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AWARENESS OF INDOOR AIR POLLUTION AND FACTORS ASSOCIATED WITH THE USE OF UNCLEAN COOKING FUELS AMONG RESIDENTS OF MBALALA TOWN, MUKONO DISTRICT, UGANDA: A CROSS-SECTIONAL STUDY.

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Abstract

Background

In most low- and middle-income countries, many households still rely on unclean cooking fuels (such as firewood and charcoal) despite the associated indoor air pollution exposure. We assessed people's awareness of indoor air pollution and factors related to the use of unclean cooking fuels among residents of Mbalala town, Mukono district.

Methods

This was a descriptive cross-sectional study in which we collected both quantitative and qualitative data. Quantitative data were collected on socio-demographic characteristics, awareness of indoor air pollution (effects, causes, risks, control measures), and cooking practices (including the use of clean/unclean cooking fuels) from 385 respondents. We computed the proportions of respondents who were aware of indoor air pollution, and who used unclean fuels, and determined the factors associated with using a modified Poisson regression model. Qualitative data were collected from 10 key informants (community leaders and village health teams) and analyzed manually following a thematic framework approach.

Results

The mean age was 32.5 years (SD: ±11.5). Three-quarters of the respondents (75.3%, n=290) were aware of indoor air pollution. Awareness of indoor air pollution was associated with being 46 years or older, being male, having a tertiary/University education, and earning between US$104 and US$209 monthly. Ninety-four percent (n=350) used unclean cooking fuels. Use of unclean cooking fuels was significantly lower among men than women, and among respondents with primary/secondary education than those without education. Qualitative findings showed that participants used unclean cooking fuels because they were cheaper and accessible. Restrictions on the use of electric appliances by landlords and lack of electricity limited the use of gas cookers or other electric appliances.

Conclusion

Despite the high awareness of indoor air pollution, nearly all respondents reported using unclean cooking fuels.

Recommendation

Community sensitization on the health risks associated with the continued use of unclean cooking fuels is urgently needed.

Keywords: *Indoor air pollution, Awareness, Unclean Cooking Fuels, Uganda*
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Introduction

Nearly half of the global population (2.4 billion people), the majority of whom live in low- and middle-income countries, still rely on solid fuels such as firewood, animal dung, charcoal, crop wastes, and coal for cooking partly due to poverty (Puzzolo and Pope, 2017). In addition, over 750 million people globally lack access to electricity which leads them to use polluting devices such as unvented kerosene lamps for lighting hence exposing them to high levels of fine particulate matter (CDC, 2015). Other sources of indoor air pollution include tobacco smoke, biological materials (such as molds), radon, and interior furnishings (CDC, 2015, Coker et al., 2020, WHO, 2022). However, solid fuels are reported the most common source of indoor air pollutants globally (Smith et al., 2004). These fuels emit carbon monoxide, particulate matter, oxides of nitrogen and sulfur, volatile organic compounds, and semi-volatile organic compounds on

incomplete combustion (CDC, 2015, Hankey et al., 2015). When these pollutants are inhaled, they can cause serious health risks such as allergic attacks including asthma, lung cancer, ischaemic heart disease, stroke, and chronic obstructive pulmonary disease (COPD) (WHO, 2022, Smith et al., 2000). Children under 5 years and women are the most affected by the impacts of indoor air pollution exposure because they spend most of their time indoors, as well as women are more involved in cooking, and working closely with their children (WHO, 2022, Zhang and Smith, 2003).

In Sub-Saharan Africa, indoor air pollution contributes to approximately 10% of the total premature deaths (Faisal et al., 2021). Similarly, literature shows that indoor air pollution accounts for over 64% of child deaths in Uganda due to acute lower respiratory tract infections (Chirambo, 2018). This is probably because in Uganda, over 90% of the population uses solid fuels for cooking (Bamwesigye et al., 2020, Wafula et al., 2022). Furthermore, approximately 80% of Uganda's population still uses paraffin lamps for lighting in homes which produces a lot of soot in houses (Mbaha, 2017). This situation is similar to what is happening in Mbalala town, Mukono district, an industrialized area with many factories close to residences that emit fumes from different industrial processes (Datantify, 2023). In addition, the majority of people in the town are low-income earners and hence use solid fuels for cooking, mainly charcoal (Monitor, 2021). This poses a serious public health concern because health risks from these pollutant exposures not only depend on their concentrations but also the length of exposure (Hankey et al., 2015).

