Measuring the concentration of copper in the blood of people working in Al-Shaheed General Company in Iraq

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Background: The copper element plays an important and vital role in the chemistry of human organs and body, as it is involved in many vital activities. Therefore, copper lake or deficiency leads to make many health problems and defects in some of the functions of the human body. The body of any human obtains copper by adsorption throughout the daily food consumption. While the liver controlling the process of absorption, subtraction, and storage of copper. Besides, the liver also controls the concentration of copper in human blood within a certain range.

Objectives: The current study aims to obtains the average concentration of copper in the blood of people working directly with this element in copper foundries, especially people working in the copper foundry in the Al Shaheed General Company affiliated to the Iraqi Ministry of Industry, to find out the extent of the effect of direct contact between humans and this metallic element on the levels of copper concentration in the blood of those people, the target of this study.

Patients and Method: This study was conducted on the people work at copper foundry in Al Shaheed General Company located in Fallujah city. The blood samples were collected from the workers during 1/3/2024 to 1/4/2024.

Results: The results showed a noticeable increase in the concentration of copper in the blood of people working in direct contact with the industrial production of this element, which requires conducting other research studies to diagnose and know the health effects of this increase in copper concentration rates among people working in this industrial site.

Conclusion:

The results showed unacceptable concentration of copper in worker's blood therefore, more studies should be conducted on these workers to find out the health problems from this matter and more than this to find the solution.

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Keywords: Copper, Transition Metal, Human Blood

Introduction:

Among the transition elements, copper is considered to be one of the important elements and it is well-known element since an ancient time to the present. That is why one of the humanity eras went through was named after the discovery and uses of bronze, the common name of copper, which is the Bronze Age. [1] In addition, the copper element plays an important and vital role in the chemistry of human organs and body, as it is involved in many vital activities. Therefore, copper lake or deficiency leads to make many health problems and defects in some of the functions of the human body. [2-4] And also because of the presence of copper in human diet and food sources. [5] The body of any human obtains copper by adsorption throughout the daily Copper ion is an important component of many enzymes found in the human body which is can be called co-enzyme, such as amine oxidase, cyroplasmin, cytochrome c oxidase, dopamine beta-hydroxylase, hephastin, and tyrosinase, in addition to other enzymes. [1-3]

Many published articles, text-books and other types of literatures indicate that the average concentration of copper in the human body varies according to the gender, age, nutrition and the chemical content of residence place, as the average amount of copper present in the human body ranges between 1.4 milligrams to 2.1 milligrams per kilogram of human weight. [2-4] As for the rate of copper concentration in human blood, it varies according to age and gender, as the average concentration of copper in the blood of newborns ranges from 9 to 45 micrograms per deciliter, and for children up to six months of age ranges from 0.7 to 1.6 micrograms per liter, and for adult males it ranges from 104.8 micrograms per 100 milliliters and for adult females, it is about 117.1 micrograms per 100 milliliters. [5] The sources indicate that an increase or decrease in the concentration of copper from these normal rates causes disorder and ill health in the human being and in many functions in the human body.

The liver plays a vital role in controlling the concentration of copper in human blood within normal ranges by storing copper entering the body through nutrition or drinking water, or by excreting excess copper with urine. [6] On this basis, we find that the natural limit for copper concentration in human urine, it ranges from 4 to 63 micrograms per 100 milliliters. Copper deficiency in the human body leads to many symptoms and signs such as anemia, in addition to many neurological problems such as peripheral neuropathy, myelopathy, and optic neuropathy. [7] The reason for the lack of copper in the human body is due to many factors, including the genetic factor, as well as increased consumption of zinc in food and water, in addition to poor absorption of copper in the intestine. The results published in different scientific journals show that copper concentrations in human body and blood of various organisms are shown in following figure. [8, 9]

Organism	Concentration (microgram copper per one gram or one milliliter)
Brain	**3.32**
Liver	**3.47**
Kidney	**2.15**
Stomach	**1.10**
Intestines	**1.54**
Lung	**1.91**
Spleen	**1.23**
Heart	**3.26**
Bile	**3.6**
Blood	**0.85**

Methodology:

Blood samples (5ml) were drawn from people working in the copper foundry of Al Shaheed State Company - Iraqi Ministry of Industry and Minerals. Then, the blood serum was separated by centrifugation method from the drawn blood samples.

