# Awareness of Carbon Monoxide Poisoning among Ghanaians: A Case of Residents in the Ho Municipality of the Volta Region

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**ABSTRACT**

This study aimed to determine the level of awareness of carbon monoxide poisoning among residents of the Ho Municipality in Ghana's Volta Region. The population was made up of residents of Ho, and the study utilised a descriptive approach. A total of 569 people were chosen utilising stratified and convenience sampling procedures. Google Forms was used to collect data, and SPSS was used to analyse it. The findings suggested that respondents had a low level of awareness of carbon monoxide poisoning. In addition, the majority of the respondents' apartments lacked smoke or CO alarms, making them more vulnerable to CO poisoning. Finally, the study discovered that CO poisoning awareness programmes were rare in the Municipality. Therefore, the study recommended, among other things, more CO poisoning awareness programmes.

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## Introduction

Carbon monoxide is a colourless, odourless, tasteless gas produced by burning gasoline, wood, propane, charcoal or other fuel. Improperly ventilated appliances and engines, particularly in a tightly sealed or enclosed space, may allow carbon monoxide to accumulate to dangerous levels.

Carbon monoxide (CO) is the leading cause of poisoning deaths in many countries, including Japan (Kinoshita, 2020), where it claims about 2000-5000 lives in Japan annually— over half of the total number of poisoning deaths. According to a Health and Safety Executive Northern Ireland report, carbon monoxide, the silent killer as it termed it, had claimed the lives of over 60 people in Northern Ireland between 2000 and 2010 (HSENI, 2011). Similarly, documentation proves that carbon monoxide intoxication is one of the most common causes of morbidity due to poisoning in the United States (e.g., Cobb, 1991 and NCHS, 1991). Each year, carbon monoxide (CO) poisoning is responsible for more than 50,000 emergency department visits resulting in more than 400 deaths according to the Center for Disease Control and Prevention; and Americans between the ages of 65 and older are among the highest fatalities. Further, reports on carbon monoxide poisoning in Utah, a state in the US, revealed 224 emergency department visits and two deaths reported in 2017 for CO poisoning, with increasing risks during winter. In a 10-year study period, there were 2667 deaths from CO poisoning in Turkey, most of them resulting from stoves for cooking and heating in the winter in rural areas (Can et al., 2019).

The human body naturally produces carbon monoxide as a byproduct of haemoglobin degradation, resulting in baseline carboxyhemoglobin (COHb) saturation of 1-3% among those who do not smoke, which increases to 10-15% amongst heavy smokers. Exposure to carbon monoxide occurs mainly in indoor home environments through malfunctioning home-heating systems, the operation of gasoline-powered equipment in enclosed or semi-enclosed areas, and improperly vented gas appliances (Girma, 2017). Inhalation of carbon monoxide can reduce oxygen transport by the blood, which starves the cells and organs in the body. Studies on carbon monoxide related deaths (e.g., Braubach, Algoet, Beaton, Lauriou, Héroux & Krzyzanowski, 2013; Hampson, 2016; Janik, Ublová, Kučerová & Hejna, 2017) have revealed that more than half of unintentional deaths were caused by motor vehicle exhaust. Burning charcoal, wood, kerosene, or natural gas for heating and cooking also produces carbon monoxide.

Carbon monoxide poisoning is a significant public health problem and may be responsible for a considerable percentage of all poisoning deaths (Ashraf *et al.*, 2013). Several studies have suggested that CO poisoning may be responsible for more than one-half of all fatal indoor poisonings that are reported worldwide each year (Cobb and Etzel, 1991; Mathieu et al., 1996). In the past, Ashraf *et al.* (2013) have observed that the environmental concern for air pollution has mainly been focused on pollution outdoors. However, in recent times, due to an increased incidence of deaths suspected to be from indoor air pollution, scientists' attention has shifted to the quality of air indoors, especially as it relates to carbon monoxide poisoning. Indoor air pollutants are usually not different from outdoor air pollutants. However, in some instances, as Asraf *et al.*, 2013 had observed, the concentration of indoor pollutants may exceed the standard set for the outdoors. These pollutants reach such high levels though emitted in small volumes because they cannot escape easily from the buildings due to lack of proper ventilation. Since an average person may spend early 16 to 18 hours indoors, indoor air pollution is more harmful and poses more significant health hazards.

