Original Article

Exposure of gasoline station workers to leaded gasoline in the Gaza Strip: Awareness and self reported symptoms.

ˆAbdel Monˆem H. Lubbad[1], ˆAdnan I. Al-Hindi[2], ˆAbed Al-Rahman I. Hamad[3] and Maged M. Yassin[4].

[1] Department of Pathology, Faculty of Medicine, The Islamic University of Gaza, Palestine.
[2] Department of Biology, Faculty of Science, The Islamic University of Gaza, Palestine.
[3] Department of Medical Technology, Faculty of Science, The Islamic University of Gaza, Palestine.
[4] Department of Physiology, Faculty of Medicine, The Islamic University of Gaza, Palestine.

تعرض عمال محطات الوقود المحتوى على الرصاص في قطاع غزة: مدى الإدراك والأعراض المصاحبة.

عبد المنعم حسين لبد، عدنان إبراهيم الهندي، عبد الرحمن إبراهيم حمد، ماجد محمد ياسين.

الخلاصة: تناولت الدراسة تقييم مدى الإدراك والأعراض المصاحبة الناتجة عن التعرض للوقود المحتوى على الرصاص لدى 105 من عمال محطات الوقود في قطاع غزة. وقد إستخدم الباحثون الاستبانات للحصول على المعلومات. بينت النتائج وجود مستوى عال من المعرفة لدى العمال عن التأثيرات الصحية للوقود المحتوى على الرصاص 88 (83.8%) وعن الرصاص كملوث للبيئة 89 (84.8%). وقد كان استخدام وسائل الحماية ضعيفا وكانت المعرفة لدى العمال ليس لها تأثير كبير على الممارسة، أي على استخدام أدوات الحماية في المحطة، ووجد أن الأعراض الصحية الأكثر شيوعا بين العمال هي الأعراض العصبية وتشمل الصداع 78 (74.3%) وضعف العضلات 74 (70.5%) والإثارة العصبية 66 (62.9%) وصعوبات في التركيز 65 (61.9%) واضطرابات في النوم 55 (52.4%)، وكان معدل انتشار الأعراض يزداد بزيادة سنوات العمل في المحطة (χ^2 corrected=7.713, P=0.021) وقد تبين أن استعمال قناع التنفس يحد بكفاءة من هذه الأعراض (χ^2corrected=8.325, P=0.004).

Abstract: Awareness and self reported symptoms among 105 gasoline station workers in the Gaza Strip were assessed. A cross section of workers was asked to fill in a questionnaire. Workers reported high level of knowledge on health effects of leaded gasoline 88 (83.8%) and lead as an environmental pollutant 89 (84.8%). Protective measures were poorly used. Knowledge seems not to have much influence on practice. The most common self reported symptoms were neurological symptoms including headache 78 (74.3%), fatigue 74 (70.5%), irritability 66 (62.9%), concentration difficulties 65 (61.9%), and sleep disturbance 55 (52.4%). The prevalence of symptoms increased with increasing years of work (χ^2 corrected=7.713, P=0.021). Use of respiratory mask in particular can potentially limit such symptoms (χ^2 corrected=8.325, P=0.004).

Keywords: lead, gasoline, Gaza, health.

Introduction:

Although leaded gasoline has been or is being phased out in many countries, it is still imported from Israel and widely used in the Gaza Strip [*1*]. Leaded gasoline contains tetraethyllead and, to some extent, tetramethyllead which are used as "anti-knock" additives to gasoline [*2*]. Therefore, leaded gasoline is identified as a source of lead pollution with adverse health effects in humans. Lead exposure in gasoline station occurs from lead fumes generated during filling cars, from cars emissions and from contaminated hands, food, water and clothing [*3*,*4*].

As a fume or fine particulate, lead is readily absorbed through the lungs. It is relatively less well-absorbed from the gastrointestinal tract. Inorganic lead is not absorbed through intact skin, but organic lead compounds (tetraethyllead, tetramethyllead) can be [*5*]. Once lead has been absorbed into the bloodstream, it is distributed between the bones and teeth, the soft tissues (kidneys, brain, liver) and the blood, and in part excreted in the urine and in bile [*6*]. With chronic exposure, most absorbed lead accumulates in the bone which ultimately provides a source of remobilization and continued toxicity after exposure ceases [*7*].