The blood serum separated from the blood samples of the subjects was modeled following the following steps [6, 7]:

1- A mixture of concentrated nitric acid (HNO_3), (2ml) and blood serum was heated in a glass beaker to dryness to digest the organic substances in the blood serum.

2- After conducting the first heating process, the baker was left to cool slightly.

3- Then (2ml) concentrated nitric acid (HNO_3) was added to the content, and the heating process was performed to the mixture again until it was completely dry, and after the completion of the second heating process, (1ml) of concentrated nitric acid was added and the heating process was repeated to completely dry.

4- Then (5ml) of concentrated (HNO_3) acid was added in fractional form, the baker was also left to cool down a little, and then (2ml) of concentrated hydrochloric acid (HCl) was added as well, then a heating process was also performed on it to the point of dryness, and from After that, the remaining concentrated hydrochloric acid (1ml) was added, then the heating process was repeated, and finally a little distilled water (100mL) was added, while the heating process continued to get rid of some toxic fumes, and then it was transferred to a volumetric flask and the volume was completed to (50ml) of distilled water with the addition of (1ml) hydrochloric acid (HCL), and the same method was followed for all models or samples, taking into account the cleanliness and dryness of glassware.

The obtained data have been analyzed by using the well-known software statistical package of Statistical Packages for Social Sciences- version 27. The data were illustrated in a simple measurement which are percentage, mean, standard deviation, and value ranges which are arranged from minimum value to maximum value.

The differences of significance of the different obtained data means, quantitative data, were tested by using the well-known method that is called Students-t-test for differences between any two independent means which is also called ANOVA test for difference among more than two independent means. Besides, the differences

significance of different values percentages for qualitative data were also tested by using the well-known method which is called Pearson Chi-square test (χ^2-test) with application of Fisher Exact test or Yate's correction whenever applicable was required. More than this, statistical significance was also considered in the analysis whenever the P value of the obtained data was less or equal to 0.05 value. [10-19]

Results & Discussion:

The results obtained in the current study showed copper concentration in blood worker in copper mine who are in direct contact with copper (Table 1, Figure 1 & 2). It was noticed that the concentration of copper is significantly higher than the normal limit (4.0664±0.6530 in controls compared to 2.4778±0.3859 in administration employee and 4.9629±0.7571 in workers) (Table 2), which makes us reconsider dealing with these results for the purpose of knowing the health, physiological and psychological effects that accompany an increase their copper concentration. [10] There is no doubt that the feeding method is not an effective cause of increasing copper concentration. Rather, direct contact with copper metal is the main cause, in addition to not dealing properly and seriously with safety equipment and not applying occupational safety conditions in the foundry. [11-13] Indeed, there is severe negligence on the part of workers in applying safety conditions and wearing special safety equipment required in such industrial sites. [14-16]

It was also noted that all workers consume food, drinks and water at the work site without any restrictions or conditions and without exercising caution, washing hands, or eating food and drinks away from the work site in rooms or places designated for these purposes, which increases the risk of contamination of the digestive system with copper. [16-17]

It was also note that the concentration of copper is significantly and significantly higher than the normal rate. Therefore, we recommend conducting more research and studies on these workers to determine the health problems that these workers suffer from, which are directly linked to the increased concentration of copper in the blood, the body, and the rest of the body's organs, as well as the vital activities of the body's systems and hormones, and various enzymes in their bodies. [18]

It is also necessary to know the main reason behind the discrepancy in copper concentration among these workers. Is it due to differences in their bodies' susceptibility, or due to differences in the percentage of exposure to copper, or due to differences in non-compliance with occupational safety guidelines? All of these matters must be researched to address them and determine their causes and effects for the purpose of benefiting from these problems in the future. [19]

Table 1: The distribution of cupper concentration in different groups.

