بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Effect of Occupational Lead Exposure on Zinc and Chromium Level among Factory Workers

التعرض المهني للرصاص وأثره في مستوى الزنك والكروميوم بين عمال المصانع

A dissertation Submitted in partial Fulfillment for MSc Degree in Medical Laboratory Science (Clinical Chemistry)

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الآية

بسم الله الرحمن الرحيم

(يَا أَيُّهَا الَّذِينَ آمَنُوا إِذَا قِيلَ لَكُمْ تَفَسَّحُوا فِي الْمَجَالِسِ فَافْسَحُوا يَفْسَحِ اللَّهُ لَكُمْ ۖ وَإِذَا قِيلَ انشُزُوا فَانشُزُوا يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ ۚ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ)

سورة المجادلة الاية(11)

Dedication

To The candle which burns to light my life my mother who always encourage me and she oblivious thank you for giving me a chance to prove and improve myself through all my work I love you.

Thank you for your unconditional support with my studies; I am honored to have you as my brother.

Thank you for believing in me and allowing me to further my study my family.

To my wonderful friends whom shared happy and sad time always.

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Thank you my god, for giving me the ability and courage to bring this research to light.

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Finally our deep thanks are extended to everybody that assisted in this project.

Abstract

Introduction: Lead is an oxidation reduction inactive metal however it interacts with a group of essential elements such as copper, zinc, selenium and chrome and iron. Accordingly current study aims to evaluate the effect of occupational Lead exposure on zinc and chromium level among factory workers.

Materials and Methods: A cross-sectional study included 41 Lead exposure workers and 40 non exposure subjects as control group. Serum chromium and zinc were measured using Atomic Absorption spectroscopy.

Results: Independent t-test analysis showed, there was insignificant difference in zinc and chromium concentration of Lead exposure subject in comparison with non exposure (*p*-value= 0.576 and 0.167) respectively. Person's correlation analysis showed no correlation observed between zinc and study variables (age and duration), also chromium revealed no correlation with study variables.

Conclusion: The study concludes that, occupational Lead exposure have no effect on chromium and zinc level.

المستخلص

مقدمة: الرصاص معدن مؤكسد مختزل غير نشط ومع ذلك فإنه يتفاعل مع مجموعة من العناصر الأساسية مثل النحاس والزنك والسيلينيوم والكروم والحديد. وفقا لذلك تهدف الدراسة الحالية إلى تقييم تأثير التعرض للرصاص على مستوى الزنك والكروم بين عمال المصانع.

المواد والطرق: وتشمل دراسة مستعرضة 41 عامل تعرضو للرصاص و 40 عامل غير تعرضو كمجموعة تحكم. تم قياس الكروم والزنك في الدم باستخدام الامتصاص الذري الطيفي

النتائج: تحليل اختبار تي مستقلة أظهرت انه ليس هناك اختلاف في تركيز مستوى الزنك والكروم عند الاشخاص المعرضين للرصاص مقارنة مع غير المعرضين (القيمة الاحتمالية = 0.576 و0.167) على التوالي.

وأظهر تحليل الارتباط ان متغيرات الدراسة (العمر والمدة) عند الاشخاص المعرضين والغير معرضين للرصاص ليس لها اي تاثير على مستوى الزنك او الكروم في الدم

الخاتمة: وتخلص الدراسة إلى أن التعرض للرصاص المهني ليس لديه اي تأثير على مستوى الزنك،

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Chapter One

Introduction and Literature Review

Chapter one

Introduction & literature Review

1.1 Lead toxicity

Lead is a stable, silver-gray, ubiquitous heavy metal and is detectable in all phases of the inert environment (e.g., air, water, and soil) as well as in most biological systems. It is one of the more commonly used metals in the world, and like many other metals is rarely found in its elemental form, it is found in a variety of compounds, complexes, storage and alloys. Metallic lead is used in products such as electric batteries, lead solder, radiation shields, pipes, and sheaths for electric cable **(Juberg, 2000)**.

Lead has been used since ancient times. It is a pervasive and persistent environmental pollutant which exists in almost all phases of environment and biological systems. Lead is still being widely used in industry and life hence it has indispensable properties like resistance to corrosion, malleability and low meting point. Unfortunately exposure to lead is unavoidable since it has many applications in the current life of human being from work to home and its accumulation in environment. Lead causes neurological, hematological, gastrointestinal, reproductive, circulatory and immunological pathologies depending upon the level and duration of exposure. Lead is an oxidation reduction inactive metal however it interacts with a group of essential elements such as copper, zinc, selenium and chrome and iron **(Bal *et al*., 2015)**.

