

Effect of Air Lead Pollution on Blood Bilirubin and Lactate Dehydrogenase Levels among Occupationally Exposed Workers in Main Sudanese Cities

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Abstract: Up-regulation of bilirubin and lactate dehydrogenase in blood serum due to lead poisoning has been correlated to many adverse health impacts. Traffic policemen and petrol station workers are more likely affected by air lead pollution. This study was conducted to determine blood lead, bilirubin and lactate dehydrogenase levels in traffic policemen and petrol station workers, beside determination of some medical complications due to lead toxicity. A total of 150 subjects were randomly selected from different cities of Sudan, in which 100 samples taken as exposed group and 50 as un-exposed (control). Blood lead concentration was determined by using atomic absorption spectrometer. Biochemical parameters were measured in serum using standard methods. Data was collected with the aid of writing a questionnaire. Mean blood lead concentration in exposed group was found to be 32.2 µg /dl, whereas in control was 12.4 µg/dl. No correlation was found between blood lead levels and work duration in both exposed and control groups understudy. Serum lactate dehydrogenase (LDH) was significantly higher ($p < 0.001$) in exposed group than in control. The Serum total bilirubin was slightly high ($p < 0.05$) in exposed group as compared to control.

Keywords: Traffic policemen, lead pollution, traffic police, bilirubin, lactate dehydrogenase

I. Introduction

The common sources of lead are; lead-containing paint, water, leaded pipes from public water supply, Asian herbal remedies, lead-glazed ceramics, and lead shot game [29]. Whereas the most hazardous man-made source of lead is exhaust from motor vehicles using gasoline that contains alkyl lead added as an anti-knocking agent [39]. Gasoline combustion globally contributes an estimated 60% of total lead emissions [33]. Recorded mean concentration of lead in air is 80 – 4000 mg/m³ [31]. Lead is largely emitted as fine particles by petrol combustion in inorganic state causing lead pollution of air and human beings. The major biochemical effect of lead is its interference with heme synthesis, which leads to hematological damage [32]. Lead may be deposited in the red blood corpuscles, soft tissues of children mainly in the kidney region, but the greater concerning matter is that 70 to 90% of this lead is deposited in bones. This is the most hazardous because the half-life of lead in the bones is 28 years, whereas lead in the blood and kidneys remains only up to two to four weeks [15].

It is estimated that nearly half a million of children in the United States have blood lead levels high enough to cause irreversible damage to their health, lead paint being the major source of lead toxicity in children [29]. Typically, lead-intoxicated patients present with neurological complaints and neurobehavioral disorders. However, toxic levels of lead do not only affect the nervous system but also hematopoiesis and renal function [5,2]. Lead-induced liver damage is an uncommon finding and has anecdotally been reported [3]. The resulting histopathological changes have rarely been described in humans. However, descriptive animal studies reported that lead is a persistent metal and commonly present in our living environment. Even at low doses of developmental stages, lead exposure resulted in embryonic toxicity, behavioral alteration in adult been reported [26], learning/memory deficit [8]. Consistently, Gargouri *et al.* [13] studied the effect of lead acetate exposure in drinking water on mothers during gestation, from the 5th day of gestation to day 14 postpartum, revealing that caused lead deposition was found in the brain and cerebellum of newborns as well as cerebellum tissue damages and significant decrease in weight and protein content of these tissues. Oxidative stress and changes in antioxidant enzyme activities in brain tissues were also recorded [13]. Moreover, lead induced deficits in learning and memory through over activation of hippocampal serine/threonine protein phosphatases PP1 and PP2A [30]. In addition, lead acetate disturbed biochemical and hematological indices and induced nephrotoxicity and hepatotoxicity through profound elevation of reactive oxygen species (ROS) production and oxidative stress, leading to increased lipid peroxidation level and depletion of intracellular reduced glutathione (GSH) level in

