RESEARCH ARTICLE

Detecting the Concentration of Some Trace Elements in Blood Samples of Fuel Station Workers

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Received: 10th March, 2023; Revised: 20th April, 2023; Accepted: 10th June, 2023; Available Online: 25th June, 2023

ABSTRACT

Trace elements mediate critical biological events by functioning as cofactors or catalysts for numerous enzymes and as centers for enzyme and protein structure stabilization. As a result, imbalances in trace element metabolism and homeostasis (deficiency or excess) may play a role in a number of disorders. The aim of this study was to investigate the blood concentration of essential trace elements of fuel station workers blood in AL-Ramadi city compared with any people who didn't work in fuel station (control) by measurement of zinc (Zn), copper (Cu), iron (Fe) because they have negative effects on metabolism and considered to be carcinogenic factors.

Total 50 male fuel workers and 50 control from ten fuel stations at Al-Ramadi City- Iraq, were participated in the present study. The levels of Zn, Cu and Fe in serum were measured spectrophotometrically by using laboratory kits.

The result clarified that there was a significant increase in zinc, copper and iron mean ($p<0.05$) in fuel workers group compared to control group. Age had a significant correlation with copper levels and no correlation with zinc and iron. The daily hours of exposure showed no significant correlation with zinc, copper and iron. There was a significant increase in zinc levels in smokers compared to nonsmokers; copper and iron showed no correlation with smoking. The years of work in fuel stations significantly correlated with zinc and copper levels, while it showed no correlation with iron levels. The results of this study showed that there is no significant correlation between zinc, copper and the worker's weight, while it showed a significant weak positive correlation between iron and the worker's weight ($p<0.05$). There was a significant increase in copper levels in the workers with chronic illnesses compared to healthy workers, while zinc and iron had no correlation with chronic illnesses.

The conclusion of study is the role of the increase of trace elements on the health of the fuel workers group, attention to use of safety gloves and face mask is recommended for fuel workers and a long follow-up to the studied group is necessary to discover the developments. Also, it is highly recommended to reduce the working hours for fuel workers in order to decrease the accumulative effects of benzene exposure and to allow the body to detoxify the blood.

Keywords: Trace elements, Blood samples, Pharmaceutics, Pollutants.

International Journal of Drug Delivery Technology (2023); DOI: 10.25258/ijddt.13.2.19

How to cite this article: Alhadithi AQ, Kadhim F. Detecting the Concentration of Some Trace Elements in Blood Samples of Fuel Station Workers. International Journal of Drug Delivery Technology. 2023;13(2):584-590.

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

In most towns and cities, air pollution has increased as a result of urbanization and the rapid increase in the number of automobiles. Numerous epidemiological studies have demonstrated lung function impairments and other health concerns linked to long-term air pollution exposure.[1]

People are exposed to gasoline fumes while fueling and recharging at gas stations, but gas station workers are at higher risk due to their work environment.[2] As a result, spotting on gas station employees who are exposed to gasoline on a regular basis seemed required.[3]

Benzene is a substance that is widely found in the environment. The main sources of benzene in the environment are industrial operations. Emissions from coal and oil burning, benzene waste and storage operations, motor vehicle exhaust, and evaporation from gasoline service stations can all raise benzene levels in the air. Tobacco smoke is another source of benzene in the air, particularly indoors. Water and soil surfaces can release benzene into the air. Benzene combines with other chemicals in the air and breaks down within a few days. Rain or snow can also drop benzene in the air on the ground.[4]

The term "heavy metals" has a few different definitions. Metals and metalloids with relatively high densities (greater than 5 g/cm^3), bio-accumulative potential along the food chain, and usually severe toxicity to living creatures are referred to as bio-accumulative metals and metalloids. Some

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academics propose that the phrase "heavy metals" be replaced with "possibly harmful components".[5] This group comprises toxic metals, including cadmium (Cd), lead (Pb), nickel (Ni), chromium (Cr), mercury (Hg), and metalloids, such as arsenic (As), from both natural sources and industry. It is well known that exposure to xenobiotic metals can cause gastrointestinal, respiratory, cardiovascular, reproductive, renal, hemopoietic, and neurological disorders.[6,7] Some heavy metals promote the growth of malignancies and limit their sensitivity to treatment through several pathogenetic connections.[8,9] It is worth mentioning that simultaneous exposure to a mixture of xenobiotics (heavy metals, pesticides, and other toxins) may have a cumulative effect.[10,11] The permissible level units of different heavy metal ions, set by World Health Organization (WHO) and European Medical Agency (EMA), range from ppt to ppm. Arsenic (As), cadmium (Cd), lead (Pb) and mercury (Hg) are within the 10 chemicals of major public health concern.[12]

