



**ORIGINAL ARTICLE**

## **Occupational Lead Exposure among Petrol Station Workers in Sana'a City, Yemen: Awareness and Self-Reported Symptoms**

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### **ABSTRACT**

**Background:** This study assessed the awareness of occupational lead exposure risks, self-reported lead poisoning symptoms and work practices and using personal protective equipment among petrol station workers in Sana'a city, Yemen.

**Subjects and methods:** A cross-sectional study was conducted among 172 petrol station workers in nine districts of Sana'a between January and May 2017. Data about demographic characteristics, awareness of the lead exposure risks, self-reported lead poisoning symptoms and work practices and use of personal protective equipment were collected. Inclusion criteria were workers who gave informed consent to participate, were aged 18-60 years and had been working for  $\geq 6$  months. The data were then analyzed using appropriate statistical tests.

**Results:** The majority of workers were aware of the adverse health effects of leaded petrol (61.0%) and that lead is an environmental pollutant (60.5%). However, personal protective equipment was poorly used. Workers with secondary education and above had better practices than those with primary education. Approximately 76.2% of workers had poor knowledge of lead risks, and 13.4% of them had good practices. The most common self-reported symptoms were neurological, including fatigue (68.0%), concentration difficulties (61.6%), joint pain (58.1%) and headache (55.2%).

**Conclusions:** Petrol station workers in Sana'a realize the exposure to lead risks because leaded petrol is the fuel type used in the country. Although the majority of workers perceived such adverse health effects, use of personal protective equipment was poor among most of them. The level of workers' education seems to influence their practices of using personal protective equipment.

**Keywords:** Lead; Awareness; Self-reported symptoms; Petrol station worker; Yemen

### **INTRODUCTION**

Lead is a neurotoxic heavy metal that is widely distributed in the environment. In contrast to trace elements such as iron and zinc, it has no known benefits to the human body [1]. The widespread use of lead is associated with extensive environmental contamination and health problems in many parts of the world. Human exposure to lead is estimated to account for 143,000 annual deaths and 0.6% of the disease global burden [2].

Petrol station workers are constantly exposed to leaded petrol and benzene during their work as a result of fine particle emissions that enter their bodies by inhalation, ingestion or through the skin [3]. Lead poisoning can affect multiple organs, particularly the central and peripheral nervous systems in addition to renal, hematologic, gastrointestinal and reproductive systems [4]. The most commonly reported signs and symptoms of lead poisoning include hearing loss, anemia, renal failure,

reduced immunity, low birth weight, stillbirth and abortion, premature birth, and elevated urine and blood lead levels [5].

Occupational exposure to lead occurs primarily through the respiratory system, which is the most important route of entry, followed by the gastrointestinal system. Cutaneous absorption of inorganic lead through food, water and paint products is negligible. However, organic lead compounds, such as leaded petrol, are readily absorbed through the intact skin because of their lipid solubility [6]. Respiratory lead absorption mainly depends on particle size, where 30-40% of inhaled lead may reach the blood. However, solubility, respiratory volume and physiologic variation are less important factors [4]. For this reason, efforts have been made to reduce its exposure over the past decades [7], where activities related to the workers' safety and occupational health have been launched in Iran since 1946 [8].

Leaded petrol remains the only option used as a fuel in Yemen. Most petrol station workers in the country work for more than nine hours daily. This exposes them to lead sources for long periods. Nevertheless, no published studies were found to explore the awareness of the risks of occupational exposure to lead or the use of personal protective equipment among petrol station workers in the country. Therefore, the present study aimed to assess the awareness of occupational risks of lead exposure, self-reported symptoms of lead poisoning and work practices and the use of personal protective equipment among petrol station workers in Sana'a.

## **SUBJECTS AND METHODS**

### **Study design, setting and population**

This was a cross-sectional study conducted among petrol station workers in nine districts of Sana'a city between January and May 2017. The study was approved by the research ethical committee of the University of Science and Technology - Sana'a and was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. Written informed

consent was obtained from all participants after explaining the purpose of the study, and permission was also obtained from the Ministry of Oil and Minerals in Sana'a. and from the owners of the petrol stations to allow their workers to participate in the study. The study included all petrol station workers who gave consent to participate in the study voluntarily, were aged between 18 and 60 years and had been working for six months or more.