In many settings in Uganda, deaths due to indoor air pollution are hardly documented (Monitor, 2020). This makes the low-income residents of Mbalala town vulnerable to dangers arising from indoor air pollution. Indoor air pollution also raises concern regarding the achievement of the United Nations Sustainable Development Goals (UNSDGs) by 2030, especially Goal 3 (Good Health and Wellbeing). This is because exposure to indoor air pollution increases the risk of non-communicable diseases (NCDs) including stroke, ischaemic heart disease, chronic obstructive pulmonary disease, and lung cancer (WHO, 2023). Despite these known risks, only a handful of studies have assessed awareness of indoor air pollution among rural residents (who are more likely to use unclean cooking fuels) as well as the factors associated with the use of unclean cooking fuels. This study assessed awareness of indoor air pollution and factors associated with the use of unclean fuels among residents of Mbalala town, Mukono district, to generate data that can inform the scale-up of interventions intended to reduce exposure to indoor air pollution as well as contribute to the achievement of health-related SDGs.

Methods

Study area and setting

This study was conducted in Mbalala, a small town along the Kampala-Jinja highway, approximately 7km from Mukono town and 27km from Kampala, the capital city. The town is located within a swampy area in the Nama sub-county, Mukono district, Uganda, and has an estimated population of over 6,000 people, based on the Local Council report. This town is occupied mostly by low-income earners and is industrialized, having a significant part of its population working in factories as casual laborers. Some residents have small business enterprises while others work in stone quarries. Mbalala has several institutions including schools, religious places of worship, and others. The schools in the area include kindergartens and secondary schools. This town was selected for this study because its residents were believed to be very vulnerable to indoor air pollution given that many of them were observed using unclean fuels even before the study.

Study design and population

This was a descriptive cross-sectional study in which both quantitative and qualitative data were collected. The study was conducted among residents of Mbalala town in Mukono District who were 18 years of age or older. Households were the study units while household members were the participants. Interviews were also conducted among community leaders and members of the village health teams (VHTs) as key informants.

Sample size and sampling procedure

The sample size was determined using the formula by Kish Leslie (Kish, 1965), with the desired 95% level of confidence, at an assumed prevalence of 50% to get the maximum sample size possible, and a desired standard precision of 5%. With these assumptions in mind, a sample size of 385 respondents was obtained. To enroll respondents in the study, lists of households were obtained from the area's local leaders and purposely selected the household head in each household until the required sample size was attained. The decision to target household heads was because they are always well-acquainted with household information and challenges. However, if, for some reason, the household head was absent, any other eligible household members were invited to participate in the interview.

For the qualitative interview participants, ten (10) key informants were purposively selected to participate in the study. These were individuals who were considered to have a good understanding of the subject matter or who held positions of responsibility in the community. These included: four (4) village health team (VHT) members and six (6) community leaders. All these individuals were purposively identified with the support of the local leaders in the area.

Data collection procedures

Quantitative data were collected using a semi-structured questionnaire while qualitative data were collected using a key informant interview (KII) guide. These data collection tools were designed by the lead author (GN), based on the literature on indoor air pollution from previous studies, with technical support from the

academic supervisor (DM). Before data collection, both tools were pre-tested in a similar setting, among residents and local authorities of Nakapinyi village in Kasenge parish, Mukono District. This was done to ensure the easiness and comprehensiveness of the tools. The data collection tools were also translated into the local language (*Luganda*) for ease of administration.

Following pre-testing, the questionnaire was configured into a *Kobo Collect* mobile data collection tool and administered by the lead author (NG). Quantitative data were collected on socio-demographic characteristics, awareness of indoor air pollution in general, and, in particular, awareness of the dangers of indoor air pollution, likely causes of indoor air pollution, individual risk perception for indoor air pollution, and what can be done to control indoor air pollution. Data were also collected on cooking practices that could predispose respondents to the risk of indoor air pollution including cooking fuels used (categorized as clean or unclean), ventilation of cooking spaces, amount of time spent cooking, and whether or not cooking was done indoors. All the data collected were saved on an online server daily until the end of the data collection process.

