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Evaluation of the Smoking Factor in the Blood of Workers in Diyala State Company and its Relationship to Heavy Metals (Lead, Nickel and Copper)

Estabrak Kareem Abdulla[*1] and Munther Hamza Rathi [2]

Department of Biology – College of Science – University of Diyala, Diyala – Iraq

Estabrakkareem91@gmail.com

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Abstract

Environmental pollution of heavy metals is becoming an increasing problem and has become a major concern due to the adverse effects it causes worldwide. Heavy metals are naturally occurring elements that have a high atomic weight and a density at least five times greater than water. It's a multiple industrial, domestic, agricultural, medical and technological applications have led to its widespread use in the environment; Raising concerns about their potential effects on human health and the environment. The aim of the current study is Evaluation the relationship between the smoking factor in the blood of workers in Diyala State Company and to the percentage of the heavy metals such as lead (Pb), nickel (Ni) and copper (Cu) . This study was conducted for the period from 1/10/2021 to 1/3/2022, Eighty two blood samples were collected (58 blood samples from workers working in the Diyala State Company affiliated to the Ministry of Industry and Minerals, while, 24 control samples were from control samples for employees who don't working with industrial emissions).The workers were divided into three groups based on the location work inside the station, sector (A) represented painter workers,

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sector (B) characterized the workers specialized in the copper coil of the electrical transformer, while sector (C) represented the iron core section of the electrical transformer. Five ml. of venous blood was taken for each sample. The concentration of Pb, Ni and Cu in the blood samples were determined by using the Flameless Atomic Absorption Spectrometer (FLAAS). The results of the intensive study showed the presence of high levels of lead, nickel and copper in smokers and non-smokers workers within the profession compared to control samples during the service period, with significant differences ($P < 0.05$). The results showed increasing levels of lead, nickel and copper with the progression of the service life, and the elements (lead, nickel and copper) recorded the highest average during the service period of 21-34, The painting worker showed high level of Ni while, Cu level peaked in wires worker . Based on age periods, elements levels (Pb, Ni, and Cu) were increased with age period progression, where it is found the levels of Pb, Ni, and Cu scored highest mean within >50 age period, while the least mean value of Pb, and Cu at 3-40 years age period, and least mean value of Ni was at <30 age. Finally, the results discovered there is positive correlations among metals and worker's age.

Keywords; Occupational exposure, Lead, copper, Nickel.

(تقييم عامل التدخين في دم العاملين في شركة ديالى العامة وعلاقتها بالمعادن الثقيلة الرصاص ، النيكل والنحاس)

استبرق كريم عبد الله ومنذر حمزة راضي

قسم علوم الحياة – كلية العلوم – جامعة ديالى

الخلاصة

أصبح التلوث البيئي للمعادن الثقيلة مشكلة متزايدة وأصبح مصدر قلق كبير بسبب الآثار الضارة التي يسببها في جميع أنحاء العالم. المعادن الثقيلة هي عناصر تحدث بشكل طبيعي ولها وزن ذري مرتفع وكثافة أكبر بخمس مرات على الأقل