### **Sampling strategy and sample size**

A total of 134 petrol stations were legally registered and distributed in the 10 districts of Sana'a city in 2016 as follows: Maeen (26) Bani Alharith (19), Althawra (22), Azal (2), Altahrir (2), Alsabain (36), Alwahdah (13), Old Sana'a (2), Assafiah (3) and Shuaub (9). However, those in Old Sana'a district refused to participate in the study. Therefore, the 132 stations in the remaining nine districts were included in the present study. Out of 341 petrol station workers in these nine districts, only 172 agreed to participate and recruited in the present study.

### **Data collection and analysis**

Data were collected using a pre-designed questionnaire through a face-to-face interview. The questionnaire was validated by three experts from the Community Medicine Department, where their notes were followed. Ethical approval to conduct the present study was obtained from the Research Ethics Committee of the Faculty of Medicine and Health Sciences, University of Science and Technology in December 2016.

The questionnaire was composed of mixed question (open, yes/no and multiple-choice questions) divided among three sections. The first section included questions related to demographic characteristics (such as age, marital status and education), work duration as well as knowledge of lead as an environmental pollutant, its routes of entry into the human body and the adverse health effects of leaded petrol. The second section included questions about the use of personal protective equipment such as wearing protective clothes, smoking, eating and drinking during work, chewing gum,

chewing khat, frequent milk drinking and having a shower at the workplace. The third section included questions about self-reported symptoms.

Data were analyzed using IBM SPSS Statistics, version 23 (IBM Corp., Armonk, NY, USA). Given that correct answers were scored “one” and incorrect answers “zero”, the workers’ knowledge and practices were assessed based on their answers to 6 and 11 questions, respectively. Workers were considered to have good knowledge or practice if they answered correctly  $\geq 50\%$  of questions and to have poor knowledge or practice if they answered correctly  $< 50\%$  of questions. Chi-square with Yate’s correction and Fisher’s exact tests, whichever suitable, were used to test the significance of associations between the outcomes (general knowledge or practice) and other variables of interest. *P* values  $< 0.05$  were considered statistically significant.

## RESULTS

### Characteristics of the study population

Table (1) shows that the mean age of petrol station workers was  $27.5 \pm 6.9$  years old (range: 18– 50). Of 172 participating workers, more than half of the workers were aged 20-29 years (56.4%), were married (61.6%), had an educational level of secondary school and above (62.2%) and had been working in the petrol stations for less than 5 years (54.7%). Details of the characteristics of the petrol station workers included in the present study are presented in Table (1).

### Knowledge, practices and self-reported symptoms of exposure to lead among petrol station workers

Table (2) shows that 14.5% (25/172) of workers heard of lead poisoning. However, 60.5% (104/172) and 61% (105/172) of workers knew that lead is an environmental pollutant and that leaded petrol exposure does affect human health, respectively. When asked about the possible routes of exposure to lead, 82.6% (142/172) of workers claimed that inhalation is the route of entry, followed by 30.2% (52/172) and 22.1% (38/172) who reported skin and mouth as the routes of entry

into the body, respectively. Eight (4.7%) workers indicated that there was an institution that raised their awareness of the health risks from exposure to lead.

Table (3) shows that only 5.2% (9/172) of workers tested their blood lead level. On the other hand, workers who mentioned no smoking, no drinking, no eating, no chewing gum and no chewing khat during work in the stations were 112 (65.1%), 10 (5.8%), 23 (13.4%), 65 (37.8%) and 11 (6.4%), respectively. The majority of workers (93.6%; 161/172) reported washing their hands before eating and smoking during work in the stations, while 48.8% (84/172) reported taking a shower at the workplace before going home. More than half of workers reported changing their clothes before going home (52.9%; 91/172) and frequently drinking milk (55.2%; 95/172). Regarding the use of personal protective equipment, wearing protective clothes was the most frequently used measure (7.0%; 12/172), while wearing gloves or goggles were the least frequently used measure (0.6%; 1/172).

Table (4) lists the reasons for not using personal protective equipment during work, where 15.5% did not use them because they saw them not necessary, 28.6% believed that these tools are uncomfortable, and 55.9% of petrol station workers were not provided with such tools.

