Respiratory illness and associated factors among women households using charcoal for cooking in Gondar town, Ethiopia: A cross-sectional study

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Abstract

Background

In Ethiopia, less than 5% of the population has access to clean fuels. Exposure to the pollutants from charcoal cooking leads to respiratory illness among women households. There is a dearth of data about women health-related to biomass fuel cooking in Ethiopia. Hence, this study was set out to establish the burden of respiratory diseases among women households using charcoal cooking, its exposure, and factors associated in Gondar town, Ethiopia.

Methods

A community-based cross-sectional study was conducted using systematic random sampling method. A total of 285 women household using charcoal for cooking participated in the study. Self-reported symptoms of respiratory illness and factors associated was collected using a structured questionnaire. Descriptive statistics and regression model was employed to analyze data.

Results

Using the operational definition for respiratory illness, the prevalence of respiratory illness among charcoal cooking women was found to be 48.1% and the most common symptom reported was cough. Women households who lacked formal education (AOR 1.96, 95% CI: 1.62, 6.51), indoor cooking (AOR 2.57, 95% CI: 1.23, 5.39), self-reported inadequate ventilation facility at home is about 1.7 times associated with respiratory illness.

Discussion and conclusion

The higher prevalence reported in this study relates to the fact that only less than 5% of Ethiopian population have access to clean fuels. Compare and contrast was inconvenient due to the inconsistence and variability among studies conducted in Sub-Saharan Africa. Still, the higher prevalence of respiratory illness among Ethiopian women households is alarming and demands attention to improve women health.

Keywords: Ethiopia, charcoal, cooking, biomass fuels, respiratory illness

Background

In Ethiopia, gas and electricity are not widely used as a cooking fuel because of their cost, fear, caution, and mostly unreliable supply (1). It is estimated that Ethiopian cities and towns burn over three million tons of charcoal every year. Charcoal is 99% flammable when dry, cost effective compared to modern sources, easily accessible (2). Hence, more preferred fuel for cooking by households in developing countries (3). In Ethiopia, the poor are engaged in charcoal making and distribution. Dependency on charcoal is rather increasing because of the rapid growth of urban population, and rise in the price of modern sources of energy like electricity, Liquefied Petroleum Gas (LPG) and kerosene (4). It is also a source of cash income for rural households with little or no land rather than source of energy; many urban youth, and women in particular are engaged in the retail business. On the other hand, studies in many African countries report that charcoal making is among the primary drivers of deforestation and subsequent land degradation (5–7).

Though, charcoal meets a significant portion of households energy needs and supports the livelihood of numerous rural households in Ethiopia (8). Many consumers those who use charcoal as a primary source of fuel are mostly unaware of its adverse health and environmental impacts. According to the International Energy Agency (IEA 2002) traditional stoves that uses dung and charcoal emit large amounts of carbon monoxide and other noxious substances which may lead to a wide range of illness and diseases including respiratory tract infection, low birth weight, nutritional deficiency, airway diseases, lung disease and lung cancer, tuberculosis, cardiovascular disease and cataracts. Exposure to these pollutants is reported to be higher in women living in developing countries (9,10).

Socio-demographic factors like age, gender, education level, income, tradition and cultural factors, individual factors like health status, residence factors like ventilation, infra-structural facilities, indoor or outdoor cooking, family size, frequency of cooking and other factor like cost effective fuel, fuel availability are considered as factors associated with adverse health effects of charcoal cooking among women households in different epidemiological studies. The WHO 2018 health statistics report suggest that access to clean fuels and technologies for cooking has improved marginally until 2016 (11). However, coverage levels vary greatly between countries and population growth continues to outplace the transition to clean fuel (12). About 3 billion

people are estimated to be still cooking with polluting fuel combinations. The resulting household air pollution is estimated to have caused 3.8 million deaths from NCDs and acute respiratory infection in 2016 (11).

Alarming Global Health Observatory (GHO) data of the WHO for 2016 estimated that less than 5 % proportion of Ethiopian population to have primary reliance on clean fuel. Our extensive search revealed that there is a dearth of knowledge and data about the burden of respiratory illness and factors associated with charcoal cooking in Ethiopia. Hence, this study was set out to establish the burden of respiratory diseases among women households using charcoal cooking, its exposure, and factors associated in Gondar town, Ethiopia.