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Carbon monoxide poisoning occurs when carbon monoxide builds up in your bloodstream. When too much carbon monoxide is in the air, your body replaces the oxygen in your red blood cells with carbon monoxide. This situation can lead to severe tissue damage or even death. Hence, any attempt at studying indoor air pollution and its impact on people's health in any environment is justified since the global population explosion may lead to more indoor pollution gases.

These pollutions, with a focus on CO, may be as a result of the use of various fuels for cooking, the place of cooking, indoor smoking, outside smoke coming inside the house, ventilation in the home, and also the floor space per person in the sleeping rooms, the poor household environmental condition responsible for the occurrence of diseases as well as office space and chemicals used in factories.

Most countries in Sub-Saharan Africa, including Ghana, still depend extensively on unprocessed solid cooking fuels, with many people exposed daily to harmful emissions and other health risks. Researches by the World Bank in 2000 and currently by Global Resolve reveal that indoor air pollution (carbon monoxide) due to the use of solid fuel in Ghana is a serious problem, and about 96% of the Ghanaian populace use this type of fuel. According to the report, Carbon monoxide poisoning is among the top five environmental risks to public health, contributing to an annual 8.5 million deaths in Africa. In terms of environmental contributors to ill health, indoor smoke is responsible for one-third of premature mortality and disability worldwide, second only to unsafe water, sanitation, and hygiene.

Even though carbon monoxide poisoning has been well documented, especially regarding the dangers and symptoms, the recent developments in the use of fuel-burning appliances have increased dangerous exposures to carbon monoxide throughout building environments. The danger is that carbon monoxide is impossible to detect by an exposed person because it is colourless, tasteless, odourless, and non-irritating. Again, the frequency of health problems associated with sub-lethal levels of CO is challenging to quantify.

However, it is generally agreed that informing users about symptoms and suggesting annual inspection of CO producing devices will reduce CO poisoning.

This short review has shown several related studies on carbon mono oxide risk and awareness across populations in several countries. These studies have revealed an alarming ignorance of the threat of CO poisoning and a close link to morbidity and health-related issues. However, there remains to date no documentation of such studies in Ghanaian society. Given the rising use of CO-emitting gadgets and lifestyles that encourage CO poisoning and increasing population and population density, this study seeks to ascertain the level of awareness of CO poisoning among Ghanaian citizens, especially in Ho and its environs.

## Materials and Methods
### Study Area

The study was done in the Ho Municipality. Ho is the capital city of the Ho Municipal District and the Volta Region of Ghana. The Municipality shares boundaries with Adaklu and Agotime-Ziope Districts to the South, Ho West District to the North and West and the Republic of Togo to the East. The population of Ho Municipality according to the 2010 Population and Housing Census was 177, 281. About 62 percent of the population resides in urban localities. The Municipality has a household population of 172,068, with a total number of 49,826 households. The average household size of the Municipality is 3.6 persons. Children constitute the largest proportion of households and account for 34.1 percent. Spouses form about 10.7 percent of households. Nuclear families (head, spouse(s) and children) constitute 23.4 percent of the total number of homes in the Municipality.

The housing stock of Ho Municipality is 31,832, representing 8 percent of the total number of houses in the Volta Region. The average population per house is 5.6. Over half (55.4%) of dwellings in the Municipality are compound houses; 31.9 percent of all dwelling units are separate houses, and 5.8 percent are semi-detached houses. About two-fifth (43.2) of the dwelling units in the Municipality are owned by members of the household. Less than one percent (0.9 %) of the dwelling units is owned through mortgage schemes.

The primary construction material for outer walls of dwelling units in the Municipality is cement blocks/concrete, accounting for 73.5 percent, with mud-brick/earth constituting 18.7 percent. Cement (89.5%) and mud/earth (6.4%) are the two main materials used to construct floors of dwelling units in the Municipality. Metal sheets (85.4%) account for the main roofing material for dwelling units in the Municipality. One room constitutes the highest (89.6%) percentage of sleeping rooms occupied by households in the Municipality's housing units. About 5.9 percent of households with ten or more members occupy single rooms. The two main lighting sources in the Municipality are electricity (76.4%) and Kerosene lamp (17.8%). The main fuel source for cooking for most households in the Municipality is charcoal (36 %).