For the qualitative interviews, data were collected using a KII guide by the lead author. All interviews were audio-recorded with permission from the participants. The KII guide included open-ended questions to get a broader view and richer information on participants' perceptions and issues that lead people to use unclean fuels. The key informants were found at their respective workplaces, or places of residence for the interviews. Each KII lasted for an average of 20 minutes.

Measurement of variables

The primary outcomes were the proportion of participants who: a) were aware of indoor air pollution or b) used unclean fuels. We defined the term 'awareness' as someone's understanding of the risks, sources, effects, and control strategies of indoor air pollution. Awareness was measured using questions such as: *"Have you ever heard of the term 'indoor air pollution'?"* and *"What are the sources of indoor air pollution?"*. Awareness questions were coded with 0= "No" or 1= "Yes" and eventually standardized to generate percentages. Respondents were considered to be aware of indoor air pollution if they scored ≥75% and "unaware" if they scored <75%, based on the blooms cut-offs (Ashebir et al., 2022). We defined unclean fuels as those that emit smoke during cooking. Respondents who reported that they used petroleum gas, solar energy, and electricity for cooking were considered to be using "clean cooking fuels" while those who reported using kerosene/paraffin stoves, sawdust, firewood, charcoal, and vegetables/plant residues for cooking were considered to be using "unclean cooking fuels".

Data analysis

Initially, all the quantitative data were downloaded from an online server into Microsoft Excel software for cleaning. The cleaned quantitative data were then exported to STATA/MP 14.1 for analysis. Factors associated with each outcome variable were computed separately using a multivariable modified Poisson regression model to determine the adjusted prevalence ratios and their 95% confidence intervals. We opted for a modified Poisson regression because the prevalence of the outcomes (awareness, and use of unclean fuels) was more than 10% (Greenland, 2021). Variables with $p<0.25$ in the bivariate analysis were included in the multivariable modified Poisson regression model. However, some variables (such as age, marital status, occupation, and average monthly income) were included in the final model (although they were not significant at the bivariate analysis level) due to biological plausibility based on other studies. In this study, $p<0.05$ was considered to be statistically significant. Qualitative data were transcribed within 12 hours of data collection, translated, and then analyzed manually using thematic content analysis. This analysis included coding, checking for the constituency, generation of major themes and sub-themes, and afterward presenting supporting quotes from the participants' interviews to supplement quantitative data.

Ethical considerations

The researcher got permission from Makerere University School of Public Health to conduct the study as part of the Bachelor in Environmental Health Sciences program. This being a student's academic study, it was not subjected to an ethical review board but rather approved at the level of the supervisor, who is among the authors of this publication (DM). In addition, permission was also obtained from the local leaders of Mbalala town to conduct the study in his area of jurisdiction. The researcher ensured that all research participants took part in the study after providing written informed consent, and kept all the collected information private, protected, and confidential.

Bias and bias control

There was self-reporting which may have led to bias in some of the responses provided by the respondents. To minimize this kind of bias, there were probing questions following each of the responses provided by the respondents.

Results

Socio-demographic characteristics of the respondents

Two-thirds of the respondents were females 255/385 (66.2%). The mean age of the respondents was 32.5 years (SD: ±11.5). Only 12.7% (49/385) of the respondents had attained tertiary/university education and the biggest number of the participants 207/385 (53.8%) were married. Furthermore, a large percentage of the respondents 74.0% (285/385) earned below 104 USD per month (Table 1).

