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Original Research Article

Heavy Metals Level Comparison in Blood of Industrial and Office Workers in Hail, KSA

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Abstract: Increased use of pesticides and contaminated water in the agriculture in the modern society has highlighted on the putative role of metals in the development of chronic disorders in urban area. This study was carried out to assess the influence of working area and time period for exposure on metals deposition in acute (blood) among Industrial and Office workers in Hail, KSA. The study was conducted on a group of 160 male volunteers, 80 hand workers in industrial factories and 80 office workers in residential regions of Hail city aged between 20 and 66 years old, workers were divided into three subgroups according to age. Blood samples were analyzed for Pb, Cd, Zn, Cu, and Fe levels using Flame Atomic Absorption Spectrometer. Mean lead concentration for industrial workers was 0.81 µg/L with a significant increase (r=0.42 p<0.001) when compared with B-Pb office workers. H-Pb levels were significantly influenced by duration of exposure (p<0.05), whereas, B-Pb levels were not significantly correlated with Zn, Cu, Cd, and Fe levels. In addition, there was an exponential increase in B-Pb levels in age groups in proportion of 55% in comparison between age 1 group and age 3 groups.
Keywords: Heavy metals, Industrial exposure, Hail, Blood, Flame Atomic Absorption Spectrometer

INTRODUCTION

Heavy metals are significantly related with the incidence of acute and chronic disorders, not only they play an essential role in disrupting homeostasis of biochemical reactions in human body, but also, through their dissemination and storage in different tissues [1]. The concentration of trace metals may vary from tissue to tissue throughout the body, for example metals concentration is higher in liver than the blood stream [2]. Environmental factors like temperature, pH, water hardness, and organic matter can influence the toxicity of metals in biological systems [3]. Exposure to metals can occur through variety of routes; metals may be inhaled as dust of fume or smoking, or even ingested involuntarily through food and drink [4]. Trace metals are divided into two main groups: essential and non-essential metals. Essential metals are important to human health (including fluorine, copper, vanadium, boron and lithium); e.g. copper propagate the maintenance of the cardiovascular system. While non-essential metals are toxic for human health (including lead, cadmium, mercury and aluminum); e.g. cadmium and lead correlate with development of heart-related disease [5]. The toxicity of metals most commonly involves certain organs such as brain and kidneys, some metals, such as arsenic, are clearly capable of causing cancer [6].

The increase in hypertension disorder due to idiopathic causes and its association with smoking habit has pointed to the putative role of heavy metals as cadmium and lead in the prognoses of cardiovascular disorders [7]. Cadmium induces deleterious side effects in the human body such as renal dysfunction, vascular disorders and interstitial cell tumors in the testes in chronic metals exposure [8] and [9]. Exposure to cadmium would lead to an increase in blood pressure; prevalence of hypertension, and cardiovascular disease [10]. Chronic exposure to airborne cadmium results in a number of toxic effects; the two main symptoms are lung emphysema and proteinuria [11].

However, there have been few reports about intake of calcium, proteins, or vitamin D, zinc, and selenium may modify the toxicological effects of cadmium as they are antagonists to cadmium, and they have shown to prevent or reduce various effects of cadmium administration, such as hypertension, fetal abnormalities, damage to ovaries, and testicular injury [12]. Vulnerability of individuals toward trace metals exposure and the complexity of biochemical interaction with proteins of various sorts which determine metabolic processes in the detoxification mechanisms cause strong variations in defining baseline for tolerable metals concentration [13]. In this study, our main goal is to elucidate the variation of blood metal levels (as acute exposure indicator) between hand workers in an industrial area and office workers of residential area in hail district.

MATERIAL AND METHODS

The study was conducted on a group of 160 male volunteers, 80 hand workers in industrial factories and 80 office workers in residential regions of Hail city aged between 20 and 66 years old. The workers were divided into three subgroups according to age. Group 1 aged between 20 and 35 years, group 2 aged 35 to 50 years and group 3 more than 50 years old.

A 5 mL Blood sample was collected from two areas (industrial area and Residential area expose to the investigated elements (Fe, Cu, Zn. Pb and Cd). Blood samples were collected into tubes free of trace elements. Double distilled water and analytical grade reagents were used for the preparation of standard solutions of metal. The metal measurement was performed with a Flame Atomic Absorption Spectrometer (A Analyst 400 Perkin Elmer) (College of Public Health and Health Informatics, Hail).

For the determination concentration of metals, 1.0 ml of sample was burnt in the furnace at 600 º c after that they obtained residue were dissolved in 5.0 of conc. nitric acid. The digestion process was repeated until clear solution was obtained [14]. After dilution with ultra-pure water, the digests was analyzed. Measurements were done against metal standard solutions according to table 1.

