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Original Article

The Association between Improved Cookstove Use and Respiratory Illness in Rural Southern Ethiopia

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Abstract

Background: The use of traditional fuelwood for cooking in developing countries poses significant health risks, particularly for women who are primarily responsible for household activities. Indoor air pollution (IAP) arising from the inefficient combustion of biomass fuels releases harmful pollutants, including particulate matter (PM), which have been linked to various respiratory illnesses. Improved cookstoves (ICS) offer a promising solution to reduce IAP and improve health outcomes. This study aimed to assess the association between cookstove use and respiratory illness among women in Chencha District, Gamo Zone.

Methods: A cross-sectional study was conducted in March 2020 among 513 women in the Chencha Zuriya district. Eight kebeles were selected, four from communities using improved cookstoves and four from non-user communities. Households within each kebele were selected using systematic random sampling, with proportional allocation based on population size. Trained health professionals conducted face-to-face interviews, and data analysis was performed using SPSS version 21. The prevalence of respiratory illness was determined, and various socio-economic and household factors, including cookstove use, were analyzed for their association with respiratory illness.

Results: The overall prevalence of respiratory illness was 33.5% (172/513) [95% CI: 29.5–37.6]. Non-users of improved cook stoves had significantly higher rates of respiratory illness (55.2%) compared to users (12.6%) (AOR = 2.97; 95% CI: 1.15–7.67). Women with no formal education had significantly higher odds of respiratory illness compared to those with secondary education or above (AOR = 5.24; 95% CI: 2.69–10.20). Households with more than five members also had significantly higher odds of respiratory illness (AOR = 2.50; 95% CI: 1.37–4.56). Inadequate cooking facilities, such as stoves without chimneys (AOR = 5.16; 95% CI: 1.93–13.81) and homes without permanent roof ventilation (AOR = 6.37; 95% CI: 1.70–23.82), were strongly associated with respiratory illness. However, crowding and time spent in the kitchen did not show a significant adjusted association.

Conclusion: This study highlights the significant role of improved cook stove use, education, and

household conditions in the prevalence of respiratory illness among women in rural Ethiopia. The use of improved cookstoves and inadequate household ventilation were key contributors to respiratory health issues. Interventions to promote improved cooking technologies, better household infrastructure, and educational initiatives are crucial in mitigating respiratory illnesses in rural Ethiopian communities.

Keywords: Improved cookstoves, respiratory illness, indoor air pollution, Ethiopia

Introduction

Indoor air pollution (IAP) remains a major global health concern, particularly in low- and middle-income countries where reliance on solid fuels for cooking and heating is widespread. In 2019, household air pollution (HAP) contributed to an estimated 91.5 million disability-adjusted life years (DALYs) and 2.31 million deaths worldwide, with the highest burden observed in sub-Saharan Africa (1).

The use of polluting fuels, including solid biomass and kerosene, remains prevalent in this region, declining only modestly from 90% in 1990 to 84% in 2020 (2). In Ethiopia, over 95% of households rely on biomass fuels, with 76.4% of urban households and 98.1% of rural households using solid fuels such as charcoal, firewood, and agricultural residues for cooking (3).

Prolonged exposure to HAP has been strongly linked to adverse health outcomes, including acute respiratory infections, chronic obstructive pulmonary disease (COPD), cardiovascular diseases, and premature mortality (4). This disproportionately affects women and children, who spend extended periods near cooking areas, are disproportionately affected (5). In Ethiopia, the use of biomass fuel for cooking is common and, few studies on air pollution-related health impact estimation show that the household air pollution-attributable mortality is just over 49.5% due to ALRI, 49.5% due to COPD, and 49.5% due to lung cancer (6). To mitigate the harmful effects of IAP, improved cookstoves (ICS) were promoted as a cleaner and more efficient alternative to traditional three-stone stoves. ICS technologies, such as the Mirte and Tikikil stoves in Ethiopia, were designed to reduce fuel consumption and emissions, thereby decreasing exposure to harmful pollutants and associated respiratory illnesses (7). While evidence suggests that ICS adoption can lower the incidence of respiratory diseases, barriers such as affordability, cultural acceptability, and maintenance constraints continue to limit widespread and sustained use (8).

