Determinations of lead, zinc, cobalt, and iron concentrations in sera of industrial workers (Occupational exposure)

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Abstract

All metals are potentially toxic, but, some metals are essential for life. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, pharmaceutical, industrial, or residential settings. Industrial exposure accounts for a common route of exposure for adults [1]. We get exposed to these metals from our surroundings whether our immediate environment or our place of work.

This study focused on the workers that worked in industrial field and they are always keeping touch with minerals like Fe, Pb, Zn and Co. These minerals may be poising if they were overdose and causes many healthy problem if the concentration of these elements increased in human body more than body requirement. The occupational exposures for these elements by inhalation or touching or orally are very risk on the healthy. So the present study included twenty four tinkers, and mechanic subjects that work in tin, solder and car repaired and fifteen subjects that were non-worker as control group. The elements, lead, zinc, iron and cobalt were determined in serum of each subject. The results revealed highly significant increase ($p<0.0001$) in concentration of Pb, Zn, Fe and Co comparing with the control. The worker subjects were classified into groups according to age, smoking, period of working, and obesity depending on body mass index (BMI) then studies their effect on the concentration of these elements. The results showed no any significant differences between each group. There is no significant differences between subjects their age (18-40)year and those (41-60) year in addition no significant differences between smokers and non-smoker groups, obese and non-obese group and no significant differences between workers that works within the period (1-5) year and (6-15) year.

The aim of this object was investigated the association between the elements, Pb, Zn, Fe, Co as a risk factors and workers that work in industrial field and they are always touching with these element.

Key words: metal toxicity, elements, poising, lead, zinc, cobalt, iron.

الخـــــلاصــــــة

جميع المعادن تكون سامة ولكن البعض منها يكون ضروري للحياة. العناصر الثقيلة تكون سامة عندما لا يتم ايضها بواسطة الجسم وتتجمع في الأنسجة الرخوة. العناصر الثقيلة قد تدخل إلى جسم الإنسان من خلال الطعام, الماء, الهواء, أو من خلال امتصاصها عبر الجلد عندما تكون بتماس مع الإنسان في مجال الزراعة, المصانع, الصيدلة, الصناعة او نفايات المساكن. يعد التعرض الصناعي الأكثر شيوعا عند البالغين. إذ ان تعرضنا إلى تلك العناصر يكون من البيئة المحيطة بنا او من أماكن عملنا.

هذه الدراسة ركزت على العاملين في المجال الصناعي والذين يكونون دائما في تماس مع المعادن مثل الرصاص, الحديد, الخارصين, والكوبلت. إذ إن هذه المعادن تكون سامة إذا كانت بجرعات عالية وتسبب مشاكل صحية إذا كان تركيزها أكثر من حاجة الجسم إليها. إن التعرض المهني لهذه العناصر عن طريق الاستنشاق أو الملامسة أو عن طريق الفم يعد خطرا جدا على صحة الإنسان.لذلك تضمنت الدراسة الحالية 24 سمكري وميكانيكي من العاملين في مجال اللحيم وتصليح السيارات في محافظة كربلاء و 15 عينة من غير العاملين في هذا المجال كمجموعة سيطرة. وتم جمع عينات الدم في شهر نيسان

2010. العناصر التي تم تقديرها في مصل العاملين هي الرصاص, الخارصين, الحديد, والكوبلت. اظهرت النتائج وجود زيادة معنوية عالية ($p<0.0001$) في تركيز كل من الرصاص والخارصين والحديد والكوبلت مقارنة بمجموعة السيطرة. وعند تقسيم عينات العاملين إلى مجاميع وفقا لــ العمر, التدخين, فترة العمل, والسمنة تم دراسة تأثيرها على تركيز العناصر التي تم تقديرها. أظهرت النتائج عدم وجود فروق معنوية بين تلك المجاميع($p>0.05$) اذ ليس هناك فرق معنوي بين العينات التي أعمارهم (18-40) سنة و(41-60) سنة بالإضافة الى ذلك لايوجد فرق معنوي بين العاملين المدخنين وغير المدخنين, كذلك بين أصحاب الوزن الزائد والذين ليس لديهم وزن زائد. كذلك اظهرت النتائج عدم وجود فروق معنوية بين العاملين للفترة من (1-5) سنة والفترة من (6-15) سنة.

الهدف من الدراسة هو للتحري عن تركيز عنصر الرصاص, الخارصين, الحديد, والكوبلت كعوامل خطورة للعاملين في المجال الصناعي والذين يكونون دائما في تماس مباشر مع تلك المعادن.

