

## The effect of physical exertion on the concentration of copper and blood pressure in athletes

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### Abstract

**Background and Study Aim** Several mineral elements are necessary for the athlete's body, which significantly impact the development of sports achievements because of their active role in bringing internal balance to the athlete's body. The study aims to determine the concentration of copper in the blood before and after the implementation of physical exertion at a level of 180 pulse/min on middle-distance runners.

**Material and Methods** Twelve athletes who are team members at Egyptian clubs were chosen deliberately as a research sample. The study participants were at the end of their special preparation. The experiment was conducted between July 12, 2021, and July 14, 2021, on the research sample, resting after exerting physical effort by running on a treadmill at a speed of 10 km / h. The runner continued at this speed for 3 minutes, after which the device's speed increased by 2 km / h every minute until reaching a heart rate of 180 pulse/ min.

**Results** The mineral differences in the copper element are attributed to the immediate induced by physical exertion by increasing the copper element in the blood within the normal level. This causes many changes and responses within the body cells. The copper element plays a significant role in oxidation and reduction processes via enzymes that require the copper element to produce energy in the cells and tissues due to the body's exposure to physical exertion. Athletes' exposure to physical exertion causes copper-dependent enzymes to produce energy in cells and tissues due to the element's requirement.

**Conclusions** Copper affected the physical effort of middle-distance runners at a heart rate of 180 pulse/min. In addition, Middle-distance runners' blood pressure (systolic and diastolic) was affected by the physical exertion at a heart rate of 180 rpm.

**Keywords:** copper, blood pressure, athletes, physical exertion

### Introduction

Mineral elements are essential for an athlete's body because they are vital in bringing internal balance to the athlete's body, significantly affecting athletic achievements [1]. Therefore, modern techniques are used to measure and determine the proportions of mineral elements to support the movement of progress, and the events of a state of development increase the level of responses of the cells in athletes [2]. Reaching high athletic levels requires consistent training over a long period to any of the body's responses [2, 3, 4, 5]. Copper is a component of many proteins and enzymes that perform critical biological functions in the cells and contribute to maintaining their homeostasis [2]. It is a necessary metal for living things, but it is also potentially toxic to cells due to its ease of oxidation as a free ion [6]. Therefore, to perform their essential functions, copper-dependent metalloproteins,

such as antioxidants, the copper ion must be compartmentalized and present in appropriate intracellular and extracellular concentrations [7].

This mineral's deficiency and excess can both harm cellular integrity and functionality. A sufficient copper intake is required to ensure athletes perform well [8]. Other nutrients, such as iron and zinc, may adversely affect copper homeostasis and harm the antioxidant function when consumed in excess [9]. Athletes frequently use nutritional supplements that do not adequately consider copper supply, which may jeopardize copper's essential role during physical activity [10]. Intense physical exercise increases the release of reactive oxygen species and may affect copper homeostasis. Several factors influence the levels of metalloproteins, serum copper, and physical activity [11].

Trace minerals (TMs) are necessary for the human body due to several biological functions that could be directly or indirectly involved during different physiological processes that can be altered as adaptation mechanisms to endurance exercise

[12, 13, 14, 15]. Changes in blood pressure during any athletic event are one of the physiological mechanisms by which the cardiovascular system provides oxygen to the exercising muscles. Blood pressure in healthy normotensive men never exceeds safe levels during strenuous exercise [16]. However, the evidence for a correlation between serum copper and blood pressure (BP) has been inconsistent or contradictory, and most studies have been conducted in adult populations [17]. Therefore, the subjects with high blood pressure who wishes to participate in competitive athletics should proceed with caution. Although this problem has recently received much attention, information on the effects of muscular exercise on human blood pressure is primarily limited to laboratory tests.

#### *Purpose of the Study.*

- To evaluate the concentration of copper in the blood before and after the implementation of physical exertion at a level of 180 pulse/min on middle-distance runners.
- To determine the blood pressure before and after the implementation of the physical effort at a level of 180 pulse/min on middle-distance runners.

## **Materials and Methods**

### *Participants*

Temporal domain: From July 1, 2021, to July 29, 2021.

