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Social knowledge of symptoms, risk factors, causes, and preventive measures of CO poisoning among Saudi Arabia's general population

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ABSTRACT

Background: Carbon monoxide (CO) is a highly poisonous gas that has no identifiable colour or odor. People could be affected by CO emissions from various sources that include gas stoves, water heaters, fire places and motor vehicles. *Aim:* The study aims to assess the perception & knowledge regarding symptoms, risk factors, causes and preventive measures of CO poisoning among the Kingdom of Saudi Arabia (KSA) general population. *Subjects and methods:* This is a cross sectional study of the general population of the KSA. The study targeted non health care providers using an electronic survey. The questionnaire mainly consists of three parts; socio-demographic data, knowledge assessment, habitual factors and practices related to CO poisoning. *Results:* Out of 568 participants, (52.8%) were aged between 18 to 25 years with (64.1%) being females. The majority had poor knowledge (67.6%), negative attitude (72.4%) but good prevention practices (64.4%). *Conclusion:* There was a deficiency in terms of knowledge and attitude. However preventive practices are inspiring. Respondents who have heard about CO poisoning tend to exhibit better knowledge and practices as compared to the rest of the population.

Keywords: Carbon monoxide, poisoning, knowledge, Saudi Arabia.

1. INTRODUCTION

Carbon monoxide (CO) is a highly poisonous gas. It is colorless and odorless. People could be exposed to CO from a variety of sources, including furnaces, gas stoves, water heaters, fire places, gas heaters and motor vehicles (Alberreet et al., 2019). Victims usually present with unspecific, highly variable symptoms, including headache, dizziness, nausea, malaise,

confusion, is orientation and visual disturbances while in severe cases may come with unconsciousness, coma and convulsions. Eventually death could occur by asphyxiation (Up To Date Carbon monoxide poisoning, 2021). CO poisoning represents a worldwide health burden. Fire related sources are accountable for most of the CO poisoning while non fire related CO poisoning accounts for many emergency department (ED) visits which goes as high as 50,000 visits per year. Therefore, it is among of the primary causes of poisoning and death in the United States with a mortality rate of 1 to 3 percent and around 1200 deaths per year (Manker and Perry et al., 2021). According to the Global Health Data Exchange registry, it has been estimated that the cumulative worldwide incidences of CO poisoning in 2017 at 137 cases per million and mortality accounted for 4.6 deaths per million, although there was a decline of 36% in death counts from CO poisoning between the years 1992 and 2017 due to the unreliable data sources in variable countries and misdiagnosis of CO poisoning. Careful measures should be taken and more studies are required (Mattiuzzi & Lippi et al., 2019).

A systematic review was conducted to identify the prevalence of CO poisoning at the level of Middle East as well as North Africa. Included studies ranging from 2000 to 2021; the result showed that CO poisoning is still a significant burden though it is possibly preventable. An Iranian study concluded that most are unaware of all CO poisoning symptoms (Emami-Razavi et al., 2014). A retrospective study conducted at Dammam, KSA, aimed to assess CO poisoning from 2004 to 2013. The findings showed the highest rate was in the winter seasons, accounting for (50%), the fire source was the source in 64% of cases, 91% of the death were classified as accidental and most of the CO deaths occurred at home (88%) (Mohammed et al., 2015). The risk increases in winter seasons when people tend to spend a long time indoors with heaters all the time, also the public places where smoking and Shishas used to be served in open areas and many alternatively tend to do all these in closed spaces as well. In addition to the lack of similar research in our area such data has inspired us to make this study. Our goal is to measure the general perception and awareness of CO poisoning.

2. SUBJECTS AND METHODS

Study design and setting

A descriptive cross sectional study among Saudi adults (18 years and above). It was carried out from 2021/07/4 – 2022/09/12 and aimed to assess the knowledge and general perception of the habits, risk factors and preventive measures associated with CO poisoning among non healthcare practitioners.

