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Indoor air pollution from biomass combustion and its adverse effect on health of rural women while cooking

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Abstract : Exposure to indoor air pollution from the combustion of solid fuels is one of the causes of morbidity and mortality in developing countries. The toxic gases like Carbon monoxide, carbon dioxide, nitrogen dioxide, formal dehyde, sulphur dioxides are released during cooking. The health effects from indoor air pollution are experienced soon after exposure, or possibly years later. Immediate effects may show up after a single exposure or repeated exposures. These may include irritation of eyes, nose and throat headache, dizziness and fatigue. The present research is planned to assess the emission of CO and CO_2 while cooking with biomass stove in rural areas of Dharwad districts and its effect on health of selected rural women. The study was carried out in villages of Dharwad district with a sample size 90 women respondents selected randomly for the study. The respondents belong to the age group of 20-30 with a normal body mass index with a mesomorph body type with a mean systolic and diastolic blood pressure of 120/74 mmHg. . Average carbon monoxide and carbon dioxide level during cooking was 370 ppm and 1480 ppm which exceeds the limit set by World Health Organization. The health effects indoor air pollutants are burning sensation in the eye, irritation in nose, cold and fever, cough, shortness of breath was common among biomass users. There was significant correlation between carbon monoxide level and diastolic blood pressure.

Key words: Body mass index, Carbon dioxide, Health problems, Pollution

Introduction

The indoor air pollutants are nearly the same as that of outdoor ones. However, in some instances the concentration of household pollutants exceeds the standard set for the outdoors. These pollutants reach such a high level despite, they are emitted in small volumes but they cannot be escaped easily from the buildings due to lack of proper ventilation. Indoor air pollution is more harmful and poses greater health hazards, because on an average a person spends nearly 16-18 hours indoors. Carbon monoxide is tasteless and non irritating gas, hence can have serious effect before being detected. The gas kills quickly at concentrations over 1000 ppm. This concentration can cause unconsciousness in about 1 hour and death in 4 hours. A concentration of 500 ppm probably be inhaled for little more than 1 hour without serious effects. However, a concentration as little as 200 ppm may produce symptoms of poisoning, if inhaled for few hours. It may be even toxic at concentration of 30 ppm as it causes head ache and dizziness. Several studies have been conducted in households of Asia, Africa and the America has reported that indoor air pollution levels in home is much higher than the limit set by the Department of Environment in Bangladesh, and world health organization. Indoor air pollution is a greater public health hazard in the developing countries than malaria or lack of access to clean water and sanitation, resulting in fatality every 20 seconds. Biomass fuels are considered to be one of the major indoor air pollutants in the developing countries. The incomplete combustion of biomass releases complex mixture of organic compounds, which includes suspended particulate matter, carbon monoxide, poly organic material, poly aromatic hydrocarbons (PAH), formaldehyde etc. The biomass may also contain intrinsic contaminants such as sulphur, trace metals etc. The biomass fuels releases byproducts like carbon monoxide, carbon dioxide, sulphur dioxide, and polycyclic and poly aromatic hydrocarbons which are known to produce adverse health effects. Health effects from indoor air pollutants may be experienced soon after exposure or possibly years later. Immediate effects may show up after a single exposure or repeated exposures. These include irritation of eyes, nose and throat headache, dizziness and fatigue. Such immediate effects are usually short term and treatable. Hence, the present research aims to analyze the effects of indoor air pollutants on health of rural women who mainly rely on biomass for cooking.

The objectives were to assess the health status of rural women using biomass for cooking, to record the indoor air pollutants released during cooking with biomass fuel and to know the relationship between cardiovascular parameters and indoor air pollutants.

Material and methods

Locale of the study: The study was conducted in three selected villages of Dharwad district namely Hirehonnalli (Kalagatagi taluk), Marewad (Dharwad taluk) and Gokul (Hubballi taluk) Karnataka state.

Sampling method: Simple random sampling technique was used to select the sample for the study. From each village thirty households were selected randomly thus a total sample comprises of 90. Thirty cooperative women respondents were selected for the experimental study.

Tools used: Pre structured interview schedule was used to collect the data on health details of the respondents among biomass users. Portable Carbon dioxide meter and Portable

carbon monoxide meter were used to note the carbon monoxide level and carbon dioxide level in the kitchen during cooking and also Omron portable blood pressure monitor was used to record the blood pressure of the respondents. These records are taken for 40 minutes that is before cooking, after 30 minutes of cooking, after completion of cooking.

Statistical tools:

i. Frequency, Percentage, mean, standard deviation, correlation, t-test was used to analyze the data.

ii. The ill effects on the health of women were recorded by using three point scales ranging from rarely (1), occasionally (2) to frequently (3). Weighted mean score were calculated to analyze the data.