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من كثافة الماء. أدت تطبيقاتها الصناعية والمنزلية والزراعية والطبية والتكنولوجية المتعددة إلى انتشارها على نطاق واسع في البيئة إثارة المخاوف بشأن آثارها المحتملة على صحة الإنسان والبيئة. تهدف الدراسة الحالية الى تقييم عامل التدخين في دم العاملين في شركة ديالى العامة وعلاقتها بالمعادن الثقيلة (الرصاص، النيكل والنحاس). أجريت هذه الدراسة للفترة من 1/10/2021/ إلى 2022/3/1 حيث تم جمع 82 عينة دم (58 عينة دم من العاملين في شركة ديالى العامة التابعة لوزارة الصناعة والمعادن، و24 عينة من عينات السيطرة للموظفين الذين لا علاقة لهم بالانبعاثات الصناعية) وتم تقسيم هؤلاء العمال إلى ثلاث مجموعات على أساس موقع العمل داخل المحطة حيث يمثل القطاع (A) العاملين في مجال الدهان ويمثل القطاع (B) العاملين المتخصصين في الملف النحاسي للمحول الكهربائي بينما يمثل القطاع (C) قسم القلب الحديدي للمحول الكهربائي. تم سحب 5 ml من الدم الوريدي لكل عينة. تم تحديد تركيز الرصاص والنيكل والنحاس في عينات الدم باستخدام مطياف الامتصاص الذري غير اللهبي (FLAAS). أظهرت نتائج الدراسة المكثفة وجود مستويات عالية من الرصاص والنيكل والنحاس في العاملين المدخنين وغير المدخنين داخل المهنة مقارنة بعينات السيطرة خلال فترة الخدمة مع وجود فروق معنوية ($P < 0.05$). حيث لاحظنا زيادة مستويات الرصاص والنيكل والنحاس مع تقدم فترة الخدمة، حيث وجد أن مستويات الرصاص والنيكل والنحاس سجلت أعلى متوسط خلال فترة خدمة 21-34، وأقل قيمة متوسطة عند أقل من فترة الخدمة. بناءً على الأماكن المهنية، لاحظنا أعلى مستويات الرصاص في عامل القلب الحديدي، وكان مستوى النيكل أعلى في عامل الدهان، وكان مستوى النحاس أعلى في عامل الأسلاك وكان أقل مستوى من بين جميع المعادن عند عينات السيطرة. بناءً على الفترات العمرية، أظهرنا زيادة في مستويات الرصاص والنيكل والنحاس مع تقدم الفترة العمرية، حيث تم العثور على مستويات Pb و Ni و Cu سجلت أعلى متوسط خلال> 50 فترة عمرية، بينما أقل متوسط قيمة Pb، والنحاس في الفترة العمرية من 30-40 عامًا، وكان متوسط قيمة النيكل على الأقل أقل من 30 عامًا. أخيرًا، نلاحظ وجود ارتباط إيجابي بين المعادن وعمر العمال.

كلمات مفتاحية: التلوث البيئي، الرصاص، النحاس، النيكل.

Introduction

The problem of environmental pollution is one of the most important problems of the modern era, as a result of the large number of environmental pollutants facing humans, especially human pollutants, as many pollutants are released into the atmosphere from various industrial facilities and can lead to toxic effects on humans and environment [1]. Industrial dust may

contain components of heavy metals such as arsenic, lead, copper, nickel, zinc, manganese, etc. depending on the type of industrial pollutants emitted from factories that cause dust, Pollution with heavy metals such as lead, copper and nickel is worrying and dangerous because, metals have ability to accumulate in living organisms and environment which make metals considered as a toxic nature [2]. Most workers in industrial facilities do not adhere to occupational safety precautions by wearing glasses, masks and other safety measures, and thus are directing exposed to industrial emissions such as: gases and particles of different sizes through breathing or contact [3].

Industrial processes, mining operations, incineration of solid waste and various factory wastes can lead to the release of heavy metals into the environment. The impact of heavy metals persists for many years, and they may spread into the environment, [4]. These elements may also accumulate in our body, affecting internal organs such as bones, nervous system, kidneys, brain, lung and liver. Many of these minerals may lead to cancer [5]. It was necessary to conduct this study to find out the concentration of some pollutants in the blood for the workers of Diyala state company in different work periods and also, to answer the question: does quarantine and lacking of working hours during the outbreak of the Coronavirus have an effect on the levels of heavy metals in the blood?

Materials and Methods

Samples collection

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, While, the 24 control samples were from employees working in educational institutions who do not related to industrial emissions, Ages of all

samples range between 18-59 years. These workers were divided into three groups based on the location work inside the station, 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].

Determination the concentrations of Pb, Cu and Ni

The concentration of Cu, Pb and Ni in the blood samples were determined by using the Flameless Atomic Absorption Spectrometer (FLAAS), Analylik Jena, Germany [7].