Introduction

There are 35 metals that concern us because of occupational or residential exposure; 23 of these are the heavy elements or "heavy metals": antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc. Interestingly, small amounts of these elements are common in our environment and diet and are actually necessary for good health, but large amounts of any of them may cause acute or chronic toxicity (poisoning). Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer [1].

The symptoms of toxicity resulting from chronic exposure (impaired cognitive, motor, and language skills; learning difficulties; nervousness and emotional instability; and insomnia, nausea, lethargy, and feeling ill are also easily recognized; however, they are much more difficult to associate with their cause. Symptoms of chronic exposure are very similar to symptoms of other health conditions and often develop slowly over months or even years [1].

All metals are potentially toxic, yet, many metals are essential for life. Homeostasis is key to survival. Metals are frequently bound to proteins for transport and storage [2]. In small quantities, certain heavy metals are nutritionally essential for a healthy life. Some of these are referred to as the trace elements (e.g., iron, copper, manganese, and zinc) [1].

Lead, ubiquitous in the environment as a result of mining and industrialization, is found as a contaminant in humans although it has no known physiological function there [3]. While lead serves no function in our bodies, it is usually found in the body in some amount since it is so common in the environment. Low levels in adults are not thought to be harmful [4]. Lead is a dangerous element that can be harmful even in small amounts. It is enters the human body in many ways. It can be inhaled in dust, from lead paints, or waste gases from leaded gasoline. It is found in trace amounts in various foods, notably fish, which are heavily subjected to industrial pollution. Some old homes may have lead water pipes, which can easily contaminate drinking water. Most of the lead we take in is removed from our bodies in urine; however, there is still risk of buildup, particularly in children. If Lead buildup occurs, health problems including damage to the nervous system, mental retardation, and even death, can ensue [5]. The signs and symptoms of lead poisoning in adults may include: pain, numbness or tingling of the extremities, muscular weakness, headache, abdominal pain, memory loss, reproductive impairment in men, constipation, and anemia [5]. Lead level blood, this test is used to screen people at risk for lead poisoning, including industrial workers and children who live in urban areas [4]. In Adults lead Less than 20 micrograms/dL of lead in the blood. Adults who have been exposed to lead should have blood lead levels below 40 micrograms/dL. Treatment is recommended if you have symptoms of lead poisoning, or if your blood lead level is greater than 60 micrograms/dL [4].

Cobalt is essential in trace amounts for human life. It is part of vitamin B-12, and plays a key role in the body's synthesis of this essential vitamin. Exposure to very high levels of cobalt can cause health effects. Effects on the lungs, including asthma, pneumonia, and wheezing, have been found in workers who breathed high levels of cobalt in the air. The International Agency for Research on Cancer has determined that cobalt is a possible carcinogen to humans. Studies in animals have shown that cobalt causes cancer when placed directly into the muscle or under the skin. Cobalt did not cause cancer in animals that were exposed to it in the air, in food, or in drinking water. Cobalt and cancer studies on people are inconclusive. Higher exposures can occur for workers who are exposed to cobalt in industries that process it or make products containing cobalt. The levels of cobalt are in the range 0.1–0.5 $\mu g \backslash L^{-1}$[6].

Zinc is a very essential requirement for a healthy body but the excess of it can be harmful, and cause zinc toxicity [7]. High doses of zinc, in the area of 300 mg per day, may impair immune function [8]. Long term zinc supplementation above 50 mg per day has shown to decrease HDL cholesterol and increase total cholesterol [8].Occupationally exposed population include, zinc plant workers, galvanisers, metal workers, farm workers, paint workers, cosmetic workers [9]. Repeated applications of zinc solutions to the skin may cause erythematous, papular and granulomatous reactions in susceptible individuals. One case of exposure to zinc chloride has been associated with leg pains, fatigue, weight loss and anorexia; the symptoms resolved after removal from the source of contamination [9]. The mean plasma concentration of zinc is 960 µg/L in healt adults and 890 µg/L in healthy children [9]. The normal or therapeutic value in blood is 68 to 136 microgram/100 ml and, in the CSF, 20 to µg/kg/liter. Serum concentrations of zinc can be used in the diagnosis of poisoning. In various species, more than 2.5% of a topical dose is absorbed through the skin. Chronic poisoning due to occupational exposure to zinc chloride has been associated with leg pains, fatigue, loss of appetite and loss of weight. The patient's condition improved following removal from the zinc source [9]. Oral Zinc and its salts are poorly absorbed from the gastrointestinal tract; only a small proportion of dietary zinc is absorbed. Zinc is distributed widely throughout the body and is excreted in the feces with only traces appearing in the urine, since the kidneys have little or no role in regulating the content of zinc in the body. Ingestion of soluble salts may cause nausea, vomiting and purging [9].