Table (5) illustrates the frequency of self-reported symptoms among petrol station workers, where the most common symptom was fatigue (68%; 117/172) while anemia was the least common symptom (1.7%; 3/172). The majority of workers (94.2%; 162/172) reported one or more neurological symptoms, while 62.2% (119/172) reported one or more non-neurological symptoms.

### Association of certain characteristics to the knowledge and practices related to lead exposure among petrol station workers

Table (6) shows a statistically significant association ( $P = 0.002$ ) between the educational level of petrol station workers in Sana’a and their practices related to lead exposure, where those with secondary

education or above had significantly higher levels of good practices compared to those with preparatory education or less. In contrast, age, duration of work, length of work per day, marital status, self-reported symptoms or using

personal protective equipment were not significantly associated with the levels of knowledge and practices of petrol station workers.

**Table 1.** Characteristics of petrol stations' workers in Sana'a city (2017)\*

Variable	n (%)	Mean ± SD (range)
<b>Age (years)</b>		27.5 ± 6.9 (18–50)
<20	18 (10.5)	
20 - 29	97 (56.4)	
30 - 39	43 (25.0)	
≥ 40	14 (8.1)	
<b>Duration of work (years)</b>		5.8 ± 5.3 (0.5–26)
< 5	94 (54.7)	
5- 10	50 (29.1)	
> 10	28 (16.2)	
<b>Length of work per day (hours)</b>		11.4 ± 2.9 (4–18)
≤ 8	41 (23.8)	
9 - 12	83 (48.3)	
> 12	48 (27.9)	
<b>Marital status</b>		
Unmarried	66 (38.4)	
Married	106 (61.6)	
<b>Educational level</b>		
Preparatory school and less	65 (37.8)	
Secondary school and above	107(62.2)	

\* Total number of petrol station workers included in the study was 172; SD, standard deviation.

**Table 2.** Knowledge of the risks of exposure to lead among petrol station workers in Sana'a city (2017)\*

Knowledge item	Yes	No/ Do not know
	n (%)	n (%)
Have you heard of lead poisoning?	25 (14.5)	147 (85.5)
Is lead considered an environmental pollutant?	104 (60.5)	68 (39.5)
Does exposure to lead has an adverse impact on health?	105 (61.0)	67 (39.0)
What are the routes of lead entry into the human body?		
Inhalation	142 (82.6)	30 (17.4)
Skin	52 (30.2)	120 (69.8)
Mouth	38 (22.1)	134 (77.9)
Is there an institution that has raised your awareness of the health risks from exposure to lead?	8 (4.7)	164 (95.3)

\* Total number of petrol station workers included in the study was 172.

**Table 3.** Work practices and use of personal protective equipment of petrol station workers towards lead in Sana'a city (2017)\*

Practice item	Yes	No
	n (%)	n (%)
Have you ever tested your blood lead level?	9 (5.2)	163 (94.8)
Are you doing the following during work?		
Smoking	60 (34.9)	112 (65.1)
Drinking	162 (94.2)	10 (5.8)
Eating	149 (86.6)	23(13.4)
Chewing gum	107 (62.2)	65 (37.8)
Chewing khat	161(93.6)	11 (6.4)
Do you wash your hands before eating or smoking?	161 (93.6)	11 (6.4)
Do you take a shower at work site before going home?	84 (48.8)	88 (51.2)
Do you change your clothes before going home?	91 (52.9)	81 (47.1)
Do you frequently drink milk?	95 (55.2)	77 (44.8)
Do you wear the following during work?		
Gloves	1 (0.6)	171 (99.4)
Respiratory mask	2 (1.2)	170 (98.8)
Work clothes	12 (7.0)	160 (93.0)
Goggles	1 (0.6)	171 (99.4)
Special boots	3 (1.7)	169 (98.3)
Cap	3 (1.7)	169 (98.3)

\* Total number of petrol station workers included in the study was 172.