Material and method

Study design and study settings

A community-based cross-sectional study was conducted from April to June 2019 in Gondar city, Northwest Ethiopia, situated in northern part of Ethiopia in Amhara National regional state and 824 km from the capital city Addis Ababa. Based on the 2016 population estimates of Gondar city administration bureau Gondar had a total population of 335,000 with $3200/km^2$, with an estimated total household count of 53725 and 182000 (52%) women. Gondar town has 24 administrative areas (kebeles) of which 12 are classified as sub-cities or urban kebeles, 11 are rural kebeles and 1 special kebele (13).

Sampling procedure

Among the kebeles in Gondar city, Kebele 18 was conveniently selected for the study purpose due to feasibility constraint reason and close proximity of the study area to University of Gondar Referral Hospital (UoGRH) which shall benefit the affected individuals in case of referral of identified health issues among study samples during data collection. The number of households in Kebele 18 as per Kebele 18 administration office records was 26,000, Since the population size is known, Epi Info version 7 was used to determine the sample size fixing these factors such as actual population size 26,000 households, Confidence Level 95%, expected frequency 25%, and Confidence limits 5% .The final sample size was calculated to be 285 households.

Systematic random sampling was used (with sampling interval K = 92) to select the households. In case of charcoal fuel cooking not found in the selected household, until the next consecutive households reporting charcoal cooking was recruited and in the presence of more than one households using charcoal cooking inside the same premise a lottery method decided participation. A face-to-face interview method was employed using a structured questionnaire for data collection and 4 data collectors who were hotel management graduates. The randomly selected data collectors from the registered list were intensively trained for one day on the questionnaire by the principal investigator (TAPM).

Data collection and study variables

The data collectors introduced themselves and explained the purpose of this study to the participants. Informed consent was obtained from each participant and in case absence of participant or locked door situation in a selected household during the first visit; the same household was marked and re-visited only once after 24 hours and in case of absence again the immediate next house was approached. If a randomly selected participant was not willing to participate it was considered as non-response and the refusal reasons were noted. The questionnaire was prepared in regional language (Amharic) and a pre-test was conducted (10% sample size) in Kebele 17, which has similar characteristics to the study area. The principal investigator checked for completeness and clarity of the data each day and again prior to analysis. Respiratory illness is considered to be present when a participant self-report the presence of shortness of breath at rest, cough, breathing difficulty, and chest tightness

Data analysis

Data were initially coded and entered in Epi Info software version 7.0 and then exported to IBM Statistical Package for Social Sciences (SPSS) version 21 for Windows for statistical analyses. Data entry was done by the principal investigator and checked for correctness. Descriptive statistics (frequency, percentages, means, and standard deviations (SD) were used for all participant characteristics and associated variables for charcoal cooking and self-reported adverse health effects. With self-reported symptoms of respiratory illness (categories: no versus yes) as the dependent variable, bivariate and multivariate binary logistic regression model was used to identify associated independent variables. Independent variables with a p-value less than

< 0.2 in the bivariate logistic regression were fitted into the multivariable logistic regression analysis for controlling the possible main effect of confounders and interaction terms was used to examine the potential associations. Results were considered statistically significant when 95% confidence intervals not containing unity (equal to p-value < 0.05) for both main effects and interaction terms.

Results

Socio-demographic characteristics

A total of 285 household women using charcoal cooking were selected and all of them consented to participate with response rate of 100%. The mean age of women participants was 33.19 years (S.D± 10.35). The self-reported respiratory conditions of 1236 family members were questioned during data collection, which includes 562 (45.6%) children, 280 (22.7%) men, and 392 (31.7%) women. Only 13% of the women participants reported to have no formal education and majority of them were married 156 (54.7%). One hundred and sixty three (57.2%) of women households reported of cooking three times on a typical day. More than half (67%) of the women households reported of cooking inside their house and majority (82.5%) of agreed that they have good ventilation at their home. More sample characteristics are presented in Table 1.