### Research Strategy

This present study employed the descriptive research design. This method was deemed appropriate for the study since not much was yet known about the research problem in the study area. In using this method, the researchers could source data from participants in their natural environment without any form of manipulation. This enabled them to provide insight into the research problem by giving answers to the following questions:

● Who suffers exposure to CO poisoning?
● What is the mode of exposure?
● When does poisoning occur? and
● How can CO poisoning be reduced among participants?

Answers to these questions were collected from respondents using the survey method, and the responses analysed for frequencies and percentages. Hence, generally, the descriptive research aided in specifying the nature of CO poisoning in the Ho Municipality and enabled the researchers to find answers to the identified research problem in the best possible way within acceptable limits. This paved way for the generalisation of the study results to other localities within the study area.

### Population and sample of the study

The population was heterogeneous in nature. It included residents living in different parts of Ho Municipal, different age groups, diverse occupation groups, socio-economic classes, and different residential accommodation in the Municipality. The total population of the study consist of the total population of the Ho Municipality. According to the Ghana Statistical Service, the population of Ho Municipality was 177, 281 in 2010 (GSS, 2010). However, the population of Ghana has grown by 19.544% over the years. Applying the

population growth rate to the GSS, 2010 population of Ho municipal (177281), and using the 19.544% growth rate, the study's target population is estimated to be 223, 614.

Using a margin of error of 5%, a confidence level of 95%, a population size of 223, 614 and a response distribution of 80%, the minimum sample size is determined to be 384. But being an online survey, respondents exceeded the minimum sample size of 384. The final sample size therefore used was 569.

*Sampling Techniques*

The study used a combination of probability sampling and non-probability sampling methods in selecting respondents. Stratified sampling under the probability sampling method was first done by grouping respondents into individual strata based on their area of residence. This was followed by convenience sampling under the non-probability sampling method. Convenience sampling was used to enable the researchers to collect needed information at their convenience without the complications of using a randomised sample.

*Data Collection Tools/Instruments*

An online structured questionnaire using Google Forms was the main tool used in collecting data from the respondents. They were used because it was a relatively cheaper, quick and efficient way of obtaining information from respondents than other methods like interviews and focus group discussions. Also, using the questionnaire gave the students' time to focus on other aspects of the study since it did not require them to be filled in their presence. The ease in analysing questionnaire data was also considered in selecting it as the main data collection tool for the study. The items in the questionnaire were divided into different sections based on the demographic information of the respondents and specific objectives of the study. The first section collected the demographic information of the participants. Part two of the questionnaire collected data on CO poisoning awareness among various groups of people. Section C sought respondents' view on safety measures to prevent CO poisoning, and information on awareness campaigns to help reduce CO poisoning was collected in Section D.

*Data Collection Procedure*

The link for the online questionnaire was distributed to respondents within the study area to fill. The dashboard responses were received, which kept updating in real-time as they responded to the online survey. The resulting data was later exported to MS Excel and SPSS for further analysis.

*Data Analysis*

The data collected for the study used the Statistical Package for Social Sciences (SPSS, version 20.0) computer software and Microsoft Excel (2013) in analysing the data. To achieve accuracy in the analysis, the questionnaires were analysed under the various objectives of the study. Both descriptive (simple frequencies) and inferential statistics (chi-square) were employed in the analysis of the data.

**Results and Discussions**

*Demographics*

Most of the survey respondents (215) fell within the 26 - 30 age range, forming 37.4% of respondents for the study. This was followed by the 31 - 35 age range, with 138 respondents making 23.8% of the respondents. According to the 2010 Housing and Population census, these groups are the most active in the Municipality, comprising students and workers.

In terms of gender, males made up most respondents, with a frequency of 305 counts, comprising 53.8% of respondents. The occupation data showed that 311 respondents, representing 53.6%, were student-workers. This was followed by 174(30%) students only, then 88(15.2%) workers only.

Of the 569 respondents that answered the questions on their smoking status, 555 of them, representing 97.5% of respondents, were non-smokers. Of the 22 that smoked, 7 (31.8%) smoked two cigarettes a day, followed by 6 (27.3%) that smoked four sticks a day. Just 53 respondents, representing 9.2% of respondents, said someone smoked in their apartment.