Despite national efforts to promote ICS adoption, research assessing their health impacts in rural Ethiopian settings remains limited. This study aims to address this gap by evaluating the association between ICS use and respiratory illness in rural households in the Chencha Zuriya district of Southern Ethiopia. Findings from this study will contribute to the growing body of evidence on the health benefits of ICS and inform policies to improve adoption and long-term sustainability in similar settings.

Methods and materials

Study Area

The study was conducted in Chencha Zuriya district, which was one of 18 districts (14 rural and 4 urban administrative areas) of Gamo zone, SNNP regional state. The district is located at a longitude and latitude of 6°15′N37°34′E. It is located 37 kilometers north of Arba Minch and around 593 km of Addis Ababa. The district is categorized mainly into two agro-climatic zones; Dega (high altitude) covers about 18% of the area with an altitude of more than 2300 meters above sea level and Woinadega (mid-altitude)

ranges from 1900-2300 meters above sea level and covers about 82% of the area. In 2020, the district's projected population was 155,925. With a total area of 373.5 km², this resulted in a population density of 417 people per square kilometer. According to the meteorological report obtained from the Agricultural and Rural Development Office of the District (ARDOD), the mean annual temperature and rainfall were 22.5 0 C and 1201-1600 mm, respectively. Based on the information obtained from the Chencha Zuriya District Water and Mining Office 2019 report, the district encompasses 39 (38 rural and 1 urban) administrative kebeles and there have been 1854 improved cookstoves in use in 15 rural kebele.

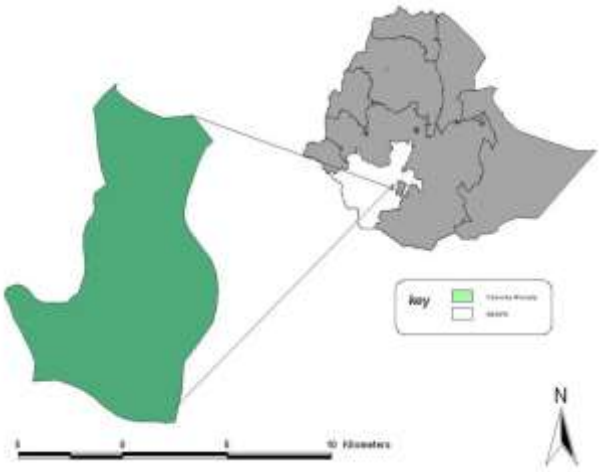

Figure 1 Mape of Chencha Zuriya district, Gamo zone, south Ethiopia

Study Design and Period

A community-based comparative cross-sectional study design was used among cookstove users and non-user women in Chencha Zuriya District in March 2020.

Source and study Population

The source population was those rural households living in Chencha Zuriya District and both traditional and improved cookstove users. The study population was a sample of women with ages greater than 18 and having food preparation/cooking responsibility of selected households from the source population.

Sample Size Determination

The sample size was calculated using a single proportion formula, based on the assumption that the prevalence of ARI among women in a similar study was 32% (9).

$$n = \frac{Z_{\frac{\alpha}{2}}^{2} \times p(1-P)}{d^2}$$

$$\text{n} = \frac{(1.96)^2 * 0.32 * 0.68}{(0.05)^2} = 334$$

Where n = the required sample size, z = critical value for standard normal distribution (z-statistic) at 95% confidence level (z = 1.96), 5% margin of error, p = expected prevalence of ARI=32%.

With the addition of a 10% non-response rate, the total sample size was calculated to be 367. After accounting for a design effect of 1.5, the final sample size was determined to be 550. This number was then equally distributed between households using improved cookstoves (ICS) and those using traditional cookstoves

Sampling Procedures

A purposive sampling technique was employed to select 8 kebeles from the 38 rural kebeles in the district, based on the improved cookstove (ICS) distribution reports provided by the District Energy Office and an NGO project operating in the area. Among the 15 kebeles with a relatively higher number of ICS user households, four kebeles with the highest number of stove adoptions and utilization periods exceeding two years were selected. In addition to the ICS user kebeles, four non-user kebeles were selected through systematic random sampling, using a sampling frame containing the list of kebeles in the district (Table *1*). For the

household survey, a sample was drawn from both user and non-user kebeles, ensuring equal representation of the two groups. Accordingly, 50% (275 households) of the sample was allocated to ICS user households, while the remaining 50% (275 households) was allocated to non-user households. This brought the total sample size to 550 households. Households were selected for data collection through systematic random sampling, using a sampling frame derived from official lists. For ICS users, the household list was obtained from the District Water and Mine Office, while for non-users; the list was sourced from the District Finance and Economic Development Office. Data collection involved on-the-spot observations of cookstove utilization and household environments.