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Table1. Socio-demographic characteristics of the respondents

Variable	Frequency (n = 385)	Percentage (%)
Sex		
Male	130	33.8
Female	255	66.2
Mean age	**32.5 years (SD: ±11.5 years)**	
Religion		
Catholic	95	24.7
Protestant	96	24.9
Muslim	95	24.7
Seventh Day Adventist	21	5.5
Pentecostal	76	19.7
Isah Messiah	2	0.5
Tribe		
Baganda	112	29.1
Basoga	102	26.5
Bakiga	18	4.7
Banyankole	15	3.9
Bagisu	23	6.0
Others (e.g., Banyoro, Bagwere)	115	29.9
Occupation		
Formal job	12	3.1
Informal job	319	82.9
Unemployed	54	14.0
Education level		
None	17	4.4
Primary	135	35.1
Secondary	184	47.8
University/tertiary	49	12.7
Marital status		
Married	207	53.8
Separated/divorced	10	2.6
Single	154	40.0
Widowed	14	3.6
Average monthly income (USD)		
<104	285	74.0
104 – 209	90	23.4
>209	10	2.6

Awareness of indoor air pollution

Of the 385 respondents interviewed, 90.4% (348/385) had ever heard about the term 'indoor air pollution'; 88.1% (339/385) were aware of the sources of indoor air pollution; 89.6% (345/385) were aware of the risks due to indoor air pollution, while 55.8% (215/385) were aware of the long-term effects due to indoor air pollution. On average, 75.3% (290/385) were aware of at least one aspect of indoor air pollution. Slightly more than half of the respondents (53.3%, 205/385) perceived themselves to be at risk of indoor air pollution, 65.7% (253/385) were aware of the recommended cleaner cooking fuels while 62.6% (241) believed that indoor air pollution can be controlled (Table 2).

Table 2. Awareness of indoor air pollution

Variables	Frequency (n=385) /%
Ever heard of the term 'indoor air pollution'	348 (90.4%)
Aware of the sources of indoor air pollution	339 (88.1%)
Aware of the risks due to indoor air pollution	345 (89.6%)
Aware of the long-term effects of indoor air pollution	215 (55.8%)
Perceive yourself to be at risk of indoor air pollution	205 (53.3%)
Aware of the recommended cleaner fuels	253 (65.7%)
The belief that indoor air pollution can be controlled	241 (62.6%)
Awareness of at least one aspect of indoor air pollution	**290 (75.3%)**

At bivariate analysis, awareness of indoor air pollution was positively associated with being male (Prevalence Ratio [PR] = 1.06; 95%CI: 1.08, 1.34), university/higher education (PR = 1.48; 95%CI: 1.04, 2.12), informal jobs/unemployment (PR = 0.72; 95%CI: 0.61, 0.85), and earning more than 104 USD (PR = 1.27; 95%CI: 1.02, 1.58). At multivariable analysis, awareness of indoor air pollution was significantly associated with being 46 years of age or older (Adjusted Prevalence Ratio [aPR] = 1.22; 95%CI: 1.04, 1.43), being male (aPR = 1.20; 95%CI: 1.08, 1.33), tertiary/university level of education (aPR = 1.56; 95%CI: 1.08, 2.24) and earning between US$ 104 and US$209 (aPR = 1.56; 95%CI: 1.03, 1.30 (Table 3).

Table 3. Factors associated with awareness of indoor air pollution

Variables	Total (N)	No./Percentage, aware of at least one aspect of indoor air pollution		Prevalence ratio (PR) and 95% Confidence Interval (95%CI)	Adjusted PR and 95%CI
		N	%		
Age-group (years)					
<30	179	129	72.1	1.0	1.0
30-45	159	122	76.7	1.06 (0.94-1.21)	1.04 (0.92-1.19)
46+	47	39	83.0	1.15 (0.98-1.35)	**1.22 (1.04 -1.43)**
Sex					
Female	225	180	70.6	1.0	1.0
Male	130	110	84.6	**1.06 (1.08-1.34)**	**1.20 (1.08-1.33)**
Education level					
None	17	11	64.7	1.0	1.0
Primary	135	93	68.9	1.06 (0.74-1.54)	1.11 (0.76-1.61)
Secondary	184	139	75.5	1.17 (0.81-1.68)	1.22 (0.85-1.76)
Tertiary/university	49	47	95.2	**1.48 (1.04-2.12)**	**1.56 (1.08-2.24)**
Occupation					
Formal job	12	12	100.0	1.0	1.0
Informal job	319	239	74.9	**0.75 (0.70-0.80)**	0.98 (0.87-1.10)
Unemployed	54	39	72.2	**0.72 (0.61-0.85)**	0.98 (0.79-1.21)
Marital status					
Married	207	157	75.9	1.0	1.0
Divorced/separated	10	5	50	0.66 (0.35-1.23)	0.64 (0.34-1.18)
Single	154	117	76.0	1.00 (0.89-1.13)	1.03 (0.90-1.17)
Widowed	14	11	78.6	1.04 (0.78-1.38)	0.99 (0.74-1.34)
Average monthly income (USD)					
<104	285	202	70.9	1.0	1.0
104 – 209	90	79	87.8	**1.24 (1.11-1.38)**	**1.16 (1.03-1.30)**
>209	10	9	90.0	**1.27 (1.02-1.58)**	1.16 (0.93-1.44)