1.2 Zinc

Zinc is bluish white, lustrous metal and zinc is stable in dry air and becomes covered with a white coating when exposed to moisture. Zinc is fourth most used metal (after iron, aluminum, and copper), zinc and its compound are used in production of alloys, especially brass (with copper) in galvanizing steel, in die casting in paints in skin lotion in treatment of Wilsons disease and in many over-the-counter medication **(Bishop *et al.,* 2010)**.

1.2.1 Functions of Zinc in Humans

Zinc is extraordinarily useful in biological systems. It is involved in many biochemical processes that support life and required for a host of physiological functions including normal immune function, sexual function, neurosensory function such as cognition and vision. Numerous proteins, enzymes and transcription factors depend on zinc for their function. Zinc is an essential component of hundreds of proteins and metalloenzymes including alkaline phosphates lactate dehyrogenase, carbonic anhydrase, carboxypeptides, and DNA and RNA polymerases found in most body tissues. Zinc plays specific and important catalytic, co-catalytic and structural roles in enzyme molecules and in many other proteins and biomembranes, other important functions of zinc in humans include cell proliferation, differentiation and apoptosis, immune response onset, regulation protein synthesis, DNA metabolism, repair energy metabolism and vitamin A metabolism, insulin storage, release spermatogenesis and steroidgenesis, neurogenesis, synaptogenesis, neuronal growth, sequestration of free radicals, protection against lipid peroxidation, cellular division, signal messenger and neuro transmission and stabilization of macromolecules **(Nriagu, 2007)**.

1.2.2. Zinc absorption

Zinc is absorbed in the small intestine by a carrier-mediated mechanism. Zinc is released from food as free ions during digestion. These liberated ions may then bind to endogenously secreted ligands before their transport into the enterocytes in the duodenum and jejunum. Specific transport proteins may facilitate the passage of zinc across the cell membrane into the portal circulation. With high intakes, zinc is also absorbed through a passive paracellular route. The portal system carries absorbed zinc directly to the liver, and then released into systemic circulation for delivery to other tissues. About 70% of the zinc in circulation is bound to albumin, and any condition that alters serum albumin concentration can have a secondary effect on serum zinc levels. Although, serum zinc represents only 0.1% of the whole body zinc, the circulating zinc turns over rapidly to meet tissue needs **(Roohani *et al* ., 2013)**.

1.2.3 Zinc transport

In blood plasma, Zn is bound and transported by albumin (60%, low-affinity) and transferrin (10%) **(Osredkar and Sustar, 2011**)

Ion gradients are generated by two main mechanisms: primary pump utilizing the energy of ATP-hydrolysis and secondary active mechanism that uses an ion gradient such as Na^+ for generating Zn^{2+} gradients **(Sekler *et al*., 2007)**

1.2.4 Zinc distribution

The human body contains 2–3 g zinc, and nearly 90% is found in muscle and bone other organs containing estimable concentrations of zinc include prostate, liver, the gastrointestinal tract, kidney, skin, lung, brain, heart, and pancreas **(Plum *et al* ., 2010)**.

1.2.5 Zinc excretion:

The pancreas, prostate, and mammary gland are secretary tissues that have unique Zn requirements. These tissues accumulate abundant Zn into secretary vesicles and tightly regulate Zn secretion to provide Zn for critical biological processes. Importantly, dysregulated Zn metabolism in these tissues is implicated in disorders such as diabetes, cancer, and infertility **(Kellcher *et al*., 2011)**.

1.2.6. Pathology of zinc

The acute effects of zinc are usually the result of short term, high dose exposure and depend strongly on the point of contact. Chronic somatic effects tend to be associated with low-dose exposure over an extended period of time.

1.2.6.1. Acute toxicity of zinc

acute exposure to zinc chloride fume have many symptom include irritation of the nose and throat, conjunctivitis cough, hoarseness, dyspnea, wheezing, rales, rhonchi ,chaste tightness or pain, nausea, vomiting, epigastic pain, lightheadedness, listlessness, metallic taste in the mouthand even death. These effects may be accompanied by comorbid neurological and cardiovascular features.

Dermal: Skin contact with zinc powders or concentrated solutions can result in severe corrosive effects including ulceration, blistering and permanent scarring**.**

Ocular: Zinc salts are strong eye irritants, causing pain and erythema which may be complicated by corneal ulcerations, edema and burns, iritis, hyperemia, hemorrhaging, bullous keratopathy, glaucoma and cataract formation.

