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Associations of Exposure to Lead with Hematological Change among Petrol Station Workers in Sana'a City- Yemen

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ABSTRACT

Lead is a toxic element and has become a growing health concern in different countries which causes acute, subacute, or chronic poisoning through environmental and occupational exposure. Up to now, no report is available on the assessment and evaluation of the health effects of lead exposure in petrol station workers. Therefore, this study aimed to assess the changes in hematological parameters associated with occupational lead exposure among petrol station workers in Sana'a city -Yemen. A comparative descriptive cross-sectional study was conducted from January to June 2020 among petrol station workers in Sana' a city. A total of 50 blood specimens were randomly collected from 38 workers and 12 control groups aged between 18 to 66 years. The hematological parameters and level of blood lead were measured by using fully automated Hematology and atomic absorption spectrophotometer, respectively. Also, the required information and associated risk factors were gathered by a standard questionnaire. The result revealed mean blood Lead levels are significantly higher among petrol station workers (17.80 ± 8.06 µg/dl) when compared to control groups (5.00 ± 2.34) (P =0.003). Also, a higher rate of blood Lead level was found among the age group of ≤ 20 years old, uneducated individuals working for 6-10 years, and working more than 12 h per day. The means of RBCs, HBG, HCT, and WBC in petrol station workers were insignificantly lower than those in control groups (P>0.05). There is a positive relationship between reticulocyte count and blood Lead level (r= 0.526; P=0.001). It can be concluded that high levels of blood Lead among petrol station workers consider seriously affect workers' health resulting from lack of personal protective equipment. The level of workers' education seems to influence their practices of using personal protective equipment. Therefore, a clear educational and protection policy is required for those who are occupationally exposed to Lead.

CONTENTS

1. Introduction:

Lead is an element of risk for the environment and human health and has harmful effects that may exceed those of other inorganic toxicants. Most of the atmospheric lead is emitted from two main sources, motor vehicles, and industrial sources, such as gasoline stations,

lead smelters, batteries, and auto-radiator repair (1).

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 (2). Exposure can occur occupationally and domestically as a result of the ubiquitous use of benzene-containing petroleum products, including motor fuels and solvents. Also, the major sources of the exposure of leaded petrol workers are lead fumes generated during filling cars or exposure to cars fumes and when lead from contaminated hands, food, water, cigarettes, and clothing is ingested (1).

Oral and inhalation are the main absorption routes of the inorganic Lead compounds (40% from the respiratory tract and approximately 5–10% from the gastrointestinal tract). Lead after absorption into the bloodstream is distributed in several organs, particularly to the kidney and liver, which then may be accumulated in the bones and cause hurt to the various organs including the liver, central and/or peripheral nervous system, heart, immune system, kidneys, and male gonads (3,4).

Thus, occupational exposure leads to hemato-toxicity and blood disorders such as blood cancer (leukemia), aplastic anemia, and dysplastic bone marrow. Lead poisoning is mainly a cause of microcytic hypochromic anemia due to its impairment of hemoglobin synthesis Besides, occupational exposure to petrol vapors has lethal effects on a variety of organs like the heart, lungs, skin, and kidney and systems such as the respiratory, immune, and nervous systems which in turn causes various diseases (5,6).

Benzene metabolism is taken place in the liver and bone marrow; hence, these are the main sites for benzene toxicity. Benzene metabolite covalently binds to cellular macromolecules last resulting in the dysfunction of bone marrow. Thus, long-term exposure to benzene leads to consistent structural and numerical chromosomal aberrations in lymphocytes and bone marrow cells (7, 8).

Lead has no biological functions as reported in several studies and any blood lead level should be considered significant (28). The blood lead level (BLL) of 10 µg/dL was accepted as cut-off level for high BLL, ≤10 µg/dL was defined that a nontoxic level by the US-Centers for Disease Control and Prevention (CDC) (13). Occupational Safety and Health Administration of the US (OSHA) has declared BLLs ≥ 40 µg/dL in people working in environments where lead containing materials are used as lead poisoning (14).