Results and discussion

Table 1 depicts that health status of women respondents. Majority of the respondents age belong to 20-30 years (40.00%) followed by 40-50 years (33.33%) and 30-40 years (26.67%). With respect to body mass index majority of them (46.67%) have normal body mass index followed by CED Grade III sever (33.33%) and obese grade-I (20%). Majority of the respondents (66.67%) belonged to the body type followed by ectomorph (23.33%) and endomorph (10%)

Table 2 presents the mean blood pressure and pulse rate of the selected respondents while performing the cooking activities The results of 30 sub sample systolic blood pressure was 120, 118.23, 120.10 mmHg before cooking activity, during cooking activity and after cooking activity respectively. Diastolic blood pressure was 73.76, 74.23, 74.86 mmHg before cooking activity, during cooking activity and after cooking activity and pulse rate with the mean of 80.56, 79.73, 78.16 beats per minute before

Table 1. Health status of women respondents N=30

Physical parameters		Frequency	Percentage
Age (years)	20-30	12	40.00
	30-40	08	26.67
	40-50	10	33.33
Body Mass Index(BMI)	<16 CED Grade III sever	10	33.33
	20.25.0 Normal	14	46.67
	25.0-30 Obese Grade –I	06	20
Body type	Ectomorph	07	23.33
	Mesomorph	20	66.67
	Endomorph	03	10

Table 2. Mean blood pressure and pulse rate of the selected respondents N=30

Details	Before cooking (5 minutes)	After 30 minutes of cooking	After completion of cooking (5min)
Systolic Blood Pressure(mm/Hg)			
Mean & SD	120±16.38	118.23±13.02	120.10±19.25
Diastolic Blood Pressure (mm/Hg)			
Mean ±SD	73.76±13.28	74.23±10.65	74.86±12.94
Pulse rate (beats/ minute)			
Mean ±SD	80.56±13.73	79.73±12.08	78.16±12.46

Table 3. Health problems faced by selected women from indoor air pollution N=90

Health problems	Frequently	Occasionally	Rarely	Never	Weighted Mean Score
Eye					
Irritation in eyes	75(83.3)	2(2.2)	8(8.9)	5(5.6)	2.63
Burning sensation in eyes	74(82.2)	2(2.2)	7(7.8)	7(7.8)	2.65
Watering of eyes	73(81.1)	4(4.4)	9(10.1)	4(4.4)	2.61
Strain in eyes	74(82.3)	3(3.3)	7(7.7)	6(6.7)	2.59
Diminution of vision	41(45.5)	4(4.4)	7(7.7)	38(42.4)	1.51
Cataract	7(7.8)	-	4(4.4)	79(87.8)	0.27
Nose					
Irritation in nose	35(38.9)	7(7.8)	10(11.1)	38(42.2)	1.43
Sneezing	19(21.1)	24(26.7)	10(11.1)	37(41.1)	1.27
Upper respiratory symptoms					
Irritation of throat	27(30)	8(8.9)	11(12.2)	44(48.9)	1.20
Sore throat	18(20)	7(7.8)	13(14.4)	52(57.8)	0.18
Running nose	35(38.8)	5(5.6)	7(7.8)	43(47.8)	1.35
Cold and fever	2(2.2)	71(78.9)	10(11.1)	7(7.8)	1.75
Sinusitis	12(13.3)	4(4.4)	7(7.8)	67(74.5)	0.56
Lower respiratory symptoms					
Wheeze	16(17.8)	5(5.6)	10(11.1)	59(65.5)	0.75
Cough	24(26.7)	48(53.3)	10(11.1)	8(8.9)	1.97
irritating cough	24(26.7)	28(31.1)	9(10)	29(32.2)	1.52
Cough with phlegm	16(17.8)	28(31.1)	14(15.5)	32(35.6)	1.31
Chest					
Repeated pain in chest	16(17.8)	6(6.7)	10(11.1)	58(64.4)	0.77
Tightness in chest	22(24.4)	7(7.8)	10(11.1)	51(56.7)	1.00
Shortness of breath	26(28.9)	3(3.3)	9(10)	52(57.8)	1.03
Breathlessness	24(26.7)	3(3.3)	8(8.9)	55(61.1)	0.95
Asthma	5(5.6)	3(3.3)	6(6.7)	76(84.4)	0.30

Figures in parenthesis indicate percentage.

cooking activity during cooking activity and after cooking activity respectively in this studies on biomass cooking. The similar results were found by Baumgarther.*et al.* (2015) and Weihua *et al.* (2013).