In terms of accommodation, 151 respondents (26.6%) lived in single rooms. This was closely followed by 126 of them (22.2%) that lived in a hall-and-chamber apartment. It is worth noting that a further 103(18.1%) lived in hall-and-chamber self-contained apartments, while 33 respondents (5.3%) lived in single-room self-contained flats.

*Level of Carbon Monoxide Poisoning Awareness in the Municipality*

Data on the level of awareness of respondents is presented in Table 1.

A one-way chi-square test was used in analysing these data. The researchers expected an equal number of respondents (192) to respond equally to all categories (Yes, No, Don't know). However, there were significant differences in the responses received for all questions. Hence the null hypothesis was rejected in all cases [*Can carbon monoxide be found in your dwelling?* $\chi^2$ (2, N = 576) = 20.385, p < 0.05; *Can you see carbon monoxide?* $\chi^2$ (2, N = 576) = 114.26, p < 0.05; *Does carbon monoxide have a smell?* $\chi^2$ (2, N = 576) = 50.005, p < 0.05; *Can carbon monoxide affect your health?* $\chi^2$ (2, N = 576) = 507.89, p<0.05].

Results revealed that 204 respondents (35.4%) agreed that carbon monoxide could be found in their dwelling, 143 respondents (24.8%) indicated carbon monoxide could not be found in their residence, and 229 respondents (39.8%) said they did not know. This finding, if true, would be consistent with that of Nazari, Dianat, and Stedmon (2010), who found low CO poisoning awareness among households in a related study.

**Table 1. Level of CO poisoning awareness among respondents**
*(Ho: observed frequencies are equal to expected frequencies).*

| Question | Yes (Freq/%) | No (Freq/%) | Don't know (Freq/%) | $\chi^2$ (df = 2) | Decision | Interpret. |
|---|---|---|---|---|---|---|
| Can Carbon Monoxide be found in your dwellings? | 204 (35.4%) | 143 (24.8%) | 229 (39.8%) | 20.385 | Reject H*o* | Significant |
| Can you see carbon monoxide? | 119 (20.7%) | 312 (54.2%) | 145 (29.2%) | 114.26 | Reject H*o* | Significant |
| Does carbon monoxide have a smell? | 252 (43.8%) | 116 (20.2%) | 207 (36%) | 50.005 | Reject H*o* | Significant |
| Can carbon monoxide affect your health? | 441 (76.6%) | 20 (3.5%) | 115 (20%) | 507.89 | Reject H*o* | Significant |

Apart from the response affirming CO poisoning affected their health, and if carbon monoxide could be seen, answers to other questions show respondents do not have adequate knowledge of CO poisoning. For instance, the number of respondents who had no idea exceeded that of those who stated CO could be found (35.4%) or not found (24.8%) in their dwelling. This may cause respondents to engage in activities that could expose them to CO poisoning in their homes, of which they may have no idea what the outcomes of their actions would be. Emami-Razavi et al. (2014) have noted that CO poisoning symptoms are not specific, making definite diagnosis difficult by even experts in most cases of patients, and hence almost impossible to be noticed by laypersons. The results show that respondents may be highly susceptible to CO poisoning, resulting in adverse health outcomes without their knowledge.

With regards to whether respondents could see carbon monoxide, 119 (20.7%) respondents agreed they could see carbon monoxide, 312 (54.2%) stated otherwise, and 145 (29.2%) had no idea whether carbon monoxide could be seen or not. Half of the respondents' not being aware of whether CO was visible could result in them being unable to tell when they suffer from CO related problems. The results also back the definition of CO by Sebbane et al. (2013), who defined CO as a non-irritating, colourless, odourless gas produced by incomplete burning of carbon-containing fossil fuels. These features outlined by the author confirm that, even when present in homes, CO is not visible. This may lead to limited attention paid to CO generating activities in the dwellings of these respondents.