Sample Size and Technique

The sample size is determined by Raosoft software with a margin error of 5%, confidence level of 95%, population size of about 1000000 and response distribution of 50% for sample size calculation. The minimal sample size will be 400 participants. We will be following a convenience sampling technique for the selection of the participants. A cross sectional study with one stage sampling technique. The questionnaire was structured based on relevant previous studies. The validity and reliability of the proposed survey were studied and edited by a panel of reviewers, which was followed by a cognitive interview technique using online interviews with a group of 6 participants. The questionnaire will be randomly distributed. Using the means of electronic surveys. The main structure of the questionnaire consists of three parts; 1: participants' biographical data, 2: Knowledge assessment part assesses the perception of CO poisoning, 3: Reviewing the habitual factors that can be related to CO poisoning.

Data management and analysis plan

The data was stored in the computer with high privacy and confidentiality even though it will not contain any identifiable data. The data analysis will be conducted throw SPSS software Descriptive statistics v23. (Means, SDs, proportions) will be used to analyze the mean of ages and male & female proportions.

Statistical Analysis

The knowledge about the symptoms, risk factors and causes was assessed using 8-item questionnaires with correct answers had been identified. The overall knowledge score has been calculated using 50% and 75% as cutoff points to determine the knowledge level. Participants will be classified into three main scores. A score below (50%) represents poor knowledge, while (50% to 75%) is considered a moderate level of knowledge, while a higher than (75%) indicates a good knowledge level.

3. RESULTS

A total of 568 participants met the inclusion criteria. Table 1 describes the participants' socio-demographics. More than half (52.8%) were aged between 18 to 25 years, with nearly two-thirds (64.1%) being females. Participants who were university degree holders were 53%, whereas 37% were still students. With regards to marital status 63.2% were still not married. The prevalence of respondents who have heard of CO poisoning was 52.1%.

Table 1 Socio-Demographic characteristics of participants (n=568)

Study data	N (%)
Age group	
18 – 25 years	300 (52.8%)
26 – 30 years	99 (17.4%)
31 – 40 years	79 (17.4%)
41 – 50 years	52 (09.2%)
>50 years	38 (06.7%)
Gender	
Male	204 (35.9%)
Female	364 (64.1%)
Educational level	
Uneducated	28 (04.9%)
Secondary or below	204 (35.9%)
University degree	301 (53.0%)
Postgraduate	35 (06.2%)
Occupational status	
Self-employed	72 (12.7%)
Non-healthcare provider	177 (31.2%)
Student	211 (37.1%)
Unemployed	108 (19.0%)
Marital status	
Single	359 (63.2%)
Married	182 (32.0%)
Divorced or widowed	27 (04.8%)
Heard of carbon monoxide poisoning	
Yes	296 (52.1%)
No	272 (47.9%)