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].

Results and Discussion

A- Effect of the smoking factor on the levels of lead, nickel and copper in the blood of workers less than 1 year in the occupation:

Table (1) showed there were significant differences in the concentrations of lead, nickel and copper at the probability level ($p \leq 0.05$) between the smoking workers and the control group in Diyala State Company, where the level of lead in the blood of smoking workers (less than 1

year in service)) (1.1478ppb), Compared with the non-smokers control group (less than 1 year of service), the lead concentration was (0.2425ppb).

Table (1) also noted increasing the concentration of nickel in blood of smoking workers (less than 1 year in the profession), reached (5.7522 ppb) while the level in the control group(non-smokers) was (less than 1 year in the profession) (3.5513 ppb) with significant differences ($p \leq 0.05$). The copper concentration in the blood of smoking workers in the company (less than 1 year of service) reached (106.7278ppb) while the level reached in the control group of non-smokers (less than 1 year in profession) (7.4613 ppb), at the probability level ($p \leq 0.05$).

The explanation for the presence of significant differences in the concentrations of lead, nickel and copper among smoking workers compared to the non-smokers control group is the result of exposure of smoking workers in the company to high levels of heavy metals compared to non-smokers who work in occupations far from places of exposure to heavy metals, as well as smoking is an important factor in the bioaccumulation of heavy metals and their deposition in the various organs of the body.

The current results in table (1) showed significant differences at the level ($p \leq 0.05$) for the concentrations of lead, nickel and copper in the blood of smoking workers compared to non-smoking workers in Diyala State Company, where the concentration of lead in the blood of smoking workers reached (1.1478ppb)), while recorded (0.714286ppb)in the blood of non-smoking workers the concentration of nickel in the blood of smoking workers was (5.7522ppb) compared with the level of nickel in the blood of non-smoking workers, where which was (3.7815ppb) in the company, There are high significant differences in the concentration of copper in the blood of smoking workers compared to non-smoking workers in the company, the concentration in smoking workers reached 106.7278 ppb, while the copper level in the blood of non-smoking workers reached (39.2529 ppb) at a probability level ($p \leq 0.05$).

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The explanation of rising the heavy metals of blood in smoking workers compared to non-smokers in Diyala State Company was that smoking is a major factor in the accumulation and deposition of heavy metals in the various organs of the body, which leads to the exposure of the body to various diseases compared to non-smokers.

Table 1: The mean and standard deviation of the levels of lead, nickel and copper in the blood of workers less than 1 year in the occupation, smokers and non-smokers in Diyala State Company

Heavy Metals ppb	Less than 1 in the profession smokers n= 9	Less than 1 in the profession non-smokers n= 7	Less than 1 control non-smokers n= 8
Pb	1.1478±.49494 A	0.714286± 0.6957 AB	0.2425±.02605 B
Ni	5.7522±.76120 A	3.7814±1.32398 B	3.5513±1.43978 B
Cu	106.7278±36.04705 A	39.2529±45.08555 B	7.4613±1.81751 B
Age	24.1111±10.17895 A	22.4286±5.44234 A	24.5000±2.07020 A

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

The intensive study showed increasing in the percentage of lead, nickel and copper levels for smoking workers in Diyala State Company compared to non-smoking workers and the control group, this is consistent with the study of Viana *et al* [9], where the results of the study proved the high concentrations of lead in cigarettes was (2.460 ppb).

Some previous studies that were conducted by some researchers to evaluate carcinogens and levels of heavy metals in Brazilian cigarettes, the concentration of lead in cigarette brands was 150 ppb, while the nickel level which was (710 ppb), smokers who smoke large numbers of cigarettes are more exposed to cigarette smoke therefore can pose a greater risk of developing carcinogenic effects due to higher levels of minerals [10].