Table 1: Metal standard solutions concentrations

Metal	Std 1 ppm	Std 2 ppm	Std 3 ppm	Std 4 ppm	Std 5 ppm	Std 6 ppm	Std 7 ppm
Zn	0.012	0.05	1	3	6	1	3
Fe	0.015	0.03	0.09	0.3	0.9	3	9
Cu	0.03	0.06	0.15	0.3	0.6	1.2	4.2
Pb	0.001	0.005	0.01	0.05	0.1	0.5	1
Cd	0.005	0.01	0.05	0.1	0.5	1	1.5

RESULTS & DISCUSSION

Mean metals level for Zn, Fe, Cu, Cd, and Pb were 0.61 μg/ml, 0.11 μg/ml, 0.09 μg/ml, 0.01 μg/ml and 0.56 μg/ml for the population study, respectively. The concentrations of metals in blood of industrial and office workers are presented in Table (2).

Table 2: Heavy metals level in the blood of industrial workers and office workers in Hail region

		No.	**Zn (μg/ml)** Mean ± SD	**Fe (μg/ml)** Mean ± SD	**Cu (μg/ml)** Mean ± SD	**Cd (μg/ml)** Mean ± SD	**Pb (μg/ml)** Mean ± SD
Workers	20-35 Yrs	23	0.29 ±0.0 31	0.08 ± 0.009	0.04 ±0.005	0.01 ±0.002	0.54 ±0.006
	35-50 Yrs	27	0.47 ±0.043	0.08 ± 0.009	0.10 ± 0.008	0.01 ±0.0009	0.61 ±0.0064
	>50 Yrs	30	0.53 ±0.047	0.11 ± 0.013	0.09 ±0.010	0.01 ±0.0009	0.89 ±0.0091
	Average	80	0.51 ±0.054	0.10 ±0.012	0.08 ±.010	0.01 ±0.002	0.81 ±0.0084
Civil	20-35 Yrs	27	0.55 ±0.057	0.10 ±0.012	0.05 ±0.006	0.00 ±0.0	0.19 ±0.0017
	35-50 Yrs	25	0.63 ±0.064	0.09 ±0.011	0.11 ±0.010	0.00 ±0.0	0.23 ±0.0020
	>50 Yrs	28	0.77 ±0.074	0.12 ±0.010	0.10 ±0.012	0.01 ±0.0	0.34 ±0.0029
	Average	80	0.70 ±0.068	0.11 ±.010	0.09 ±0.012	0.01 ±0.0	0.31 ±0.0033
	All	160	0.61 ± 0.059	0.11 ±0.010	0.09 ±0.008	0.01 ±0.0009	0.56 ±0.0054

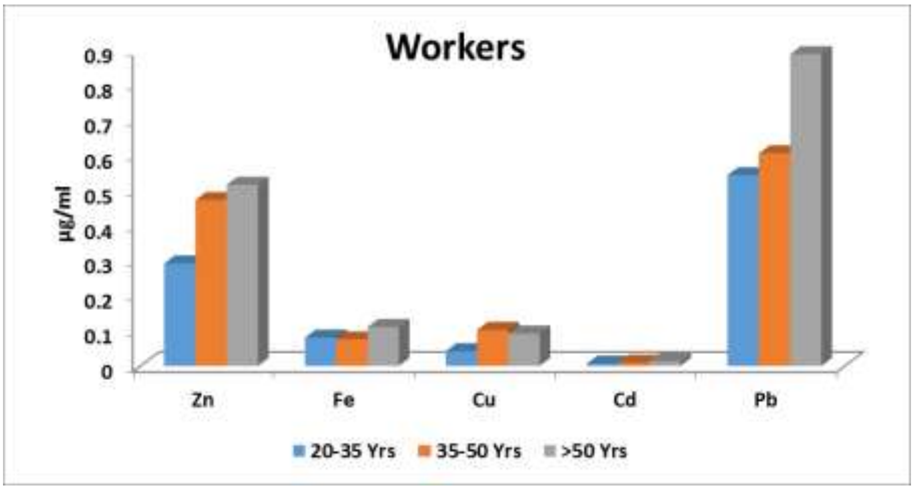

Fig 1: Comparison of metals level in blood of industrial workers according to age