kidney and liver [16, 37, 19]. Consistently, lead acetate has been found to induce biochemical and histological abnormalities in blood, kidney, liver and brain tissues [27]. Karita *et al.* [18] reported a significant positive correlation between blood lead and total cholesterol and LDL levels. Prolonged exposure to lead insidiously affects the different organs and systems in the body resulting in hematopoietic, cardiovascular, hepatic, renal and neurological dysfunctions with biochemical changes in the body. Lead exposure is negatively correlated with hemoglobin and RBC count [18,35]. The kidneys are particularly susceptible to toxic effects of lead and may result in nephropathy, proximal tubular damage, glomerular sclerosis, interstitial fibrosis and lowered glomerular filtration rate [4, 20]. Effects on cardiovascular system including hypertension, coronary heart disease, stroke, and peripheral arterial disease were also reported [22, 24]. Many researchers reported the lead associated liver injury in occupational workers with raised alanine aminotransferase, alkaline phosphatase and lactate dehydrogenase (LDH) activity and the formation of bilirubin in serum can be increased due to an abnormally high peripheral breakdown of haemoglobin [38]. Faloppi *et al.* [12] reported that LDH is a glycolytic key enzyme in the conversion of pyruvate to lactate under anaerobic conditions, and up-regulation of LDH may ensure both an efficient anaerobic/glycolytic metabolism and a reduced dependence on oxygen under hypoxic conditions in tumour cells.

Therefore, the objective of this study is to investigate the effect of lead poisoning on each of blood bilirubin and lactate dehydrogenase among exposed workers.

II. Materials and methods

Study area and sample size

This study was conducted in different cities of Sudan (Abohamad ,Marwy, Portsudan, kassalla ,Wadmadany ,Kostey , Gabalmarah , Alobed , Aldalang and Khartoum state). The samples size is 150 subjects (100 exposed taken from both petrol station workers and traffic policemen and 50 unexposed (control samples).

Study design:

A case – control study was conducted. Data was collected with the aid of writing a questionnaire.

Sample collection:

A total of 150 blood samples were collected from petrol stations and traffic policemen. Four ml of venous blood was taken from each exposed and control groups, then kept in clean heparinized container and stored in a refrigerator pending analyses. A questionnaire was designed to collect information, namely: address, age, sex, weight, smoking habit, duration of work, hour's day working and symptoms (Fatigue, headache, convulsion, numbness, hypertension and GIT disorder).

Lead extraction

Lead was extracted from blood used NIOSH method, where two ml of blood was taken, then one ml of distilled water was added, half ml of ammonium pyrrolidine dithiocarbamate and half ml of triton was added, 0.75ml of methyl isobutyl ketene was added. The mixture was then rotated in centrifuge; the top layer which contains lead was observed [25].

Lead concentration determination

Lead concentration was estimated by an atomic absorption spectrometer.

The biochemical measurements

Determination of Serum Total Bilirubin

The total bilirubin was measured by Jendrassik and Grof method [7]. Bilirubin in the serum reacts with diazotized sulfanilic acid in the presence of DMSO forming azobilirubin. There are two bilirubin fractions in the serum, bilirubin-glucuronide and free bilirubin. The terms total bilirubin equivalents of the two bilirubin fractions.

Determination of conjugated bilirubin concentration

The conjugated bilirubin was measured by Jendrassik and Grof, method adopted by Cheesbrough [7]. Direct bilirubin is measured as the total bilirubin method but in absence of the caffeine- benzoate catalyst and at acid pH. Under these conditions only the conjugated bilirubin will react.

Unconjugated bilirubin (mg/ dl) = Total bilirubin concentration- Conjugated bilirubin

Determination of serum LDH

Serum LDH activity was determined according to the method described by (Spanish Society of Clinical Chemistry 1989).

Statistical analysis

T-test was applied for analysis of data, used statistical package for social science (SPSS).