Table 1 Proportional allocation of the sample to the selected kebeles, Chencha Zuriya District, Gamo Zone, South Ethiopia, 2020

SN	Cookstoves user kebeles	Number of households having cookstoves	Selected kebeles with a respective sample size	Kebeles with non-user of Improved stove	Non–user sample size
1	Gendo gembela	154	78	Elenachare	78
2	Mafonazolo	127			
3	Holo-o	126			
4	Lakanamaldo	132	67	Hayizo	67
5	Ayira	117			
6	Doshike	128	65	Godiye	65
7	Metsonagada Dita	111			
8	Mesho	121			
9	Tida	129	65	Dalona Zara	65
10	Dambo	121			
11	Shaye	111			
12	Yoyira	113			
13	Gedeno	114			
14	Kale	123			
15	Zute	127			
	Total	1854	275 (15% of total ICS users)		275
					550

Study variables:

Dependent variables

Respiratory illness (cough, phlegm, sneeze, nasal secretion, nasal congestion, nasal irritation and headache).

Independent variables

Age, Marital status, number of household members, level of education, occupation, wealth index, work environment: health and safety education (awareness related to health effect of cookstove), hours passed in the kitchen per day, separate kitchen, window available, chimney availability, stove type (Traditional versus Improved), sanitation

Data collection tools and procedures

Data were collected using semi-structured questionnaires through face-to-face interviews with participants and direct observation. Data collectors were selected based on their professional background and knowledge of

respiratory problems, particularly symptoms related to respiratory illnesses caused by incomplete combustion of fuel smoke. As a result, the data collectors had at least a bachelor's degree in human health (e.g., BSc in Nursing or Health Officer) and more than one year of work experience. The collected data were mainly focused on points incorporated in six sections: (i) socio-demographic information; (ii) awareness regarding the health effect of cook smoke; (iii) assuring using improved biomass and traditional stove and their experience; (iv) women's duration of exposure involved to the kitchen smoke; (v) kitchen ventilation; and (vi) occurrences & frequencies of cooking practice related symptoms of respiratory disease.

Data quality control and management

Data collectors received three days of training before the actual field data collection, and close supervision was provided by the principal investigator to ensure data quality. Standard questionnaires were translated from English to Amharic and then back-translated to English to ensure accuracy. The tools and data collection process were pre-tested before implementation. To address potential confounding factors, covariates known to influence respiratory symptoms, such as exposure to environmental tobacco smoke (ETS) and past smoking habits, were captured through the respiratory symptoms and exposure questionnaires.

Operational definition of terms:

Attached kitchen: A kitchen that shares one or more walls with the main living house.

Cough: Defined as a "yes" response to at least one of the following questions: (i) coughing first thing in the morning, (ii) coughing during the day or night, (iii) coughing four to six times a day within a week, or (iv) coughing for most of the day for three consecutive months in a year.

Improved cookstove: A type of stove optimized for fuel efficiency or designed to minimize emissions.

Phlegm: Defined as bringing up phlegm from the chest (deep in the lungs) either first thing in the morning or during the day within the past 12 months.

Respiratory illness (RI): Defined based on the WHO criteria, including any combination of the following symptoms: cough with or without fever, nasal congestion, nasal secretion, sneezing, sore throat, phlegm, often accompanied by lung infection. It encompasses both upper and lower respiratory tract infections. Mothers who have experienced at least one of the above-mentioned symptoms were considered to have respiratory illness.

Safe use of improved cookstove: Consistent use of an improved cookstove without using a traditional stove.

Unsafe use of improved cookstove: Defined as using an improved cookstove interchangeably with a traditional stove at least three times per week.

Data entry and Analysis

Data entry and cleaning were made using statistical software for epidemiology Epi-data and exported to IBM SPSS Version 21 for analysis. After visualizing the general features of the data, descriptive statistics such as mean and standard deviation for continuous variables and frequency and percentage for categorical variables were determined separately for the user and non-user participants of the improved cookstove. Bivariate logistic regression was carried out to determine the distribution of the study subjects by independent variable of interest and to see crude association; whereas multivariable logistic regression analysis was used using adjusted odds ratio. Those variables found to be associated with the dependent variable in the bivariate analysis or have a p-value below 0.25 were exported to multivariable

logistic regression analysis to evaluate the relative effect of solid fuel use by adjusting for other exposure factors. For all tests, the p-value was set to <0.05 to determine significance.