Key informants reported that while most of the residents of Mbalala Town were aware of the risk of indoor air pollution, they were limited by resources to practice good habits regarding indoor air pollution control.

"Most people know because they have witnessed deaths due to indoor air pollution but they have no option because of limited space to cook outside or set up standard kitchens therefore end up cooking in their houses" (VHT)

Cooking practices related to indoor air pollution

Complete data on cooking practices were available for 373 (96.9%) respondents. Of these, 85.5% (319/373) used charcoal stoves with a corresponding 85.5% (319/385) reporting charcoal as their main source of cooking fuels. When asked about where they cook from, 47.7% (178/373) reported that they cook from indoors. On average, 93.8% (350/373) of all the respondents use unclean cooking fuels. Of those who cook indoors, 98.3% (175/178) reported that they did something to reduce exposure to solid fuel smoke with 92% (161/175) reporting that they opened windows while cooking; 20.6% (36/175) put holes in kitchen walls, while 14.3% (25/175) lit the charcoal stoves from outside (to minimize exposure to smoke) and thereafter entered them into the house after they were well lit (Table 4).

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Table 4. Cooking practices that can increase the risk of exposure to indoor air pollution

Variable	N = 373 (%)
Cooking facility used	
Traditional tripod stove	27 (7.2%)
Gas cooker	12 (3.2%)
Charcoal stove	319 (85.5%)
Electric coils	11 (3.0%)
Improved cook stove	2 (0.5%)
Other facility (e.g., Paraffin stoves)	2 (0.5%)
Fuels used during cooking	
Charcoal	319 (85.5%)
Cow dung	0 (0.0%)
Firewood	29 (7.7%)
Plant residues	0 (0.0%)
Electricity	11 (3.0%)
Gas	12 (3.2%)
Other fuels (e.g., paraffin)	2 (0.5%)
Cooking place at home (Yes)	
Indoors	178 (47.7%)
Outdoors	195 (52.3%)
Of those that cook indoors, a percentage reports that they did anything to reduce exposure to solid fuel smoke (Yes/No)*	175 (98.3%)
Of those who did anything to reduce exposure to solid fuel smoke, what is it that they did? (Multiple responses allowed)**	
Put holes in walls	36 (20.6%)
Installed chimneys	13 (7.4%)
Open windows while cooking	161 (92.0%)
Installed ventilators	17 (9.7%)
Remove ash before adding another solid fuel	1 (0.6%)
Lit the charcoal stove from outside and thereafter entered it into the house	25 (14.3%)
Other action taken (e.g., using quality charcoal)	6 (3.4%)
Average time spent cooking indoors in a typical day (hours) (n=178)	
< 1	2 (1.1%)
1-2	111 (62.4%)
3+	65 (36.5%)
The average proportion of respondents that used unclean fuels***	350 (93.8%)

Expressed as a percentage of those who cook indoors; **Expressed as a percentage of those who did something to reduce exposure to solid fuel smoke

Factors associated with the use of unclean cooking fuels

At bivariate analysis, use of unclean cooking fuels was positively associated with being male (PR = 0.93; 95%CI: 0.87, 0.99), having at least primary education (PR = 0.95; 95%CI: 0.91, 0.99), and awareness of indoor air pollution (PR = 0.93; 95%CI: 0.90, 0.97). At multivariable analysis, the use of unclean cooking fuels was significantly associated with being male (aPR = 0.93; 95%CI: 0.87, 0.98) and having secondary education (aPR = 0.93; 95%CI: 0.88, 0.98) (Table 5).