III. Results and discussion

A total of 150 blood samples were analyzed to investigate the lead content in the study groups. The analyzed samples revealed that lead was detected in all the investigated blood samples with different concentration levels, as given in figure (1). In Khartoum City, the concentration levels of mean blood lead in exposed group was nearly reached 45µg/dl (the maximum permissible level that adopted by WHO for blood lead in adults is 40 µg/dl), seconded by Wadamany and Portsudan which both of them were above 35µg/dl. Alobed was almost reached 35µg/dl. Whereas exposed group in Abohamad, Marwy, Kosty and Kassala Towns were all found have mean blood lead levels above 30µg/dl, the result obtained for the mean blood Lead levels (about 20 µg/dl) for exposed group belonging to Aldalang. The blood sample collected from Gabalmarah showed less concentration of leads (below 20 µg/dl), as shown in figure (1). These differences may be due to differences of air lead pollution among exposed group. Khartoum is the most highly populated city and, therefore, the traffic policemen and fuel petrol workers have the highest blood lead levels. This could be attributed to lead emissions from motor vehicles. In unexposed group (control), the highest mean blood levels were found in Khartoum City (above 20 µg/dl), while in both of Aldalang and Gabalmarah Towns were found to be less than 10 µg/dl. The rest of control samples found to be have mean blood lead levels less than 15 µg/dl.

In general, the obtained results clearly indicated that the blood samples collected from the Sudanese cities contained less concentration of blood lead when compared with the study that investigated lead content in blood samples of shopkeepers from different locations of Khyber Pukhtunkhwa, Pakistan, which found that blood lead levels were ranged from 227.5 to 381.1µg/dl^[36]. Another study conducted in traffic police constable of Karachi, Pakistan, found that the mean lead level was 47.8 µg/dl and attributed this variation to that shopkeeper in Khyber Pukhtunkhwa performed more duties in their shops range from 12 to 14 hrs every day. Another similar study was conducted in traffic controllers of Alexandria, Egypt, road intersections were reported high blood lead levels (68±13 µg/dl) and attributed this to that the Alexandria is the most highly populated city and the traffic police that control traffic lights at road manually and therefore, the high blood lead levels could be resulted to lead emissions from motor vehicles^[36].

On contrast, the effect of environmental lead pollution and high blood lead level has not always yielded convincing positive results. Many studies have failed to detect increased blood lead levels among traffic police, even when the subjects were tested with a sophisticated electro-thermal atomic absorption spectrometer^[28].

In our own opinion, the safety limit that was set for the maximum blood lead levels is not restrict and still controversial issue, Manser, *et al.*^[21], reported that the upper limits for blood lead levels has been often quoted as 40 µg/dl for adults and 30 µg/dl for children, while 25 µg/dl blood lead regarded as elevated in U.S.A as adopted by CDC^[6], and the European Committee decided on a mean acceptable value of 20 µg/dl^[9]. Therefore, severe actions should be made in order to minimize the use of fuel that contains lead, new restrict legislations and standard managements for lead intoxication also should be made by the Sudanese Government as are being practiced by the developed world. As shown in figure (2), the percentage of smokers in exposed group was higher (above 60%) than that in unexposed control group (above 20%). All variables showed positive correlation with air lead pollution, headache and fatigue seemed to be symptoms of blood lead poisoning, above 70% of exposed group suffer from headache while almost 70% of them suffer from fatigue. Only about 10% of exposed group suffer from convulsion while none of control group suffer from this variable. Similar percentage (above 40%) was noticed in both exposed and unexposed groups regarding hypertension. Remarkable percentage (near 49%) of gitdisorder was noticed in exposed group while in unexposed control group the percentage of gitdisorder was found to be about 21%. It has been reported by Gotschi *et al.*^[14] that there are enough epidemiological studies demonstrated that vehicular pollution can cause increased morbidity and mortality, and some human health adverse effects may result from short-term exposure, while others are related to long-term exposure. Noteworthy to mention that Gotschi *et al.*^[14] stated that there are many different adverse health effects caused by air lead pollution, but the majority of previous studies, devoted to traffic policemen, have largely focused only on three specific outcomes; respiratory morbidity, cytogenic effect and carcinogenic effect.