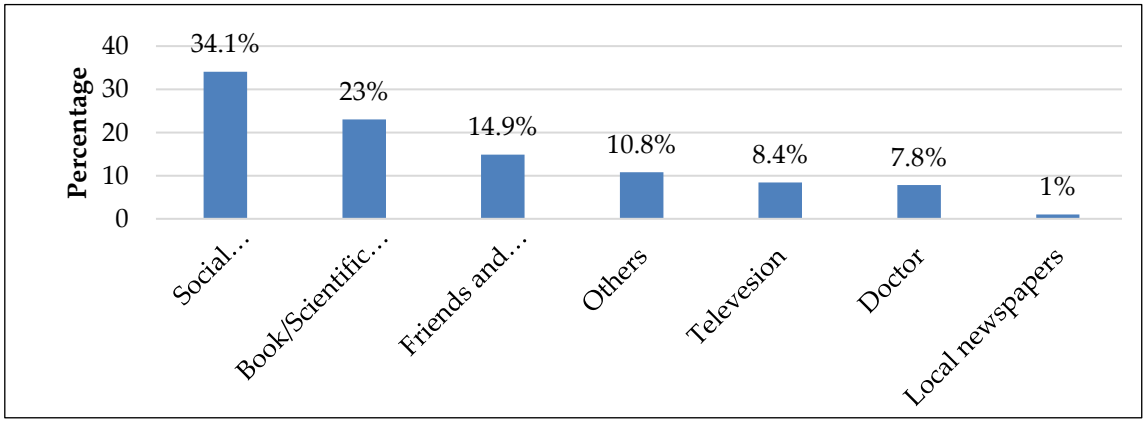

Figure 1 Sources of carbon monoxide poisoning information

In Figure 1, of those who have heard about CO poisoning, the most commonly known source of information was social networking sites (34.1%), followed by book/scientific journals (23%) and friends and family (14.9%).

Table 2 Assessment of knowledge of symptoms, risk factors and causes of CO poisoning (n=568)

Knowledge statement	Correct Answer N (%)
Carbon monoxide has an odor that characterizes its emission	149 (26.2%)
Carbon monoxide is a distinctive color	57 (10.0%)
Most cases of carbon monoxide poisoning occur in certain seasons of the year	88 (15.5%)
Do you think everyone is susceptible to carbon monoxide poisoning?	262 (46.1%)
How dangerous is carbon monoxide poisoning to human health?	254 (44.7%)
Choose what is a source of carbon monoxide *	
Fire smoke	429 (75.5%)
Coal combustion	382 (67.3%)
Car exhaust	362 (63.7%)
Smoking/Hookah	281 (49.5%)
Heater/Fireplace	247 (43.5%)
Clogged ventilation system	198 (34.9%)
Dye spray	171 (30.1%)
Carbon monoxide poisoning has symptoms that distinguish it from others	34 (06.0%)
Signs or symptoms of carbon monoxide poisoning *	
Tiredness and fatigue	321 (56.5%)
Loss of focus	310 (54.6%)
Headache	280 (49.3%)
Nausea/Vomiting	260 (45.8%)
Rapid breathing	250 (44.0%)
Chest and abdominal pain	229 (40.3%)
Harmful effects on muscles	214 (37.7%)
Coma	212 (37.3%)
Spasm	156 (27.5%)
Neurological disorders	136 (23.9%)
Death before symptoms appear	120 (21.1%)
Total knowledge score (mean ± SD)	9.51 ± 5.75
Level of knowledge	
Poor	384 (67.6%)
Moderate	148 (26.1%)
Good	36 (06.3%)

* Variable with multiple response answers.

In the knowledge assessment of symptomatic features, risks and hazards factors that could be a cause of CO poisoning (Table 2), it can be noticed that there was deficient knowledge in several knowledge statements, including CO odor that characterizes its emission (26.2%), CO distinctive color (10%), seasons of the year where CO poisoning mostly occur (15.5%), the knowledge that anyone is susceptible to CO poisoning (46.1%), the hazard of CO poisoning to human's health (44.7%). CO poisoning has different

symptoms than the others (6%). However, respondents were aware that CO's most common source was fire smoke (75.5%), followed by coal combustion (67.3%) and car exhaust (63.7%), while respondents were less aware that heater/fireplace (43.5%), clogged ventilation system (34.9%) and dye spray were also sources of CO. Regarding the symptomatic features of CO poisoning, respondents were aware that the most commonly reported, which includes tiredness and fatigue (56.5%), followed by loss of focus (54.6%), headache (49.3%), nausea/vomiting (45.8%) and rapid breathing (44%). The overall knowledge mean score was 9.51 (SD 5.75), with 67.6%, 26.1% and 6.3% constituting low, moderate and good knowledge levels.