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Table 5. Factors associated with using unclean cooking fuels that can expose individuals to indoor air pollution

Variables	Total (N)	No./Percentage of respondents who used unclean cooking fuels that can expose them to indoor air pollution		PR and 95%CI	APR and 95%CI
		n	%		
Age group (years)					
<30	173	165	95.4	1.0	1.0
30-45	153	142	92.8	0.97 (0.92-1.02)	1.00 (0.95-1.05)
46+	47	43	91.5	0.96 (0.87-1.05)	0.94 (0.86-1.03)
Sex					
Female	253	243	96.1	1.0	1.0
Male	120	107	89.2	**0.93 (0.87-0.99)**	**0.93 (0.87-0.98)**
Education level					
None	17	17	100.0	1.0	1.0
Primary	132	125	94.7	**0.95 (0.91-0.99)**	**0.93 (0.87-0.99)**
Secondary	176	166	94.3	**0.94 (0.91-0.97)**	**0.93 (0.88-0.98)**
Tertiary	48	42	87.5	**0.88 (0.79-0.97**)	0.94 (0.85-1.04)
Occupation					
Formal job	11	8	72.7	1.0	1.0
Informal job	309	291	94.2	1.29 (0.90-1.86)	1.16 (0.84-1.59)
Unemployed	53	51	96.2	1.32 (0.92-1.90)	1.18 (0.85-1.63)
Average monthly Income (USD)					
<104	278	268	96.4	1.0	1.0
104 – 209	85	76	89.4	0.93 (0.86-1.00)	0.94 (0.87-1.01)
>209	10	6	60.0	0.62 (0.37-1.03)	0.64 (0.40-1.02)
Awareness of at least one aspect of indoor air pollution					
No	90	89	98.9	1.0	1.0
Yes	283	261	92.2	**0.93 (0.90-0.97)**	0.97 (0.94-1.00)

The use of unclean fuels can be attached to the cost of electricity which participants reported to be too high for them to afford coupled with the belief that food cooked with electricity and gas is not up to the required quality in terms of scent, taste, texture, and color.

"Some people think using gas and electricity is being so luxurious and showing off, and some people believe that food cooked with electricity/gas is not tasty and scented. If it is matooke, it does not yellow well nor soften on cooking which makes it hard to mash" (Community leader)

The key informants also reported that the residents mostly used charcoal and firewood because they were cheaper/accessible, firewood is fast at cooking, and some landlords put restrictions on the use of electric appliances. Furthermore, it was mentioned that most people did not know how to operate gas cookers, and some homes lacked electricity.

"Most people are low-income earners and hence cannot afford to use electricity or gas, and some homes do not have electricity. Some landlords restrict the use of electric appliances such as kettles, and electric coils otherwise you can be evicted from the house. Other people do not know how to operate gas cookers which limits use and compromises safety. Gas services are not easily accessed in Mbalala town since there are no gas refilling stations hence someone has to incur transport to go to Mukono town to refill. Therefore, it is better using readily available charcoal" (Community leader)

Discussion

Understanding people's level of awareness and factors associated with the use of unclean cooking fuels is crucial in obtaining information that can guide the generation of effective interventions to mitigate the threatening indoor air pollution exposure, particularly among people who cook indoors. However, limited data exists on people's awareness of the health risks posed by indoor air pollution or the factors associated with the continued use of unclean fuels that emit smoke during cooking. Our study aimed to fill this void. Study findings show that, on average, three-quarters of the respondents were aware of at least one aspect of indoor air pollution. However, nearly half of the respondents cooked indoors, thereby exposing themselves to the effects of indoor air pollution. Luckily, nearly all

those who cooked indoors reported that they had done something to minimize the potential effects of indoor air pollution.

The finding that three-quarters of the respondents were aware of at least one aspect of indoor air pollution is consistent with findings from other studies done in Oke-Oyi (Aderibigbe 2010) and Banda parish, Nakawa division-Kampala (Abitegeka, 2018). These studies found that most people were aware of indoor air pollution (Aderibigbe, 2010, Abitegeka, 2018). The high level of awareness could be due to access to at least secondary education among the majority of the respondents. However, these findings are different from those in a study conducted in South West Nigeria where most respondents were not aware of indoor air pollution (Afolabi et al., 2016). This difference could be due to differences in exposures and experiences in the respective settings. This therefore implies that personal exposure can greatly influence people's awareness of indoor air pollution.