Results

Socio-demographic characteristics

Out of 514 participants, 252 (49%) were from households using improved cookstoves, while 262 (51%) were from non-user households. The majority of participants, 373 (72.6%), were housewives in both groups. Regarding educational status, 135 (26.3%) had no formal education, 176 (34.2%) had completed elementary school, and 203 (39.5%) had completed high school or higher education. Most households, regardless of cookstove usage, had more than five family members, accounting for 379 (73.7%) of participants. Among households with poor wealth status, 112 (44.4%) were from improved cookstove user households, and 111 (42.4%) were from non-user households (Table 2).

Cooking-Related characteristics of women in study households

The majority of participants, 478 (93.0%), lived in households with more than five family members. Among these, 221 (87.7%) were from Improved Cookstove (ICS) user households, and 257 (98.1%) were from non-user households. Of the total 514 participants, 485 (94.4%) had a separate kitchen, with 230 (91.3%) from ICS user households and 255 (97.3%) from non-user households. Most participants, 484 (94.2%), cooked in a separate kitchen, but during the rainy season, 477 (92.8%) cooked inside their living spaces (Table 3).

Table 2: Sociodemographic and Household Characteristics of Improved Cookstove (ICS) Users and Non-Users, Chencha Zuriya District, Gamo zone, south Ethiopia, 2020

Variables	Category	ICS Users, N (%)	ICS nonusers, N (%)
Age	≤ 35	54(21.4)	78(29.8)
	36 – 45	81(32.1)	79(30.2)
	> 46	117(46.4)	105(40.1)
Educational status	No formal education	52(20.6)	83(31.7)
	Elementary school	93(36.9)	83(31.7)
	High school & above	107(42.5)	96(36.6)
Occupation status	Civil servant	19(7.5)	34(13.0)
	Business worker	33(13.1)	40(15.3)
	Housewife	197(78.6)	185(70.7)
	student	3(1.2)	3(1.1)
Husband occupation	Civil servant	50(19.8)	81(30.9)
	Business worker	38(15.1)	45(17.2)
	Farmer	156(61.9)	126(48.1)
	No husband	8(3.2)	10(3.8)
Household's wealth	Poor	112(44.4)	111(42.4)
	Medium	94(37.3)	95(36.3)
	Wealthy	46(18.3)	56(21.4)
Family size	≤ 5	51(20.2)	84(32.1)
	> 5	201(79.8)	178(67.9)

Table 3: Cooking Environment and Practices among Improved Cookstove (ICS) Users and Non-Users, Chencha Zuriya District, Gamo zone, south Ethiopia, 2020

Variables	Category	ICS Users, N (%)	ICS nonusers, N (%)
Crowding per house	≤ 5 people/room	31(12.3)	5(1.9)
	> 5 people/room	221(87.7)	257(98.1)
Have separate kitchen	Yes	230(91.3)	255(97.3)
	No	22(8.7)	7(2.7)
Cooking is done inside (the living house)	Throughout the year	25(9.9)	11(4.2)
	During the rainy season	227(90.1)	251(95.8)
Cooking location	Inside kitchen/living house	20(7.9)	80(29.8)
	In and outside the kitchen/house	232(92.1)	184(70.2)
When do you cook food for your family per day	Morning	17(6.7)	63(24.0)
	At lunch period	17(6.7)	6(1.1)
	Evening	30(11.9)	2(.8)
	Morning & evening	156(61.9)	149(56.9)
	All time	32(12.7)	45(17.2)
Time spent in the kitchen	< 3 hours	246(97.6)	82(31.3)
	≥ 3 hours	6(2.4)	180(68.7)
Permanent ventilation in the roof of the cooking area	Yes	140(55.6)	225(85.9)
	No	89(35.3)	31(11.6)
	No kitchen	23(9.1)	6(2.5)
Availability of window to the kitchen wall	Yes	137(54.4)	224(85.5)
	No	92(36.5)	32(12.0)
	No kitchen	23(9.1)	6(2.5)

The Respiratory symptoms of the women

Out of the 514 study participants, 77 (15.0%) claimed that they had a cough, among these 63 (81.8%) and 14 (18.2%) were from non-ICS users and ICS user households, respectively. One-third of the participants, 170 (33.1%) had Sneeze, of which 131 (77.1%) and 39 (22.9%) were from non-ICS user and user households, respectively. The major respiratory symptoms of the women were reported mainly from both groups as follows, 214 (41.6%) nasal secretions, 123(23.9%) Nasal congestion and 63 (12.3%) claimed Phlegm (Figure *2*).