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Previous studies carried out by researchers showed that the content of lead and copper in cigarette brands was high, the concentration of lead in cigarette tobacco was (3.4ppb), while the level of copper reached (22.6ppb) [11].

Smoking accelerates the excretion of lead from the bone deposit, as 80-95% of lead is stored in the bone. Smoking increases the excretion of mineral salts, including lead, from bones, especially bones that store lead for long periods. The effect of smoking on bones is not yet fully understood [12].

B- Effect of the smoking factor on the levels of lead, nickel and copper in the blood of workers 2-20 years in the occupation:

Table (2) showed that there were significant differences in the concentrations of lead, nickel and copper at the probability level ($p \leq 0.05$) between the smoking workers and the control group in Diyala State Company, while the level of lead in the blood of smokers (2-20 years in service) was (1.1867. ppb), compared to the control group of non-smokers (2-20 years in service) where the lead level was (0.2375ppb).

Table 2: The mean and standard deviation of the levels of lead, nickel and copper in the blood of smoking and non-smoking workers 2-20 years in the occupation in the Diyala State Company

Heavy Metals ppb	From 2-20 in the profession smokers n=9	From 2-20 in the profession smokers n=10	Non-smokers control 2-20 n=8
Pb	1.1867±.57747 A	1.0250±.56514 A	0.2375±.03412 B
Ni	6.2622±1.50987 A	5.3210±.61256 A	3.5438±1.31313 B
Cu	82.6056±27.87751 A	83.1260±40.62807 A	6.7925±.97648 B
Age	41.2222±8.42285 A	41.8000±4.39191 A	30.8750±6.83348 B

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

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Table (2) presented a rise in the concentration of nickel in the blood of smoking workers (2-20 years in the profession), where its level reached (6.2622 ppb), while the level in the non-smokers control group (2-20 years in the profession) reached (3.5438 ppb) at significant differences ($p \leq 0.05$).

The copper concentration in the blood of smoking workers in the company (2-20 years in service) reached (82.6056ppb), and in the control group of non-smokers (2-20 years in the profession) reached (6.7925ppb), at the level of probability ($p \leq 0.05$).

The reason for the increase in heavy metals (lead, nickel and copper) in the blood of smoking workers in Diyala State Company compared to the control group is the result of exposure of smokers workers in the company to high levels of heavy metals, as the workers were in direct contact with heavy metals, unlike the non-smokers from control group whose occupations are in places far from exposure to heavy metals.

The current results in table 2 showed that there were no significant differences at the level ($p \leq 0.05$) in the levels of lead, nickel and copper in the blood of smoking workers compared to non-smoking workers in Diyala State Company.

The recent finding in table 2 showed that there were significant differences at the probability level ($p \leq 0.05$) in the levels of lead, nickel and copper in the blood of non-smoking workers in Diyala State Company compared to the control group, while the concentration of lead in the blood of non-smoking workers was (0.2375ppb)), However, the level in the blood of people in the control group was (0.714286ppb), while the concentration of nickel in the blood of non-smoking workers was (5.3210ppb) compared with the level of nickel in the blood of non-smokers, where its concentration was (3.5438ppb), While there were significant differences at the level of probability ($p \leq 0.05$) in the concentration of copper in the blood of non-smoking workers in Diyala State Company compared to the control group, where its concentration in

non-smoking workers reached (83,260ppb), while the level of copper in the blood of the control group (6.7925 ppb) .

The explanation for the high concentration of heavy metals (lead, nickel and copper) in the blood of non-smoking workers in Diyala State Company compared to the control group of non-smokers is the result of different workplaces and the amount of exposure to heavy metals, as well as the duration of exposure taken by the company's workers The workers during work were not wearing protective masks or suits and equipment that protect them while dealing with heavy metal sources, which makes them in permanent danger and this negatively affects their health and life compared to the control group of non-smokers who are far from heavy metal sources and their danger.