Personal habits and lack of protective measures at the workplace, and lack of awareness campaigns were reported to contribute in facilitating exposure to leaded gasoline [*8,9*]. Major symptoms of intoxication with leaded gasoline include headache, fatigue, irritability, impaired concentration, wrist/foot drop, nausea, dyspepsia, constipation, colic, lead line on gingival tissue, loss of libido and anemia [*10-12*].

Although leaded gasoline is being used in the Gaza Strip, there were a lack of data on awareness and self reported symptoms among gasoline station workers. In addition, poor use of protective measures during work in the station (personal observation) promoted the authors to conduct this study. Therefore, the overall aim was to assess various aspects of awareness and self reported symptoms among gasoline station workers exposed to leaded gasoline in the Gaza Strip. The objectives of this study were to answer the following research questions: (1) do gasoline station workers have knowledge on route of lead entry into the body, lead health effects and lead as an environmental pollutant?; (2) what is the workers attitude and practice towards the protective measures?; (3) does workers' knowledge reflect their practice towards the use of protective gear?; (4) what are the self reported symptoms among workers?; and (5) is there an association between the frequency of self reported symptoms and the use of protective gear?

Study area

The Gaza Strip is a part of the Palestinian coastal plain bordered by Egypt from the South, the green line from the North, Nagev desert from the East and the Mediterranean Sea from the West. The total surface area of the Gaza Strip is 360 km^2, where about 1,416,543 Palestinian people live and work [*13*]. The Gaza Strip is divided geographically into five Governorates: Northern, Gaza, Mid Zone, Khan Younis and Rafah. Gaza Strip is a poor area suffering from a long-term pattern of economic stagnation and plummeting development indicators [*14*]. The situation becomes even worse since Israel imposed extreme restrictions on the movement of goods and people in response to the new political situation in the Gaza Strip. Unemployment in Gaza is close to 40% and is set to rise to 50% [*15*]. The Gaza Strip suffers from many environmental problems including extensive use/misuse of pesticides, water pollution and lack of sewage and solid waste treatment [*16-18*]. Air pollution is another environmental burden in the Gaza Strip caused to a large extent by carbon monoxide, nitrogen oxide and lead emitted by petrol vehicles. Leaded gasoline imported from Israel [*19*] is still the predominant fuel grade in the Gaza Strip. Lead emitted from such fuel imposes serious health problems on both general population and gasoline station workers in the Gaza Strip.

Subjects and Methods:

Study design and target population

The investigation was a cross sectional study. The target population was gasoline station workers in the five Governorates of the Gaza Strip. The workers who did not meet the criterion of being involved in the work in the station during the spring of 2006 were excluded. For ethical consideration, the necessary approval to conduct the study was obtained from Helsinki committee in the Gaza Strip in January, 2006.

Sample size and sampling

The estimated number of legal gasoline stations registered in the Gaza Strip in the year 2006 was 81 distributed in the five Governorates of the Gaza Strip as follows: Northern (17), Gaza (27), Mid Zone (10), Khan Yunis (19) and Rafah (8). According to the municipalities of Gaza Governorates, Palestinian National Authority (Personal communication), the estimated total number of workers in Gaza Governorates was 208, distributed as follows: Northern (36), Gaza (77), Mid Zone (24), Khan Yunis (45), and Rafah (26). A stratified sample was used based on the number of workers in each Governorate and distributed as follows: Northern (18), Gaza (39), Mid Zone (12), Khan Yunis (23), and Rafah (13). Therefore, our sample size was 105 gasoline station workers.

