Occupational Exposure to Lead, Nickel and Copper among Workers in Diyala State Company/Ministry of Industry and Minerals-Iraq.

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Abstract

The objective of this study was assessment occupational exposure to Pb, Ni, and Cu metals of workers in Diyala state company. Eighty two blood samples were collected (58 blood samples from workers working in the Diyala State Company and 24 samples from control samples for employees who don't relate with industrial emissions). Five ml. of venous blood was withdrawn for each sample. the concentration of Pb, Ni and Cu in the blood samples was determined by using the Flameless Atomic Absorption Spectrometer(FLAAS). Depending on the years of work, high levels of Pb, Ni, and Cu in company workers than controls with significant differences ($p<0.05$). Where we noticed increase levels of Pb, Ni, and Cu with occupation period progression, where it is found the levels of Pb, Ni, and Cu scored highest mean within 21-34 occupation period, and least mean value at <1 occupation period . Based on occupational places, we noticed highest levels of Pb in Iron heart worker , Ni level was highest in painting worker , and Cu level was highest in wires worker and least of all metals was at controls. Depending on age stages, we showed increase levels of Pb, Ni, and Cu with age stages progression, where it is found the levels of Pb, Ni, and Cu scored highest mean within >50 age stage, while the least mean value of Pb, and Cu at 3-40 years age stage, and least mean value of Ni was at <30 age. Finally, we notices there is positive correlations among metals and workers age.

1. Introduction

The problem of environmental pollution is one of the most serious problems of the era, due to many environmental pollutants to which humans are exposed, especially human activities, many pollutants are released into the atmosphere from various industrial facilities in the form of black smoke and can cause toxic effects on human health and the environment. [1]. Pollutants may be invisible, without smell or taste, and the danger of environmental pollution to humanity and other forms of life on our planet lies, as polluted air can cause harm to all forms of life [2]. Industrial dust may contain compounds of heavy metals such as lead, nickel, copper, arsenic, manganese, zinc and others depending on the type of industrial emissions that cause dust) . Pollution with heavy metals such as lead, copper and nickel is considered a man-made pollution, so it has become a dangerous and worrisome issue as a result of its bioaccumulation in the environment and the bodies of living organisms, as well as its toxic nature [3]. Industrial processes, burning of solid waste , mining operations and different factories wastes may release heavy metals into the environment, and the effect of heavy metals extends for long periods, and they can spread in the environment [4]. These minerals can also accumulate in the human body, which affects the internal organs such as nervous system , bones, brain , kidney , liver , lung and many of them can lead to cancer ,Most workers in industrial facilities do not adhere to occupational safety precautions by wearing masks, glasses and other procedures, therefore they are directly exposed to industrial emissions such as: gases and particulate matter of different sizes through breathing or contact [5]. It was necessary to conduct this study to find out the concentration of some pollutants in the blood of workers Diyala state company for different work periods and also , to answer the question :Does quarantine and the lack of working hours during the outbreak of the Coronavirus have an effect on the levels of heavy metals in the blood?

2. Materials and Methods

This study was conducted for the period from 1/10/2021 to 1/3/2022. Eighty two blood samples were collected from males (58 blood samples from workers working in Diyala State Company / Ministry of Industry and Minerals, and 24 samples from employees working in educational institutions who do not related with industrial emissions which represents control sample) , the ages of all samples range between 18-59 years. These workers were divided into three groups based on the location work inside the station , Where group A represents the workers who work in the field of painting, group B represents the workers who work in the copper coil of the electrical transformer, while group C represents the workers who work in the iron core section of the electrical transformer, The necessary information for workers (working years, age smoking and health status including chronic diseases)was obtained through a form prepared for this study. Five ml of venous blood was withdrawn for each sample, and the blood was placed in sterile plastic tubes by immersing them in dilute nitric acid, then washed with deionized water, then transferred to the cooling box and from there to the freezer to be kept at a temperature of 20°C until examination[6] . The concentration of Cu, Pb and Ni in the blood samples were determined by using the Flameless

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Atomic Absorption Spectrometer (FLAAS), Analylik Jena, Germany [7].

3. Statistical Analysis

The data was statistically analyzed using a computer by (SPSS) for windows TM version (22.0) by Microsoft Excel 2010. The data are described as standard deviation by Complete Randomized Design (CRD) [8].

