A Comparison Study of Lead Poisoning of Occupational Workers in Acid Battery Factory

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Abstract

In this investigation, a comparison study of blood lead levels (BLL) were performed for occupational workers of Babil -1 Acid Battery Factory in Baghdad when the plant was fully operational, in 1987, and after eight years 2003 closer. A substantial amount of lead, 22%, was excreted as compared to that of 1987 results. Such finding has been confirmed as normal values by the widely used indicator of oxidative stress, malonaldehyde were reduced in a similar fashion. The poor correlation between BLL and malonaldehyde level in plasma has R^2 value of 0.0013. Forty two volunteers were randomly selected, twelve served as control.

دراسة مقارنة بين التسمم بالرصاص من العمال المهنية في مصنع حمض البطارية

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مفتاح البحث: المواد المضادة للاكسدة، والرصاص، Malonaldehyde، الامتصاص الذري، والدم.

الـخلاصة :

في هذا البحث اجرينا دراسة مقارنة للتسمم بالرصاص من خلال قياس تراكيز الرصاص في دم المتعاملين بشكل مباشر بالرصاص في معمل بابل -1 لبطاريات الرصاص في بغداد وذلك عندما كان المعمل في حالة تشغيل قصوى في عام 1987 وبعد ثمان سنوات من وقف العمليات الانتاجية في اذار 2003 مع بقاء العاملين بدوام نصفي . اظهرت الدراسة تناقص مستويات الرصاص بنسبة ملحوظة(22%) في دم العاملين نتيجة طرحه من الجسم بمرور الزمن . وقد تأكدت مصداقية هذه النتيجة من خلال تناقص تراكيز مادة المالون الديهايد (للمستوى الطبيعي)المعروفة بكونها افضل مقياس لحالات الاجهاد التاكسدي . العلاقة بين مستوى الرصاص في الدمضعيفة ومعامل التشتت $R^2 =$ 0.0013

اشترك 42 متطوعا في الدراسة من منتسبي المعمل اختيروا بالطريقة الاحصائية العشوائية واختيراثناعشر منهم كمجموعة سيطرة.

Introduction:

The problem of heavy metal poisoning continues to attract the attention of scientists in an attempt to explore the best ways to solve resulting health problems and associated implications. In developing countries, lead poisoning is a persistent health problem for all people especially children. However, occupational workers are the worst affected. Industries of high lead exposure include battery, petroleum, ammunition, demolition renovation. The health-based standards and guidelines for BLL have dropped from 60 µg/dL in 1975 to 25 µg/dL for adults and less than 5 µg/dL in 2012 as set by the Centers for Disease Control. [1,2]

One of recent lead poisoning epidemic happened in Nigeria were 400 children were killed and thousands of workers needed medical treatment. Blood level lead, BLL, greater than 900 µg/dL was reported.[3] One of the main lead poisoning causes is piping of tap water as shown in the study in US, District of Columbia. [4]
Various ligands are used for masking lead so that it can be excreted. High blood lead levels, BLL, of industrial workers was measured using the Lead Mobilisation Test. Dimercaptosuccinic acid was used as the chelating agent. They found that 15% and 43% of the tested workers have BLL > 40 µg/dL and WHO guidelines of > 30 µg/dL respectively.[5]

Occupational workers of industries like printing acid battery and ammunition are subject to lead poisoning.[6-8] Due to more automated systems and implementation of strict environmental and health regulations, workers of acid-battery factories in the United States were exposed to lower levels of contamination (< 6% have BLL of more 60µgldL as compared to developing countries like Jamaica[6,9] In Sudan a study of BLL of similar groups have shown that 28% have BLL of greater than 60 µgldL.[10]

Even low lead poisoning has severe health problems including oxidative stress.[13] Lead poisoning affects many body organs including the heart, kidneys and the brain.[14-15] . Indicators of lead poisoning are erythrocytes and the affects erythrocytes and the bones.[16] High lead levels in the body causes cellular injury, oxidative stress. Malonaldehyde is one the byproducts of cell lipid peroxidation. It is widely used as probe for oxidative stress [17].

When blood lead levels are recorded, the results indicate how much lead is circulating within the blood stream, not the amount being stored in the body.[11] Determination of blood lead level is the only diagnostic for lead exposure that can be compared with international standard for quality control. The later include WHO and the American CDC. GF–AAS continued to be the widely used method for determination of BLL for its high sensitivity (0.05 µg/dL) and small sample-size requirements (< 50 µL).