Some elements such as copper, zinc, selenium, and manganese are essential at trace levels. "Trace" is defined as concentrations from 10 to 104 μg/L in blood or serum. Excessive exposure to any element can be harmful. Essential trace element metabolism disruption can have an impact on growth, health, and development. Some elements are also of interest since their metabolism is linked to a number of disorders (e.g., Wilson's disease, hemochromatosis, and thalassemia).[13]

MATERIALS AND METHODS

A-Test group: Blood samples were collected from 50 fuel workers who work in fuel stations and were exposed to different fuel derivatives. The mean age of fuel workers was (36.44 ± 10.5) years, the mean of the time of exposure was (9.16 ± 2.972) hours, the mean of the years of work was (12.80 ± 7.725) years and the mean of weight was (84.14 ± 16.010) kg. Questionnaires were precisely filled. The samples were collected from ten fuel stations located in Al Ramadi city-Iraq.

B-Control group: 50 healthy adult males were selected as a control group. The mean age of control group was (26.6 ± 6.02) years.

Measurements

Venous blood was collected from all subjects by vein puncture and 5 mL disposable syringe were used, then 4 mL of blood from each were transferred into a gel tube and allowed to coagulate. Serum was separated by centrifugation at 3000 rpm for 10 minutes. The serum was divided into two plain tubes measured spectrophotometrically the concentrations of zinc, copper and iron using laboratory kits. The serum samples were stored at -20°C until analyzed.

Statistical Analysis

- Statistical analysis was carried out using a statistical package for social sciences SPSS version 24 and Excel 2016.
- Student t-test was used for testing the significance of mean difference between numerical variables.
- Correlations between the two numerical variables were examined using Spearman's correlation analysis.
- The data presented by line charts were also used.
- A level of *p-value* less than 0.05 was considered significant.

RESULTS

The Effect of the Exposure to Benzene on the Trace Element Variables Compared with Control Group

This result clarified that there was a significant increase in zinc, copper and iron mean in fuel workers group compared to control group (102.14 ± 20.8 and 91.96 ± 20.4;158.32 ± 24.4 and 127.28 ± 26.2; 119.46 ± 79.4 and 88.110 ± 34.1 μg /dl) *p-value* was 0.0012, 0.001, 0.0012 respectively (Table 1).

The Effect of Some Factors on the Blood of Fuel Workers

Factors that may affect hematological and serum biochemical parameters might include age, time of exposure, smoking habit, years of work, weight and disorders like diabetes mellitus, hypertension or both.

Age Effect on the Trace Element Variables

The current study showed that the copper value significantly increased with age (weak positive correlation $p<0.05$) while it showed no significant correlation between zinc and iron with fuel worker's age Figure 1.

Time of Exposure (hrs.) Effect on Trace Element Variables

The results of this study showed no significant correlation between time of exposure and zinc, copper and iron (*p-value* = .122, .873 and .715), respectively, Figure 2.

Smoking Effect on Trace Element Variables

The results in this study showed a significant difference that the mean value of zinc was larger in smokers than nonsmokers

Table 1: The mean difference of trace element variables between test and control

Trace element variable		*Mean ± SD*	*p-value*
Zinc	control	91.96 ± 20.422	0.012
	test	102.14 ± 20.885	
Copper	control	127.28 ± 26.296	0.001
	test	158.32 ± 24.477	
Iron	control	88.110 ± 34.1182	0.012
	test	119.464 ± 79.4477	