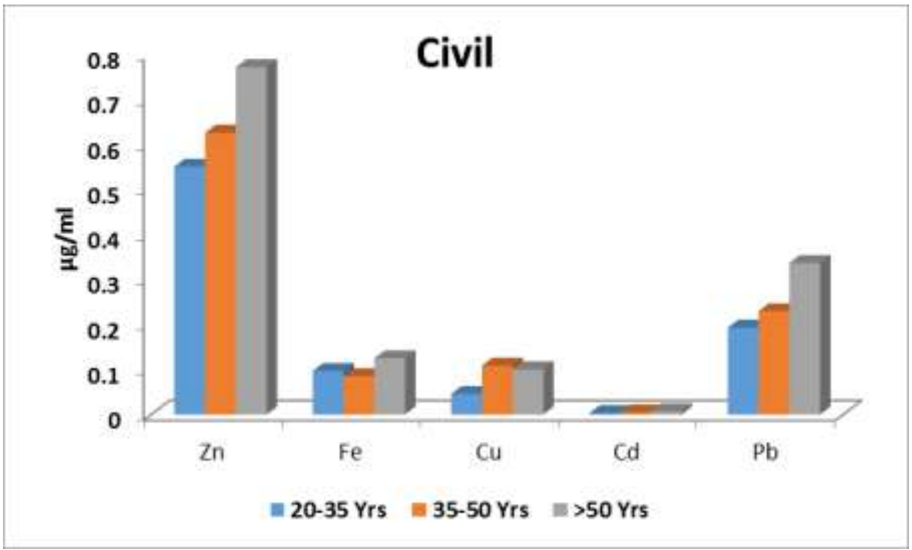

Fig 2: Comparison of metals level in blood of office workers according to age

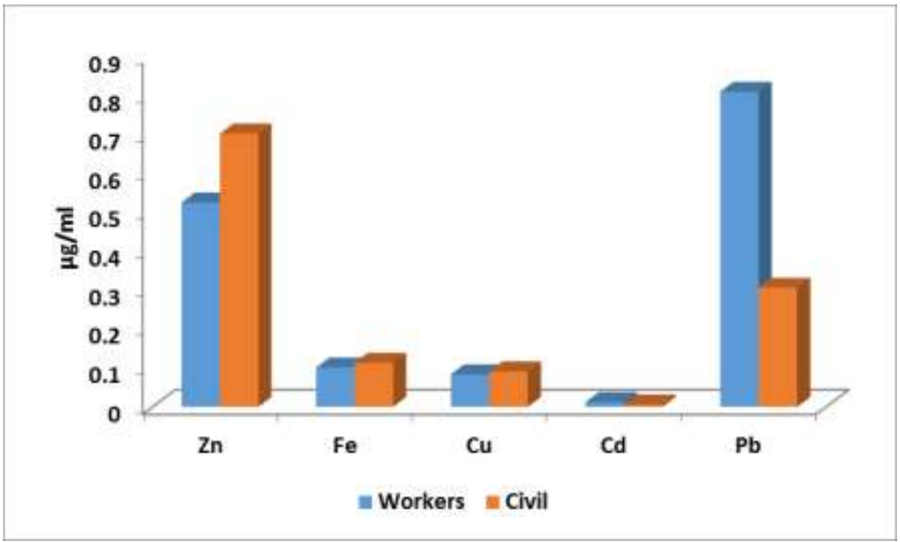

Fig 3: Cumulative comparison of metals level in blood of industrial workers and office workers

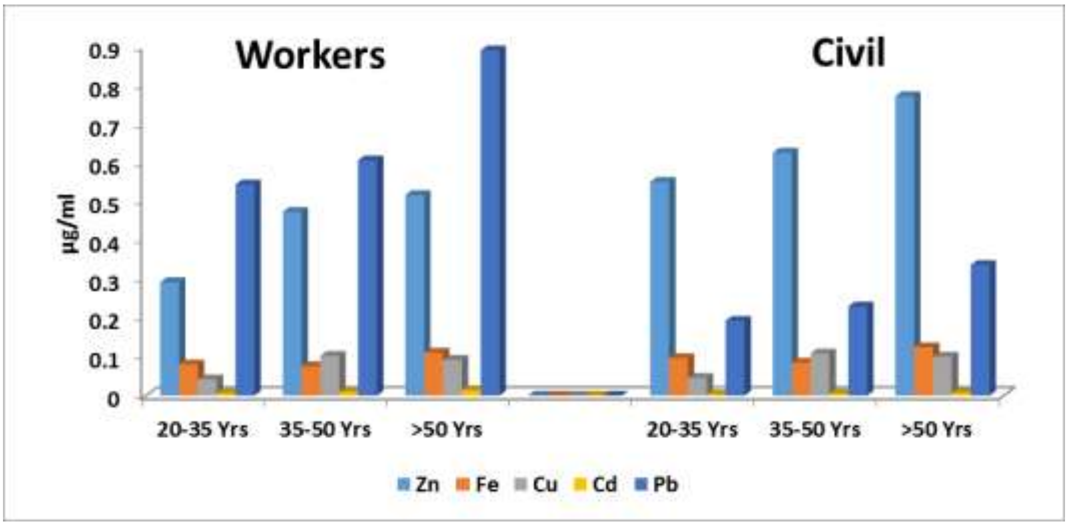

Fig 4: Cumulative comparison of metals level in blood of industrial workers and office workers according to age