Prevalence of respiratory illness

The prevalence of respiratory illness among the study participants in Chencha District was 33.5% [95% CI: 29.5 - 37.6] at Chencha Zuriya District, Gamo Zone. However, the prevalence of respiratory diseases in non-improved cookstoves users was much higher (55.2%) than the users (12.6%).

Determinants of respiratory illness

Participants with no formal education had significantly higher odds of experiencing respiratory illness compared to those with high school education or above (AOR = 5.24; 95% CI: 2.69–10.20). Elementary school education showed no statistically significant association. Although poor households had higher crude odds of respiratory illness (COR = 1.72), the adjusted odds ratio (AOR = 1.72; 95% CI: 0.9–3.32) was not statistically significant after adjustment. Households with more than five members had significantly higher odds of respiratory illness compared to those with five or fewer members (AOR = 2.50; 95% CI: 1.37–4.56). Non-users of improved cookstoves were more likely to report

respiratory illness compared to users (AOR = 2.97; 95% CI: 1.15–7.67). Although crowding (more than five people per room) showed high crude odds of respiratory illness (COR = 8.12), the association was not significant after adjustment (AOR = 1.80; 95% CI: 0.60–5.44). Households without a chimney stove had significantly higher odds of respiratory illness compared to those with a chimney stove (AOR: 5.16; 95% CI: 1.93–13.81). Time Spent in the Kitchen: Spending more than three hours in the kitchen was associated with higher crude odds of respiratory illness (COR: 6.40); however, the adjusted association was not statistically significant (AOR: 2.29; 95% CI: 0.92–5.70). Households with no permanent roof ventilation showed higher odds of respiratory illness compared to those with ventilation (AOR: 6.37; 95% CI: 1.70, 23.82) (Table 4).

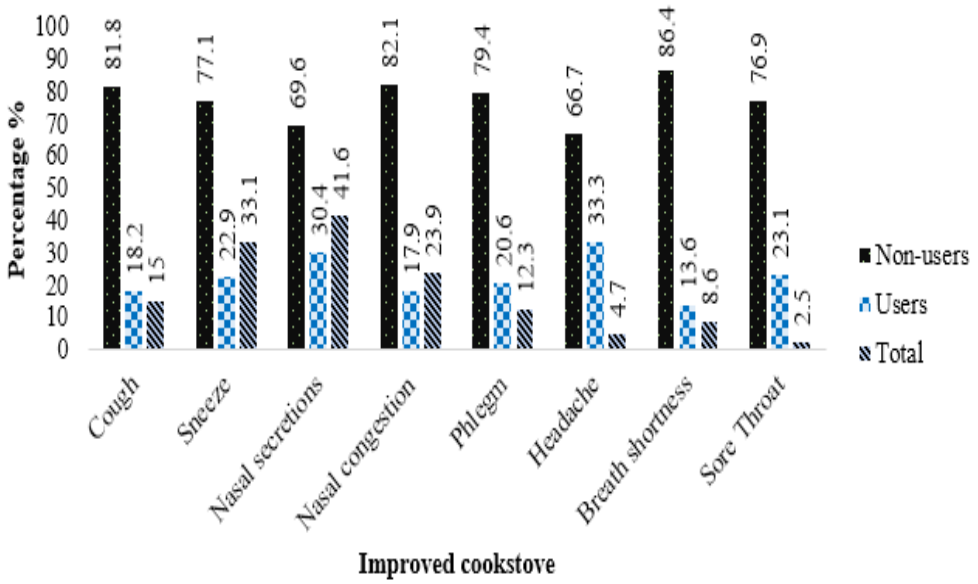

Figure 2: The Respiratory symptoms of the women from improved cookstove user and non-user households in Chencha Zuriya District, Gamo zone, south Ethiopia, 2020.