Respondents were further asked if carbon monoxide had a smell. From the results, 252 respondents (43.8%) agreed they could smell carbon monoxide, 116 respondents (20.2%) said they could not smell carbon monoxide, and 207 respondents (36%) did not know if carbon monoxide had a smell or not. Compared to the number of respondents who stated carbon monoxide did not have an odour, other groups of respondents may be misled about the presence of CO in their homes. Of those who agreed CO had a smell (43.8%), they could influence those who do not know if CO had a smell or not (36%). These respondents may associate any strange smell in their environments to CO, which may not be correct as the odourless nature of carbon monoxide is one of its features outlined in the definition by Sebbane et al. (2013). Such people may be prone to experiencing high levels of exposure to CO unawares, which, according to Girma (2017), mostly occur in indoor environments. Exposure occurs through malfunctioning home-heating systems, the operation of gasoline-powered equipment in enclosed or semi-enclosed areas, and improperly vented gas appliances. Even when experiencing CO poisoning symptoms, groups of people with inadequate knowledge may have no idea until it gets to extreme cases, which may account for unintentional deaths. People in indoor environments with poor ventilation, coupled with limited knowledge of CO, stand the risk of suffering the harmful effects of exposure to CO poisoning compared to those with proper ventilation.

*Safety Measures in Place to Prevent Carbon Monoxide Poisoning*

The study also sought to determine safety measures instituted to prevent CO poisoning in homes within the study area. Responses are should in Table 2.

A one-way chi-square test was used in analysing responses on safety measures in place to prevent CO poisoning. An equal number of respondents (192) were expected to respond to all categories (*yes, no, don't know*). However, expected frequencies were different from observed frequencies [*Is there a smoke detector fitted in the apartment?* $\chi^2$ (2, N = 576) = 887.47, p < 0.05; *Is there a carbon monoxide detector fitted in the apartment?* $\chi^2$(2, N = 576) = 819.89].

One question on the safety measures to prevent carbon monoxide poisoning asked if respondents had a smoke detector in their apartment. To this question, 19 representing (3.3%) respondents agreed they had a fitted smoke detector in their apartments, 529 representing (92.5%) respondents said they didn't, and 24 representing (4.2%) respondents did not know. Also, concerning if respondents had a CO detector fitted in their apartments, 9 respondents (1.6%) said yes, 515 respondents (89.4%) said no, and 52 (9%) did not know.

Some authors have noted that a sure way of determining CO poisoning awareness levels is to measure the prevalence of CO detectors in places of residence (Iqbal et al., 2012). Other authors (e.g., Chiew & Buckley, 2014; Ryan & Arnold, 2011; Hampson & Weaver, 2011) indicated the installation of CO detectors as an effective way of protecting people and homes from CO poisoning. It may be deduced from the results that preventive measures of CO poisoning were low among respondents. For instance, with no smoke detectors fitted, detecting an indoor fire outbreak in its early stages may be challenging, a significant CO poisoning source. Not fitting CO detectors would also make it challenging to determine CO levels in one's dwellings. In such a situation, people may suffer from the effects of CO poisoning that they may not be aware of. Installing such devices serve as an early warning when CO levels increase to dangerous levels. This enables people to get prepared to reduce CO in their dwellings when they are notified.
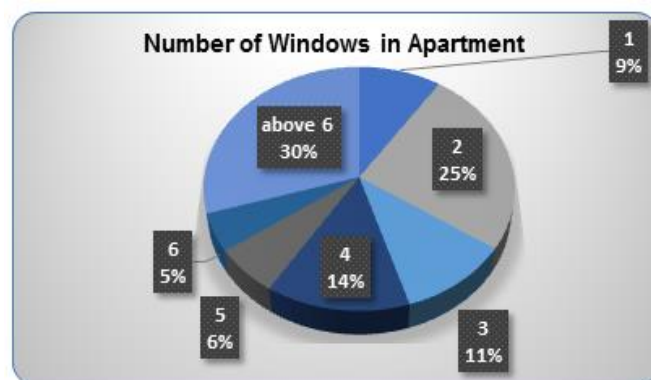


**Figure 1. Number of Windows in Respondents' Apartment**

**Table 2. Safety Measures in Place to Prevent CO Poisoning**
*(Ho: observed frequencies are equal to expected frequencies).*

| Question | Yes | No | Don't know | $\chi^2$ (df = 2) | Decision | Interpretation |
|---|---|---|---|---|---|---|
| Is there a smoke detector fitted in the apartment? | 19 (3.3%) | 529 (92.5%) | 28 (4.2%) | 887.47 | Reject Ho | Significant |
| Is there a carbon monoxide detector fitted in the apartment? | 9 (1.6%) | 515 (89.4%) | 52 (9%) | 819.89 | Reject Ho | Significant |

**Source: Online Survey, 2020.**      **P< 0.05.**

Further, on the measures to reduce CO poisoning in homes, respondents were asked about their homes' ventilation systems. The results are presented in Fig. 1.

