1	No fire coming out of the stove	2.11	3.7	19*	2.06	3.61	19.29*
2	Continuity of fire burning	1.68	2.50	9.18*	1.48	2.43	10.36*
3	Equal distribution of flame	1.35	2.66	15.08*	1.25	2.51	14.71*
4	No smoke problem	2.00	3.96	29.31*	2.00	4.03	21.40*
5	Less soot on walls	1.00	3.26	22.56*	1.00	3.21	20.80*
6	No smell to food	2.36	3.53	14.68*	2.18	3.91	14.92*
7	Low fuel consumption	2.00	3.95	44.32*	2.00	4.2	26.54*
8	Enables faster cooking	3.26	3.78	6.41*	2.85	3.36	6.15*
9	Low time consumption	2.28	3.88	21.07*	2.13	4.26	19.83*
10	Reduces workload for fuel wood collecting	1	3.1	24.79*	1.00	2.95	19.65*
11	Free time for other activities	2.16	3.33	13.52*	2.16	3.0	15.05*
12	Does not require constant supervision	2.00	2.03	1.42*	2.00	2.00	0.655 **
13	Suitable for all cooking vessels	3.00	3.36	5.84*	3.00	3.2	3.84*



14	Cleanliness	2.00	3.9	28.80*	2.00	3.91	25.13*
15	Easy to maintenance	2.26	3.83	16.81*	3.56	2.28	12.35*
16	Safety for small children	1.00	2.33	21.72*	1.00	2.53	26.60*
17	Overall satisfaction	3.00	4.5	23.04*	3.00	4.4	11.73*

Note:- \* Significance level at 0.05 level \*\* Significance level at 0.01 level

1-Extremely dis satisfied, 2- Dis Satisfied, 3- Good, 4- Satisfied, 5-Extremely satisfied

problem, low fuel consumption, does not require constant supervision, cleanliness (2.00), continuity of fire burning (1.68), equal distribution of flame (1.35), less soot on walls, reduces workload for fuel wood collecting, safety for small children (1.00). benefit scores regarding to the improved biomass stove, it had high mean score and also it had the more benefits than the traditional stove, benefit scores followed by overall satisfaction was given high mean score (4.5) followed by no smoke problem (3.96), low fuel consumption (3.95), cleanliness (3.9), low time consumption (3.88), easy to maintenance (3.83), enables faster cooking (3.78), no fire coming out of the stove (3.7), no smell to food (3.53), suitable for all cooking vessels (3.36), free time for other activities (3.33), less soot on walls (3.26), reduces workload for fuel wood collecting (3.1), equal distribution of flame (2.66), continuity of fire burning (2.50), safety for small children (2.33), does not require constant supervision (2.03). The results of the study are in line with Douglas *et al.* (2012)<sup>[1]</sup> and Yadav *et al.* (2009)<sup>[6]</sup>.

With respect to the Bhaganagar village women respondents were given the high mean score to the statement of easy to maintenance (3.56) followed by overall satisfaction and

suitable for all cooking vessels (3.00), enables faster cooking (2.85), no smell to food (2.18), free time for other activities (2.16), low time consumption (2.13), no fire coming out of the stove (2.06), no smoke problem, low fuel consumption, does not require constant supervision, cleanliness (2.00), continuity of fire burning (1.48), equal distribution of flame (1.25), less soot on walls, reduces workload for fuel wood collecting, safety for small children (1.00). benefits regarding to the improved biomass stoves, overall satisfaction was the highest mean score (4.4) followed by low time consumption (4.26), no smoke problem (4.03), no smell to food, cleanliness (3.91), no fire coming out of the stove (3.61), enables faster cooking (3.36), less soot on walls (3.21), suitable for all cooking vessels (3.2), free time for other activities (3.00), reduces workload for fuel wood collecting (2.95), safety for small children (2.53), equal distribution of flame (2.51), continuity of fire burning (2.43), easy to maintenance (2.28).

The highly significant difference was found between the improved biomass stove and traditional stove. This indicates that the benefits were more effective while using improved biomass stove compared to traditional stove.

**Table 4:** Estimation of Carbon dioxide and Carbon Monoxide n=10

Parameters	Traditional stove			Biomass stove			Percentage reduction
	Max	Min	Average	Max	Min	Average	
CO <sub>2</sub>	754	519	637	510	401	468	26%
CO	21	01	7.50	12	01	5.50	26%
Temp (.c)	40	32	38	38	29	35	
RH (%)	36.6	13	28	34	16	21	

Estimation of Carbon dioxide and Carbon Monoxide (CO<sub>2</sub>) and (CO) was presented in table 4. The production of Co<sub>2</sub> was found to higher than the safe level while CO was lower than the safe level. The reduction in percentage of both carbon dioxide and carbon monoxide was found in biomass stove compared to traditional stove. It could be due to the reduction in smoke and fuel wood consumption in the biomass stove. It was observed from the table that the reduction in temp (35°C) and RH (21%) compared to traditional stove.

### Conclusion

Improved biomass stoves plays an pivotal role on health of rural families and it should be promoted to encourage the rural women for better usage of biomass cook stove. Rural women must have education regarding usage and importance of improved biomass stoves on their quality and healthy life. The government should enact the policy on subsidiary towards the improved biomass stove. Action oriented research should be taken up to create awareness on usage of improved biomass stove and safeguard the environment.

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