NB: in this figure, the total is calculated from the overall sample size. The percentage of cases among the users and nonusers was calculated from the whole cases.

Discussion

The study found that the prevalence of respiratory illness among participants in Chencha Zuriya District, Gamo Zone, was 33.5% (172 out of 513) [95% CI: 29.5–37.6]. In comparison, a higher prevalence (46.1%) of respiratory symptoms was reported among mothers of under-five children in Northwest Ethiopia (10). Similarly, a study in Lesotho found that 27.6% of adults experienced cough, followed by sneezing (23.0%) and fever (17.5%) (11). Another study in Sri Lanka reported the prevalence of respiratory symptoms among women as follows: cough (14%), phlegm (16%), both cough and phlegm (9.9%), wheeze (22%), breathlessness (22.3%), and diagnosed asthma (6.3%) (12). These findings highlight the significant burden of respiratory illnesses, underscoring the need for public health interventions.

Table 4 Determinants of respiratory illness among study participants in Chencha Zuriya District, Gamo zone, southern Ethiopia in 2020.

Variables	Respiratory illness		COR 95% Cl	AOR 95% Cl	p-Value
	Yes, N (%)	No, N(%)			
Educational status					
No formal education	65(48.1)	70(51.9)	2.77(1.74, 4.40)	5.24(2.69, 10.20)	<0.001*
Elementary school	56(31.8)	120(68.2)	1.39(0.89, 2.18)	1.44(0.82, 2.53)	0.200
High school & above	51(25.1)	152(74.9)	1	1	
Household's wealth					
Poor	88(39.5)	135(60.5)	1.72(1.03, 2.87)	1.72 (0.9, 3.32)	0.104
Medium	56(29.6)	133(70.4)	1.113(0.65, 1.90)	1.03(0.52, 2.05)	0.935
Wealthy	28(27.5)	74(72.5)	1	1	
Family size					
≤ 5	23(17.0)	112(83.0)	1	1	
> 5	149(39.3)	230(60.7)	3.16(1.93, 5.17)	2.50(1.37, 4.56)	0.003*
Improved cookstove use					
No	139(55.2)	113(44.8)	8.54(5.49, 13.27)	2.97(1.15, 7.67)	0.024*
yes	33(12.6)	229(87.4)	1	1	
Crowding per house					
≤ 5 people/room	144(30.1)	334(69.9)	1	1	
> 5 people/room	28(77.8)	8(22.2)	8.12(3.61, 18.24)	1.80(0.60, 5.44)	0.296
Stove having chimney					
No	165(45.3)	199(54.7)	16.94(7.72 37.18)	5.16(1.93, 13.81)	0.001*
Yes	7(4.7)	143(95.3)	1	1	
Time spent in the kitchen					
< 3 hours	21(11.5)	161(88.5)	1	1	
≥ 3 hours	151(45.5)	181(54.5)	6.40(3.87, 10.58)	2.29(0.92, 5.70)	0.076
Permanent ventilation in the roof of the cooking area					
Yes	77(21.1)	288(78.9)	1	1	
No	74(60.7)	48(39.3)	5.766(3.707, 8.97)	6.37(1.70, 23.82)	0.028*
No kitchen	21(77.8)	6(22.2)	13.09(5.11, 33.56)	2.51(1.48, 4.25)	0.103

The significant difference in respiratory illness prevalence between individuals using traditional cooking methods (55.2%) and those using improved cookstoves (12.6%) highlights the critical role of household air pollution in respiratory health. This finding is consistent with previous research, which has established a strong link between exposure to indoor air pollution from biomass fuel combustion and an increased risk of respiratory diseases (13, 14). This study reaffirms the urgent need to scale up the adoption of improved cookstoves to mitigate the health burden of respiratory illnesses. Integrating clean cooking interventions into broader public health and environmental strategies can significantly enhance community well-being while contributing to global efforts in air pollution reduction and climate change mitigation.

The study also revealed significant associations between respiratory illness and socioeconomic factors. Women with no formal education had significantly higher odds of developing respiratory illness compared to those with secondary education or higher (AOR = 5.24; 95% CI: 2.69–10.20, p < 0.001). This finding is consistent with similar research conducted in

Kenya (14), Nepal (15), and Northwest Ethiopia (8). A possible explanation for this association is that women with lower education levels may have less awareness of the health risks associated with indoor air pollution, limited access to cleaner cooking technologies, and fewer opportunities to adopt preventive health measures.