The previous reports documented that the range of blood Lead level among petrol station workers were 7.5–56 µg/dl in Iraq (9), 10.5–97.5µg/dl in Khartoum city, Sudanese (10), 4.0-90.0µg/dL in Saudi Arabia (11). 35.4 -190 µg/dl in Garage (12),

In Yemen, workers at petrol stations are heavily exposed to lead and no safety measures are being taken to reduce this exposure. Up to now, no report has estimated the assessment and evaluation of the blood Lead level among petrol station workers. Therefore, this is the first study that aimed to assess the changes in hematological parameters associated with occupational lead exposure among petrol station workers in Sana'a city -Yemen.

Materials and Methods

This is a comparative descriptive cross-sectional study that was carried out in Sana' a city among petrol station workers from January to June 2020. A fuel station was randomly selected from different areas in the city of Sana'a, such as (Bin Al-Harith, Al-Thawra, Al-Wehda, Azal, Al-Tahrir, and Al-Shuob). We took three workers from each directorate, three workers from each station, the number of workers was 38, with an average serving of (10 years) in average daily work of about (10 hours), and. 12 control subjects selected from the general population who has no history of being worked at petrol stations and matching the study group in age.

All workers who work for a minimum of two years and more than 8 hours per day in petrol

stations workers were enrolled in this study. While, subjects who had a history of diabetes mellitus, hypertensive patients, smoker cessation, or patients with chronic diseases as well as refused to participate in the study were excluded from the study.

A designed questionnaire was used to collect the essential data from each participant in this work. The age, education level, years of work, and knowledge about the route of lead entry into the human body were asked. Also, practice questions included the wearing of protective gear, smoking, drinking and eating during work, and chewing Qat, were included in the questionnaire. The questionnaire was filled out via direct interview face to face.

Ten milliliters (10 mL) of venous blood were collected from the study participant under aseptic procedures by vein puncture and transferred into a tube. Then, 5 mL of blood sample was immediately transferred into tubes containing a sterile potassium EDTA anticoagulant for CBC test, blood film morphology, and reticulocyte count. Also, about 2.5 mL of blood sample was drowned into a tube without anticoagulation for the blood lead test. The hematological parameters, CBC) were measured by using a fully automated Hematology analyzer Sysmex KX 21N (Sysmex Corporation, South Korea) at Laboratories of National Center for Central Public Health Laboratories (NCPHL). The blood cell morphology was examined by blood film using a leishman stain. The reticulocyte count was done by a new – methylene blue stain.

The level of blood lead was estimated by using an atomic absorption spectrophotometer (Model 5100, Perkin Elmer,) (Perkin-Elmer Corp., US) at Geological Survey and Mineral Resources Board. Blood lead concentration in serum was measured at the wavelength of 283.3 nm.

The objectives, benefits, and risks of the study were explained to the participants and informed consent was obtained from each worker and person who contribute to this study. The information about the study participants was kept confidential and was referred to concerned health personnel for appropriate intervention. The obtained data were statistically analyzed by the computer program SPSS, version 19. (SPSS Inc., Chicago, USA). Data are expressed as mean, standard deviation, number, and percentage. One-way ANOVA is used to determine the significance of the numeric variable. A chi-square test is used to determine the significance of the non-parametric variable.

Results

The present result showed that the most of specimens were collected from petrol station workers in the age group of 20-29 years 20 (52.6%) working in Al-Wahda station 10 (26.3%) hold a secondary school certificate 18 (47.4%) who worked ≤ 5 years 16(42.1%) and working for less than or equal 8 h per day at 20 (52.6%) as illustrated in **Table (1).**

Table (1). Demographical characteristics of study subjects

Variable	Category	Frequency	Rate (%)
Age group	**< 20 years**	2	5.3
	20-29 years	20	52.6
	30-39 years	7	18.4
	≥ 40 years	9	23.7
Address of station	**Ban Al-Harth**	5	13.16
	Al-Thawra	6	15.79
	Main	2	5.26
	Al-Wahda	10	26.32
	Azal	6	15.79
	Al-Tahrer	3	7.89
	Shwoob	6	15.79
Education level	**Illiterate**	6	15.79

	Primary	6	15.79
	Secondary	18	47.37
	Bachelor	8	21.05
Years of work	**≤ 5 years**	16	42.11
	6-10 years	9	23.68
	>10 years	13	34.21
Time of work (hours)	**≤ 8 hours**	20	52.63
	9-12 hours	15	39.47
	>12 hours	3	7.89