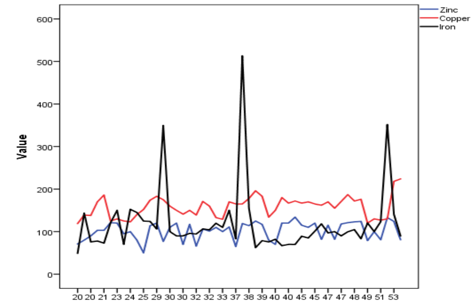

Figure 1: Relationship between age and trace element variables

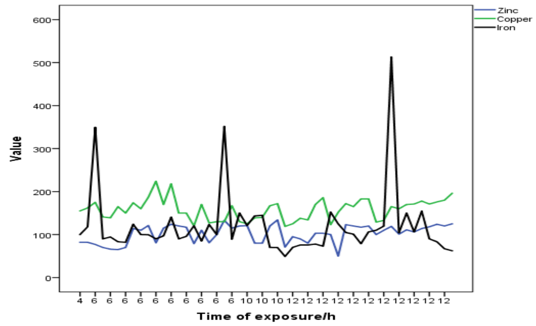

Figure 2: Relationship between time of exposure and trace element variables

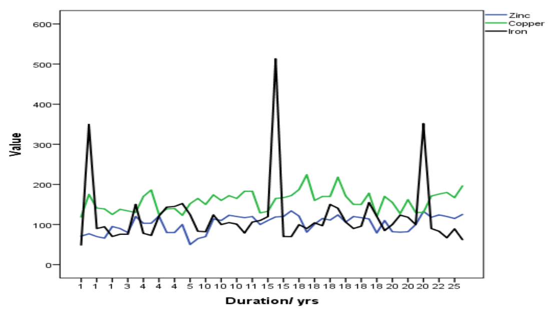

Figure 3: Relationship between duration of works and trace element variables

(p-value =0.001), the mean of zinc in smokers and nonsmokers was (106.93 ± 15.884 and 96.52 ± 24.742 µg /dl) respectively, while it showed no significant difference in mean value of copper, the mean of copper in smokers and nonsmokers was (158.26 ± 20.963 and 158.39 ± 28.549 µg/dl), respectively and no significant difference in the mean value of iron, the mean of iron in smokers and nonsmokers was (117.359 ± 82.65and 121.935 ± 77.28 µg/dl), respectively Table 2.

Table 2: difference of mean value of trace element variables between smokers and nonsmokers

	Smoke	*Mean ± Std. Deviation*	*Std. error mean*	*p-value*
Zinc	Yes	106.93 ± 15.884	3.057	0.001
	No	96.52 ± 24.742	5.159	
Copper	Yes	158.26 ± 20.963	4.034	0.1
	No	158.39 ± 28.549	5.953	
Iron	Yes	117.359 ± 82.6518	15.9063	0.5
	No	121.935 ± 77.2866	16.1154	

Table 3: Correlation between duration of works and trace element variables

Trace element variables		*Duration/years*
Zinc	Pearson Correlation	.479
	Sig. (2-tailed)	.000
	N	50
Copper	Pearson Correlation	.401
	Sig. (2-tailed)	.004
	N	50
Iron	Pearson Correlation	-.021
	Sig. (2-tailed)	.884
	N	50

Table 4: Correlation between workers weight and trace element variables

Biochemical variables		*Weight*
Zinc	Pearson Correlation	.233
	Sig. (2-tailed)	.104
	N	50
Copper	Pearson Correlation	-.165
	Sig. (2-tailed)	.251
	N	50
Iron	Pearson Correlation	.347
	Sig. (2-tailed)	.014
	N	50

Duration (years of work) Effect on Trace Element Variables

The results of this study showed significant weak positive correlation between zinc, copper and years of work (*p-value* <0.001, 0.004, respectively), while there is no significant correlation between iron and years of work (Table 3 and Figure 3).

Weight Effect on Trace Element Variables

The results of this study showed that there is no significant correlation between zinc, copper and the workers weight (*p-value* = .104 and .251), respectively, while it showed significant weak positive correlation between iron and the workers weight *p-value* =0.014) (Table 4, and Figure 4).

Health Condition Effect on Trace Element Variables

The results of this study showed a significant difference in copper value (*p-value* =0.001), the mean of the workers who had positive health conditions (had some disease like diabetes or hypertension) and the mean of those who had negative health conditions (no disease) (175.50 ± 52.5 and 156.83 ± 20.9 µg/dl) respectively. At the same time, there is no significant difference in zinc value, the mean of the workers who had positive health condition (had some disease like diabetes or hypertension). Those who had negative health conditions (no disease) (109.50 ± 23.5, 101.50 ± 20.8 µg/dl), respectively and showed no significant differences in iron value, the mean of the workers who had positive health condition (had some disease like diabetes or hypertension) and those who had negative health condition (no disease) (170.500 ± 122.6, 115.026 ± 74.9 µg /dl), respectively Table 5.

