RESEARCH ARTICLE

Camping-related carbon monoxide poisoning: Knowledge and risk behaviours among young Saudi campers

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Abstract

Objectives: To evaluate the Saudi campers' knowledge and the applied safety practices regarding carbon monoxide poisoning during camping activities.

Method: The cross-sectional questionnaire-based study was conducted from December 1, 2018, to February 1, 2019, in Riyadh, Saudi Arabia, and comprised young male campers from recreational camps in the northern parts of the city. Data was collected from the participants regarding socio-demographic characteristics, knowledge regarding carbon monoxide poisoning, the applied safety measures to prevent carbon monoxide poisoning and the dealing with carbon monoxide poisoning during camping activities. Data was analysed using SPSS 22.

Results: There were 235 male subjects with mean age 24.47±1.139 years (range: 21-32 years). Of the total, 50(21.3%) participants had received civil defence education or training. Overall, 137(58.3%) participants had a good mean knowledge score, and 157(66.8%) participants had a good mean practice score for applying healthy measures in preventing and managing carbon monoxide poisoning. As a preventive measure against carbon monoxide poisoning, the use of carbon monoxide detectors was valued by 107(45.5%) participants. Having civil defence training, having a monthly income >10,000 Saudi Riyals, and having a good knowledge score were the elements that had significant association with the choice related to carbon monoxide detector usage.

Conclusion: The campers had relatively high knowledge regarding carbon monoxide poisoning, but this knowledge was not fully translated into good health practice.

Keywords: Environmental toxin, Camping, Carbon monoxide poisoning, Knowledge, Practice. (JPMA 72: 2025; 2022)
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Introduction

The incomplete combustion of carbon-based fuels produces carbon monoxide (CO) under restricted oxygen condition. The tasteless, odourless, non-irritating and highly toxic CO gas cannot be easily detected by the human senses. The popular CO sources include fires, automobile exhaust, water heaters, kerosene space heaters and furnaces.[1]

CO poisoning (CO-P), the unnoticed poison of the 21st century, is a significant public health problem. Even in a small concentration, CO-P can lead to hypoxic neurological tissue damage with a fatal outcome.[2]

The World Health Organisation (WHO) estimates that unintentional poisonings caused 193,000 worldwide deaths. CO-P is the second most common poisoning in high-income countries, like Saudi Arabia.[3]

Saudi Arabia has a desert climate with seriously high day-time temperatures and a sharp temperature drop at night, especially in winters when it can reach 0°C.[4] Camping is a popular activity among the Saudis. Families pitch tents (khyam) in the middle of the desert or at one of Saudi Arabia's parks, and enjoy the beauty of nature. During winter, these camping trips are popular, especially on rainy days when the desert blooms.[5] During camping, charcoal grills, firewood and kerosene heaters are essential heating methods.

The Saudi youth in the 15-34 age group most commonly indulge in outdoor recreation activities, and their awareness and level of the applied safety precautions regarding CO-P need to be assessed, especially with the new move in Saudi Arabia over the past couple of years, called Vision 2030, which is geared towards the promotion of tourism investment.[5]

In Saudi society, women are mainly responsible for household tasks and child care. There is also a lack of access to safe, recreational activities for women, and, therefore, men, especially young, college-educated ones, are more likely to participate in leisure time physical activities, including camping.[6]

The increasing CO-P incidence and its preventable health-related effects[7] deserve the assessment of community knowledge. The current study was planned to evaluate

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the use of CO-detecting devices during camping activities and factors affecting its use among young Saudi campers by assessing their knowledge regarding CO poisoning and the applied safety practices.

Subjects and Methods

The cross-sectional questionnaire-based study was conducted from December 1, 2018, to February 1, 2019, in Riyadh, Saudi Arabia, and including young male campers from recreational camps in the northern parts of the city. Female, campers aged > 35 years, and non-Saudi campers were excluded from the study.

After approval from the institutional review board, Princess Nourah bint Abdulrahman university with reference number (H-01-R-059), a pilot study was conducted which showed acceptable level of awareness about CO among 45% subjects, and on the basis of data, the sample size was calculated with margin of error 10%, level of confidence 95%, and power 80%. The sample was raised using convenience sampling technique.

After informed consent from all the subjects, data was collected using a pre-designed paper-and-pencil questionnaire. Age, monthly family income, and civil defence education were used as variables for assessing socio-demographic characteristics.

The participants' knowledge regarding CO and its toxicity was assessed through 21 questions, using a cut-off score of 15. A score <15 indicated faire knowledge, while a score of 15 or greater indicated a good one. The questionnaire also collected data regarding sources of information.

The participants' practices regarding the applied safety measures during camping to prevent and deal with CO-P were assessed using 15 questions, with a cut-off score of 10. A score of <10 was considered unhealthy practice, while 10 or greater score was considered a healthy one.

The questionnaire was modified in the light of feedback from the pilot study. The questionnaire's reliability was tested using Cronbach's alpha which was 0.8 for participants' knowledge and 0.71 for participants' practice.