Table (1) and table (2) showed the relationship between blood lead levels in both exposed and control groups and their work duration (year and hours/day, respectively). The increase in blood lead levels in the exposed group was exponentially correlated with the work duration. The differences of high blood lead concentrations due to long work duration were found to be significant (P<0.001). Agha *et al.*^[1] reported that there was no significant difference found in mean blood lead values at various age groups or work duration in the study conducted in traffic police constables in Islamabad, Pakistan, while the levels were found to be significantly (p<0.0001) high at all age groups in traffic constables of Karachi as compared to Islamabad.

Biochemical parameters:

Comparison between LDH concentration in petrol station workers and traffic policemen and control samples in different cities in Sudan is shown in table (3), A student t test showed high significant ($P < 0.001$) increase in LDH concentration in petrol station workers and traffic policemen (exposed group) compared to control. The obtained results of this study were further substantiated by previous studies that were conducted by Mikhail, *et al.* [23, 17, 10].

Comparison between blood total bilirubin, direct bilirubin and in direct bilirubin concentrations in exposed and control sample in different cities in Sudan is shown in table (4). The blood total bilirubin, direct bilirubin and indirect bilirubin concentrations in exposed and control sample were slightly higher ($p < 0.05$) in exposed group as compared to control. High concentration of lead has been shown to produce morphological changes and destruction of red cells when administered in vitro and in vivo [11]. Therefore, it appears that the higher bilirubin level could be a consequence of intravascular hemolysis.

IV. Conclusion And Recommendations

The results of this study revealed a prevalence of elevated blood lead levels among many Sudanese traffic policemen and gasoline exposed professionals in the different cities of Sudan, and in Khartoum City was higher than the limit permitted by the World Health Organization. It was found an obvious increase in LDH, total bilirubin, direct bilirubin and in direct bilirubin blood lead level for Traffic- and Gasoline Exposed Professionals compared to control samples, Therefore, it is important to recognize that, in addition to further studies in this field, good health promotion and protection measures should be taken for Traffic- and Gasoline Exposed Professionals.

It is of paramount necessary to consider that the present study not included hazardous air particles come from the incomplete combustion e.g., nitrogen, sulfur oxide, carbon monoxide and other organic compounds, which may increase lead poisoning in the study groups.

It could be recommended that serious actions should be taken in order to minimize the use of fuel that contains lead, new restrict legislations and standard managements for lead intoxication should be made by the Sudanese Standard and Metrology Organization and stakeholders as are being practiced by the developed world.

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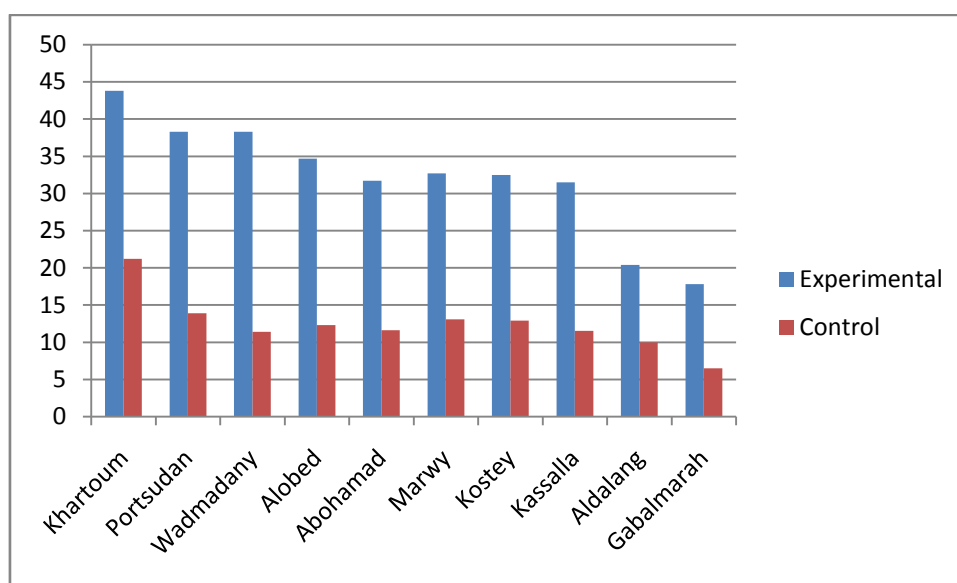


Fig (1): Shows descriptive data concerning the Blood lead levels from the targeted professionals and the controls in different cities in Sudan.