	Cu (µmol/L)		
	Worker in	Administration	Controls
Mean±SD	4.9629±0.7571	2.4778±0.3859	4.0664±0.6530
Standard Error of Mean	0.1050	0.1114	0.1088
Range	3.4956-6.5268	1.9152-3.1365	3.0000-5.8000
Percentile 05th	3.8894	1.9152	3.0000
25th	4.3513	2.2072	3.6000
50th (Median)	4.8635	2.3068	3.9500
75th	5.5959	2.8289	4.6000
95th	6.4651	3.1365	5.3000
99th	6.5268	3.1365	5.8000
Control compared to P value	0.0001*	0.0001*	-
Administration compared to P value	0.0001*	-	-
P value comparing All	0.0001^	-	-

*The Significant difference between two independent means using Students-t-test at 0.05 level.

#The significant difference among more than two independent means using ANOVA-test at 0.05 level.

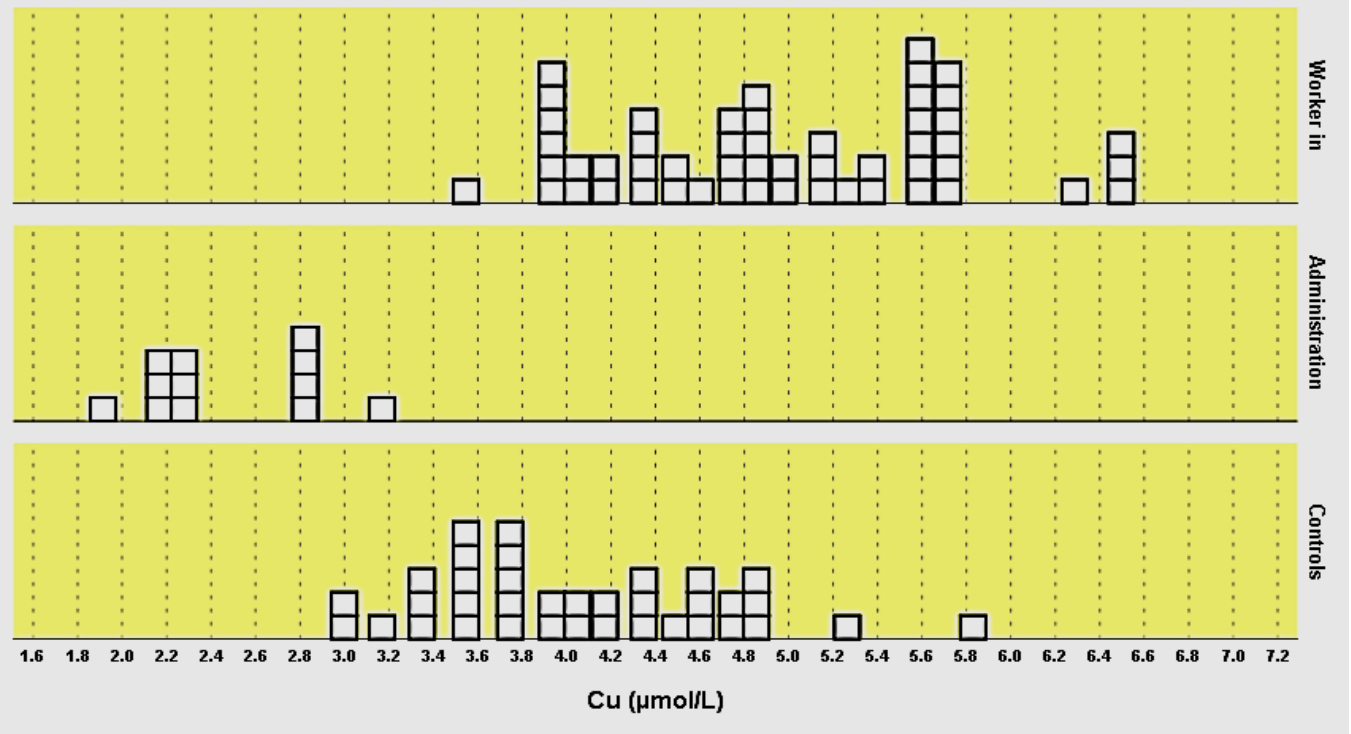

Figure 1: The distribution of cupper concentration in different groups.