Questionnaire interview

A meeting interview was used for filling in the questionnaire. All interviews were conducted face to face by one of the authors who had a Master Degree of Medical Technology. The questionnaire was based on adult lead poisoning questionnaire, and on that used in a similar study with some modifications related to work duration and practice [*20*,*21*]. The questionnaire was validated by four specialists in the fields of environment and public health, and their notes were followed. Most questions were one of two types: the yes/no question, which offers a dichotomous choice; and the multiple choice question, which offers several fixed alternatives [*22*]. A questionnaire was piloted among 10 gasoline station workers not included in the sample, and modified as necessary for improving reliability. The questionnaire included questions related to: personal profile such as age, marital status and education; Work duration; house location; knowledge on the route of lead entry into the human body, health effects of leaded gasoline and lead as environmental pollutant; and attitudes towards the work in the station and the effectiveness of the protective gear. Practice questions included: the wearing of protective clothes; smoking; eating and drinking during work; chewing gum; whether they drink milk frequently or not; and whether to have a water bath or not at workplace. Self-reported symptoms questions were also included in the questionnaire.

Limitations of the study

They included weak cooperation of some station owners who in some instances did not allow the workers to participate in the interview. Far distances between stations, and limitation of literature on awareness aspects of gasoline station workers were other obstacles.

Data analysis

Data were computer analyzed using SPSS/PC (Statistical Package for the Social Science Inc. Chicago, lllinois USA, version 13.0) statistical package. Simple distribution of the study variables and the cross tabulation were applied. Chi-square (χ^2) was used to identify the significance of the

relations, associations, and interactions among various variables. Yates's continuity correction test, $\chi 2$ (corrected), was used when not more than 20% of the cells had an expected frequency of less than five and when the expected numbers were small [*23*]. The result was accepted as statistically significant when the p-value was less than 5% ($p<0.05$).

Results:

Personal profile of the study population

Table 1 shows that age of the gasoline station workers (n=105) ranged between 19 and 65 years with mean age±SD 34.4±10.7 years old. A total of 88 (83.8%) were married; 7 (8.0%) had no children. Analysis of the educational status of the workers showed that 22 (21.0%) had a university degree, 38 (36.2%) had finished secondary school, 22 (21.0%) had finished preparatory school, and 23 (21.9%) had passed primary school. It is worth mentioning that none of the workers was illiterate.

Table 1. Personal profile of the study population (n =105).

Personal profile	No. (%)
Age (Year)	
<27	27 (25.7)
27-42	54 (51.4)
>42	24 (22.9)
Mean±SD (range)	34.4±10.7 (19-65)
Marital status	
Single	17 (16.2)
Married	88 (83.8)
Have children	81 (92.0)
Have no children	7 (8.0)
Education	
University	22 (21.0)
Secondary school	38 (36.2)
Preparatory school	22 (21.0)
Primary school	23 (21.9)

Work duration and house location

As indicated in Table 2, more than half of the workers 59 (56.2%) worked in the gasoline station for more than 5 years, whereas 26 (24.8%) and 20 (19.0%) of them worked for 2-5 and <2 years, respectively. It is worth mentioning that, all interviewed workers had no history of other lead-related job. House location in relation to some sources of lead pollution e.g. battery workshop, auto radiator workshop, garage and gasoline station is presented in Table 3. The total numbers of workers who mentioned that their houses are located at a distance of <50, 50-100 and >100 m from the sources of lead pollution were 13 (12.4%), 9 (8.6%) and 6 (5.7%), respectively. Although there are three small lead smelters in the Gaza Strip for manufacturing battery plates and sinkers, none of the workers mentioned that their houses are located near lead smelter.

Table 2. Work duration in the gasoline station of the study population (n =105).

Work duration (Year)	No. (%)
<2	20 (19.0)
2-5	26 (24.8)
>5	59 (56.2)

Table 3. House location in relation to some sources of lead pollution as reported by the study population (n=105).

House location	Distance (meter)		
	<50 No. (%)	50-100 No. (%)	>100 No. (%)
Battery workshop	1 (1.0)	1 (1.0)	1 (1.0)
Auto radiator workshop	2 (1.9)	1 (1.0)	0 (0.0)
Garage of cars	7 (6.7)	5 (4.8)	4 (3.8)
Gasoline station	3 (2.9)	2 (1.9)	1 (1.0)
Total	**13 (12.4)**	**9 (8.6)**	**6 (5.7)**

Workers' knowledge on route of lead entry, its health effects and lead as an environmental pollutant

When questioned about the possible routes of exposure to lead; 91 (86.7%) workers claimed that inhalation is the route of entry, followed by 34 (32.4%) who reported that skin is the route of entry, and 31 (29.5%) who claimed that the mouth is the route of entry of lead into the body (Table 4).