DISCUSSION

The significant increase in zinc and copper levels in this study[14] while the increase in iron levels was inconsistent with the result[15] which showed a significant decrease in iron. These differences may be due to methods that had been used

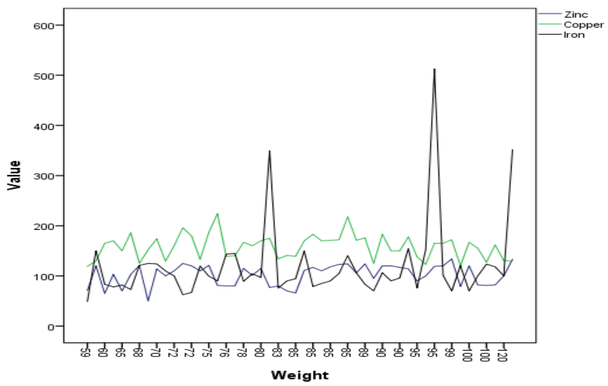

Figure 4: Relationship between workers weight and trace element variables

in different lifestyle and nutritional habits, so the exposure to benzene is significant on the trace elements level.

According to certain research, numerous trace elements have diverse functions in body metabolism, chronic hyperglycemia, and cellular homeostasis.[16-18] Trace element imbalances have been linked to the development of cardiovascular disease (CVD), including hypertension.[19]

Recent studies on the relationship between exposure to petroleum products and trace metal status and liver toxicity in gasoline-filling workers found that liver enzymes and serum Cu and Zn levels are elevated, implying that long-term exposure to petroleum products may increase the risk of liver toxicity.[20]

Chronic low-level hazardous metal exposure is a growing global issue. The signs of toxic metal deposition are many and nonspecific, and overt manifestations of toxic consequences may not show until later in life.[21]

The significant correlation between copper value and workers' age is inconsistent with the results of[14] which showed no significant correlation between copper and the workers age. The result was similar to the study conducted by,[22] which showed a non-significant correlation between zinc, iron level and the worker's age.

Trace elements (TEs) mediate critical biological events by functioning as cofactors or catalysts for numerous enzymes and as centers for enzyme and protein structure stabilization. As a result, imbalances in trace element metabolism and homeostasis (deficiency or excess) may play a role in a number of disorders.[23] Despite earlier research indicating a relationship between various TEs and major age-related chronic illnesses such as type 2 diabetes (T2D), cardiovascular disease (CVD), and cancer.

Copper aids in the maintenance of the immune system. This trace element is strongly associated with blood immune cell activities such as natural killer (Nk) and T helper (Th) cells, which are necessary to eradicate viral infections and manufacture antibodies. Cu's recommended daily ingestion (RDI) is 0.90 mg/day.[24]

However, because the interplay of trace elements (TEs) is poorly understood, beneficial or negative effects observed in observational studies could be the result of other linked TEs or their interaction. For example, serum copper concentrations are strictly regulated by compensatory mechanisms that keep them within certain nutritional intake ranges. This changes under inflammatory conditions where specific mechanisms decrease serum concentration of (Zn) and increase serum concentration of Cu. As a result, a rise in the Cu-to-Zn ratio appears to be a common characteristic of various age-related chronic disorders.[25]

Table 5: Difference of mean value of trace element variables between workers who had positive and negative health condition

Trace element variables	*Health condition*	*Mean ± Std. Deviation*	*p-value*
Zinc	negative	101.50 ± 20.801	0.8
	positive	109.50 ± 23.558	
Copper	negative	156.83 ± 20.963	0.001
	positive	175.50 ± 52.596	
Iron	negative	115.026 ± 74.9514	0.1
	positive	170.500 ± 122.6972	

Age is connected with a decline in the zinc concentration of the organism. In particular, less than half of the elderly obtain the essential quantity of zinc equal to the recommended dietary allowance (RDA).[26]

The result of this study was similar to the results[27] which showed a significant increase in zinc levels in smokers group, while the non-significant differences in copper, iron levels between smokers and nonsmokers groups were agreed with the results.[28,29]

The scientific literature has evidence of the adverse health consequences of chemical compounds and gases released by tobacco smoke. Cigarettes are also widely recognized for producing a huge quantity of oxidants. Many studies now connect cigarette smoking to increased morbidity and death from cardiovascular disease, cancer, and chronic obstructive pulmonary disease.