In our study, awareness of indoor air pollution was significantly associated with the respondents' age, sex, level of education, and average monthly income. This could be attributed to increased acquittance while in school, and increased experience age. Literature also shows that exposure to outdoor environments among males and females could similarly have attracted more attention to indoor air quality information than females (Al-Shidi et al., 2021). It is also possible that low socio-economic status influences the use of unclean fuels which leads to experience of indoor air pollution hence creating awareness among the victims. Similarly, other related studies also found that awareness of indoor air pollution was associated with sex, income, age, and education (Chen et al., 2017, Al-Shidi et al., 2021). One's age, sex, education, and income could therefore have a role to play in their awareness of crucial facts such as indoor air pollution.

Our study found that the largest number of participants 350/373 (93.8%) used solid fuels for cooking. Similarly, other literature showed that the highest number of individuals in Latin American and Caribbean countries still rely on solid fuels. This is attributed to access to and cost of cleaner fuels (Troncoso and da Silva, 2017). However, these findings are inconsistent with those from a study done in rural Mexico where 31% of the participants jointly used firewood and Liquefied Petroleum Gas (Troncoso et al., 2007). This inconsistency could be due to improved standards of living among residents of Mexico. This implies that improving socio-economic status can minimize risk practices to indoor air pollution.

Our study showed that the use of unclean fuels was associated with being male and secondary level of education. The males were less likely to use unclean fuels probably due to inconveniences associated with unclean fuels such as smoke, and also males are usually more financially empowered (Azuwike et al., 2023). Furthermore, also those with secondary education probably were less likely to use unclean fuels probably due to more cautiousness about what they could have about their health. These findings correlate with those from another study which showed that males were less likely to engage in poor practices such as the use of unclean cooking fuels than females, and equally educated individuals (Al-Khamees, 2018, Ang'u et al., 2023). This similarity could be a contextual issue whereby there are similar gender-based roles that may contribute to indoor air pollution in different settings. Notably, the acquisition of education might influence people's actions and way of life. However, these findings are inconsistent with another study which revealed that income was associated with the use of unclean fuels (Ang'u et al., 2023). The difference could be due to different life priorities in different settings. Therefore, average monthly income may not always influence decisions on which cooking fuels to use.

Study limitations

Cooking places were not visited to verify the respondents' reports which may have underestimated or overestimated the actual number of households that are exposed to indoor air pollution. However, to overcome this challenge, several questions were asked about cooking facilities such as where cooking took place, and what respondents did to control solid fuel smoke.

Some respondents were hesitant to mention their actual average monthly income. This could be the reason why the association between income and the use of unclean fuels was not detected in this study, yet the two variables were associated in similar studies (Heltberg, 2005, Behera and Ali, 2016). However, the effects of concealing this information were minimized by probing various ventures from which the respondents earned, which were used to estimate their average monthly income.

Strengths of the study

The study used both quantitative and qualitative data collection methods which enabled triangulation of findings.

Conclusion

The majority of respondents were aware of indoor air pollution but nearly all respondents reported that they were still using unclean cooking fuels.

Recommendations

There is a need for more community sensitization by district authorities and health workers to increase awareness about the health risks associated with the continued use of unclean cooking fuels to foster behavior change. In addition, government interventions to enable cheaper access to cleaner fuels including the use of solar energy are needed.

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Conflict of interest
The authors declare no conflict of interest.

Abbreviations and acronyms
Apr	Adjusted Prevalence Ratio
CDC	Center for Disease Control
CI	Confidence Interval
COPD	**Chronic Obstructive Pulmonary Disease**
KI	Key Informant
KII	Key Informant Interview
LC	Local Council
NCDs	Non-Communicable Diseases
PR	Prevalence Ratio
SD	Standard Deviation
UNSDGs	United Nations Sustainable Development Goals
VHT	Village Health Team
WHO	World Health Organization

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