Table 4. Knowledge of gasoline station workers (n=105) on route of lead entry into the body, health effects of leaded gasoline exposure and lead as an environmental pollutant.

House near to	No. (%)
Route of lead entry into the body	
Inhalation	91 (86.7)
Skin	34 (32.4)
Mouth	31 (29.5)
Health effects of leaded gasoline exposure	88 (83.8)
Lead as an environmental pollutant	89 (84.8)

A total of 88 (83.8%) and 89 (84.8%) workers knew that leaded gasoline exposure do affect human health and that lead is an environmental pollutant, respectively. The variation in such workers' knowledge by their education levels was not found to be significant (Table 5). In addition, results showed that workers who did not use protective gear had more knowledge on route of lead entry, its health and environmental effects than those who did (Table 6), indicating that knowledge does not necessary to reflect practice. However, the interaction between use of protective gear and knowledge of workers in this regard was not significant (P>0.05).

Attitudes of workers, attending training courses, and health professional visits to the station

A total of 37 (35.2%) workers (n=105) were against work in the station. However, as mentioned by workers, the main cause of engagement in such work was the lack of job opportunities in the Gaza Strip. A total of 81 (77.1%) workers believed that use of protective gear is effective in preventing lead exposure, whereas 24 (22.9%) had the opposite opinion. Neither workers attended training courses nor they had health professionals visited their station.

Table 5. Frequency and percentage of gasoline station workers' education in relation to their knowledge.

Knowledge about	Education				P value
	Primary school (n=23)	Preparatory school (n=22)	Secondary school (n=38)	University (n=22)	
Route of lead entry into body					
Inhalation *(n=91)*	18 (78.3)	20 (90.9)	32 (84.2)	21 (95.5)	0.637*
Skin *(n=34)*	9 (39.1)	8 (36.4)	11 (28.9)	6 (27.3)	0.776
Mouth *(n=31)*	9 (39.1)	8(36.4)	7 (18.4)	7 (31.8)	0.281
Health effects of leaded gasoline exposure *(n=88)*	18 (78.3)	19 (86.4)	31 (81.6)	20 (90.9)	0.897*
Lead as an environmental pollutant *(n=89)*	17 (73.9)	18 (81.8)	34 (89.5)	20 (90.9)	0.584*

* p value of χ^2 (corrected) test

Table 6. Use of protective gear among gasoline station workers (n=105) in relation to their knowledge.

Knowledge about	Using Protective gear (n=42) No. (%)	Not using Protective gear (n=63) No. (%)	p value
Route of lead entry into body			
Inhalation *(n=91)*	38 (41.8)	53 (58.2)	0.519*
Skin *(n=34)*	11 (32.4)	23 (67.6)	0.268
Mouth *(n=31)*	11 (35.5)	20 (64.5)	0.541
Health effects of leaded gasoline exposure *(n=88)*	35 (39.8)	53 (60.2)	0.913
Lead as an environmental pollutant *(n=89)*	34 (38.2)	55 (61.8)	0.375

* p value of χ^2 (corrected) test

Practices of gasoline station workers towards protective measures

Table 7 lists the different protective measures regularly used by gasoline station workers (n=105) during work at station. The highest number (n=30, 28.6%) wore gloves and the lowest number (n=1, 1.0%) wore hats or special boots. The causes of not using

such protective gear were carelessness 51 (48.6%), not provided 41 (39.0%), discomfortable 7 (6.7%), and not necessary 6 (5.7%). The number of workers who mentioned not smoking, not eating, not drinking and not chewing gum during work in the station was 51 (48.6), 17 (16.2), 17 (16.2) and 10 (9.5), respectively. A total of 47 (44.8%) were frequently drunk milk and 15 (14.3%) had a water bath after work at work place.

Table 7. Gasoline station workers (n=105) who reported using protective measures during work at the station.