4. Result and Discussion

Results of current study showed high levels of Pb, Ni, and Cu in workers of different working period than controls with significant differences ($p<0.05$). Table 1illustrates the increase in levels of Pb, Ni, and Cu with increase the working period, the levels of Pb, Ni, and Cu were higher (1.3570, 5.7709,and92.5191 ppb) than the control groups(0.2350, 2.8488 and 7.6813) within 21-34 occupation period, respectively, where it is found the levels of Pb , Ni, and Cu were higher (1.1016, 5.7668 and 82.8795 ppb) than the control groups(0.2375, 3.5438 and 6.7925 ppb) through 2-20 years working period , respectively, the results showed that the levels of lead, nickel and copper for one working years was (0.9581, 4.8900 and77.2075 ppb))higher than the control groups (0.2425, 3.5513 and 7.4613 ppb) (Table 1).

Table 1: Mean and S.D. of Lead, Nickel and Copper for different working periods.

Heavy metals(ppb)		One or less in occupational period	2-20 in occupational period	21-34 in Occupational period
Pb	Experimental group	0.9581±0.61124 a*	1.1016±.56105 b	1.3570±.58675 c
	control	0.2425±.02605 ab	0.2375±.03412 ab	0.2350±.05372 ab
Ni	Experimental group	4.8900±1.42469 aa	5.7668±1.19747 bb	5.7709±.86390 bb
	control	3.5513±1.43978 ab	3.5438±1.31313 ab	2.8488±1.20174 ab
Cu	Experimental group	77.2075±51.97324 abc	82.8795±34.21686 abc	92.5191±32.46372 abc
	control	7.4613±1.81751 ab	6.7925±.97648 ab	7.6813±1.58974 ab

*different letters mean there are significant differences (P< 0.05).

The present study showed high levels of Pb, Ni, and Cu in workers of different working period than controls, The results of the current study are in agreement with those of AL-Heety et al. [9], which was conducted at General Electric Company in Al-Ramadi City. It was found high levels of Pb, Ni, , Cr, and Cu in people within company of electrical generators. Radhi et al. [10] showed high levels of Ni, Cu, Cr, and Pb in Al-Anbar population that exposure to factory dusts compared to permitted background values. Additionally, Mehdi et al. [11] show high levels of metals in workers at storage-battery factories in Iraq.

The world is being polluted in so many ways with heavy metals, mostly due to human contamination, that it is affecting the health of so many people. All these diagnoses should go on to make us aware of the adverse effects that are being caused by these metals, the symptoms that are seen, and ways to remove some of the contamination we have from all the heavy metals [12].

Environmental exposure to heavy metal is believed to affect human health adversely even at moderate levels of exposure [13]. Some metals and their complexes pose a major environmental and industrial problem due to their reported toxic effects. Occupational exposure to certain metals, such as Co, Ni, Zn, Cr, and Be, has been linked to clinical hypersensitivity and especially contact hypersensitivity, the most common occupational disease , Although nickel chloride showed a consistently suppressive effect on the interferon system (component of the immune system), salts of iron, chromium, cadmium, thorium, or lead did not.

Previous study revealed that, there were significant levels of both lead and copper in hair of workers at different oil product distribution companies in Iraq compared to control group [3]. This reflects higher rate of exposure to toxic metals and higher incidence of pollutions of oil product distribution workers. Workers might be exposed to toxic metals through different routes. [14] reported that high level of heavy metals in hair of sanitation workers or people living nearby compared to people living far from hazardous waste sites, and these results nearly to our study that showed high levels of Pb and Cu of industries workers.

Present results are consistent with that previously reported by Al-Rudainy [15] from Basrah city and by Al-Shammari et al. [16] from Najaf city in Iraq They found significant elevation in blood lead levels in workers from different factories. In Kirkuk city, Iraq ,Al-Tamimi et al. [17] showed high levels of As, Cd, Cu, Fe, Mn ,Ni, Zn, Cr and Pb in drink water supply company workers compared to permitted background values.

Previous study revealed significantly higher blood levels of lead, cadmium, chromium, zinc and copper in auto repair garage workers compared with the unexposed control subjects. In addition, the observed blood levels of lead, cadmium, chromium and zinc in occupationally exposed auto workers were above the permissible range and could be a potential health hazard. This study also demonstrates that the higher blood levels of these metals in automobile workers are influenced by their occupational practices, lack of protection against workplace environment pollutants, thus placing them at risk of exposure to toxicity [18].