Our current study is consistent with the study conducted by Al-Ghabban, [7], on a group of smokers and non-smokers in Baghdad governorate, and the measurement of lead concentration in the blood of smokers compared to non-smokers, where the concentration of lead was in heavy smokers (3.17 ppb), while the concentration of lead in the blood of non-smokers was (1.29 ppb), a rise in the concentration of lead was found in all smokers, although no signs of lead poisoning appeared, but it indicates an increase in the absorption rate.

Previous studies carried out by some researchers to study the toxic effects of lead in the blood of workers in gas stations in Hilla city compared to the control group, where the concentration of lead in the blood of workers in the gas station reached (4.45 ppb), while the level of lead in the control group was(0.63 ppb),medium and long-term exposure to fuel, which leads to the accumulation of heavy metals in addition to increased oxidative stress due to not using face masks, during work, which increases the level of heavy metals in the blood as a result of inhaling the polluted air. Not using protective clothing and body lotion after work may also increase skin absorption and this is consistent with our current study [13].

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The heavy metals do not decompose naturally, it gradually accumulate in plants and soil. Copper, iron, manganese, and zinc cause reduced growth at high concentrations, while cadmium, nickel, lead, and chromium cause reduced growth at low accumulation levels. Heavy metals pose a number of risks to human health. Therefore, its concentration in the environment and its effects on human health must be monitored regularly [14].

A previous study revealed the presence of cadmium and nickel in tobacco smoke for some brands of cigarettes, and the concentration of nickel in some brands of cigarettes reached (7.55 ppb). The study proved that the side smoke inhaled from cigarettes directly or indirectly affects the surrounding environment and thus poses a health risk to smokers and non-smokers [15].

In one of the studies conducted by in the Shanghai region of China on a number of workers who work in copper and nickel mines, showed that 42.65% of workers be under occupational pressure, this indicates that occupational stress is prevalent among this working population. Higher level of occupational stress, The lower quality of life for miners indicates that stress is a risk factor that can reduce their quality of life, where it was found that miners workers aged 30 to 34 years had the highest level of occupational stress Copper and nickel miners workers usually work in remote locations, in a harsh working environment, with heavy and tiring tasks affecting their lives, Occupational stress affects physical and mental health, and negatively affects the ability and quality of work [16].

C- Effect of smoking factor on blood lead, nickel and copper levels for workers aged 21-34 years in the profession:

Table (3) showed that there were significant differences in the concentrations of lead, nickel and copper at the probability level ($p \leq 0.05$) between the smoking workers and the control group in Diyala State Company, where the level of lead in the blood of smoking workers (21-

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34 years in service) was (1.3570ppb), While the level of lead fo the control group of non-smokers (2-20 years in service) was (0.2350ppb).

Table 3: The mean and standard deviation of the levels of lead, nickel and copper in the blood of smoking and non-smoking workers aged 21-34 years in the occupation in Diyala State Company

Heavy Metals ppb	From 21-34 in the profession, smokers n=10	From 21-34 in the profession, smokers n=13	Non-smokers 34 - 21 control n=8
Pb	1.3570±.62174 A	1.3569±.58417 A	0.2350±.05372 B
Ni	5.3980±.72501 A	5.7038±.96435 A	2.8488±1.20174 B
Cu	79.8220±22.85881 B	102.2862±36.09088 A	7.6813±1.58974 C
Age	47.5000±5.10446 A	48.0000±4.98331 A	49.8750±2.85044 A

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

Table (3) noted increasing the concentration of nickel in the blood of smoking workers (21-34 years in the profession), was (5.3980ppb), while the level in the control group of non-smokers (21-34 years in the profession) reached (2.8488 ppb) at significant differences ($p \leq 0.05$).

The copper concentration in the blood of smoking workers in the company reached (21-34 years in service) ((79.8220ppb), while the level in the control group of non-smokers (2-20 years in the profession) was (7.6813ppb), at the level of probability ($p \leq 0.05$).