Protective measures in use	No. (%)
Wear gloves	30 (28.6)
Wear goggles	3 (2.9)
Wear hat	1 (1.0)
Wear respiratory mask	10 (9.5)
Wear special boots	1 (1.0)
Wear overall	15 (14.3)
Not smoking during work	51 (48.6)
Not eating during work	17 (16.2)
Not drinking during work	17 (16.2)
Not chewing gum during work	10 (9.5)
Frequently drink milk	47 (44.8)
Have water bath at work place	15 (14.3)

Prevalence of self-reported symptoms

The recall period was shortened to three months preceding the interview to minimize the possibility of recall bias. Table 8 lists the prevalence of self reported symptoms among gasoline station workers (n=105), with headache being the most common (n=78, 74.3%) and seizures the least common (n=1, 1.0%). A total of 95 (90.5%) workers had 2 or more self reported symptoms. However, one worker (1.0%) recalled one poisoning cases associated with leaded gasoline exposure. There was a significant increase in the prevalence of self reported symptoms with increasing years of work in the station (χ^2 corrected=7.713, P=0.021) as illustrated in Table 9. In addition, Table 10 pointed out that the interaction between the use of protective gear and self reported symptoms was statistically significant only for respiratory mask (χ^2 corrected=8.325, P=0.004).

Table 8. Self reported symptoms related to leaded gasoline exposure of the gasoline station workers (n=105).

Symptoms	No. (%)
Neurological symptoms	
Fatigue	74 (70.5)
Irritability	66 (62.9)
Coma	4 (3.8)
Convulsion	3 (2.9)
Headache	78 (74.3)
Concentration difficulties	65 (61.9)
Sleep disturbance	55 (52.4)
Seizures	1 (1.0)
Hearing loss	22 (21.0)
Wrist/foot drop	39 (37.1)
Non-neurological symptoms	
Loss of libido	33 (31.4)
Nausea	50 (47.6)
Dyspepsia	45 (42.9)
Constipation	49 (46.7)
Abdominal pain	39 (37.1)
Lead line in gingival tissue	18 (17.1)
Renal pain	15 (14.3)
Hypertension	52 (49.5)
Infertility	3 (2.9)
Have 2 or more symptoms	95 (90.5)

Discussion:

Leaded gasoline imported from Israel is still the predominant fuel grade in the Gaza Strip [*1,19*]. Lead emitted from such fuel imposes serious health problems on both gasoline station workers and general population in the Gaza Strip. Therefore, the present work was intended to assess various aspects of awareness and self reported symptoms among gasoline station workers exposed to leaded gasoline in the Gaza Strip. The result that none of the workers found to be illiterate do reflect a well educated community.

Such finding may give the impression that the high rate of educated workers is a result of them not getting another job because of the unemployment

crisis in the Gaza Strip. In addition, restriction of jobs in the Gaza Strip forced the study population to be engaged in gasoline stations.

Regarding work duration and history, the finding that more than half of the workers worked in the gasoline station for more than 5 years and that all workers had no history of other lead-related job may imply that most of lead exposure coming from the workplace.

The result that a higher proportion of gasoline station workers were more aware of inhalational of leaded gasoline than other routes of exposure agrees with other studies which have found that most occupational exposure to lead occur through inhalation [*12,24*].

Table 9. Distribution of the study population (n=105) by prevalence of self reported symptoms in relation to education, yearly work duration and house location.

Variable	Have symptoms (n=95)* No. (%)	P value **
Education		
Primary school *(n=23)*	22 (95.7)	0.936
Preparatory school *(n=22)*	20 (90.9)	
Secondary school *(n=38)*	34 (89.5)	
Diploma or University *(n=22)*	19 (86.4)	
Work duration (Year)		
<2 *(n=20)*	15 (75.0)	0.021
2-5 *(n=26)*	22 (84.6)	
>5 *(n=59)*	58 (98.3)	
House location (Meter)		
<50 *(n=13)*	13 (100)	0.916
50-100 *(n=9)*	7 (77.8)	
>100 *(n=6)*	6 (100)	

* Workers reported 2 or more symptoms
** p value of χ^2 (corrected) test

The small number of workers (<10%) lived <50 meters distance from other lead sources and the no significant relation between house locations and self reported symptoms (p=0.916) probably support this view.