Our study demonstrated high levels of lead contamination among industrial workers 0.81 µg/mL compared with office workers 0.31 µg/mL on the acute (blood). The Agency for Toxic Substances and Disease Registry (ATSDR) has recommended of B-Pb less than 1 µg/mL [15]. Additionally, according to statistical analysis of correlation coefficient for our study sample there was a significant correlation between B-Pb levels and age (r =0.42 p < 0.001). Niculescu et al. showed there is an increase in blood samples among occupationally exposed workers, [16]. In Mexico City, Farias et al. demonstrated level of B-Pb in teenagers was 0.75 µg/mL [17]. Dabbas et al. 2000 showed mean lead level in whole blood sample of Jordanian citizens was 0. 196 µg/mL [18]. Abu Rayyan 2016 showed mean lead level in blood of students in Amman, Jordan 0.3 µg/mL [19]. According to the previously published data of lead concentrations at different geographic locations worldwide, there is a controversy in lead levels in different countries and evenly in Saudi Arabia. These variations in results of blood lead level are still within the recommended limit of ATSDR for lead level in blood. Lead levels were in an acceptable range for metals exposure in reference to other countries studies [20].

Epidemiological studies carried out in Japan indicated that the incidence of proteinuria in the urine of contaminated population is significant in cadmium-polluted areas [21]. It has been reported that, the minimum critical level of cadmium required to produce renal tubular damage is approximately 0.2 mg/g; renal stones formation, impaired liver function and osteoporosis disorders are affected by chronic cadmium exposure. Once a metal is absorbed, it distributes in tissues and organs, later on, excretion typically occurs primarily through kidneys and digestive tract, some metals tend to persist in some storage sites, like hair, liver, bones and kidneys, for years or decades [6] In our study, mean cadmium concentration for blood in the study population was 0.1 µg/ml, respectively. There was a significant correlation between cadmium levels in hair and blood (*r =0.56 p < 0.5)*. Comparative studies for blood cadmium concentration were conducted in Boston and London citizens showed cadmium levels of 0.73 µg/ml and 0.5 µg/ml, respectively[22, 23]. A study for blood cadmium concentration in non-occupationally population for middle age men in England aged from 40-59 years showed the mean cadmium levels in nonsmokers was 1 µg/ml and current smokers showed a marked gradient with daily amount smoked , with a mean of 0.39 µg/ml in men smoking 40 or more cigarettes per day [13]. Descriptive study was conducted in Amman to measure trace metals in the blood of Jordanian smokers and nonsmokers population demonstrated a level of 0.312 µg/ml for cadmium [1].

Based on these figures, cadmium, concentration in our study population demonstrated low level of cadmium in Saudi population. This figure could be explain due to the young ages of our study population as it has been reported toxicokinetics of cadmium demonstrate high levels of cadmium deposition in tissues after age of 50 [24]. This implicates that cadmium storage and dissemination in different organ systems is highly dependent on the acute or chronic state of cadmium exposure in human body by itself. In addition, cadmium distribution was under control of other factors such as age and duration of smoking, which in turn contributed to continuous deposition and shifting of cadmium between soft and hard tissues on different organ systems. These levels of cadmium could not cause deleterious pathological disorders on the short term; nevertheless, the clinical manifestations may develop after 10 or 20 years of smoking. Other source for cadmium contamination is the leakage of cadmium from old water pipes in the municipal drinking water system itself [25]. Zinc levels ranged from 0.21 µg/mL to 0.83 µg/mL with mean of 0.61 µg/mL. Whereas, Cupper levels ranged from 0.03 µg/mL to 0.13 µg/mL with mean of 0.09 µg/mL. In the other hand, Iron levels ranged from 0.08 µg/mL to 0.14 µg/mL with mean of 0.11 µg/mL. International agency for vitamins and trace elements reported a normal range of, whereas, 0.7 to 1.4 µg/mL for cupper [26]. There is a depletion in the metals concentration which could be explained to low metals concentration in food and vegetables of hail [27].

CONCLUSION AND RECOMMENDATIONS

From our data, we found that lead deposition in blood tissues in the study population has showed a dramatic increase in relation with both Age and exposure. In addition, we show B-Pb levels did not exceed 1 µg/mL. Even thought, B-Pb levels were with the recommended limits, the development of clinical manifestations may arise after 10-20 years. It could be concluded that, despite the low lead concentration in blood of workers there should be enforcement for applying good safety practice for metals exposure in the industrial regions. In addition, we highly recommend using fortified food or mineral pills to increase Zn, Cu and Fe metals level in blood.

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