The exposure of heavy metals to humans involve various diverse forms through food and water consumption, inhalation of polluted air, skin contact and most important by occupational exposure at workplace. Though some heavy metals such as iron, Cu, Pb, and manganese are essential for certain biochemical and physiological activities in the body, elevated level in the body can have delirious health effects. Most of the other heavy metals are generally toxic to the body at very low level. The main mechanism of heavy metal toxicity include the generation of free radicals to cause oxidative stress, damage of biological molecules such as enzymes, proteins, lipids, and nucleic acids, damage of DNA which is key to carcinogenesis as well as neurotoxicity. Some of

the heavy metal toxicity could be acute while others could be chronic after long-term exposure which may lead to the damage of several organs in the body such as the brain, lungs, liver, and kidney causing diseases in the body [5]. Study results indicated that workers from lead-zinc mines may be exposed to higher levels of heavy metals which could lead to greater risk of kidney damage [19].

Ibrahem et al. [20] show high levels of lead and cadmium in wastewater plats workers in Iraq companies, and these increase leaded to host DNA damage, and subsequently is associated with many diseases.

Previous study showed the increasing heavy metal pollution especially in the blood, urine, and hair samples of the exposed workers and indoor dust samples. The heavy metals Cr, Ni, Cd, and Pb were identified as the main culprits posing the highest health risks and inducing the oxidative stress in the workers. Shivering/crusting, cutting, and stitching of leather were highlighted as the highest heavy metals contributing sections in the bio-matrices of the exposed workers through ingestion of the contaminated dust. Further, this study concluded that the unsafe and unhygienic indoor environment contaminated with industrial dust make workers susceptible to high metal exposure [21].

Goyal et al. [22] showed elevated levels of Nickel, Arsenic and Lead and decreased copper, Selenium and Zinc levels in metal forging factory workers than in control subjects respectively. Additionally, there was no gender based differences observed in metal levels studied in factory workers when compared with control subjects. However, Zn, copper, and Pb level was significantly correlated with length of service (LOS) of factory workers ($r=0.562$; $p=0.015$) , and these results compatible to our results that showed increases levels of metals with length of service (LOS).

Table 2 shows the high levels of Pb, Ni, and Cu among the workers of company of diyala general compared to controls and according to working place with significant differences ($p<0.05$).

Table 2: Mean and S.D of of Pb, Ni, and Cu in workers working in Diyala state company with working place.

Heavy metals(ppb)	Iron heart industry department	Wires industry department	Industrial paintment department	Control
Pb	1.2425±.73731 a*	1.3724±.62878 a	0.8895±.28623 b	0.2383±.03807 c
Ni	5.1075±1.37672 a	5.4643±.95397 a	5.6890±1.22932 a	3.3146±1.30708 b
Cu	60.8169±32.40844 b	122.9900±25.11687 a	65.8148±23.84225 b	7.3117±1.48788 c

*different letters mean there are significant differences (P< 0.05).

Present study noticed high level of pb in wires industry department (1.3724ppb) then in Iron heart industry department (1.2425ppb) then industrial payment department (0.8895ppb) compared with control (1.2383 ppb) with significant differences among them except between Iron heart industry department and wires industry department . As well as table 2 shows the high levels of Nickle in industrial payment department and Iron heart industry department (5.6890, 5.4643 and 5.1075ppb) respectively, compared to the control group (3.3146ppb). No significant differences was found among all group that work in Diyala general company but significant differences was found between these group and control group ($p<0.05$).

Finally Cu level was high workers working in Wires industry department (122.99ppb) then industrial payment department (65.8148ppb) then Iron heart industry department (60.8169ppb) , while Cu level in control reached to 7.3117 ppb.

No significant differences between Iron heart industry department and industrial payment department, but was found significant differences among all other groups [23].

The authors' systematic review of available clinical trials on human lead toxicity, in which markers of body iron status were considered as a possible modifying factor, demonstrated that the vast majority of studies proved a significant negative correlation between these factors. The inverse relationship between Pb level and iron status indices had a greatest statistical significance in the case of children. A majority of referred intervention programs of counteracting lead poisoning by iron supplementation demonstrated its efficiency. It may suggest that such a prevention strategy may be successfully carried in an exposed population [24].

