

**EFFECTS OF LEAD EXPOSURE ON LIVER FUNCTION MARKERS OF PAINTING
WORKERS IN WADI AL-HAYAH, LIBYA**Ashraf Albakoush^{1*}, Mohamed Masaud Almatamed², Apojela A. Ahmed³ and Waled Alsalmi⁴^{1,4}Department of Medical Laboratory, Faculty of Medical Technology, Surman, Sabratha University, Libya.²Department of Biology, Faculty of Education, Wadi Alshati University, Libya.³Department of Chemistry, Faculty of Education, Alghoryfa, Sebha University, Libya.

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Article Received on 14/10/2024

Article Revised on 04/11/2024

Article Accepted on 25/11/2024

ABSTRACT

The heavy metal lead is a common occupational and environmental pollutant, and damage caused by lead exposure is still a major public health problem. It is a toxic and harmful substance that can impact the homeostasis process of hepatic biochemical markers and blood pressure. The study aimed to evaluate blood lead levels among painting workers (lead paint exposed group) and in unexposed subjects (control group), and to investigate its adverse impact on liver function and blood pressure. A total of 64 adult male participants whose ages ranged between 20-45 years were included in this study, 34 of painting workers (lead paint exposed group) and 30 subjects as a control group (lead paint unexposed group). The mean age of painting workers and control group was 35.76 ± 6.47 years and 35.33 ± 6.48 years, respectively. Blood lead and hepatic biomarkers (ALT, AST, Total protein and serum albumin) were all biochemically estimated in the study. Systolic and diastolic blood pressure were also measured in the study. All the results were statistically analyzed using SPSS version 14 for applying one-way ANOVA test. Blood Lead level of exposed and unexposed groups were 6.39 ± 3.32 $\mu\text{g/dL}$ and 1.25 ± 0.58 $\mu\text{g/dL}$, respectively. Significant elevation in the levels of blood lead, ALT, AST and blood pressure among painting workers (lead paint exposed group) as compared to unexposed group, on the other hand, there was a significant reduce in total protein and serum albumin among painting workers as compared to unexposed group. It is concluded that lead paint exposure has an adverse effect on liver function and blood pressure which may contribute to cardiovascular diseases by elevating blood pressure even at low lead levels. Moreover, long susceptibility to lead exposure leads to more significant alterations in hepatic biomarkers and blood pressure.

KEYWORDS: Adverse Effect, Lead Paint, Liver Function, Hepatic Markers and Blood Pressure.**INTRODUCTION**

Occupational toxicity as a result of exposures to hazardous chemicals is common in industries using solvents based materials as well as in indoor environments, including painters, where they exposed to volatile organic compounds from various sources.^[1] Various chemical compounds are being used in paint products as pigments, extenders, binders, solvents and additives.^[2]

Lead is widely used in industries due to its chemical properties and is considered as the fifth most frequently used metal worldwide.^[3,4] It is a highly prevalent and persistent environmental pollutant and toxicant which has high toxic impacts to many body organs which was identified as one of the 10 chemicals of major public health concern globally.^[5,6,7,8] Lead Poisoning can interfere with many biochemical and metabolic processes

in the body and as a result adverse effects occur in many organ systems.^[9]

According to the recent definitions by the United States (US) centers for disease control and prevention and National Institute of Occupational Safety and Health (NIOSH), blood lead levels (BLLs) equal to or greater than 5 $\mu\text{g/dL}$ are considered as to be increased in adults. The US Department of Health and Human Services also recommends that the blood lead levels in adults should be decreased below 10 $\mu\text{g/dL}$.^[10] However, there is no defined safe threshold for lead as even lower and minor levels can cause lead-associated effects and complications.^[11] 90 parts per million (ppm) is the standard in several countries with lead-paint laws and is the lowest lead limit in paint Currently.^[12]

Occupational lead exposure occurs mainly through the respiratory tract. Approximately 30–40% of inhaled lead

is absorbed into the bloodstream. 99% of circulating lead is bound to erythrocytes for approximately 30–35 days and is distributed into the tissues, such as the liver, renal cortex, blood vessels, brain, lungs, spleen, teeth, and bones, over the following 46 weeks. In adults, approximately 80–95% of absorbed lead is stored in bones.^[13] The half-life of lead in the soft tissue and blood is 20–40 days whereas in bone is 10–30 years.^[14]

The liver is a largest gland and essential organ in the human body which is involved in detoxification and excretion of metabolites, glycogenesis, and albumin production and coagulation factors. Occupational exposure to lead has been associated with oxidative stress in liver tissue and abnormal liver function.^[15]