Ingestion: Zinc is relatively non-toxic if taken orally and instances of acute poisoning due to zinc exposure from environmental sources are extremely rare. **Gastrointestinal Toxicity:** Zinc salts tend to be corrosive and ingestion can result in severe injury to the mouth, throat and stomach.

Pancreatitis: A woman who swallowed 28 g of zinc sulfate (7 g of zinc) suffered hypoglycemia and tachycardia and eventually died as a result of pancreatic hemorrhage and renal damage.

Cardiovascular Toxicity: Reported symptoms in people exposed to high levels of zinc include premature atrial beats, hypertension secondary to intravascular volume, hypovolemic shock (pulse over 120 beats per minute) and hypertension

Pulmonary Toxicity: Ingestion of correction fluid by an asthmatic patient brought about an acute episode of bronchospasms and severe oropharyngeal and laryngeal inflammation which led to stridor and dysphonia

Hepatic Toxicity: associated severechronic cholestatic liver disease progressing to end-stage biliary cirrhosis Nephrotoxicity Microscopic hematuria unaccompanied by renal failure and mild albuminuria have been associated with ingestion of high doses of zinc.

Neurotoxicity: Ingestion of high levels of zinc have resulted in lethargy, lightheadedness, staggering, difficulty in writing clearly, anxiety, depression, somnolence and comatose.

Hepatotoxicity: Transiently increased liver enzyme activities have been linked to severe gastrointestinal corrosive effects of high dose ingestion of zinc.

Cancer: Zinc has not been shown to be a human mutagen or carcinogen.

1.2.6.2 Chronic and Sub chronic Toxicity of zinc

Ingestion of zinc and zinc-containing compounds can result in a variety of chronic effects in the gastrointestinal, hematological and respiratory systems along with alterations in the cardiovascular and neurological systems of human **(Nriagu, 2007)**.

1.2.7. Clinical manifestations of zinc deficiency

The essentiality of zinc for humans was recognized in the early 1960s. The causes of zinc deficiency include malnutrition, alcoholism, malabsorption, extensive burns, chronic debilitating disorders, chronic renal diseases, following uses of certain drugs such as penicillamine for Wilson's disease and diuretics in some cases, and genetic disorders such as acrodermatitis enteropathica and sickle cell disease. In pregnancy and during periods of growth the requirement of zinc is increased.

The clinical manifestations in severe cases of zinc deficiency include dermatitis, alopecia, diarrhea, emotional disorder, weight loss, intercurrent infections, hypogonadism in males; it is fatal if unrecognized and untreated. A moderate deficiency of zinc is characterized by growth retardation and delayed puberty in adolescents, hypogonadism in males, rough skin, poor appetite, mental lethargy, delayed wound healing, taste abnormalities, and abnormal dark adaptation. In mild cases of zinc deficiency in human subjects, we have observed oligospermia, slight weight loss, and hyperammonemia, zinc also effect cell division and immunological function **(Prasad, 1985)**

1.3 Chromium:

One of the most common elements in the earth's crust and seawater, exists in our environment in several oxidation states, principally as metallic (Cr^0), trivalent (+3), and hexavalent (+6) chromium. The latter is largely synthesized by the oxidation of the more common and naturally occurring chromium and is highly toxic. Trivalent chromium, found in most foods and nutrient supplements, is an essential nutrient with very low toxicity (8). Chromium used in manufacture of stainless steel, wood treatment chrome plating (**Cefalu and Hu , 2004**)

1.3.1 Chromium function:

Chromium helps control blood sugar:

The addition of chromium resulted in a 23% reduction in blood sugar after the meal. Thus, taking chromium with carbohydrate-rich foods may be an effective way to lower the glycemic index of that meal.

Chromium and cholesterol levels:

A number of studies reported reductions in triglycerides, as much as 32%, and reductions in total and LDL cholesterol

Chromium diminishes carbohydrate cravings:

In one study, it was shown that simply taking 600 micrograms of chromium picolinate for 8 weeks significantly reduced carbohydrate cravings

Chromium fights body fat:

Chromium picolinate was able to increase lean body mass in obese patients placed on a very low calorie diet.

Chromium combats insulin resistance:

Additional of chromium increase insulin response **(Volek, 2016)**

1**.3.2 Chromium absorption:**

Chromium is absorbed thought small intestine especially in jejunum and the mode of absorption is unknown in human but thought the absorption by passive diffusion like rate. The absorption enhances by several amino acids like phenylalanine methionin and inhibits absorption by change ph to acid because absorption occurs in alkaline or neutral ph **(Gropper and Smith, 2012**).