Data was analysed using SPSS 22. Fisher's exact test was used to see the difference between family income, civil defence education, the use of CO-detecting devices, knowledge and practice scores. P<0.05 was considered statistically significant.

Results

Of the 300 male campers approached, 235(78%) participated. The mean age of the sample was 24.47±1.139 years (range: 21-32 years). Of the total, 50(21.3%) participants had received civil defence education or training. Overall, 137(58.3%) participants had a good mean knowledge score, and 157(66.8%) participants had a good mean practice score for applying healthy measures in preventing and managing CO-P (Table-1).

The participants' knowledge about CO-P and practice towards preventing it were explored in detail (Table-2).

As a preventive measure against CO-P, the use of CO detectors was valued by 107(45.5%) participants. Having

Table-1: Comparison of socio-demographic data, knowledge and practice scores between carbon monoxide (CO) detector users and non-users.

	Total 235 (100%)	Users 107 (100%)	Non-users 128 (100%)	P-value
Mean Age (years)	24.47±1.139	24.3±1.2	22.3±.9	0.95
Years in the college				
Junior	65 (27.7)	29(45)	36(55)	0.9
Senior	170 (72.3)	78(46)	92(54)	
Receiving Civil defence education/ training				
Yes	50 (21.3)	30(60)	20(40)	0.011*
No	185 (78.7)	77(42)	108(58)	
Monthly house-hold income (Riyal Saudi)				
> 10000	73 (31)	42 (57.5)	31(42.5)	0.015*
≤ 10000	162 (69)	65(40)	97(60)	
Knowledge score				
Fair knowledge	98 (41.7)	36(37)	62(63)	0.015*
Good knowledge	137(58.3)	71(52)	66(48)	
Practice score				
Poor practice	78(33.2)	29(37)	49(63)	0.07
Healthier practice	157(66.8)	78(50)	79(50)	

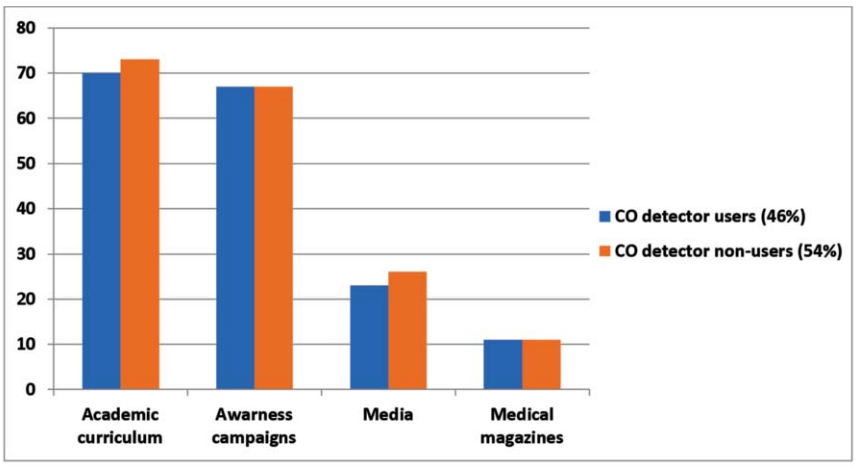

Figure: Knowledge source among carbon monoxide (CO) detector users and non-users.

Table-2: The frequency of participants' answers regarding the knowledge questions and the applied safety measures during camping.

Knowledge questions	Right answers	Wrong answers
What is the nature of carbon monoxide?	224(95)	11(5)
Is carbon monoxide detectable by human senses?	107(45)	128(54)
What are the sources of carbon monoxide?		
• Empire	191(81)	44(19)
• Car exhaust	174(74)	61(26)
• Wood heater	172(73)	63(27)
• Gas heater	148(63)	87(37)
• Cigarette smoking	132(56)	103(44)
• Grills	132(56)	103(44)
• Fire	126(54)	109(46)
• Electrical generator	48(20)	187(80)
What are the manifestations of carbon monoxide toxicity?		
• Dyspnoea	179(76)	56(24)
• Syncope	152(64)	83(36)
• Death	151(64)	84(36)
• Headache	121(51)	114(49)
• Chronic complications	118(50.2)	117(49.8)
• Nausea	112(48)	123(52)
• Fatigue	113(48)	122(52)
Can carbon monoxide toxicity occur during camping?	197(84)	38(16)
Could the following increase the risk for carbon monoxide toxicity?		
• Non-use of carbon monoxide detector	179(76.2)	56(23.8)
• Non-periodic maintenance of gas-powered devices	157(67)	78(33)
• Coal ignition in closed spaces	144(61)	91(39)
Applied safety measures	Healthy	Unhealthy
Precaution to prevent CO intoxication		
• Using CO detector	107(46)	128(54)
• Placing electrical generator away from flammable material	168(72)	67(28)
• Placing electrical generator in a well-ventilated space	178(76)	57(24)
• Placing electrical generator away from camping activities	121(52)	141(48)
• Keep inflammable material away from camping site	154(66)	81(34)
• Put ignited coal outside camping tent after usage	195(83)	40(17)
• Keep a well ventilation in the camping site	162(69)	73(31)
What will you do if you feel any of CO toxicity symptoms?		
• Getting out the closed space	189(80)	46(20)
• Open window	179(76)	56(24)
• Go to sleep	68(29)	167(71)
• Taking analgesics	127(54)	108(46)
• Go to the hospital	176(75)	59(25)
• Calling ambulance	158(67)	77(33)
• Open air-condition and close windows	124(53)	111(47)
• Shut gas sources	163(69)	72(31)