Similarly, households with more than five members were found to have significantly higher odds of respiratory illness (AOR = 2.50; 95% CI: 1.37–4.56, p = 0.003), supporting findings from other studies in Kenya (16) and Nepal (17)). Larger families may experience overcrowding, which can increase the spread of respiratory infections, and they may also face greater financial constraints, making it harder to afford improved cookstoves.

The lack of a chimney stove was another significant factor. Women in households without a chimney stove had much higher odds of developing respiratory illness (AOR = 5.16; 95% CI: 1.93–13.81, p = 0.001), which is in line with findings from rural Nepal (17) and Sri Lanka (18). Stoves without chimneys release smoke into the living environment, increasing exposure to harmful pollutants. Similarly, households without permanent roof ventilation showed six times higher odds of respiratory illness (AOR = 6.37; 95% CI: 1.70–23.82, p = 0.028), reinforcing the importance of proper ventilation in reducing indoor air pollution (19, 20).

The study also examined the impact of time spent in the kitchen on respiratory illness. Initially, spending more than three hours in the kitchen was significantly associated with higher odds of developing respiratory illness (COR = 6.40). However, after adjusting for other influencing factors, the association weakened and was no longer statistically significant (AOR = 2.29; 95% CI: 0.92–5.70, p = 0.076). This study suggests that while prolonged exposure to indoor cooking environments may increase the risk of respiratory illness, this effect is likely influenced by other factors such as fuel type, ventilation, and socio-economic conditions. The loss of statistical significance after adjusting for these variables indicates that the observed association in the initial analysis may have been confounded. Additionally, the study did not find a significant association between overcrowding (more than five people per room) and respiratory illness after adjusting for other factors. This may be due to the complex nature of overcrowding, where other unmeasured factors, such as sanitation, socio-economic status, and access to healthcare, could also influence respiratory health.

This study has limitations. Recall and social desirability biases may have affected the accuracy of self-reported data. The use of intervention measures, such as improved cookstoves, was recorded only during the enumerator's visit, potentially introducing responder and observer biases. Additionally, as a cross-sectional study, it cannot establish causality, highlighting the need for longitudinal or experimental research to confirm the findings.

Conclusion

This study highlights the significant impact of improved cookstove (ICS) usage on reducing respiratory illness among women in Chencha Zuriya District, Gamo Zone, Ethiopia. The prevalence of respiratory illness was notably higher among non-ICS users compared to ICS users, underscoring the protective role of cleaner cooking technologies. Key determinants of respiratory illness included lack of formal education, large family size, absence of chimney stoves, and poor kitchen ventilation, all of which were associated with increased odds of developing respiratory symptoms. These findings reinforce the urgent need for interventions promoting the adoption of improved cookstoves, enhancing household ventilation, and increasing awareness about the

health risks of indoor air pollution. Future programs should prioritize targeted educational campaigns and financial support to ensure wider accessibility and adoption of cleaner cooking technologies, ultimately improving respiratory health outcomes in similar settings. Future research employing longitudinal or experimental designs is recommended to further explore these associations and confirm the causal pathways between these factors and respiratory health.

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Ethical considerations

Ethical clearance was obtained from the Institutional Review Board (IRB) of Hawassa University College of Medicine and Health Science. An official letter of permission was obtained from the Department of Environmental Health. Informed written consent or permission was obtained from all Sub-cities. Establishments' managers/owners were well informed about the purpose of the study and verbal consent was obtained from them. Their privacy was also maintained. They were also informed that the information obtained from their establishment would not be disclosed to a third person/body to assure confidentiality.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author via correspondence e-mail: hunachew@gmail.com

Conflicts of interest

The authors declared no conflicts of interest exist.