1.3.3 Chromium distribution:

Chromium in food is present organic and inorganic form complexes, intestinal absorption of chromium is low and the mechanism has not yet been fully elucidated and the distribution in the body depend on species, age and chemical form **(Ducrose, 1992)**.

1.3.4 Chromium Excretion:

Orally absorbed chromium appears to be excreted mainly by the kidneys and daily urinary excretion of chromium runs from 3 to 50 Microgram/24hrs **(Prasad, 2013)**.

1.3.5 Transport of chromium:

Transferrin is considered as major physiological chromium transport agent and its function maybe distributed by insulin glucose and insulin alteration could therefore disturb chromium metabolism significantly **(Vincent, 2007)**.

1.3.6 Pathology

1.3.6.1 Cancer Effect

Chromium is human carcinogen primarily by inhalation exposure in occupational settings, although lung cancer has been established as consequence of hexavalent chromium exposure in smokers and non smokers and others cancer can be noted like in gastrointestinal and central nervous system.

1.3.6.2 Non cancer Effect

Main non cancer effects from exposure to any potentially toxic matter are usually categorized by Death, Neurological, reproductive, development, genetic and systemic effect **(Guertin *et al*., 2004)**.

1.3.6.3 Deficiency of chromium's

These results suggest that relatively isolated chromium deficiency in man, hitherto poorly documented, causes

1. Glucose intolerance,
2. Inability to utilize glucose for energy,
3. Neuropathy with normal insulin levels,
4. High free fatty acid levels and low respiratory quotient and,
5. Abnormalities of nitrogen metabolism **(Jeejeebhoy *et al*., 1977)**

1.4. Effect of lead on zinc and chromium

Toxic effect of lead is related, to metabolic interactions with essential trace elements i.e. iron, zinc and copper. Lead stimulates urinary excretion of these elements interfering with their reabsorption in kidney**,** Iron, zinc and copper deficiency results in increased lead toxicity through considerable enhancement of lead absorption from intestinal tract **(Morawice, 1991).**

1.5 Objective

General objective

To assess the effect of occupational lead exposure on zinc and chromium level among Factory workers

Specific objective

To measure zinc, chromium and lead in lead exposure (case) and health non exposure people as (control).

To compare mean concentration of zinc, chromium and lead in study groups.

To correlate between study parameters (Lead, zinc and chromium) and study variables (age and duration)

1.6 Rationale

Despite years of intensive research, educational efforts, and remedial measures, lead continues to receive as much attention as any modern environmental health risk, Lead is an important toxicant that can exert adverse effects in humans, given sufficient exposure and accumulation in the body Systems known to be susceptible to adverse effects of high exposure include neurological, reproductive, renal, and hematological disorder.

Lead is reduction oxidation inactive metal however it interacts with a group of essential elements such as copper, zinc, selenium and chromium and iron, their interactions are diverse and not clearly understood yet. Therefore the aim of this study was to determine the effect of occupational lead exposure on blood levels d of zinc and chromium.

Internationally two similar study was done, in the Sudan, we though it didn't take place until now. Benefit desired from this study is to inform worker with risk which around them.

Chapter Two

Materials and Methods

Chapter 2

Materials and methods

2.1 Materials

2.1.1 Study design

Descriptive cross-sectional study, conducted during the period of February to March 2016.

2.1.2 Study area

This study was carried out in Khartoum state.

2.1.3 Study population

Eighty one samples were enrolled in this study which divided into 2 groups, 41 Lead exposure subjects as case group, and 40 lead non exposure subjects as control group.

2.1.4 Inclusion criteria

Specimens were collected from factory workers which are exposed to lead (cases), and from workers not exposed to lead (control).

2.1.5 Exclusion criteria

Factory worker who has hypertension, diabetes mellitus, renal diseases and or alcoholism was excluded from this study

2.1.6 Collection of Samples

Samples were collected by using dry, plastic syringes, tourniquet was used to make the veins more prominent, blood samples (5ml) was collected in plane containers from each volunteer under septic condition. All blood samples were allowed to clot at room temperature, and then they were centrifuged at 4000 rpm to obtain the serum samples, and stored in -20° until the analysis.

2.1.7 Ethical Considerations

Study was approved from ethical committee of the Sudan University of Science and Technology, verbal informed consent was obtained and all participants were informed by aims of the study.