CO: Carbon monoxide.

civil defence training, having a monthly income >10,000 Saudi Riyals, and having a good knowledge score were the elements that had significant association with the choice related to CO detector usage.

Regarding the sources of knowledge, the academic curriculum provided in schools was reported as a primary source of knowledge, followed by awareness campaigns, media and medical magazines, but the source of knowledge did not significantly affect usage of CO detector (Figure).

Discussion

To the best of our knowledge, the current study is the first to investigate Saudi campers' CO-related knowledge and practices. The study found that young Saudi campers had a good knowledge about CO and its toxic manifestations that had been gained from academic curriculum and awareness campaigns. Various studies have reported that the Saudis had good knowledge towards CO-P.[8]

This may be related to inter-sector collaboration involving the ministry of health, the ministry of education, and the civil defence directorate.[9] However, unintentional CO-P remains an important health emergency, especially in the winter season.[7]

During winters, Saudi citizens prefer camping in the deserts and along the mountains as an ecotourism activity representing interpersonal youth needs for socialisation, freedom and discovery.[5] While practising camping, wood and charcoal are still used for cooking and heating inside the tents. This trend can lead to unintentional CO-P.[10]

The current study found that only one-fifth of the participants were able to correctly identify electrical generator as a source of CO. Electrical generators are used in areas with inconsistent supply of electricity, like camp-sites, where it changes mechanical energy obtained from an external source, like fuel or gasoline, into electrical energy, and releases CO.[11]

The current study revealed that the campers had a good awareness of the symptoms of CO-P that differ according to the severity and duration of exposure.[12] Contrasting results were reported earlier from Nigeria.[13]

The majority of participants in the current study recognised that CO-P was one of the common accidents that can occur while camping, especially in the absence of CO detectors, non-periodic maintenance of gas-powered devices, and using coal in closed spaces.

Campers operate stoves, heaters and smouldering charcoal to maintain a certain temperature within the immediate environment. These heating sources emit CO that can lead to accidental CO-P.[14]

Kim et al. stated that 83.4% of the studied camping-related CO-P patients did not know about charcoal's potential danger as a source of CO. Moreover, patients, aware of the charcoal burning, thought that the

permeable tent fabric would be enough to eliminate the produced CO.[15]

Thomassen et al. stated that the number of accidental camping-related CO-P cases increased significantly with the middle-aged adult male using camping stoves, camping heaters and charcoal grills inside or near a tent.[16] Moreover, a lack of legal requirements for campsites' safety regulations could increase accidental CO-P.[15]

Public adherence to the safety measures, which is affected by their knowledge, attitudes and practices, is necessary to reduce CO-P incidence.[7] Adequate knowledge was reflected in the community's practice as it had a significant influence on CO detector use in the current study. The percence of CO detectors has been increased from 11% in Hajjar et al.[8] to 42.5% in the current study. This difference could be related to Saudis' intention of using modern safety measures.

Kim et al.[15] stated that the use of handheld CO detectors, increasing the public awareness of the potential danger of using charcoal grills as well as establishing appropriate safety regulations during camping could be effective solutions for preventing accidental camping-related accidents.[17]

The participants' knowledge score and their civil defence education significantly influenced the use of handheld CO detectors. Also, low monthly income did not prevent its use.

McDonald et al.[18] and McKenzie et al.[19] noticed a significant positive relationship between the use of CO detectors and the overall knowledge of the participants on the risks associated with CO exposure. In addition, poverty was defined by Iqbal et al.[20] and Unsal Sac et al.[21] as one of the risk factors of CO-P due to lack of awareness and availability of safety measures.

The lack of personal awareness of the potential risk of CO poisoning and negligence in maintaining safety regulations could increase incidence of CO-P and its related fatalities.[22]

The current study has its limitations, including the use of convenience sampling technique, which has restricted the generalisability of the findiings.

In the light of the findings, however, it is recommended that sustained public health education should target behavioural change. Future research should detect the confounding predictors of good practice to prevent accidental CO-P, especially in camp sites.

Conclusion

There is evidence of improved level of knowledge and a better attitude towards safety practices among young Saudi campers in Riyadh province, but the link between good knowledge and good practice was found to be weak.

Abbreviations: CO-P: carbon monoxide poisoning; CO: carbon monoxide.

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