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References

1. Bennitt FB, Wozniak SS, Causey K, Burkart K, Brauer M. Estimating disease burden attributable to household air pollution: new methods within the Global Burden of Disease Study. The Lancet Global Health. 2021;9:S18.
2. Stoner O, Lewis J, Martínez IL, Gumy S, Economou T, Adair-Rohani H. Household cooking fuel estimates at global and country level for 1990 to 2030. Nature Communications. 2021;12(1):5793.
3. EPHI, ICF. Ethiopian Public Health Institute (EPHI) [Ethiopia] and ICF. 2021. Ethiopia Mini Demographic and Health Survey 2019: Final Report. Rockville, Maryland, USA: EPHI and ICF. 2021.
4. WHO. Burden of disease from household air pollution for 2016. World Health Organization, 1211 Geneva 27, Switzerland: 2018 April 2018. Report No.
5. Dida GO, Lutta PO, Abuom PO, Mestrovic T, Anyona DN. Factors predisposing women and children to indoor air pollution in rural villages, Western Kenya. Archives of Public Health. 2022;80(1):46.
6. Balidemaj F, Isaxon C. Indoor Air Pollution Exposure of Women in Adama, Ethiopia, and Assessment of Disease Burden Attributable to Risk Factor. 2021;18(18).

7. Manaye A, Amaha S, Gufi Y, Tesfamariam B, Worku A, Abrha H. Fuelwood use and carbon emission reduction of improved biomass cookstoves: evidence from kitchen performance tests in Tigray, Ethiopia. Energy, Sustainability and Society. 2022;12(1):28.
8. Adane MM, Alene GD, Mereta ST, Wanyonyi KL. Facilitators and barriers to improved cookstove adoption: a community-based cross-sectional study in Northwest Ethiopia. Environmental health and preventive medicine. 2020;25(1):14.
9. Taylor ET, Nakai S. Prevalence of acute respiratory infections in women and children in Western Sierra Leone due to smoke from wood and charcoal stoves. International journal of environmental research and public health. 2012;9(6):2252-65.
10. Andualem Z, Azene ZN, Azanaw J, Taddese AA, Dagne H. Acute respiratory symptoms and its associated factors among mothers who have under five-years-old children in northwest, Ethiopia. Environmental health and preventive medicine. 2020;25(1):20.
11. Mabeleng K, Rathebe PC, Masekameni MD. A cross-sectional study on domestic use of biomass fuel and the prevalence of respiratory illnesses in a rural community in Thaba-Tseka district of Lesotho. Heliyon. 2024;10(17).
12. Jayaweera GU, Wimalasekera SW, Goonewardena SE. Respiratory symptoms and associated factors among women exposed to biomass fuel smoke in Sri Lanka: cross sectional study. International Journal Of Community Medicine And Public Health. 2020;7(7):2475-82.
13. Adane MM, Alene GD, Mereta ST, Wanyonyi KL. Effect of improved cookstove intervention on childhood acute lower respiratory infection in Northwest Ethiopia: a cluster-randomized controlled trial. BMC Pediatrics. 2021;21(1):4.
14. Wafula EM, Kinyanjui MM, Nyabola L, Tenambergen ED. Effect of improved stoves on prevalence of acute respiration infection and conjunctivitis among children and women in a rural community in Kenya. East African medical journal. 2000;77(1):37-41.
15. Bradley RH, Putnick DL. Housing quality and access to material and learning resources within the home environment in developing countries. Child development. 2012;83(1):76-91.
16. Lozier MJ, Sircar K, Christensen B, Pillarisetti A, Pennise D, Bruce N, et al. Use of Temperature Sensors to Determine Exclusivity of Improved Stove Use and Associated Household Air Pollution Reductions in Kenya. Environmental science & technology. 2016;50(8):4564-71.
17. Soneja SI, Tielsch JM, Khatry SK, Zaitchik B, Curriero FC, Breysse PN. Characterizing Particulate Matter Exfiltration Estimates for Alternative Cookstoves in a Village-Like Household in Rural Nepal. Environmental Management. 2017;60(5):797-808.
18. Chartier R, Phillips M, Mosquin P, Elledge M, Bronstein K, Nandasena S, et al. A comparative study of human exposures to household air pollution from commonly used cookstoves in Sri Lanka. Indoor air. 2017;27(1):147-59.
19. Adane MM, Alene GD, Mereta ST, Wanyonyi KL. Prevalence and risk factors of acute lower respiratory infection among children living in biomass fuel using households: a community-based cross-sectional study in Northwest Ethiopia. BMC Public Health. 2020;20(1):363.
20. Alexander D, Linnes JC, Bolton S, Larson T. Ventilated cookstoves associated with improvements in respiratory health-related quality of life in rural Bolivia. Journal of public health (Oxford, England). 2014;36(3):460-6.