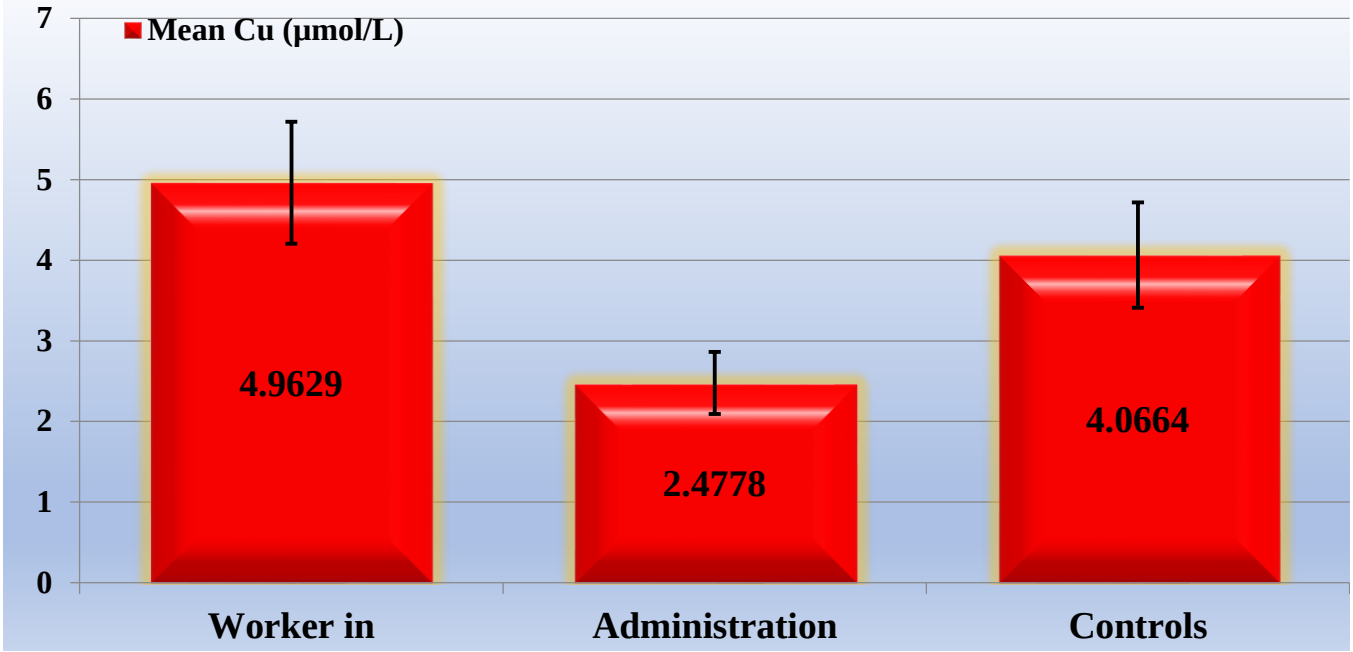

Figure 2: The mean level of cupper in different groups.

Table 2: The level of cupper according to normal level in different groups.

Cu (µmol/L)	Worker in		Administration		Controls		P value
	No	%	No	%	No	%	
Low (<1.26)	-	-	-	-	-	-	
Normal (1.26-2.44)	-	-	7	58.3	-	-	
High (>2.44)	52	100	5	41.7	36	100	

* The significant difference between proportions using Pearson Chi-square test at 0.05 level.

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