Table 3 Assessment of participants' attitude/lifestyle and prevention practices regarding CO poisoning (n=568)

Attitude statement	Yes (%)
Do you smoke (cigarettes or shisha) or accompany others in closed or poorly ventilated areas to smoke?	213 (37.5%)
Use of heater in enclosed or poorly ventilated spaces (e.g., in an enclosed bedroom)?	166 (29.2%)
Do you light fire/charcoal/wood for heating or cooking in closed or poorly ventilated areas?	103 (18.1%)
Do you use incense in enclosed or poorly ventilated places?	326 (57.4%)
Do you run your car engine in a closed or poorly ventilated location (e.g., in a garage)?	96 (16.9%)
Are you exposed to car exhaust?	195 (34.3%)
Do you own water heaters in poorly ventilated areas?	99 (17.4%)
Do you maintain ventilation and air conditioning fans and change filters regularly?	314 (55.3%)
Attitude score (mean ± SD)	2.66 ± 1.73
Level of attitude	
Negative	411 (72.4%)
Neutral	141 (24.8%)
Positive	16 (02.8%)
Prevention practices statement	
Do you think using windows and air vents helps get rid of carbon monoxide buildup?	484 (85.2%)
Do you think annual maintenance of ventilation systems, heaters and gas appliances could reduce the carbon monoxide risk?	458 (80.6%)
Do you think having a carbon monoxide detector in the home is important?	422 (74.3%)
Do you think education is important to prevent carbon monoxide poisoning?	524 (92.3%)
Practices score (mean ± SD)	3.32 ± 1.12
Level of practices	
Poor	96 (16.9%)
Moderate	106 (18.7%)
Good	366 (64.4%)

Regarding the assessment of participants' attitudes/lifestyles about CO poisoning (Table 3), it was revealed that a negative attitude had been noticeable in the following statement "Smoking or accompanying others to smoke in closed or poorly ventilated areas" (37.5%), "Use of a heater in enclosed or poorly ventilated spaces" (29.2%), "Lighting of fire/charcoal/wood for heating or cooking in closed or poorly ventilate areas" (18.1%), "Run car engine in a closed or poorly ventilated location" (16.9%), "Exposure

to car exhaust" (34.3%) and "Having water heaters in poorly ventilated areas" (17.4%) while positive attitude was noticed in the following statement "Use of incense in enclosed or poorly ventilated areas" (57.4%) and "Maintaining ventilation and air condition fans and change filters regularly" (55.3%). The overall attitude mean score was 2.66 (SD 1.73), with the predominance having a negative attitude (72.4%), 24.8% were neutral and only 2.8% showed positivity in attitude. Regarding prevention practices the majority of the participants had good prevention practices, which are reflected in the following questions such as "Believed that using windows and air vents helps get rid of CO buildup" (85.2%), "Believed that annual maintenance of ventilation systems, heaters and gas appliances could reduce the CO risk" (80.6%), "Believed that having a CO detector in the home is important" (74.3%) and "Believed that education is important to prevent CO poisoning" (92.3%). The overall mean prevention practices score was 3.32 (SD 1.12), with good, moderate and poor practices detected among 64.4%, 18.7% and 16.9%, respectively.