Iron is the most abundant trace mineral in the body and is an essential element in most biological systems. It is likely that iron was essential for developing aerobic life on earth. But iron is toxic to cells in excessive amounts. Acute iron poisoning is common and potentially lethal in dogs, cats, and many other animals. Iron is also a leading cause of unintentional poisoning deaths in children less than 6 years old.(iron4) Since no mechanism exists for excreting iron, toxicity depends on the amount of iron already in the body [10]. Ingestion accounts for most of the toxic effects of iron because iron is absorbed rapidly in the gastrointestinal tract [10].

Subjects and methods

The study was conducted on the twenty four subjects that work in the industrial field like tinkers, solder and car repaired in Karbala governorate during March 2010 and fifteen subjects, apparently healthy as a control group. The demographic and clinical data, such as age, body weight, medical history, smoking, and period of work were obtained from the subjects under study. Blood samples of 5 ml were drawn from the vein and collected in tube then centrifuged at 4000 rpm for 10 minuets. The minerals were determined using atomic absorption spectroscopy (Perken-Elmer 5000) and air-acetylene flame with hallo cathode for each element.

Statistical analysis

Data were analyzed with statistical package for the social sciences (SPSS) version 16 and expressed as mean ± standard deviation (SD). A p-Value of <0.05 was considered statistically significant.

Results and discussion

The results revealed highly significant increase ($p<0.0001$) in the concentration of Pb, Zn, Fe, and Co of workers comparing with the control (Table 1).

Table 1: Determination of heavy metals in sera of workers & controls groups

Elements	Grouping	N	Mean ± SD. (ppm)	p-Value
Pb	Workers	24	0.06 ± 0.02	
	Control	15	0.03 ± 0.01	p < 0.0001
Zn	Workers	24	1.55 ± 1.84	
	Control	15	0.98 ± 0.14	p< 0.0001
Fe	Workers	24	2.12 ± 0.21	
	Control	15	1.09 ± 0.27	p< 0.0001
Co	Workers	24	0.06 ± 0.02	
	Control	15	0.03 ± 0.01	p< 0.0001

P< 0.05 Significant P> 0.05 No significant

When the workers were classified according to their age in two groups, (18-40) year and (41-60) year, the results showed no significant differences ($p >0.05$) between the two groups (Table 2). In addition, there wasn't any significant difference between smokers and non-smokers workers (Table 3), also there wasn't significant differences between groups depending on the period of works and (BMI) (Table4&5).

Table 2: Determination of heavy metals between two ageing group of workers

Elements	Age grouping	N	Mean ± SD. (ppm)	p-Value
Pb	(18-40) (41-60)	17 7	0.06 ± 0.02 0.05 ± 0.01	p>0.05
Zn	(18-40) (41-60)	17 7	1.53 ± 0.17 1.59 ± 0.21	p>0.05
Fe	(18-40) (41-60)	17 7	2.13 ± 0.2 2.11 ± 0.27	p>0.05
Co	(18-40) (41-60)	17 7	0.06 ± 0.01 0.06 ± 0.02	p>0.05

Table 3: Determination of heavy metals between smokers & non-smokers of workers

Elements	Smoking	N	Mean ± SD. (ppm)	p-Value
Pb	Smokers Non-smokers	11 13	0.05 ± 0.01 0.07 ± 0.02	p>0.05
Zn	Smokers Non-smokers	11 13	1.55 ± 0.19 1.55 ± 0.18	p>0.05
Fe	Smokers Non-smokers	11 13	2.07 ± 0.26 2.17 ± 0.16	p>0.05
Co	Smokers Non-smokers	11 13	0.06 ± 0.02 0.06 ± 0.01	p>0.05

P< 0.05 Significant P> 0.05 No significant

Table 4: Determination of heavy metals between workers depending on period of work