**Table 4.** Reasons for not using the personal protective equipment during work by petrol station workers in Sana'a city (2017)\*

Protective equipment	Reasons for not using personal protective equipment		
	Not necessary <i>n</i> (%)	Uncomfortable <i>n</i> (%)	Not provided <i>n</i> (%)
Gloves	26 (15.2)	49 (28.7)	96 (56.1)
Respiratory mask	26 (15.3)	49 (28.8)	95 (55.9)
Work clothes	24 (15.0)	45 (28.1)	91 (56.9)
Goggles	27 (15.8)	49 (28.7)	95 (55.6)
Special boots	26 (15.4)	48 (28.4)	95 (56.2)
Cap	28 (16.6)	49 (29.0)	92 (54.4)

\* Total number of petrol station workers included in the study was 172.

**Table 5.** Self-reported symptoms probably related to lead exposure among petrol station workers during the past six months in Sana'a city (2017)\*

Variable	Yes	No
	<i>n</i> (%)	<i>n</i> (%)
Neurological symptoms (one or more)	<b>162 (94.2)</b>	<b>10 (5.8)</b>
Fatigue	117 (68.0)	55 (32.0)
Pain of joints	100 (58.1)	72 (41.9)
Wrist/foot drop	78 (45.3)	94 (54.7)
Convulsion	30 (17.4)	142 (82.6)
Irritability	53 (30.8)	119 (69.2)
Dizziness	63 (36.6)	109 (63.4)
Headache	95 (55.2)	77 (44.8)
Concentration difficulties	106 (61.6)	66 (38.4)
Hearing loss	44 (25.6)	128 (74.4)
Sleep disturbance	76 (44.2)	96 (55.8)
Non-neurological symptoms (one or more)	<b>119 (69.2)</b>	<b>53 (30.8)</b>
Nausea	47 (27.3)	125 (72.7)
Dyspepsia	51 (29.7)	121 (70.3)
Constipation	40 (23.3)	132 (76.7)
Abdominal pain	48 (27.9)	124 (72.1)
Renal pain	46 (26.7)	126 (73.3)
Hypertension	27 (15.7)	145 (84.3)
Infertility	4 (2.3)	168 (97.7)
Anemia	3 (1.7)	169 (98.3)
Respiratory problems	54 (31.4)	118 (68.6)
Blue line (lead line) in the gums	13 (7.6)	159 (92.4)

\* Total number of petrol station workers included in the study was 172.

**Table 6.** Association of certain characteristics to the knowledge and practices related to lead exposure among petrol station workers in Sana'a city (2017)

Variable	Knowledge level				Practice level				
	N	Good (N=41)	Poor (N=131)	P- value	N	Good (N =23)	Poor (N =149)	P-value	
		n (%)	n (%)			n (%)	n (%)		
Age (years)									
	<20	18	3 (16.7)	15 (83.3)	0.848	18	3 (16.7)	15 (83.3)	0.314
	20 - 29	97	23 (23.7)	74 (76.3)		97	16 (16.5)	81 (83.5)	
	30 - 39	43	12 (27.9)	31 (72.1)		43	4 (9.3)	39 (90.7)	
	≥ 40	14	3 (21.4)	11 (78.6)		14	0 (0.0)	14 (100.0)	
Duration of work (years)									
	< 5	94	25 (26.6)	69 (73.4)	0.392	94	14 (14.9)	80 (85.1)	0.803
	5 - 10	50	12 (24.0)	38 (76.0)		50	6 (12.0)	44 (88.0)	
	> 10	28	4 (14.3)	24 (85.7)		28	3 (10.7)	25 (89.3)	
Length of work per day (hours)									
	≤ 8	41	10 (24.4)	31 (75.6)	0.529	41	5 (12.2)	36 (87.8)	0.921
	9 - 12	83	17 (20.5)	66 (79.5)		83	12 (14.5)	71 (85.5)	
	> 12	48	14 (29.2)	34 (70.8)		48	6 (12.5)	42 (87.5)	
Marital status									
	Single	66	15 (22.7)	51 (77.3)	0.788	66	12 (18.2)	54 (81.8)	0.144
	Married	106	26 (24.5)	80 (75.5)		106	11 (10.4)	95 (89.6)	
Educational level									
	Primary or less	65	14 (21.5)	51 (78.5)	0.581	65	2 (3.1)	63 (96.9)	0.002*
	Secondary or above	107	27 (25.2)	80 (74.8)		107	21 (19.6)	86 (80.4)	
Number of self-reported symptoms									
	≤ 5	78	17 (21.8)	61 (78.2)	0.567	78	11 (14.1)	67 (85.9)	0.798
	> 5	94	24 (25.5)	70 (74.5)		94	12 (12.8)	82 (87.2)	
Type of self-reported symptoms									
	Neurological	46	10 (21.7)	36 (78.3)	0.787	46	4 (8.7)	42 (91.3)	0.373
	Non-neurological	3	0 (0.0)	3 (100.0)		3	1 (33.3)	2 (66.7)	
	Both	116	30 (25.9)	86 (74.1)		116	17 (14.7)	99 (85.3)	
	Neither	7	1 (14.3)	6 (85.7)		7	1 (14.3)	6 (85.7)	
Using personal protective equipment									
	Yes	14	2 (14.3)	12 (85.7)	0.584	--	--	--	--
	No	158	39 (24.7)	119 (75.3)		--	--	--	
General knowledge									
	Good	--	--	--	--	41	8 (19.5)	33 (80.5)	0.186
	Poor	--	--	--		131	15 (11.5)	116 (88.5)	