According to WHO, 2020, about 11% of all African countries have lead paint laws and legislation to regulate lead use in paints, unfortunately Libya was not included.^[12] According to a study conducted in Wadi-Alhayah, south Libya which reported that blood lead level was higher than normal levels among painting workers.^[16] Other study conducted in south Libya, which revealed that blood lead level was 2.07 ± 1.38 µg/dL for unexposed group and 2.216 ± 0.423 µg/dL among painting workers which was the second highest level among other study occupations.^[17]

Therefore, the study aims were to estimate blood lead levels among painting workers (lead-paint exposed group) and in unexposed group (control group), and to investigate its effects on some biochemical parameters related to liver function test.

MATERIALS AND METHODS

Study Population

Retrospective cohort study was performed during the period from January 2021 to September 2021 at Albalsam clinic, Garma, Obari, southwest Libya. In this study, a total of 64 adult male subjects aged between 20–45 years were selected in the study, 34 of painting workers (lead paint exposed group) and 30 subjects (lead paint unexposed group) as a control group. Both groups were matched in ages and gender. The study protocol was approved by Ethical Committee at Education college, Sebha university. Information was obtained by face-to-face interviews using structured questionnaire including age, sex and general demographic details, occupational background, work-history records with the duration of lead exposure, education, using protective equipment in work, smoking status, dietary intake habits, drugs taken, prevailing diseases and symptoms. All participants were informed of the purpose of the study, were free to ask questions throughout the study and signed a written consent form.

Inclusion Criteria

Healthy male individuals (unexposed group) and Painting workers (exposed group) whose ages ranged between 20–45 years.

Exclusion Subjects

individuals aged above 45 or less 20 years, smoking individuals, supplemented individuals with any kind of trace elements, individuals suffering from diarrhea, kidney, heart, liver and respiratory, digestive tract and osteoporosis diseases.

Sample Collection

Subjects were made to relax and comfortably seated. Venous blood samples (5ml) were obtained after 8–12 hours of overnight fasting. The sample was collected by using heparinized disposable syringes from a peripheral vein on arm of each healthy adult individual. Blood collected was delivered into tube contain heparin as anticoagulant for lead determination. Blood was allowed to clot at room temperature, and the serum was separated by centrifugation at 4000 rpm for 15 minutes for measurement hepatic function tests. Hepatic function parameters including serum glutamic pyruvate amino transaminase (SGPT), serum glutamic oxaloacetate amino transaminase (SGOT), total protein and serum albumin. The parameters were analyzed by 200 Mindray chemistry analyzer and photometer 4040.

Statistical Analysis

All the results were tabulated and analyzed using Statistical Package for Social Sciences (SPSS) version 14 to apply one-way ANOVA test to compare the means and standard deviations of Blood lead, hepatic function tests (SGPT, SGOT, total protein and serum albumin) of lead paint exposed and unexposed groups. The results were considered statistically significant at p value < 0.01 .

RESULTS

The results of the present study have been presented and tabulated in the form of tables. A total of 64 adult male individuals aged between 20–45 years were selected in the study. 34 of painting workers (lead exposed group) and 30 non lead exposed group (control group). All the results analyzed using Statistical Package for Social Sciences (SPSS) version 14. One-way ANOVA test was used to compare the means and standard deviations of the variables of exposed and unexposed group. The results were considered statistically significance at p value > 0.05 .

Table1 shows the demographic characteristics of lead paint exposed and unexposed group. The mean age of painting workers (lead exposed group) and non-exposed group were 35.76 ± 6.47 years and 35.33 ± 6.48 years, respectively. The ages were not statistically significance between the two groups (P value= 0.7). Duration work for the exposed group was 8.44 ± 1.63 years.

Table 2 illustrates comparison of lead levels and hepatic biochemical markers (ALT, AST, Total protein and serum albumin) between exposed and unexposed groups. ALT, AST were significantly elevated among painting workers (exposed group) as compared to unexposed group,

whereas, total protein and serum albumin were significantly reduced among exposed group as compared to unexposed group.

In the table 3, the results were divided into three groups according to the length of work in years. First group < 5

years, the second group was between 5-10 years and the third group was > 10 years. Lead levels and all hepatic biochemical parameters were altered significantly among the three groups (p. value > 0.05).

Table 1: Demographic characteristics of Lead paint exposed and unexposed.

Characteristics	Exposed group Mean \pm SD	Unexposed group Mean \pm SD	P. values
Age in years	35.76 \pm 6.47	35.33 \pm 6.48	0.7
Work Duration in years	8.44 \pm 1.63	

SD, standard deviation.