Table (2). Comparison of Hematological parameters among workers and control group

Hematological parameters	Workers group			Control group			*P* value
	(mean ± SD)	Range		(Mean ± SD)	Range		
		Mini	Maxim		Mini	Maxim	
RBCs($\times 10^6/\mu l$)	5.27 ± 0.48	3.78	6.92	5.44 ± 0.52	4.60	6.33	0.301
HBG (g/dl)	16.06 ± 2.16	6.11	19.30	16.41 ± 1.07	13.60	18.00	0.595
HCT (%)	45.41 ± 5.20	20.80	52.40	46.27 ± 3.30	38.90	51.60	0.595
MCV (fl)	86.32 ± 8.70	54.90	95.40	85.33 ± 6.69	74.60	95.40	0.720
MCH (Pg)	30.82 ± 4.47	16.20	40	30.36 ± 2.45	26.70	36.10	0.735
MCHC (g/dl)	36.60 ± 7.92	29.40	.49	35.57 ± 1.18	34.00	37.80	0.656
RDW	14.55 ± 2.28	12.20	26.20	14.75 ± 1.121	13.30	17.30	0.769
PLTs ($\times 10^3/\mu l$)	238.37± 76.25	91.00	561.00	238.00± 70.80	65.00	331.00	0.956
WBCs($\times 10^3/\mu l$)	5.730 ± 1.576	3.38	10.70	6.711 ± 1.732	3.94	9.82	0.072

*Significant statistics at *p*-value <0.05

The present result revealed that there were non-statistically significant differences in hematological parameters between the two study groups (*P*>0.05) **(Table 2).**

among workers and control group

Table (3) Comparison of Blood morphology

Variable	Category	Workers No. (%)	Control group No. (%)	*P*-value
RBC	Normal	31 (81.6)	11 (91.7)	0.576
	Micro	4 (10.5)	1 (8.3)	
	Macro	3 (7.9)	0 (0.0)	
Platelets	Normal	2 (5.3)	1 (8.3)	0.795
	Minute	35 (92.1)	11 (91.7)	
	Large	1 (2.6)	0 (0.0)	
WBC	Normal	13 (34.2)	7 (58.3)	0.167
	Toxic granulation	16 (42.1)	2 (16.7)	
	Cytoplasmic vaculation	1 (2.6)	1 (8.3)	

*Significant statistics at *p*-value <0.05

The current result found no significant differences in RBS, platelets, and WBC morphological results between the two groups (*P*>0.05) **(Table 3)**

Table (4). Comparison of Blood lead level and Reticulocyte count % in workers and control groups

Variable		(Mean ± SD)	*P* value
Reticulocyte count %	**Workers**	1.50 ± 0.85	0.383
	Control	1.27 ± 0.61	
Lead level	**Workers**	17.80 ± 8.06	0.003
	Control	5.00 ± 2.34	

*Significant statistics at *p*-value <0.05

Table 4 showed that the mean blood lead level of petrol station workers (17.80 ± 8.06 µg/dl) was more than that of control groups (5.00 ± 2.34), with statistically significant differences (*P* =0.003). While reticulocyte counts% of workers (1.50 ± 0.85) was more than that found among control groups (1.27 ± 0.61) with non-statistically significant differences (*P* =0.383).

Table (5). Association between blood Lead level and demographic characteristics

Variable	Category	No. (%)	Mean ± SD	*P*-value
Age group	< 20 years	2 (5.3)	21.29 ± 12.61	0.346
	20-29 years	20 (52.6)	18.87 ± 7.95	
	30-39 years	7 (18.4)	12.89 ± 2.79	
	≥ 40 years	9 (23.7)	18.46 ± 9.84	
Address of station	Ban Al-Harth	5 (13.16)	13.87 ± 9.66	0.637
	Al-Thawra	6 (15.79)	14.93 ± 10.22	
	Main	2 (5.26)	12.49 ± 4.01	
	Al-Wahda	10 (26.32)	19.94 ± 7.68	
	Azal	6 (15.79)	18.15 ± 9.91	
	Al-Tahrer	3 (7.89)	20.14 ± 6.26	
	Shwoob	6 (15.79)	20.61 ± 4.38	
Education level	Illiterate	6 (15.79)	20.68 ± 9.57	0.557
	Primary	6 (15.79)	19.30 ± 12.03	
	Secondary	18 (47.37)	17.71 ± 6.86	
	Bachelor	8 (21.05)	14.70 ± 6.32	
Years of work	≤ 5 years	16 (42.11)	14.52 ± 8.40	0.099
	6-10 years	9 (23.68)	20.33 ± 6.95	
	>10 years	13 (34.21)	20.08 ± 7.42	
Time of work (hours)	≤ 8 hours	20 (52.63)	15.11 ± 8.85	0.080
	9-12 hours	15 (39.47)	20.32 ± 6.30	
	>12 hours	3 (7.89)	23.06 ± 4.17	