2.2 Methods

2.2.1 Method of lead estimation

By atomic absorption spectrophotometer

2.2.1.1 Principle of atomic absorption spectrophotometer

Electron of the ground state atom promoted to higher orbital (excited state) for a short period of time by absorbing light energy of specific wave length. As number of atoms in light path increase, the amount of light absorbed also increases. By measuring the amount of light absorbed, a quantitative determination of the amount of analyte can be made.

2.2.1.2 Procedure of lead estimation

Brief according to manufactured, serum sample is diluted, by add 0.3ml of serum to 2.7ml of nitric acid, then the diluted serum is aspirated and the absorbance is measured at 283.3 nm by atomic absorption spectrophotometer.

2.2.2. Procedure of zinc estimation

For the determination of serum zinc, dilute the sample 1:5 with deionized water and absorbance measured at wave length 213.9 nm

2.2.3. Procedure of chromium estimation

For the determination of serum chromium, dilute the sample 1:9 with nitric acid and absorbance measured at wave length 357.9 nm.

2.2.4 Data analysis

The data was analyzed using statistical package of social science (SPSS computer program). Descriptive statistics (mean, standard deviation and standard error of mean) were calculated. Independent sample t-test was employed to compare mean concentration. Also Pearson's correlation was applied to correlate between study variable.

Chapter Three

Results

Chapter 3

Results

To compare between mean concentration of Lead (mg/l) among exposure and non exposure group, the results of independent t-test shown insignificant difference in mean Lead level of exposure group (0.379± 0.2) in comparison with non exposed (0.382±0.11) with (*p*-value= 0.425) which presented in figure 3.1.

To compare between mean concentration of chromium (mg/l) among exposure and non exposure group, the results of independent t-test shown insignificant difference in mean chromium level of Lead exposure group (0.252± 0.12) in comparison with non exposed (0.215±0.11) with (*p*-value= 0.167) which presented in figure 3.2.

To compare between mean concentration of zinc (mg/l) among exposure and non exposure group, the results of independent t-test shown insignificant difference among exposure to lead (0.235± 0. 2) in comparison with non exposed (0.209±0.15) with(*p*-value= 0.576) which presented in figure 3.3.

To compare between mean concentration of chromium (mg/l), among high and low exposure to lead the results of independent t-test shown insignificant difference among high exposure to lead (0.234± 0. 14) in comparison with low exposed to lead (0.270±0.11) with (*p*-value= 0.367) which presented in figure 3.4.

To compare between mean concentration of zinc (mg/l), among high and low exposure to lead the results of independent t-test shown insignificant difference among high exposure to lead (0.187± 0. 1) in comparison with low exposed to lead (0.281±0.33) with (*p*-value= 0.223) which presented in figure 3.5.

To correlate between chromium and the variables used Person's correlation test the results showed there is no relation between chromium and variables (age, duration, Lead and zinc) which presented in table 3.1.

To correlate between zinc and the variables used Person's correlation test the results showed there is no relation between chromium and variables (age, duration, Lead and chromium) which presented in table 3.2.