Table- 1 Socio-demographic, infrastructure, and charcoal cooking characteristics of household women in Gondar town, Ethiopia, 2019 (N=285 households, N= 1236 total family members)

Variables	Frequency	Percentage
Age (mean, in years)	33.19 ± 10.35	
18 – 30 years	145	50.9%
31 – 40 years	83	29.1%
41 – 50 years	41	14.4%
>50 years	16	5.6%
Level of education		
Illiterate	37	13%
Primary	51	17.9%
Secondary	73	25.6%
Diploma	47	16.5%
Graduate	77	27%
Marital status		
Married	156	54.7%
Unmarried	114	40%
Divorced or separated	12	4.2%

Co-habiting	03	1.1%
Occupation		
Self-employed	114	40%
Petty business	89	31.2%
Govt employment	51	17.9%
Private employment	23	8.1%
Unemployed	08	2.8%
Family member		
Single	45	15.8%
2 – 4 members	131	46%
5 and above members	109	38.2%
Total family member (n= 1236)		
Adult men	280	22.7%
Adult women	392	31.7%
Children	562	45.6%
Frequency of cooking/day		
Once	28	9.8%
Twice	94	33%
Thrice and above	163	57.2%
Place of cooking		
Indoor	193	67.7%
i. In kitchen	139	48.8%
ii. In bedroom	49	17.2%
iii. In hall/drawing room	05	1.8%
Outdoor/open air	92	32.3%
Reason for charcoal cooking		
Cheaper price	113	39.6%
Availability	116	40.7%
Traditional practice	23	8.1%
Fear in using modern fuel	33	11.6%
Interest in obtaining training on modern fuel		
Yes	269	94.4%
No	16	5.6%
Number of rooms in the house		
One	98	34.4%
Two	67	23.5%
Three and more	120	42.1%
Adequate ventilation in house		
Yes	235	82.5%
No	50	17.5%

Charcoal cooking and respiratory health related characteristics

Only 6% of the women participants self-reported not to have suffered any illness in the past 12 months. Majority of the women (37.5%) reported that their children get frequently ill when compared with adults of the households. One hundred and thirty seven women those who were involved in charcoal cooking self-reported to have any one or more of the following symptoms: breathing difficulty, cough, shortness of breath, chest pain and chest tightness. Using the operational definition for respiratory illness, the prevalence of respiratory illness among charcoal cooking women was found to be 48.1% and the most common symptom reported was cough. Among one hundred and fifty three women who reported symptom of cough, about 33.9% suffered persistent cough. More details reported about shortness of breath during rest, activities and uphill walking is presented in Table 2.

Table 2 Self-reported health characteristics of the women household with charcoal cooking in Gondar, Ethiopia 2019 (N=285)

Variables	Frequency	Percentage
Frequency of getting ill in the past 12 months		
Never	17	6%
One	144	50.5%
Two	71	24.9%
Three	33	11.6%
Multiple	20	7.1%
Family member who gets ill frequently		
Adults	101	35.4%
Children	107	37.5%
Both	77	27%
Respiratory conditions/disease		
Yes	137	48.1%
No	148	51.9%
Breathing difficulty		
Never	202	70.9
Frequently	22	7.7
Occasionally	40	14
Rarely	21	7.4
Cough		
Yes	153	53.7
No	132	46.3
SOB at rest		

Never	224	78.6
Frequently	17	6.0
Occasionally	35	12.3
Rarely	9	3.2
SOB during ADL		
Never	186	65.3
Frequently	26	9.1
Occasionally	52	18.2
Rarely	21	7.4
SOB walking uphill		
Never	184	64.6
Frequently	27	9.5
Occasionally	61	21.4
Rarely	13	4.6
Chest pain		
Never	213	74.7
Frequently	14	4.9
Occasionally	46	16.1
Rarely	12	4.2
Chest tightness		
Never	190	66.7
Frequently	09	3.2
Occasionally	64	22.5
Rarely	22	7.7

SOB- Shortness of breath, ADL- Activities of daily living

Factors associated with respiratory illness

In the bivariate logistic model, self-reported respiratory illness was significantly associated with level of educational, age, family size, frequency of cooking at home in a typical day, place of cooking (indoor), reason for preferring charcoal as cooking fuel, ventilation of house, and number of rooms in the house. The variables that were significantly associated with respiratory illness in bivariate analysis were re-entered into multivariate logistic regression model as independent variables for outcome of respiratory illness. The factors that were identified to be significantly associated with respiratory illness were; no formal education, indoor cooking, reason for preferring charcoal as cooking fuel, lack of adequate ventilation in the house, and lesser number of rooms in the house.