The results show that respondents have an appreciable number of windows in their apartments, implying they are aware of the importance of ventilating their homes, hence practising proper ventilation, which is another way of preventing CO poisoning. With practising ventilation, Seguel et al. (2017) found it to help reduce CO levels from homes and offices since many people spend most of their time indoors. Having enough windows which are opened regularly at homes/workplaces could help reduce CO levels.

*Awareness Campaigns*

The questionnaire further sought respondents' views on whether they were privy to any CO awareness campaigns. The results are presented in Table 3.

A one-way chi-square test was used in analysing the response on awareness campaigns to help reduce CO poisoning. An equal number of respondents (189) were expected to respond to all categories (*yes, no, don't know*) equally. Expected frequencies were, however, different from observed frequencies [*Do you remember any CO awareness campaign?* $\chi^2$ (2, N = 567) = 442.3 p < 0.05].

From the results, 161 respondents (28.4%) agreed, and 405 respondents (71.6%) stated otherwise. This shows that awareness campaigns on CO poisoning and prevention in the study area was very low. This conclusion was arrived at based on the number of respondents who stated they do not remember any CO awareness campaigns.

Further, respondents who said they remembered some CO awareness campaigns were asked to indicate the various means they got to know. The responses are summarised in Fig. 2.
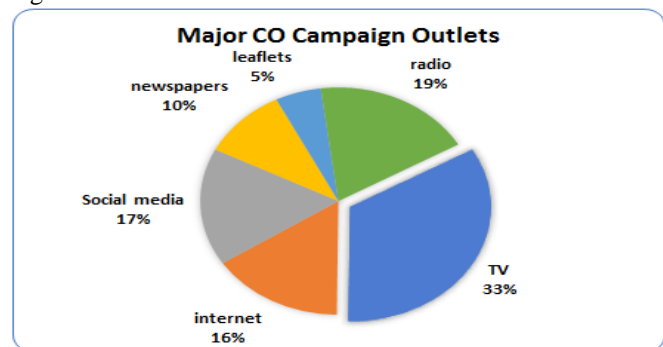


**Figure 2. CO Campaign Outlets among Respondents.**

Of the avenues through which respondents heard of Carbon monoxide campaigns, television emerged as the most common source, making up 33% of all the sources. This was followed by radio (19%) and then social media (17%), internet (16%), newspapers (10%), and leaflets (5%). This shows that respondents widely access information through TV.

The researchers attributed the limited awareness on CO poisoning to little attention paid to CO poisoning issues, especially by healthcare workers and other stakeholders in the study area. Meanwhile, awareness campaigns are one of the effective ways to reduce CO poisoning and its adverse effects (Choi et al., 2014). They saw educational campaigns as essential to informing consumers about CO risks and

providing them with information when they purchase CO-emitting products. Stretching this concept further, undertaking awareness campaigns would provide stakeholders with the platform to provide information on risk factors and preventive measures of CO poisoning and prevention to a population of people in a community. This makes it an inherent aspect of reducing the adverse effects of CO buildup and poisoning.

Finally, the study attempted to determine if these campaigns brought any change in respondents' behaviour concerning CO poisoning. The results are presented in Figure 3.
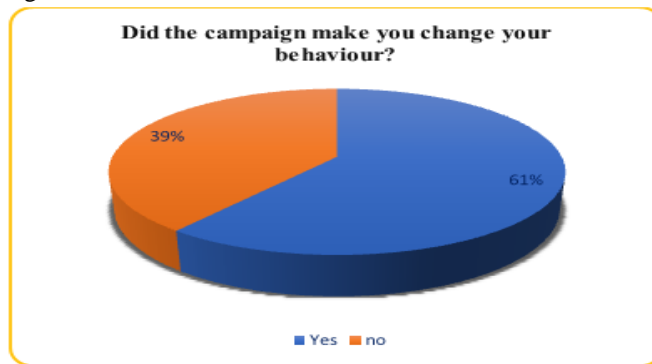


**Figure 3. Respondents' View on if CO Campaign Changed their Behaviour.**

Based on responses on if CO has changed their behaviour, (61%) said yes, and (39%) no. This indicates that regular awareness campaigns may lead to people developing positive attitudes towards preventing CO poisoning. For instance, through awareness campaigns, people may learn to keep their windows open, not cook or start cars in enclosed spaces, identify CO emitting devices, detect CO poisoning signs and symptoms, etc. People may have done all these in the past due to unawareness of CO poisoning and its adverse effects. Awareness campaigns would, therefore, reduce their ignorance.