*Significant statistics at *p*-value <0.05

Table 5 In general, there was no significant relationship between blood lead level and age, educational level, years of work, and times of work (*P* >0.05). However, the highest blood lead level was found among workers of the age group less than 20 years old, uneducated individuals, who work for 6-10 years and work more than 12 h per day.

Table (6). Association between blood Lead level and protective practices and knowledge toward lead entry into human body

Variable	Category	No. (%)	Mean ± SD	*P*-value
Gloves	**Yes**	1 (2.63)	11.49 ± 0	0.435
	No	37 (97.37)	17.96 ± 8.10	
Mask	**Yes**	3 (7.89)	10.15 ± 1.17	0.087

	No	35 (92.11)	18.45 ± 8.06	
Cap	**Yes**	4 (10.53)	10.72 ± 1.40	0.062
	No	34 (89.47)	18.63 ± 8.11	
Hand washing	**Yes**	23 (60.53)	14.44 ± 5.76	0.001
	No	15 (39.47)	22.95 ± 8.51	
Smoking	**Yes**	13 (34.21)	18.58 ± 6.44	0.673
	No	25 (65.79)	17.39 ± 8.88	
Drink and Eat	**Yes**	35 (92.11)	18.32 ± 8.17	0.175
	No	3 (7.89)	11.70 ± 2.54	
Chewing Qat	**Yes**	34 (89.47	18.41 ± 8.25	0.171
	No	4 (10.53)	12.55 ± 3.29	
Milk drink	**Yes**	23 (60.53)	17.39 ± 8.30	0.704
	No	15 (39.47)	18.42 ± 7.90	
Inhalation	**Yes**	32 (84.21)	16.67 ± 7.75	0.043
	No	6 (15.79)	23.85 ± 7.49	
Skin	**Yes**	30 (78.95)	16.37 ± 7.60	0.033
	No	8 (21.05)	23.14 ± 7.91	
Mouth	**Yes**	25 (65.79)	18.47 ± 7.02	0.483
	No	13 (34.21)	16.50 ± 9.94	

*Significant statistics at *p*-value <0.05

Table 6 shows in general, the mean blood lead level was found to be lower among workers who used and or followed protective measures than among those who did not. There was only a significant difference in use regarding hand washing of the workers (P <0.05).

While was a significant difference between BLL and knowledge of workers toward routes of lead entry to the human body regarding inhalation and skin (P= 043, 0.033, respectively),

Table (7). Correlation between blood Lead level and hematological parameters

Hematological parameters	**Blood Lead level (17.80 ± 8.06 mg/dl)**		
	Mean ± SD	**R**	***P* value**
RBCs($\times 10^6/\mu l$)	5.27 ± 0.48	-0.060	0.721
HBG (g/dl)	16.06 ± 2.16	-0.051	0.761
HCT (%)	45.41 ± 5.20	-0.170	0.308
MCV (fl)	86.32 ± 8.70	-0.120	0.474
MCH (Pg)	30.82 ± 4.47	0.080	0.631
MCHC (g/dl)	36.60 ± 7.92	-0.064	0.753
RDW	14.55 ± 2.28	0.227	0.171
PLTs ($\times 10^3/\mu l$)	239.37 ± 76.25	-0.018	0.913
MPV	9.07 ± 1.65	-0.018	0.913
WBCs($\times 10^3/\mu l$)	5.730 ± 1.576	-0.090	0.593
Reticulocyte counts	1.50 ± 0.85	0.526	0.001

Table 7 shows that there were no significant differences between blood Lead levels and hematological parameters among workers (P >0.05). While reveals that there was a positive relationship between blood Lead level and reticulocyte count % (r=0.526**), with statistically significant differences (P<0.05).