Women households who lacked formal education are almost two times more likely to have respiratory illness than the educated participants AOR 1.96, 95% CI: 1.62, 6.51. Women

households those who cooked using charcoal inside the house were more than two times more likely to develop respiratory diseases than who cooked outdoor AOR 2.57, 95% CI: 1.23, 5.39.

Women those who preferred charcoal as a cooking fuel because it is a traditional practice and cheaper fuel are four time more likely to develop symptoms related to respiratory illness. Women cooking using charcoal in a house with inadequate ventilation facility were found to be at the risk of developing respiratory illness about 1.7 times more than those in a house with adequate ventilation. Participants in household with more rooms are less likely to develop respiratory illness than those living in house with only one room AOR 0.27, 95% CI: 0.12, 0.66. Our results also showed that almost all the participants 268 (94.1%) used charcoal for cooking for more than 25 days in a typical month. None of the women participants self-reported wheezing symptom and tobacco smoking habit. Table 3

Table 3 Associated factors of self-reported respiratory illness among women households using charcoal cooking in Gondar, North-West Ethiopia 2019 (N=285).

Variable	Yes (n=137)	No (n =148)	COR (95%) CI	AOR (95%) CI	P
Level of education					
No education	19	18	1.40 (0.59, 3.33)	**1.96 (1.62, 6.51)**	**0.01***
Primary	21	30	1.57 (1.07, 3.46)	0.51 (0.20, 1.2)	0.15
Secondary	21	52	0.66 (0.28,1.55)	**0.39 (0.15, 1.0)**	**0.00***
Diploma	19	28	0.38 (0.16, 0.86)	1.28 (0.61, 3.2)	0.59
Graduate	29	48	1(ref)	1(ref)	
Age					
18– 30 years	76	69	1(ref)	1(ref)	
31 – 40 years	37	46	2.42 (1.80, 7.3)	0.48 (0.23, 1.02)	0.56
41 – 50 years	19	22	1.77 (1.25, 5.5)	0.44 (0.18, 1.13)	0.88
>50 years	05	11	1.90 (1.02, 6.4)	0.11 (0.17, 0.42)	0.30
Family size					
Living alone	21	24	1(ref)	1(ref)	
2 – 4 members	57	74	2.87 (0.93, 2.57)	0.82 (0.29, 2.23)	0.69
5 and above members	59	50	1.80 (0.80, 3.32)	0.88 (0.27, 2.45)	0.73
Cooking frequency/day					
Once	10	18	1(ref)	1(ref)	
Twice	46	48	1.50 (0.22, 1.72)	1.96 (0.63, 6.1)	0.24
Thrice and above	81	82	1.839 (1.1, 1.7)	1.43 (0.43, 4.72)	0.55
Place of cooking					
Indoor	102	91	1.82 (1.09, 3.03)	**2.57 (1.23, 5.39)**	**0.01***

Outdoor	35	57	1(ref)	1(ref)	
Reason for charcoal cooking					
Cheaper price	64	49	2.29 (1.02, 5.1)	**4.04 (1.52, 9.73)**	**0.005***
Availability	48	68	1.24 (0.55, 2.74)	1.79 (1.01, 4.66)	0.23
Traditional practice	13	10	2.28 (0.76, 6.75)	**4.01 (1.06, 10.1)**	**0.03***
Fear of modern fuel	12	21	1(ref)	1(ref)	
Adequate ventilation					
Yes	104	131	1(ref)	1(ref)	
No	33	17	2.45 (1.29, 4.63)	**1.70 (1.0, 3.9)**	**0.04***
No of rooms in the house					
One	30	68	1.07 (.65, 0.89)	**3.7 (1.47, 9.5)**	**0.006***
Two	42	25	1.422 (0.77, 2.6)	**0.27 (0.12, 0.66)**	**0.004***
Three and more	65	55	1(ref)	1(ref)	