The aim of this study is to compare blood lead levels, PbB, of workers in Babil -1 Acid Battery Factory in Baghdad after eight years of shut down with previous results taken in 1987 when the factory was fully operational.

Subjects and Method

Forty two employees were chosen randomly and asked to participate in this study; thirty were from the processing unit while the others having administration duties were selected to form the control. Only workers who spent more than three year- before closure-in the site were allowed. All are male and aged more than thirty and less than sixty years old. Those selected are non-smokers and have normal renal function as checked by creatinine and urine urea level.

In the 1987 when the plant was fully operational, 108 directly exposed workers from Babil-1 together with 61 administration employees serving as control were involved.

Samples were run in duplicate and the average is taken. A modified Hessel's method was used. Lead salt resulting from the addition of ammonium dipyrilodine dithiocarbamate and extraction by methyl isobutyl ketone. Pye Unicam instrument was use to measure the atomic absorption using standad lead concentrations.

Blood Sampling

All samples were taken at lunch time.10ml venous blood samples were withdrawn by trained medical staff and placed in heparinised tubes. Samples were kept in ice prior to use. Blood was digested as described by Miller et al[18] and an electrothermal Graphite furnace Atomic Absorption Spectrophotometer with detection limit of 3ppb was used to determine blood lead level in µg/dl. Duplicate samples were always used.

Determination of Plasma MDA Level

Chemicals in this work were of Analytical Grade bought from Sigma Chemical Company, UK. Malonaldehyde, MDA, is widely used as an indicator of lipid peroxidation, oxidative stress, associated with illness and/or poisoning as with elevated levels in the body causing cell injury. MDA reacts with thiobarbituric acid, TBA, to form a colored complex that was monitored spectrophotometrically as follows:

To 0.10mL plasma, 1.0mL 0.67% TBA and 0.50mL of 20% trichloroacetic acid were added and incubated for 30minutes at 100^{o}C. The reaction mixture was centrifuged at 12000rpm for 5.0minutes. The supernatant layer was removed and the absorbance was recorded at 532nm using Shimadzu 1600 spectrophotomer and MDA concentrations were recorded as µM using extinction coefficient of 1.56x105 $M^{-1}cm^{-1}$.[19]

Results & Discussion

As noted in tables 1,2 and figure 1 , it is important to understand that no critical cases were reported in plant during our study. Furthermore symptoms of high lead exposure were not notice including no blue line under the tongue was noticed, no complaints of loss of memory or any noticeable neurodegenerative diseases and few complained of some irregular headaches.

Only 2 out of 30 of the directly exposed workers, i.e 6.7 % worker were found to have BLL of more than 40µg/dL compared to 37% in 1987. This shows that a substantial amount of lead was excreted.

BLL results were better as compared with developing countries of similar situations. Such finding reflects the need for more awareness of environmental health issues and better diet and monitoring system for employees. However, these are higher than BLL values in the developed world like US. The use of automated systems and strict environmental rules has limited lead exposure.

In 1987, the average was 37.1 ± 15.7 compared to current study the average BLL was 29.1µg/dL and standard deviation of 8.1.i.e. a reduction of 22%. . These results clearly indicate that lead ions were excreted from the body with time and there were no noticeable health hazards. This is supported by the normal slightly higher MDA levels in the blood. The MdA as an indicator of oxidative stress is not necessarily due to lead poisoning only from the Battery Plant. Average MDA level together with standard deviation were 2.58, 0.43 and 0.86, 0.22 for control and directly exposed workers respectively.

Conclusion:

The results do not show a link between blood pressure and BLL as noticed by other research groups. This might be due to the effect of other factors such as environmental pollution.

For the studied workers, the BMI and HR were within acceptable range set by WHO.