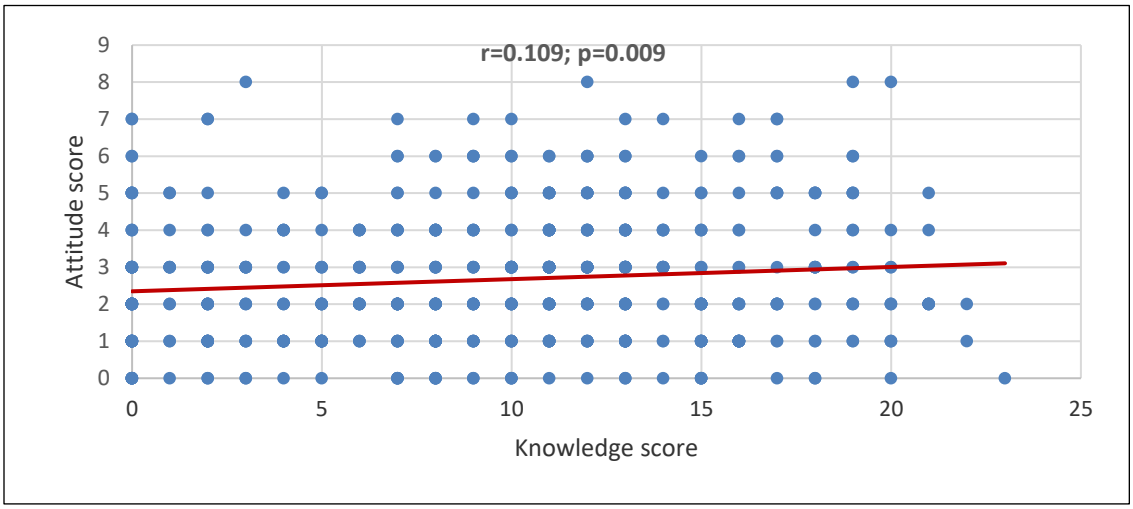

Figure 2 Correlation of knowledge score and attitude score

In Figure 2, there was a positive significant correlation observed between knowledge and attitude scores (r=0.109; p=0.009).

4. DISCUSSION

Knowledge about CO poisoning

The study is conducted to measure the understanding level of the general Saudi population toward CO poisoning signs and symptoms, hazardous factors, sources and preventive measures. Overall was insufficient. Nearly (70%) of participants were considered as having a poor level of knowledge (26.1%) were moderately aware, while only (6.3%) were good. Consistent with our findings, Dianat and Nazari, as well as Pach et al., documented poor knowledge about CO poisoning in the general population and students (Dianat & Nazari et al., 2011; Pach et al., 2010). Participants' age, gender, educational level or whether being students or employees were not seen as significant knowledge factors. In Poland, findings indicated unsatisfactory awareness of CO poisoning among non medical students, with medical students gaining significantly better scores on the CO poisoning knowledge test than the non medical students (Dianat & Nazari et al., 2011).

Moreover, in the specified knowledge assessment many of our participants lacked knowledge about the most important knowledge statements. For instance, respondents showed a poor understanding of the nature of CO emission (26.2%), its distinctive color (10%), the season where CO poisoning mostly occurs (15.5%) and the unusual CO poisoning variety of symptoms (6%). Likewise, we have noticed that although our respondents demonstrated a good level of understanding of the prominent sources of CO, including fire smoke (75.5%), coal combustion (67.3%), car exhaust (63.7%) and smoking (49.5%), however, most of them were less likely aware that heater/fireplace (43.5%), clogged ventilation system (34.9%) and dye spray (30.1%) were also its sources. In a conducted systematic review in the Middle East as well as North Africa, they found out that the overall CO poisoning incidence was 13.37 per 100,000 inhabitants yearly, where in most of these events happened in winter seasons and gas heaters were the major cause of incidents (Alberreet et al., 2019). In another study published in Riyadh they discovered that burning coal or firewood was the most prominent source of CO (Waseem et al., 2016). However, in Nigeria of the 157 respondents, (73.4%) exhibited a poor understanding of CO poisoning sources. Even though 60.5% had already been oriented about CO poisoning, suggesting that the health related hazard of CO poisoning due to in door electrical generators had been neglected which may need to enforce further awareness (Afolayan et al., 2014).

Likewise, respondents showed a poor understanding of the signs and symptomatic features of CO poisoning. Data in our study suggest that our participants were less aware of the most commonly known signs and symptomatic features. In a study by (Popiołek et al., 2021) medical students were found to be knowledgeable about the danger of being exposed to CO poisoning, which could lead to death, headache/dizziness, weakness, nervous system damage, loss of consciousness, apnoea, nausea/vomiting, heart palpitations, hypotension and somnolence. Another study headed by Raub revealed that during pregnancy, CO poisoning increases the short term complication rate and causes fetal death, chronic cerebral lesions and developmental disorders (Raub et al., 2000).