Increasing percentage of heavy metals (lead, nickel and copper) in the blood of smoking workers in Diyala State Company compared to the control group can be explained by the result of exposure of smoking workers to high levels of heavy metals, It is a normal result of the company's smoking workers being exposed to very high concentrations of heavy metals, they are in direct contact with heavy metals on an almost daily basis, This makes them to have long-

term risks and negative effects, unlike the non-smokers of the control group whose occupations are in places far from exposure to heavy metals .

The current study noted in table (3) that there were no significant differences at the level ($p \leq 0.05$) in the levels of lead and nickel in the blood of smoking workers compared to non-smoking workers in Diyala State Company, except for copper, showed on table (3) that there are significant differences at the probability level ($p \leq 0.05$) in the concentration of copper among the smoking workers compared with the non-smoking workers, and the level in the smoking workers reached 79.8220ppb)), while the concentration in the workers Non-Smokers (102.2862ppb) .

The high concentration of copper in non-smoking workers compared to smokers is the result of bioaccumulation in the blood of non-smoking workers who have 21-34 years of service, as copper is deposited in their internal organs, While, decreasing copper in the blood of smoking workers in the company confirmed the effectiveness of smoking by absorbing the copper in the intestines, which decrease the concentration of copper in the bodies of workers who smoke with the passage of time.

The current results in table (3) showed, there were significant differences at the probability level ($p \leq 0.05$) in levels of lead, nickel and copper in the blood of non-smoking workers compared to the control group in Diyala State Company. The concentration of lead in the blood of non-smoking workers was (1.3569ppb), while in control group of non-smokers was (0.2350ppb) . The concentration of nickel in the blood of non-smoking workers was (5.7038ppb) compared to the blood samples of non-smokers in the control group, which was (2.8488ppb). While, there were high significant differences in the concentration of copper in the blood of non-smoking workers compared to the control group, where its concentration in the non-smoking workers reached (102.2862ppb), while The level of copper in the control

group was (7.6813 ppb), With a significant difference at the level of probability ($p \leq 0.05$). The explanation for the high concentration of heavy metals (lead, nickel and copper) in the blood of non-smoking workers in Diyala State Company compared to the control group of non-smokers is the result of different workplaces and the amount of exposure to heavy metals, As well as the exposure period that the company's workers take while they are at work and not wearing protective masks or suits and equipment that protect them while dealing with sources of heavy metals, which makes them in permanent danger and this negatively affects their health and their lives compared to the control group of non-smokers who are far from heavy metal sources and its dangers.

A previous study carried out by some researchers on the effects of lead on smokers and non-smokers workers in the battery factory in Taiwan, the results, found the concentration of lead in the blood of smoking workers increased to (4.3ppb), while the concentration of lead in the blood of non-smoking workers was (3.71ppb) [17].

A previous study to measure the levels of lead in the blood and the health problems of lead acid battery workers in Bangladesh revealed that the concentration of lead in the blood of workers varies according to their departments, as the workers participating in the acidification process have high levels of lead in the blood (7.87 ppb), followed by those participants in the plate-making process which was ((7.357 ppb), then the workers participating in the process of opening and breaking old batteries, where the level of lead they had reached (6,677 ppb), On the other hand, the level of lead reached (3.97 ppb) in the blood of workers who were not involved in making plates or breaking batteries [18]. Previous study conducted on some nickel refinery workers noted that workers exposed to high concentrations of nickel had a higher risk of lung cancer compared to the control group [19].

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A research carried out by some scientists, to define cigarette smoking as a risk factor for the development of cataracts of eye lenses and, to determined the importance of copper, lead and cadmium in the generation of white water breed, and identified any relationship between these components. The study showed high levels of lead, copper and cadmium in heavy smokers more than their levels in non-smokers, and the concentrations of lead and copper in heavy smokers were 5.170 and 2,450 ppb, respectively. The correlation factors in cataract and normal lenses, showed significant positive correlation between copper and cadmium ($p < 0.05$), and cadmium and lead ($p < 0.05$) in cataract lenses [20].

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