The high BLL percent may be attributed to other environmental factors such as dust inhalation from building, road construction and traffic pollution.[20]

Table 1. Control: Blood lead Level for Administration Employees of Baghdad Babil-1 Factory in March 2011 together with some relevant information

No.	Age	Years of service	PbB	BMI	Blood Pressure	PR	Plasma MDA µM
1	46	18	12.6	28	143/95	81	0.79
2	51	23	18.4	24	140/83	77	0.88
3	50	23	21.6	27	138/93	65	1.12
4	38	12	9.5	22	143/93	73	1.33
5	41	15	16.3	21	145/96	68	0.66
6	44	20	10.7	24	140/85	88	1.02
7	51	29	20.1	19	133/88	80	0.79
8	38	14	18.5	29	131/88	82	0.85
9	34	13	26.0	24	123/81	77	0.91
10	51	23	22.1	23	141/82	68	0.66
11	35	11	15.5	26	137/89	70	0.68
12	42	13	17.9	27	143/93	79	0.58

Table 2. Blood lead Level for Process Employees of Baghdad Babil-1 Factory in March 2011 together with some relvant information.

No.	Age	Years of service	PbB	BMI	Blood Pressure	PR	Plasma MDA µM
1	47	22	28.8	27	138/86	78	1.04
2	51	21	33.1	23	131/83	73	1.44
3	34	13	30.2	31	147/88	78	1.33
4	53	19	16.4	28.2	141/90	77	0.30
5	54	26	19.8	19.8	136/88	70	1.24
6	46	17	27.9	31.8	137/78	76	1.19
7	44	19	40.4	22.8	148/88	73	1.54
8	38	14	25.6	28.4	139/93	77	1.34
9	38	18	29.0	24.3	143/86	81	0.44
10	53	18	30.5	20.9	134/77	66	1.22
11	51	20	44.6	33	148/92	78	1.24
12	50	20	51.4	26.6	133/82	76	1.15
13	42	15	16.7	27.6	137/80	66	1.22
14	37	11	33.6	25.5	135/89	64	1.20
15	33	13	44.3	27.9	151/86	77	0.53
16	51	24	22.9	21.6	140/ 88	66	1.30
17	44	16	33.7	18.8	156/95	63	1.33
18	43	17	19.5	19.3	130/89	64	1.27
19	38	14	19.5	26.8	126/78	69	1.26
20	39	23	27.5	27.4	129/78	76	0.38
21	44	24	33.7	22.8	133/90	72	1.44
22	54	27	22.9	25.4	128/92	81	1.28
23	48	26	33.0	30.3	150/90	86	1.14
24	52	23	18.2	29.2	144/93	77	1.28
25	35	14	29.6	22.8	143/92	65	1.41
26	41	20	22.3	26	140/94	77	1.35
27	43	18	38.4	28.1	143/95	81	1.28
28	49	23	30.6	21.7	128/88	65	1.27
29	55	28	33.1	24.4	133/90	66	1.32
30	53	25	15.9	27.1	149/92	77	1.37

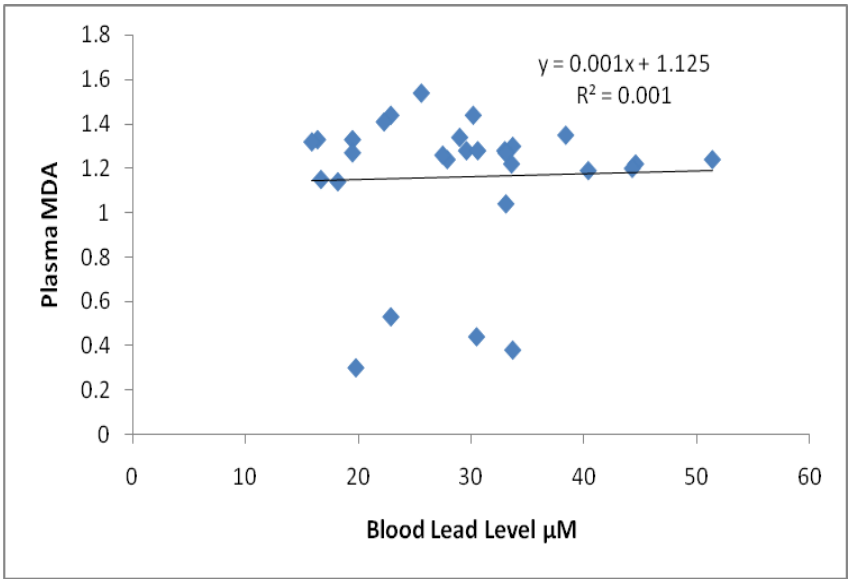

Figure 1: Effect of Blood Lead Level on MDA concentration

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