**Conclusion**

First of all, the study found that respondents' awareness level concerning CO and CO poisoning was low. This conclusion was based on the number of respondents who could not tell if CO could be found in their dwelling and also whether CO could be seen or not. Likewise, a higher number of respondents stated CO had a smell while others could not tell if CO had a smell or not. Not knowing if CO could be found in one's dwelling and if it had a smell is alarming since people may not be able to identify the dangers of CO poisoning since they could not perceive any odour in their dwelling. However, an appreciable number of respondents were aware that CO could affect their health reasonably.

The safety measures to prevent CO poisoning revealed that most respondents did not have a smoke or CO detector fitted in their apartment. This further confirms the low level of awareness of the danger of CO poisoning among respondents. For instance, respondents who cook in enclosed spaces or use heating devices may experience high CO exposure in their environment without knowing that they have no means of detecting high CO levels. Such people may also continue engaging in activities that increase their exposure level without their knowledge, making it difficult

**Table 3. Awareness Campaigns to Help Reduce CO Poisoning**
*(Ho: observed frequencies are equal to expected frequencies).*

| Question | Yes | N | Don't know | $\chi^2$(df 2) | Interpretation | Decision |
|---|---|---|---|---|---|---|
| Do you remember any CO awareness campaigns | 161 (28.4%) | 405 (71.6%) | - - | 442.3 | Significant | Reject Ho |

Source: Online Survey, 2020.      n= 567   P<0.05.

for them to tell when they are experiencing CO poisoning symptoms. Though respondents did not have smoke or CO detectors in their apartment, many of them have between 2-6 windows, which indicates they do practice ventilation, which may help reduce their exposure to CO poisoning.

On using awareness campaigns to reduce CO poisoning in the Municipality, most respondents stated they do not remember any CO awareness campaign. This may be due to the dangers of CO poisoning being downplayed by health practitioners and other stakeholders, resulting in little attention paid to CO poisoning risks. Among the few who took part in CO awareness campaigns, information was disseminated mainly through TV, radio, social media, internet, newspaper, and leaflets.

## Recommendations

The following recommendations may be considered to address CO poisoning and its associated effects in the Ho Municipality.

There is a need for public health officials to put programmes in place to increase awareness among the populace. This could be done in partnership with the administrative and traditional leaders who can easily organise their people for health talks. Likewise, health centres in the Municipality can include CO poisoning education as part of their daily activities, especially when patients visit the facilities and are waiting to be attended to. This may help reach a larger number of people, especially those in hard-to-reach areas.

Awareness campaigns must be intensified, encouraging people to fit their homes with smoke and CO detectors. This may help and even make residents conscious of CO poisoning, especially among those who cook or use heating devices in enclosed spaces, those with few windows in their apartment, and those with garages where they park their cars. Especially among those living in self-contained flats, such people do almost everything indoors and may be at a higher risk of CO poisoning, especially among those with ACs who do not open their windows regularly. Having smoke and CO devices fitted would keep them informed when their dwellings have high levels of CO.

Though awareness campaigns are done through different media, other means of disseminating information like focus groups may be used. This would help educators close contact with people and adequately understand their reasons for undertaking some activities in their homes that increase their risk of CO poisoning. This would make it easier for them to address the identified challenges.

Also, leaflets must be used widely and printed in local languages that people can easily read and understand. Using pictures with text would make it easier for people to understand messages sent across. Besides, social media platforms must be utilised effectively to reach many people with information on CO poisoning. Notifications can be in texts or videos and shared on all media to get as many people as possible.

Finally, ventilation must be encouraged, and people educated on employing professionals' services to check their electrical gadgets regularly for faults. When implemented effectively, these practices could change the attitude towards CO poisoning among stakeholders and the populace.

## Grant Support Details

## Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, has been completely observed by the authors.

## Life Science Reporting

No life science threat was practised in this research.

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