Table 10. Prevalence of self reported symptoms among gasoline station workers (n=105) in relation to protective gear in use.

Protective gear in use	Have symptoms (n=95)* No. (%)	p value**
Wear gloves		
Yes *(n=30)*	27 (90.0)	0.793
No *(n=75)*	68 (90.7)	
Wear goggles		
Yes *(n=3)*	3 (100)	0.669
No *(n=102)*	92 (90.2)	
Wear hat		
Yes *(n=1)*	1 (100)	0.166
No *(n=104)*	94 (90.4)	
Respiratory mask		
Yes *(n=10)*	6 (60.0)	0.004
No *(n=95)*	89 (93.7)	
Wear special boots		
Yes *(n=1)*	1 (100)	0.166
No *(n=104)*	94 (90.4)	
Wear overall		
Yes *(n=15)*	15 (100)	0.378
No *(n=90)*	80 (88.9)	

* Workers reported 2 or more symptoms
** p value of χ^2 (corrected) test

Knowledge of workers on the effects of leaded gasoline exposure on human health and lead as an environmental pollutant was high. However, it seems that workers' education had no significant influence on their knowledge (p>0.05).

The majority of workers did not use protective measures during work in the station. The reason for not using protective gear as claimed by workers was carelessness, not provided, discomfort and not necessary. Such practice in combination with personal habits and lack of control measures at workplace could put workers at risk of lead exposure [*8*]. In addition, workers who did not use protective gear had more knowledge about route of lead entry, its health effects, and lead as an

environmental pollutant than those who did. This implies that Knowledge does not have much influence on practice. Also, the positive attitude of workers towards the effectiveness of protective gear in preventing lead exposure seems not to translate into practice.

Neither workers attended training courses related to the hazards of leaded gasoline nor they had health professionals visited their station. This is an alarming issue that necessitates urgent campaign represented by introducing seminars and training courses, and frequent health professionals' visits to the gasoline stations. Such action would alleviate lead exposure and poisoning among workers. It was reported that workers should receive training courses including instruction about the use and care of appropriate protective equipment and on the manner of wearing them [*25*,*26*].

Regarding self reported symptoms associated with leaded gasoline exposure, results showed that the most common self reported symptoms among gasoline station workers were neurological symptoms including headache, fatigue, irritability, concentration difficulties, and sleep disturbance. These findings require urgent prevention, intervention, and protection from the Ministry of Health and other non-governmental organizations. Similar data were reported in many countries, including the neighboring ones [*27-30*].
According to the present data there was a significant increase in the prevalence of self reported symptoms with increasing years of work in the gasoline station. This positive relationship means that increasing work duration led to increase workers exposure to leaded gasoline and put their health at higher risk. Lead toxicity was more frequently encountered with longer term occupational lead exposure [*31*,*32*].
When related to protective gear use, the prevalence of self reported symptoms was not significantly different among workers who did and those who did not use such protective gear except for respiratory mask. This indicates that 1) inhalation is the main route of lead entry into human body in occupational setting, a conclusion supported by workers' knowledge on route of lead entry into the body and 2) use of respiratory mask in particular can potentially limit exposure to lead hazards. It was recommended that appropriate protective work clothing and equipment including mask or respirators should be provided to all workers by the employer [*33*].

Conclusions:
Gasoline station workers in the Gaza Strip are still exposed to leaded gasoline. Despite their knowledge on health effects of leaded gasoline exposure, the use of protective measures was poor. This implies that knowledge does not have much influence on practice. The most common self reported symptoms were neurological symptoms including headache, fatigue, irritability, concentration difficulties, and sleep disturbance. There was a significant increase in the prevalence of self reported symptoms with increasing years of work in the station. Use of respiratory mask in particular can potentially limit such symptoms. Prevention and intervention programmes regarding the use of protective measures and monitoring the health status of gasoline station workers should be implemented.

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***Corresponding author:**
Professor Maged Mohamed Yassin,
Department of Physiology,
Faculty of Medicine,
The Islamic University of Gaza,
P.O. Box 108,
Gaza Strip, Palestine
Tel: +970 8 2860700
Fax: +970 8 2860800
E-mail: myassin@mail.iugaza.edu .