Table 3, depicts the health problems faced by rural women due to Indoor air pollution. The problems frequently faced by the respondents are Eye problems especially, they faced more problem of irritation in eyes(83.33%) followed by burning sensation in eyes, strain in eyes(82.2%), watering of eyes(81.1%), diminution of vision(45.6%) and cataract(7.8%). Nose related problems those are noticed frequently are irritation in nose (38.9%), sneezing (21.1%). Upper respiratory symptoms like running nose was noticed (38.9%) followed by irritation of throat (30%), sore throat (20%), sinusitis (13.3%). Lower respiratory disease like cough, irritating cough (26.7%) followed by wheeze and cough with phlegm (17.8%) are frequently occurring diseases. As regards to chest related problem, there was shortness of breath (28.9%) followed by breathlessness (26.7%), tightness in chest (24.4%), repeated chest pain (17.8%) and Asthma (5.6%) are faced frequently by the respondents. These results are inline with Edelstein *et al.*(2008) , Oguntoke *et al.* (2010) and Banik *et al.* (2010).

Table 4, shows data on average carbon monoxide, carbon dioxide presents while cooking and temperature, humidity level at different times of cooking. The average carbon monoxide level before cooking was 10.44 ppm , after 30 minutes of cooking was 374.58 ppm and on completion of cooking was 50.79 ppm. The average carbon dioxide level before cooking was 911.41 ppm, after 30 minutes of cooking was 1489.20 ppm and on completion of cooking was 922.70 ppm. The average room temperature before cooking was 31.77 ^{0}C , after 30 minutes of cooking was 35.10 ^{0}C and on completion of cooking was 33.66 ^{0}C. The average humidity before cooking was 43.63 ^{0}C , after 30 minutes of cooking was 37.26 ^{0}C and on completion of cooking was 37.87 ^{0}C. These above results are in accordance with the studies conducted by Saeed *et al.* (2015) and Singh *et al.* (2012).

Table 5, depicts the relationship between pollution level and the cardiovascular problems of the respondents, the CO and SBP is positively correlated while before cooking and carbon monoxide and SBP negatively correlated in case of after 30 minutes of cooking and after completion of cooking. CO and DBP is positively correlated with before cooking CO and DBP significantly correlated in case of after 30 minutes of cooking and CO_2 is negatively correlated after completion of cooking. CO and heart rate is negatively correlated in case of resting and CO and heart rate during working and recovery are positively correlated. CO_2 and SBP is positively correlated while before cooking, after 30 minutes of cooking and after completion of cooking. CO_2 and DBP is positively correlated with before cooking, after 30 minutes of cooking and CO_2 is negatively correlated after completion of cooking. CO_2 and heart rate is negatively correlated in while resting, during working and recovery.

Table 4. Average Carbon monoxide, carbon dioxide level while cooking roti

N=30

Pollutants	Before cooking (5min)	After 30 minutes of cooking	After completion of cooking (5min)	't' test
Carbon monoxide (ppm)	10.44	374.5833	50.79333	-5.33**
Carbon dioxide (ppm)	911.4167	1489.2	922.7	
Temperature ^{0}C	31.77	35.10	33.66	-5.38**
Humidity ^{0}C	43.63	37.26	37.87	

** Significant at the 0.01 level
* Significant at the 0.05 level

Table 5. Relation between pollution levels and cardiovascular problems among rural women

N=30

Details	Pearson correlation coefficient	Significant (2 tailed)
Systolic blood pressure and co		
Before cooking	0.124	0.512
After 30 minutes of cooking	-0.343*	0.064
After completion of cooking	-0.310	0.095
Diastolic blood pressure and co		
Before cooking	0.045	0.813
After 30 minutes of cooking	-0.385*	0.036
After completion of cooking	-0.062	0.744
Heart rate and co		
Resting -0.240	0.201	
Working	0.067	0.726
Recovery 0.096	0.615	
Systolic blood pressure and co_2		
Before cooking	0.139	0.464
After 30 minutes of cooking	0.084	0.657
After completion of cooking	0.034	0.860
Diastolic blood pressure and co_2		
Before cooking	0.000	0.999
After 30 minutes of cooking	0.074	0.697
After completion of cooking	-0.037	0.847
Heart rate and co_2		
Resting -0.228	0.226	
Working -0.0276	0.139	
Recovery -0.146	0.441	

** Correlation is significant at the 0.01 level (2tailed)
*Correlation is significant at the 0.05 level (2-tailed).

Conclusion: The health effects of exposure to indoor air pollution from biomass are common in the rural population and in individuals using biomass fuel in urban areas. This study clearly depicts the problems faced by rural women due to biomass combination. Maximum women respondents have eye irritation, nose related problems, upper respiratory problems, lower respiratory problems and chest problems. A clear association between CO, CO_2 and blood pressure is observed in this study. Providing health education on indoor air pollution and adverse gases released during biomass combustion and creating awareness through physician on biomass smoke can help to detect and diagnose the health problem at earliest and can give a best remedy for the health problem and provide a better quality of life among rural respondents.

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