Discussion

The demographic characterizations of the present work reported that the participants enrolled in this study were aged between 18 - 66 years old with a mean of 30.84 ± 10.31 years working in seven petrol stations. In addition, the most of specimens were obtained from an

individual in the age group of 20-29 years (52.6%) hold a secondary school certificate (47.4%) who worked for ≤ 5 years (42.1%), and worked for 8 h per day (52.6%). This is similar to reports performed by some investigators (13, 14).

The current result indicates that the mean blood Lead levels are significantly higher among petrol station workers (17.80 ± 8.06 µg/dl) when compared to control groups (5.00 ± 2.34) with a statistically significant difference (*P* =0.003). This finding is higher than reports recorded in West Turkey, in Korea, and in Sulaimaniya city (13, 15, 16). The higher blood Lead levels recorded in the present study among petrol station workers may be attributed to poor use of protective measures and lack of awareness programs implemented in other countries.

The present result noticed that a higher rate of blood Lead level was found among the age group of ≤ 20 years old, uneducated individuals working for 6-10 years, and working more than 12 h per day. The earlier reports documented that the levels of blood Lead significantly increased with an increased work period, poor use of protective measures, and lack of awareness programs (13, 14).

In this work. it was revealed that the means of RBCs, HBG, HCT, and WBC in petrol station workers were insignificantly lower than those in control groups (*P*>0.05). This finding was supported by previous studies (18; 19, 20).

Regarding the hematological findings, the current study showed that there was no correlation between blood Lead levels and hematological parameter value (*P*>0.05) which came in parallel with some other previous findings (13, 16). In contrast, a study conducted by Karita *et al*. (21) who was revealed decreases in hematological parameters of laborers working with lead-containing materials as a result of increases in their blood Lead levels. This discrepancy between the studies may be due to blood Lead levels are not high enough to induce changes in hematological parameters in our results (13). However, the present result showed that the blood film morphology of RBC, WBC, and platelets among the worker group and control group was no significant difference. This agrees with a study done by Tozun *et al*. (13).

Furthermore, in the current work, there were statistically significant differences in blood Lead level and participant knowledge toward routes of lead entry to the human body regarding inhalation and skin but no significant differences regarding mouth. This is consistent with other reports (22, 23).

Regarding the use of protective practices, it was found that the majority of petrol station workers in the study area did not use such protective measures during work in the stations. Also, the mean blood Lead level was found to be lower among petrol station workers who used the protective measures than among those who did not. There was a significant difference between blood Lead level and protective measures (*P* <0.05). In the study conducted by Willi *et al*. (24) showed that an increase in blood Lead levels was found in occupational lead workers who neglected protective measures. Unfortunately, the majority of the workers' neglect or lack protective safety measures such as; facemasks, protective clothes, gloves, and washing after finishing their working shift. In turn, this carelessness makes them more susceptible to those toxic fumes (16, 25).

The current result showed that there is a positive relationship between increasing reticulocyte count with blood Lead level with statistically significant differences (r= 0.526; *P*=0.001). A significant positive correlation between total blood Lead and reticulocytes was detected previously in some reports (26, 27). It was suggested that occupational exposure to low doses of airborne lead can influence lines of the hematopoietic system (26,). Hematological effects of lead poisoning include hypochromic microcytic, hemolytic anemia, and leucoerythroblastic blood film. The cause of the well-known basophilic stippling and the hemolysis is the inhibition of pyrimidine 5 nucleosidase while the hypochromic microcytic anemia and sideroblastic erythropoiesis are due

to the inhibition of enzymes involved in heme synthesis. (29,).

Conclusion

The mean blood Lead levels are significantly higher among petrol station workers when compared to control groups). Gasoline station workers in Sana'a city are still exposed to leaded gasoline. The mean of BLL and reticulocyte count % increased significantly and insignificantly in less educated, longer work duration, and in hematological parameters in workers. The absence of personal protective equipment might lead to an increase in the blood Lead level among petrol station workers. Therefore, a clear educational and protection policy is required for those who are occupationally exposed to Lead. A further longitudinal study with a larger sample size should be conducted to explore the impact of Lead exposure on hematological change.

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