Okpogba et al. [25] shown that the individuals in cable manufacturing factory may suffer the consequences of Ni, As and Pb toxicity as well as possible defects in functions mediated by the microelements such Cu, Zn and Se and this may have negative implications on human health.

Since heavy metals are not naturally degraded, they are progressively accumulated in plants and soil. Cu, Fe, Mn and Zn cause growth reductions at high concentrations, whereas Cd, Ni, Pb and Cr cause growth reductions at lower levels of accumulation. Heavy metals interfere with physiological processes such as gaseous exchange, CO_2 fixation, respiration, and nutrient absorption and photosynthetic translocation. Heavy metal uptake is not linear in response to the increasing concentrations. Wide species variations are recorded for the accumulative efficiency for different heavy metals. The difference in metal accumulation is not correlated with tolerance to the heavy metal. Heavy metals pose a number of hazards to human health. Therefore their concentration in the environment and their effects on human health must be regularly monitored [23].

The proportion of lung cancer attributable to occupation is around 15%, with exposure to metals being frequently incriminated. Underground mining of e.g. uranium or iron is associated with a high incidence of lung cancer, as a result of exposure to radon. At least some forms of arsenic, chromium and nickel are well established lung carcinogens in humans. There is also evidence for increased lung cancer mortality in cadmium workers and in iron or steel workers [26].

Previous study revealed that higher blood levels of lead metals in pigments factory workers are influenced by

their occupational practices, lack of protection against workplace environment pollutants, thus increasing their susceptibility to metal toxicity [22].

Previous study showed the positive correlation was observed among incidence of blood pressure with Pb and Cd concentrations in biological samples of workers (adults) in battery industries . Additionally, these findings suggest that occupational exposure of toxic metals might be created adverse impacts on workers due to ill management of workshops [26].

Results of conduced study showed high levels of Pb, Ni, and Cu in workers working in Diyala state company than controls with increasing age . Significant differences were found ($p<0.05$) among all age stage and the control group. Present study noticed increase levels of Pb, Ni, and Cu with age period progression, where it is found the levels of Pb, Ni, and Cu scored highest mean (1.3685, 5.8346, and 93.9792)) respectively, within >50 age stage, while the least mean value of Pb, and Cu (0.8213and 64.7338ppb) at 31-40 years age stage, and least mean value of Ni (4.9453ppb) was at <30 age period (Table 3).

Table 3: Mean and S.D of Pb, Ni, and Cu workers working in Diyala state company with age stage.

Heavy metals (ppb)	Age stage	Less than 30 years	31- 40 years	41 - 50 years	More than 50 years
Pb	Diyala company workers	1.0100±.58914 a*	0.8213±.60184 b	1.3495±.62439 c	1.3685±.46581 d
	control	0.2402±.02217 aa	0.2425±.04992 aa	0.2775±.04425 bb	0.2000±.01581 cc
Ni	Diyala company workers	4.9453±1.34099 ad	5.5025±1.95084 ae	5.5405±.79695 ae	5.8346±.85822 af
	control	3.1593±1.35369 abc	4.5700±.18744 abe	2.5925±1.01995 abf	3.3080±1.34975 abg
Cu	Diyala company workers	77.1047±49.59451 bc	64.7338±34.88116 bd	91.9909±38.11938 be	93.9792±24.21572 be
	control	7.3709±1.49400 dd	6.9300±1.00193 de	6.7750±1.01792 de	7.9340±2.03429 di

*different letters mean there are significant differences ($P< 0.05$)

Present study noticed increase levels of Pb, Ni, and Cu with age stage progression of workers in Diyala company due to increase accumulation these metals within bodies through age progression. Von von Mühlendahl [27] showed a positive relationship between various methods exposure of Pb and age progressions, and these results matched with our study. Study results show that older age, lower income, higher education level, and higher degree of working stress were factors related to poorer quality of life. Copper-nickel miners have high levels of working stress, and it is a risk factor that can diminish quality of life [2].

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Conclusions ; The concentration of Lead ,Nickle and Copper increases with the increase in the working period as well as with the increase in the age stage , the work place effect on the level of the Heavy metals inside the body.

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