Mean Lead level (mg/l) in exposed and non exposed group

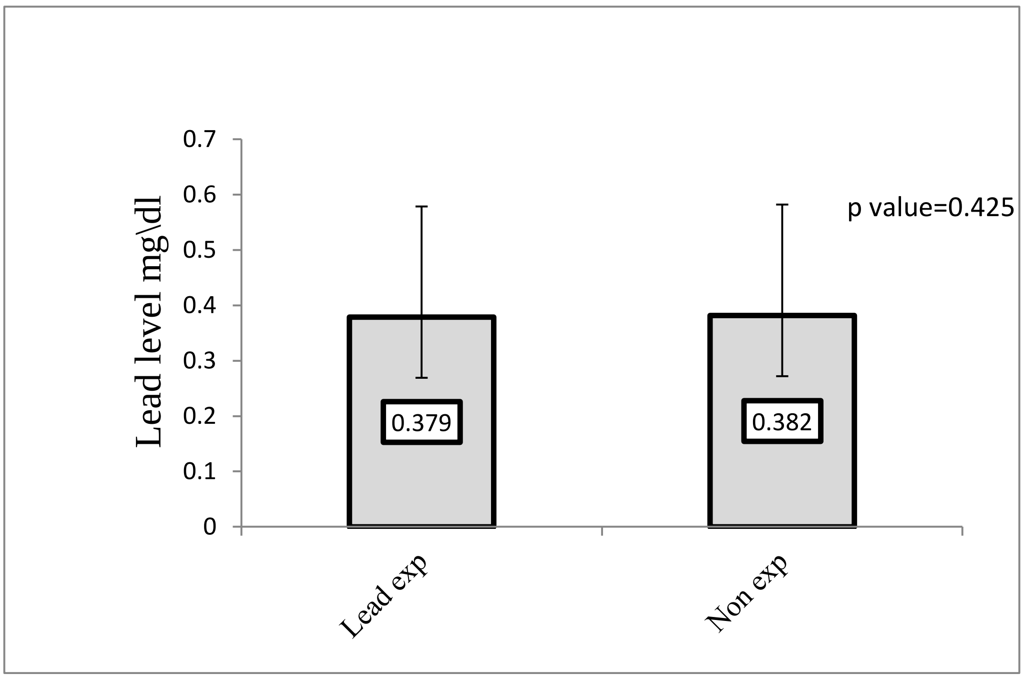

Figure 3.1: Show mean concentration of Lead which expressed as (Mean±SD) and significant difference considered as p-value ≤0.05

Mean chromium level (mg/l) in exposed and non exposed group

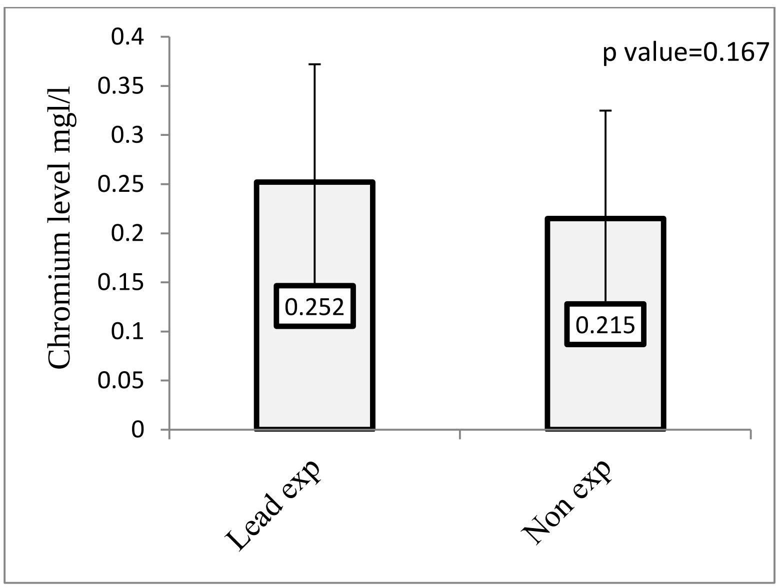

Figure 3.2: Show mean concentration of chromium which expressed as (Mean±SD) and significant difference considered as p-value ≤0.05

Mean zinc level (mg/l) in exposed and non exposed group

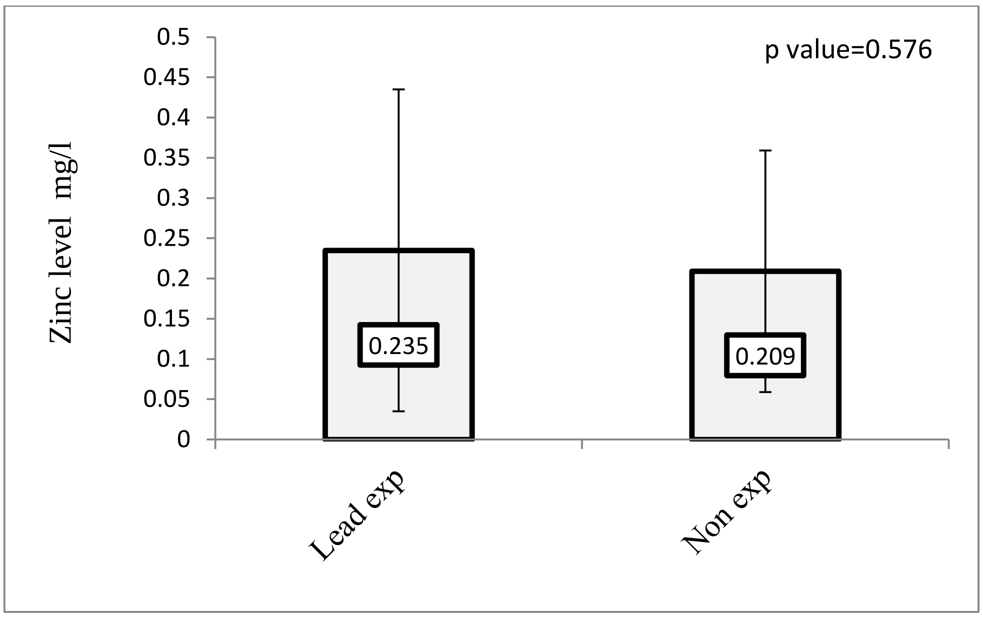

Figure 3.3: Show Mean concentration of zinc which expressed as (Mean±SD) and significant difference considered as *p-value* ≤0.05