\* Statistically significant at  $P < 0.05$ .

**DISCUSSION**

Lead is a major component of leaded gasoline that typically enters the human body through the respiratory or gastrointestinal tracts and is distributed in blood, soft tissues, and bones [9]. The present study is the first to assess the awareness of occupational risks of lead exposure, self-reported symptoms of lead poisoning and work practices and using personal protective equipment among petrol station workers in Sana'a city, Yemen. The age of petrol station workers in Sana'a ranged from 18 to 50 years with a mean of  $27.5 \pm 6.9$  years, which is somewhat less than the age reported for Nigerian workers, gas station workers in Southern Brazil and gasoline station workers from Gaza, being  $29.15 \pm 4.76$ ,  $30.25 \pm 9.58$  and  $34.4 \pm 10.7$ , respectively [10-12]. In Ghana, 79% of workers were found to be less than 30 years old.[13] The reason for the work of young adults in petrol stations could be the physical demands of the work and long working hours comprising of both 12 hours diurnal and nocturnal shifts [13].

The proportion of petrol station workers (16.2%) in Sana'a had been working for more than 10 years is higher than that (6.7%) reported from Nigeria but lower than that (54%) reported from Thailand [10,14]. In Gaza, more than half of the workers worked for more than 5 years [11]. On the other hand, about half of workers (48.3%) in the present study worked between 9 and 12 hours per day, where the majority of workers (76.2%) worked for more than 8 hours a day. The length of work per day among the workers in Sana'a is higher than that found in Nigeria [10], where 50.5% of workers worked for more than 8 hours per day. The higher proportion of highly educated workers in the present study could be attributed to the lack of job opportunities because of the war in the country.

Only a small proportion (14.5%) of petrol station workers in Sana'a heard of lead poisoning. This could be mainly attributed to because workers neither attended training courses related to the hazards of leaded petroleum nor visited by health professionals in

their station. In this context, 4.7% of workers reported that their institutions had raised their awareness of the health risks of exposure to lead. This is an alarming issue that necessitates urgent campaigns through training seminars and courses as well as frequent health professionals' visits to the gasoline stations. Such action would alleviate lead exposure and poisoning among workers [11].

In the present study, 60.5% of workers perceived that lead is an environmental pollutant and 61.0% knew the impact of lead-containing petrol on health. These findings are lower than those reported from Gaza [11], where 84.8% and 83.8% of workers knew that lead is an environmental pollutant and leaded gasoline exposure do affect human health, respectively. In Nigeria [10], a higher proportion of respondents (72.4%) were aware of work safety practices such as the harmful effects of lead on health. The finding that a higher proportion of petrol station workers (82.6%) were aware of inhalation of leaded petrol as the main route of lead entry into the human body compared to other routes of exposure agrees with other studies which found that the most common route of exposure to lead occurs through inhalation [11, 15,16].