Attitude/Lifestyle toward CO poisoning

The overall attitude of the respondents regarding CO poisoning was negative. Approximately (72.4%) were categorized as having a negative attitude, (24.8%) were neutral and fewer than (3%) had a good level of attitude. To the best of our knowledge, this study is the first in Saudi Arabia to determine the attitude level toward CO poisoning, which is an important contribution to the literature subjected for further investigations. Additionally, we observe that the respondents in our study had a positive attitude toward using incense in enclosed or poorly ventilated areas (57.4%) and maintaining ventilation and air conditioning fans (55.3%). On the contrary, participants exhibited a negative attitude in the following scenario such as smoking or accompanying some one to smoke in closed ventilated areas (375%), exposure to car exhaust (34.3%), use of a heater in enclosed ventilated areas (29.2%), lighting fire/charcoal/wood (18.1%), and running car engine in close ventilated location (16.9%). In Poland, (51.2%) of the students were using a bath room water heater, with most of them believing that they were not at risk of CO poisoning (Popiołek et al., 2021). While in Iran, non and free standing heaters were the most reported causes of unintentional CO poisoning. Surprisingly, all the house holds being inspected had no CO detector during the incident time, which added to the burden on authorities (Dianat & Nazari et al., 2011).

Prevention practices

Regarding prevention practices, nearly two-thirds (64.4%) were considered as having good practices level, (18.7%) were moderate, and (16.9%) had poor practices level. Interestingly, we found out that respondents who had heard about CO poisoning exhibited significantly better prevention practices than the participants who had not heard about it. However, current students respondents demonstrated less in prevention practices than other respondents. More investigations are needed to determine the prevention practices levels and establish its factors. Conversely, we discovered that most of our respondents were seen to have adequate practice levels in all of the prevention practices. The importance of CO detectors at home had also been discussed by (Emami et al., 2014). According to their reports, (89.1%) of Iranis reported that CO detectors would be helpful for the decrease of mortality rates from CO poisoning, whereas (84.4%) reported that opening window is important prevention of CO leakage and (93.8%) indicated that, their fuel burning devices were checked by an expert at the beginning of the winter. In contrast to these reports (Hajjar et al., 2016) documented that more than half (55.6%) do not apply safety precautions related to CO, with only 1.7% owning a CO safety alarm resulting in a high prevalence of suffocation and death cases among the sample population (89.1%).

Correlation of the knowledge, attitude, and prevention practices (KAP)

The correlation between the knowledge in regards to attitude scores was significantly positive ($p=0.009$) and practices score ($p<0.001$), indicating that higher knowledge is correlated with better attitude as well as prevention practices. However, the correlation between the attitude score and practices did not reach statistical significance ($p=0.711$). More research is warranted to validate the true correlational matrix involving KAP.

5. CONCLUSION

There was a deficiency in terms of knowledge level and good attitude toward CO poisoning, but preventive practices are inspiring. The attitude of single participants seems to be better. However, respondents who have heard about CO poisoning tend to exhibit better knowledge and preventive practices in contrast to the rest of the population. Public awareness is important to point at the gaps in knowledge and attitude. Although CO poisoning can be a burden to public health, however, it is preventable through specific policies and recommendations. Hence, strategies and obligations need reevaluation and public awareness should be raised to reduce exposure to CO, particularly those in the housing setting. Further research is necessary for better identification of the general knowledge level and awareness of good attitude and preventive practices to establish the factors that influence the level of understanding about CO poisoning, its symptomatic features, risk factors and causes.

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Ethical approval

The Institutional Review Board (IRB) of this study was obtained by King Fahad Medical City, Riyadh, KSA, dated 6/3/2022. (Ethical approval code: 09-EP-2022).

Informed Consent

Informed consent was granted from all the participants in the study.

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Conflict of interest

The authors declare that there is no conflict of interests

Data and materials availability

All data associated with this study are present in the paper.

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