Mean chromium level (mg/l) in high and low exposed group

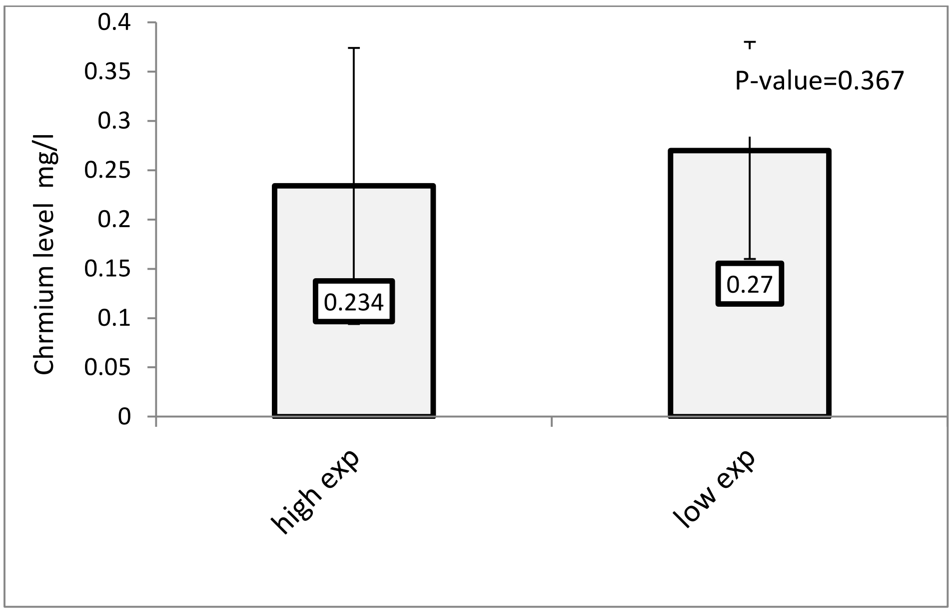

Figure 3.4: Show Mean concentration of chromium which expressed as (Mean±SD) and significant difference considered as *p-value* ≤ 0.05

Mean zinc level (mg/l) in high and low exposed group

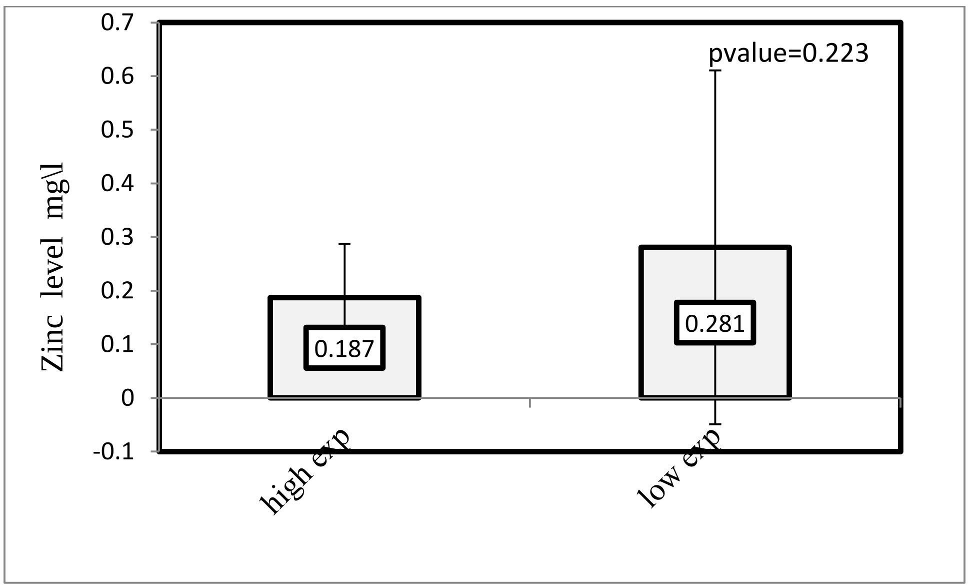

Figure 3.5: Show Mean concentration of chromium which expressed as (Mean±SD) and significant difference considered as *p-value* ≤0.05