Table 2: Comparison of Lead paint exposed and unexposed groups.

Parameters	Lead paint exposed group Mean \pm SD	Lead paint unexposed group Mean \pm SD	P. value
Lead μ g/dL	6.39 \pm 3.32	1.25 \pm 0.58	< 0.05
ALT IU/L	34.50 \pm 7.63	27.13 \pm 8.90	< 0.05
AST IU/L	37.32 \pm 10.76	26.8 \pm 8.71	< 0.05
Total protein g/dl	4.49 \pm 1.03	6.66 \pm 1.01	< 0.05
Serum albumin g/dl	3.17 \pm 0.69	4.12 \pm 1.01	< 0.05
Systolic blood pressure mmHg	100.03 \pm 12.96	121.26 \pm 16.24	< 0.05
Diastolic blood pressure mmHg	69.46 \pm 6.16	84.35 \pm 9.63	< 0.05

One-way ANOVA test was used to compare the means and standard deviations of parameters of lead levels and hepatic markers among the two groups. The results were considered statistically significance at P. value < 0.05. All parameters were statistically significant among the three groups at p value < 0.05.

Table 3: Distribution of Lead paint exposed and unexposed group in accordance to work duration.

Parameters	Work Duration			P. value
	< 5 N = 9 2.3 \pm 1.15	5-10 years N = 17 7.21 \pm 1.50	> 10 years N = 8 13 \pm 2.04	
Lead μ g/dL	3.02 \pm 0.73	5.61 \pm 2.02	10.85 \pm 1.32	< 0.05
ALT IU/L	27 \pm 1.47	36.18 \pm 5.41	39.73 \pm 9.94	< 0.05
AST IU/L	26.11 \pm 4.42	39.82 \pm 7.50	44.62 \pm 12.53	< 0.05
Total protein g/dl	5.06 \pm 0.81	4.53 \pm 1.01	4.16 \pm 1.14	< 0.05
Serum albumin g/dl	3.85 \pm 0.86	2.92 \pm 0.39	2.91 \pm 0.50	< 0.05
Systolic blood pressure mmHg	103.87 \pm 13.39	120.47 \pm 9.18	138.22 \pm 11.64	< 0.05
Diastolic blood pressure mmHg	76.62 \pm 3.15	82.23 \pm 5.10	95.22 \pm 10.95	< 0.05

One-way ANOVA test was used for statistical analysis

DISCUSSION

Morbidity and mortality are still high in many countries due to the adverse effects of lead exposure even at very low levels.^[18] According to WHO, 2009, in low and middle-income countries about 98% of adults and 99% of children are affected by lead exposure.^[19] Lead poisoning refers to excessive human exposure to lead. Exposure may occur over a short space of time (acute poisoning) or over a long period of time (chronic poisoning). No safe level of exposure to lead has so far been identified. As even small lead level has adverse effects on human organs causing lead-associated complications.^[20]

The result was higher than of a study's result conducted in Alshati, Libya which reported that blood lead level was 2.216 \pm 0.423 μ g/dL for lead paint exposed group and 2.07 \pm 1.38 μ g/dL for unexposed group.^[17] Adverse effects occur at blood lead level \leq 5 μ g/dL including (neurological, renal, cardiovascular, hematological, immunological, reproductive).^[10]

The study revealed significant increase in blood lead, ALT, AST and systolic, diastolic blood pressure levels in painting workers as compared to non-exposed group. Blood lead levels were 6.39 \pm 3.32 μ g/dL and 1.25 \pm 0.58 μ g/dL in exposed and non-exposed groups, respectively. Liver enzyme ALT levels were (34.50 \pm 7.63 and 27.13 \pm

8.90), and AST levels (37.32 ± 10.76 and 26.8 ± 8.71) in exposed and non-exposed groups, respectively. Moreover, systolic blood pressure (121.26 ± 16.24 and 100.03 ± 12.96), diastolic blood pressure (84.35 ± 9.63 and 69.46 ± 6.1) in exposed and non-exposed groups, respectively. On the other hand, there was a significant decrease in total protein levels (4.49 ± 1.03 and 6.66 ± 1.01) and serum albumin (3.17 ± 0.69 and 4.12 ± 1.01) in exposed and non-exposed groups, respectively.