Elements	Period of working (year)	N	Mean ± SD. (ppm)	p-Value
Pb	(1-5) (6-15)	15 9	0.07 ± 0.02 0.05 ± 0.01	p>0.05
Zn	(1-5) (6-15)	15 9	1.54 ± 0.18 1.57 ± 0.19	p>0.05
Fe	(1-5) (6-15)	15 9	2.16 ± 0.18 2.07 ± 0.26	p>0.05
Co	(1-5) (6-15)	15 9	0.06 ± 0.02 0.06 ± 0.02	p>0.05

P< 0.05 Significant P> 0.05 No significant

Table 5: Determination of heavy metals between obese & non-obese of workers

Elements	Body mass index (BMI)	N	Mean ± SD. (ppm)	p-Value
Pb	Obese Non-obese	14 10	0.06 ± 0.02 0.06 ± 0.02	p>0.05
Zn	Obese Non-obese	14 10	1.53 ± 0.18 1.58 ± 0.18	p>0.05
Fe	Obese Non-obese	14 10	2.05 ± 0.22 2.23 ± 0.16	p>0.05
Co	Obese Non-obese	14 10	0.06 ± 0.02 0.06 ± 0.01	p>0.05

P< 0.05 Significant P> 0.05 No significant

All metals are toxic and our bodies require special transport and handling mechanisms to keep them from harming us. The toxicity occurs in humans due to environmental pollution via soil or water contamination or due to occupational exposure. Some of these metals are useful to us in low concentrations but are highly toxic in higher concentrations. These metal toxicity cause serious morbidity and mortality [11]. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Heavy metals may enter the human body through food, water, air, or absorption through the skin when they come in contact with humans in agriculture and in manufacturing, pharmaceutical, industrial, or residential settings. Industrial exposure accounts for a common route of exposure for adults [11].

Lead environmental pollution is a major health hazard throughout the world. Several mechanisms of lead poisoning have been identified. The most common are pica, industrial exposure, drinking moonshine liquor, inhalation, gunshot wounds, retained lead pellets or particles, and a variety of folk remedies and cosmetics [12]. Studies confirm that exposure to lead causes renal damage, encephalopathy, and impaired cognitive function in children and in adult [12]. In adults, the peripheral nervous system is commonly affected (peripheral motor neuropathy). This may lead to irritability, behavioral disorders, low intelligence quotient (IQ), ataxia convulsions, and to wrist drop, foot drop, or lead colic in adults [12]. Lead has been classified as carcinogen in animals. The National Toxicology Program classifies lead, along with its compounds, as being reasonably anticipated to be a human carcinogen on the basis of limited studies in humans and more sufficient animal studies. The International Agency for research on cancer considers inorganic lead compounds as "probably carcinogenic to humans" on the basis of limited evidence in humans [12]. An estimated 90-95% of cases reported in the United States in the adult blood lead epidemiology and surveillance program result from occupational exposures. The cars and homes of workers in the lead industry may become contaminated with lead dust, which may be carried on a worker's body, clothes, and shoes. Jobs that may expose a worker to lead include automobile radiator repair, construction, painting, and metal salvaging. The major source of lead is occupational exposure from jobs dealing with lead and lead-based components; there is a high prevalence of lead toxicity in the population exposed to such activities. Occupational exposure of workers is seen in the manufacturing of lead batteries and cables, as well as rubber and plastic products. Soldering and foundry work, such as casting, forging, and grinding activities, are also associated with occupational exposures. Constructions workers involved in painting or paint stripping, plumbing, welding, and cutting are also exposed to lead [12].

Iron overload can contribute in many diseases and infections. Iron feeds on bacteria, viruses, and cancer cells. It actually causes cancer cells to metastasize. Up to 88 percent of breast cancer patients have elevated iron, and cancerous breasts have three times as much iron as normal breasts [13].

Elemental cobalt poses no recognized health hazard to people who are exposed to low levels in food or the environment [6]. An essential trace element, cobalt can cause serious adverse health effects at high exposure levels. Serum concentrations > 1 mcg/L indicate possible environmental or occupational exposure, and concentrations > 5 mcg/L are considered toxic [14].

The results refer to increase the level of heavy metals in the workers those work in car repaired field comparing with those non-worker. These may cause real complication in future.

The environment in Iraq is polluted with heavy metals specially those in industrial place and the people or workers who live there are exposure to pollute of heavy metals more than others. Clearly, current workplaces are not protecting workers and their families from unsafe heavy metals exposures. Employers and workers need support for introducing safer substitutes and work processes. In the short term, more education is needed to expand awareness about heavy metals dangers.

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