In the present study, approximately two-thirds of workers reported no smoking during work. This proportion is lower than that found among Nigerian workers, where 92.4% of workers did not light a match or smoke close to volatile organic compounds [10]. In contrast, it is higher than that reported among gasoline station workers from Gaza [11], where 48.6% of workers reported no smoking during work. On the other hand, the proportions of workers not drinking, not eating, not chewing gum and not chewing khat during work in the present study were 5.8%, 13.4%, 37.8%, and 6.4%, respectively. In contrast, 46.7% and 16.25% of Nigerian and Palestinian workers reported no eating or drinking during work, respectively [10,11]. However, 9.5% of Palestinian workers reported not chewing gum during work [11]. On the other hand, the majority of workers (93.6%) in the present study reported washing

their hands before eating or smoking. This proportion is higher than that (82.9%) reported by Nigerian workers [10]. About half of petrol station workers in Sana'a reported to take a shower at the workplace before going home, change their clothes before going home and frequently drink milk. In Nigeria, a higher proportion (81%) of workers reported to wash, path and change clothes after work [10]. However, lower proportions of 14.3% and 44.8% reported having a bath at the workplace and frequent milk drinking in Gaza, respectively [11].

Regarding the use of personal protective equipment, the majority of workers in Sana'a did not use such protective measures during work in the stations. Only 7% of them had work clothes and 1.7% had special boots and caps, while 1.2% had respiratory masks and 0.6% had gloves and goggles. The proportions of those using personal protective equipment in the present study are lower than those reported among Nigerian workers, where 19.4% of them had an apron and 2.8% had hand gloves and boots [10]. In addition, they were lower than those found among workers from Gaza, where 14.3% of respondents wore overalls, 28.6% wore gloves, 2.9% wore goggles, 9.5% wore respiratory masks and 1.0% wore special boots and hats [11]. Not using personal protective equipment as stated by workers was attributed to the fact that such measures had not been provided, believing that these measures are uncomfortable or not necessary. These findings agree with those reported in other studies, which found that the reasons for not using protective kits as claimed by workers were carelessness, personal protective equipment not provided to them by station owners, discomfort and believing that these tools are not necessary [10, 11, 14].

Regarding self-reported symptoms associated with leaded gasoline exposure, the present study showed that the most common self-reported symptoms among petrol station workers were neurological symptoms, including fatigue, concentration difficulties, pain of joints and headache. These findings

require urgent prevention and interventions from the Ministry of Health and other non-governmental organizations to protect petrol station workers. Similar findings were reported from other countries (Mansouri and Cauli 2009) [11, 17-20].

The finding that only 23.8% of petrol station workers in Sana'a had good knowledge level of occupational lead exposure present in the workplace is lower than those reported in Thailand and Nigeria [10, 13], where 34.1% and 41% had good knowledge of hazards of occupational exposure to lead, respectively. Moreover, the present study revealed a statistically significant association between the educational level and the practice level. In this respect, attainment of secondary education or above was found to be significantly associated with better practices to avoid the occupational risks of exposure to lead compared to those with primary education or less. However, no statistically significant association was found between knowledge and educational levels of participants. In another context, no relationship was found between using protective gears and the knowledge level of gasoline station workers in Gaza [11]. Therefore, good knowledge does not necessarily reflect on good practices.

#### **Limitation of the study**

One of the limitations of this study is that blood lead level among petrol station workers was not measured due to the difficulty in purchasing the necessary kits from abroad due to the ongoing war and crisis in the country. Moreover, requesting blood sample collection would have impaired their willingness to participate in the study. Although the self-reported symptoms of lead poisoning reported by the participants of the present study were not exclusive to lead and could be due to other risk factors/exposures, the high rates of exposure to lead suggest that it could be the main source.

#### **CONCLUSIONS**

Petrol station workers in Sana'a realize that they are exposed to the risk of exposure to lead because leaded petrol is the fuel type exclusively used in the country. Although the

majority of workers perceived the adverse health effects of leaded petrol, the use of personal protective equipment was poor among the majority of workers. The level of workers' education seems to influence the practice of using personal protective equipment among them. Neurological symptoms were the most common self-reported symptoms among petrol station workers. For petrol station workers in Sana'a, educational courses and preventive practices are recommended. Further studies including the determination of blood lead levels among petrol station workers are warranted.

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#### Declaration of interest

The author reports no conflicts of interest. The author alone is responsible for the content and writing of the paper.

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