Several studies have demonstrated tobacco smoking to influence trace element metabolism.[30] Because trace elements are required in tiny amounts as an important component of antioxidative enzymes (cytoplasmic Cu-Zn-superoxide dismutase comprises copper and zinc metals as cofactors), tobacco use can impact its activity, hence indirectly affecting trace elemental metabolism.[31]

Increased zinc levels are linked to chronic impacts such as poor copper status, altered iron function, decreased immunological function, and lower levels of high-density lipoproteins.[32] The increase in zinc, copper levels with the increasing of the years of the work[20] while the study of[33] showed that there is no correlation between Zn, Cu and the years of work.

The detected rise in serum Cu and Zn might be ascribed to an increase in free-form release following protein oxidation caused by long-term exposure to gasoline fumes.[34]

The result was similar to those conducted,[15] which showed no correlation between iron levels and years of work.

Risk of benzene exposure is mostly related to four main components; benzene, toluene, ethylene and xylene (known as BTEX.[35] However, because of the mutagenic and carcinogenic effects of its metabolites, benzene was shown to be the most dangerous component.[36]

Long-term and moderate benzene exposure raises the risk of a number of health problems, including inorganic elements.[37]

Exposure to fuel products regularly or extendedly is more representative of the occupational norm. Research shows frequent cutaneous contact with fuel causes skin irritation.[38] The health consequences of long-term exposure to fuel derivatives are determined by a variety of parameters, including the concentration of the chemical component and the duration of exposure. Contact with gasoline vapors may cause a variety of ailments, including headaches, nausea, and respiratory tract allergies.[15]

Recently, emphasis has been placed on the need to incorporate co-exposure to many toxicants into epidemiological research[39] as failure to capture potential interactive effects of exposure may prevent understanding the enteropathogenic mechanisms related to many nutritional disorders.[40]

The result was close to the results conducted[15] that showed no correlation between zinc, copper levels and the worker's weight. At the same time, they found no correlation between iron levels and the workers weight. Still, this result disagreed with the result of this study that showed an increase in iron levels with the increase of the worker's weight. These differences may be due to nutritional habits or different lifestyles.

Trace elements are extremely important in the control of proper human metabolism because they interact with several enzymes and hormones. Some investigations found that increasing body weight was associated with higher iron levels. As a result, iron reserves may be sequestered, rendering them unavailable for hemoglobin or myoglobin production. Over secretion of these proteins (hepcidin and lipocalin 2) increases iron accumulation in adipose tissue, laying the groundwork for the negative consequences of local iron overload; iron is capable of producing oxidative stress, inflammation, and endocrine dysfunction in adipose tissue.[41]

The copper value in the workers who had some disease like diabetes mellitus larger than the copper value in the workers who had no disease so there is a correlation between copper and the health condition of the workers, which was confirmed.[42,43]

The non-significant increase in the zinc, iron values were close to the results conducted.[42]

Chronic diseases such as diabetes and hypertension are important causes of death in the modern era.[44]

The increase in copper ion levels in diabetes mellitus patients may be due to hyperglycemia, which may enhance glycation and release of copper ions, increasing oxidative stress and producing advanced glycation end products, which are involved in the pathogenesis of diabetic complications.[45] Copper-like transition metal has greater affinity to attach with glycated proteins. In our study there is higher level of copper in patients of DM which correlates with other studies.[46,47]

Early trace element imbalances in type 2 diabetes mellitus (T2DM) generate increased oxidative stress, which may contribute to the development of T2DM and raise the risk of diabetic complications.[48]

Numerous studies have been conducted to investigate the relationship between trace elements and T2DM since their supplementation has been demonstrated to increase insulin sensitivity.[49] Trace elements have been demonstrated to improve insulin's ability to lower blood glucose levels.[17]

CONCLUSIONS

Zinc, Copper and Iron levels were significantly increased in the fuel workers group compared to the control group.

The copper level increased as the age of the workers increased.

The workers who have a smoking habit have a significant increase in their zinc levels.

There was a significant correlation between zinc and copper levels with the years of work in fuel stations.

There was a significant increase in iron levels with the increase in workers' weight.

There was a significant increase in copper levels in the workers who have a disease.

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