* Denotes significant association of characteristics with fall in multivariate model, AOR- Adjusted odds ratio, CI - Confidence Interval, COR-Crude odds ratio. Note: R^2 = 0.257 (Cox & Snell), 0.343 (Nagelkerke). Model X^2 (n=285) = 90.1, p<0.001. Correctly predicted: 77.1%

Discussion

This study investigated the prevalence of respiratory illness among women households using charcoal cooking, its exposure, and factors associated in Ethiopia. The overall prevalence of respiratory illness in this sample was 48.1%. The results indicated that respiratory illness among women household using charcoal as a cooking fuel is relatively common in Ethiopia. Though charcoal have been referred to as medium pollution fuel, when used indoor will result in higher exposure to the pollutants and chemical compounds leading to temporary to permanent damage to the respiratory tracts.

The available published studies of respiratory diseases or illness among women associated with charcoal or biomass fuel cooking had wide variability in terms of operationalizing outcome variable, and outcome measures used (10,14–18). In contrast to the industrialized countries, where chronic obstructive pulmonary diseases (COPD) and other air pollutant related respiratory illness are attributed to cigarette smoking habits, where as in the developing countries, biomass combustion like charcoal is an main predictor of respiratory condition particularly among women population. In Sub-Saharan Africa, studies done on women in Cameroon and Malawi reported prevalence of 12.7% and 16% respectively which is much lower than the prevalence reported in this study (17,19). The difference in the results might be explained by the fact that the GHO data

of WHO for 2016 estimated that less than 5% (20) of the Ethiopian population to have access to clean fuel, which probably implies that most of the women household used exclusively charcoal cooking and eventually more exposure to indoor air pollutants.

Moreover, the Malawian and Cameroon study samples contained 28% and 0.7% of cigarette smokers which would have led to over estimation of the prevalence in those studies and the other reason for their lower prevalence compared to this study might be the difference in outcome measure, both the studies used pulmonary function test to define respiratory airway diseases in contrast to self-reported symptoms in this study. A Tanzanian study reported that the prevalence of acute respiratory infection among children in the households to be 11% (21). Surprisingly, the women households in this study reported that only 1.7% children to have respiratory illness. The possible reasons might be that children spend most of their time playing out-door and in schools which reduce their exposure time to indoor air pollution. Women, on the other hand, often take more responsibility of cooking for the family in Ethiopia which makes it more difficult to reduce their exposure to the harmful pollutants of charcoal combustion.

Though, the prevalence of respiratory disease or illness among women reported by the studies in the Sub-Saharan Africa may not be directly comparable due to inconsistencies in the operational definition of outcome variable, exposure timings, use of different biomass fuels, and sampling procedure. But, the prevalence reported in this study is much higher than those reported or diagnosed elsewhere. Which should throw caution to the winds or these findings might be attributed to over-estimation due to self-reported findings. We hope that these findings will be a spotlight at mitigating the deleterious effects of exposure to charcoal cooking in women households of Ethiopia.

Considering the benefits of future research there are few limitations; the cross-sectional nature does not allow inferring of causality and effects. Convenient sampling procedure and self-reported respiratory illness might have led to over-estimations. This study did not account on the exposure time or cooking time each day. Hence, the findings of this study should be interpreted with caution. Nevertheless, the present findings indicate that there is higher prevalence of respiratory illness among women households cooking using charcoal.

Conclusion

The results of this study demonstrated the indoor charcoal cooking, lack of education among women, and inadequate ventilation at home to be associated with respiratory illness among women households. Healthcare workers in Ethiopia and the women household users of charcoal should be sensitized on the negative impact of charcoal exposure respiratory health of women and creating awareness on the negative effects of biomass fuel in Ethiopia. Health advocates should emphasize on availability and usage of clean fuel in Ethiopia.

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