3.6 Chromium correlation with variables

Variable	**R-value**	***P*-value**
Age	0.171	0.287
Duration	0.246	0.121
Lead	0.026	0.872
Zinc	0.024	0.884

R- Value = Mean + or - correlation

P-value = Mean strength of correlation

3.7 Zinc correlation with variables

Variable	R-value	*P*-value
Age	0.036	0.822
Duration	0.114	0.477
Lead	0.060	0.711
Chromium	0.024	0.884

R- Value = mean + or - correlation

P-value =mean strength of correlation

Chapter Four

Discussions, ConclusionandRecommendations

Chapter Four

Discussions, conclusion and recommendations

4.1 Discussions

Lead is one of the known and most widely studied occupational and environmental toxins for censures, despite intensive studies there is still some debate about the toxic effects of Lead, all are attributed to low-level exposure in the general population owing to environmental pollution and historic use of Lead in paint and plumbing and from exposure in the occupational setting, thus occupational exposure to Lead could produce adverse effects and experience from industries employing best practice has shown that it is possible to control the blood lead levels (**Gidiow, 2004**), the previous study agree with this study carried out to evaluate the effect of occupational exposure to Lead on factory workers in Khartoum State the result shown there is no different in Lead level between exposed and non exposed group.

The results of current study found that, there was insignificant difference in mean chromium concentration in Lead exposure group when compared with control group with (*P*-value 0.167), this finding indicates that chromium is not affected by Lead exposure, our finding in agreement with previous study, which determine the effect of occupational Lead exposure on blood levels on copper, zinc, chromium, selenium, and stated that, there was not any significant difference in chromium concentration between case group and control group (**Bal *et al*., 2015**).

The present study revealed that, there was insignificant difference in mean zinc level of Lead exposure in comparison with control group with (*p*-value 0.576). our finding contradict the previous study carried out to assess the effect of occupational Lead on various elements including zinc level the result showed high zinc concentration in occupational Lead workers (**Truckenbrodt *et al*., 1984**), in contrast other report by Wasowicz which noted that, in group of workers (men only) whom exposed to high Lead concentrations in comparison of the mean values with the results obtained in the reference group (43 men). The determinations in the workers indicated significantly lower plasma zinc concentration (**Wasowicz *et al* 2001**), these different results justified by dose of exposure, awareness by occupational safety and special nutritional died, which includes Lead chelators and neutralizers could reduce the adverse effect.

The experimental evidence showed by current study there was no correlation between chromium and the study variables (Lead, zinc, age and duration of exposure) with p-value (0.872, 0.884, 0.287and 0.121) respectively.

Finally the present study showed there was no correlation between zinc and the variables (lead, chromium, age, duration of exposure) with p-value (0.711, 0.884, 0.822 and 0.477) respectively. other study contrast with my study done on battery factory worker to determine the toxicity of lead not associated with anima for that stimulated parameter include zinc and the result showed correlation between lead and zinc **(Paul *et al*., 1999)**. These different in results justified our study demonstrate Lead exposure while the previous results correlate between concentration of Lead and zinc level and its relation to anemia.

4.2 Conclusion

Occupational Lead exposure has no effect on chromium and zinc level, thus safety precautions implemented by factory administration is useful to reduce adverse effect of lead exposure.

4.3 Recommendations

1- Predict examination of lead in serum and erythrocyte

2- Provide worker with special nutrient diet to counteract effect of lead exposure on their health

3- Use chelater to neutralize lead in their body

4- Awareness the worker with risk of lead exposure

Chapter Five

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Chapter Six

Appendices

Appendix

Sudan university of Science and Technology

College of Graduate Studies

M.SC of medical laboratory

Questionnaire

الرقم التسلسلي [ ]

1- العمر:

2- السكن:

3- المهنة:

4- عدد سنوات العمل:

5- هل تتبع نظام غذائي معين: أ- نعم ( ) ب- لا ( )

6- نوع النظام الغذائي الذي تتبعه؟

....

....

7- هل تعاني من أي حساسية: أ- نعم ( ) ب- لا ( )

8- نوع الأعراض؟

....

....

9- هل تعاني من أي أمراض:

أ- ضغط ( ) ب- سكري ( ) ج- فشل كلوي ( )