In the current study, majority of painting workers didn't use any protective equipment such as protective clothes, masks, and goggles while working at workplace to inadequate awareness of possible adverse health effects of lead toxicity, as 67.64% of painting workers were not educated (Elementary level). About 88.23% of workers were having their food and drinking water at workplace without any safe procedures and 64.70% of them didn't use special clothes for the work purpose. Therefore, all may contribute to the direct susceptibility of lead toxicity at the workplace which leading to serious health effects. Moreover, the most common symptoms among benzene exposed group were Exhaustion and headache which count for 61.17%, 58.82%, respectively. The symptoms were obvious in workers who had been working in period of more than 5 years.

The significant increase of blood lead levels among painting workers could be due to inadequate awareness of workers in safety procedures taken during work. According to the study, workers were susceptible to lead for 6-7 hours during painting work. All workers did not use the personal protective equipment, such as protective clothes, masks, and goggles, as they were unaware of possible adverse health effects of lead poisoning, however, 60% of workers were educated (Bachelor level). The study was consistent with the study which demonstrated that lack of safety measures and not adopting the standard criteria lead to more susceptible to lead poisoning.^[21] However, other study reported that even provision of control measures and the use of personal protective equipment, lead levels in exposed groups remains higher than on non-exposed group.^[22,23]

The results of the study were in agreement with several studies which all demonstrated that elevated blood lead levels among lead exposed subjects are associated with the increase in transaminases enzymes (AST and ALT) which could represent oxidant injury.^[24,25,26] furthermore, accumulation of lead in hepatocytes have a toxic effect through oxidative reactions leading to liver cell membrane damages and then increasing in circulating transaminase enzymes (ALT and AST).^[27,28,29] Moreover, the present study was aligned with previous studies which all demonstrated that increase in lead levels causes decrease in serum total protein and albumin as lead can interfere with the protein synthesis.^[30,31,32] According to Experimental animal studies which showed estimation of serum protein is useful to detect liver damages due to

exposure to lead.^[30,33,34]

The results of the study were in agreement with other studies which showed increased blood pressure and increased risk of hypertension with high blood lead level.^[35,36,37,38,39] Further, the study was consistent with the largest meta-analysis involving 58,518 subjects documented increase in systolic and diastolic blood pressure in lead exposed subjects.^[40] The cardiovascular manifestations in the form of elevated blood pressure due to chronic lead exposure is reported at blood lead levels as low as $1.41\text{--}1.75\text{ }\mu\text{g/dL}$.^[41] The lowest mean blood lead associated with increased systolic and diastolic was $1.33\text{ }\mu\text{g/dL}$.^[42] However, the association of hypertension at low blood lead levels is uncertain.^[43,44]

In this study, the results of exposed group were divided into three groups in accordance to the length of work duration in years, first group < 5 years, the second group was between 5-10 years and the third group was > 10 years. Blood lead levels were significantly elevating with the increase of work duration (3.02 ± 0.73 , 5.61 ± 2.02 and $10.85 \pm 1.32\text{ }\mu\text{g/dL}$) a, respectively, and furthermore, increasing in liver enzymes ALT (27 ± 1.47 , 36.18 ± 5.41 and 39.73 ± 9.94) and AST (26.11 ± 4.42 , 39.82 ± 7.50 and 44.62 ± 12.53), respectively. Additionally, systolic and diastolic blood pressure were also increasing with the increase of work duration, as systolic blood pressure levels were 103.87 ± 13.39 , 120.47 ± 9.18 and 138.22 ± 11.64 , and diastolic blood pressure levels were 76.62 ± 3.15 , 82.23 ± 5.10 and 95.22 ± 10.95 , respectively. Conversely, there was a significant decrease in total protein (5.06 ± 0.81 , 4.53 ± 1.01 and 4.16 ± 1.14) and serum albumin (3.85 ± 0.86 , 2.92 ± 0.39 and 2.91 ± 0.50) with the increase of work duration, respectively.

CONCLUSION

It is concluded that there is an increase in the levels of blood lead among painting workers as compared to non-painting workers. Exposure to lead causes an elevation in ALT, AST, blood pressure and a reduction in total protein, serum albumin. Liver injury could be occurred due to lead paint exposure, and furthermore, increased blood pressure may contribute to cardiovascular diseases. Long lead exposure leads to more changes in hepatic biochemical markers and blood pressure which indicates more injury in liver function.

RECOMMENDATIONS

Establishing law or legislation by the authority to regulate and restrict the amount of lead in paint, raising the awareness among painting workers of lead toxicity to take safety procedures and using protective equipment during painting work. Further researches should be conducted for lead toxicity among adults to find. Moreover, more researches should be conducted for other lead exposed occupations.

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