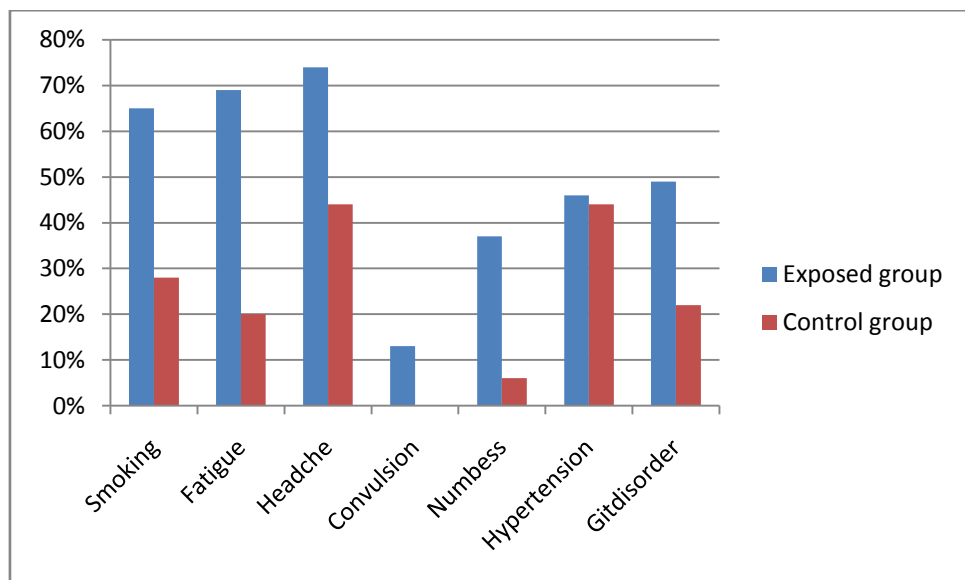


Fig (2) shows comparison between petrol station worker, traffic policemen and control samples using some variables in different cities in Sudan.

Table (1): shows the correlation between Work duration (year) and blood lead level for petrol station worker, traffic policemen Exposed in gasoline area for the study population in different cities in Sudan:-

Work duration (Year)	Mean of lead concentration	Std. Error	Level of significant
from 3 years to 9	21.06	0.778	***
from 10 to 18	29.94	2.191	***
>19	45.82	2.761	***

***significant at 0.001 level of probability

Table (2): shows the correlation between work periods (hours/day) and blood lead level for petrol station worker, traffic policemen exposed in gasoline area for the study population in different cities in Sudan:

Work duration (hours/day)	Mean of lead concentration	Std. Error	Level of significant
6 to 9	25.82	1.836	***
work 12 hour/day	32.51	2.027	***
work 13 to 16 hours /day	39.84	3.742	***

***significant at 0.001 level of probability .

Table (3): shows correlation between Blood enzyme lactate dehydrogenase (LDH) concentration for petrol station worker, traffic policemen exposed and control groups in different cities in Sudan

Parameters (Blood enzymes) (U/L)	Exposed mean	control mean	d.f	S.E+	Level of Significant
LDH	58.943	47.408	148	1.6159	***

***significant at 0.001 level of probability.

Table (4): shows correlation between blood total bilirubin, direct bilirubin and in direct bilirubin concentration for petrol station worker, traffic policemen Exposed and control groups in different cities in Sudan.

Parameters (mg/dl)	Exposed mean	control mean	d.f	S.E+	Level of significant
Total Bilirubin	1.16	1.004	148	0.027	*
D.Bilirubin	0.252	0.234	148	0.002	N.S
In. Bilirubin	0.908	0.772	148	0.025	*

*significant at 0.05, N.S not significant. at level of probability