The research sample was chosen deliberately, as it included 12 athletes who are members of Egyptian club teams.

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Suez Canal University (approval number 121/2021). All participants provided written informed consent.

### *Research Design*

The researchers used the descriptive approach using the survey method.

### *Devices and tools used in the research*

The following devices and tools were used:

- 1- Atomic absorption spectrometry
- 2- The treadmill device
- 3- Blood pressure measuring device
- 4- Medical scale for measuring weight and height
- 5- Cooling case
- 6- Plastic tubes, medical syringes, cotton, and sterile material
- 7- stethoscope

### *Body Measurements*

The subjects' height and weight were measured using a medical scale, and their height and weight were recorded

### *Functional measurements*

- 1- *Copper element measurement*

Blood samples were collected from subjects before and after exerting physical effort at a rate of

180 pulse/min, then the samples were chemically digested and prepared for measurement in the atomic absorption spectrometer. Afterward, the results were compared with the calibration curve to measure the concentration of copper in the blood.

- 2- *Heart rate measurement*

The heart rate of the research subjects was measured only at rest and for 30 seconds x 2.

- 3- *Arterial blood pressure measurement*

Blood pressure was measured before and after physical exertion at a rate of 180 p/min directly on the research sample.

- 4- *Conducting the experiment*

The main experiment was conducted between July 12, 2021, and July 14, 2021, on the research subjects in a resting position and after exerting physical effort by ascending the athletes on the treadmill.

Moving at a speed of 10 km / h, where the jogger continues at this speed for 3 minutes, and then the speed of the device increases every one minute 2 km / h until it reaches a heart rate of 180 pulse/ min, after which the assistant staff was prepared.

### *Statistical Analysis.*

Data were fed into the computer and analyzed using IBM SPSS software version 20.0. (Armonk, NY: IBM Corp). The Kolmogorov-Smirnov was used to verify the normality of the distribution of variables. Paired t-test was used to compare two periods for normally distributed quantitative variables. The significance of the obtained results was determined at 5% level.

## **Results**

The variables heart rate, height, weight, and age at rest are represented by the mean, standard deviation, and coefficient of variation. The researchers tested the homogeneity of the research sample, as shown in (Table 1), where the coefficient of variation for the variables is less than (25 %), indicating the homogeneity of the research sample. The results of copper and blood pressure before and after implementing physical effort are displayed in (Table.2).

Table 1 displays the arithmetic mean, standard deviation, and the calculated and tabulated T value for the copper, systolic, and diastolic pressure variables before and after implementing the physical effort.

The calculated (T) values for copper metal, systolic pressure, and diastolic pressure were (6.72) (11.98) (3.394), which is greater than the tabular (T) value (2.015) below the level, as depicted in (Table 2). (0.05). When the heart rate reaches 180 rbm, there are significant differences between the dimensional effort of each copper element and the systolic and diastolic pressures.

**Table 1.** Demographic data for the study sample

Variables	Arithmetic medium	Standard deviation	Variation coefficient
Heart rate/min	55.12	3.76	6.21%
Length/cm	169.01	4.31	3.01%
Weight/kg	58.22	5.52	9.22%
Age/year	23.14	1.75	6.29%

**Table 2.** Relationship between elements before and after physical effort

Variables	Physical effort		The standard deviation of differences	Standard error	T Value	P-value	Statistically significant
	Before	After					
Copper element $\mu$ /100ml	85.2	99.33	4.11	1.28	6.72	0.038	Sig.
Systolic pressure mm Hg	118	177	12.06	4.03	11.98	0.0102	Sig.
Diastolic pressure mm Hg	65	78	5.14	2.01	3.394	<0.0001	Sig.

The statistical test used: Two sample T-test; p-value<0.05 considered statistically significant (95% confidence interval).

### Discussion

The mineral differences in the copper element are attributed to the immediate induced by physical exertion by increasing the copper element in the blood within the normal level. This causes many exchanges and responses within the body cells. The copper element plays a significant role in oxidation and reduction processes via enzymes that require the copper element to produce energy in the cells and tissues due to the body's exposure to physical exertion.

Furthermore, the copper element accelerates the absorption of iron by hemoglobin, which plays a vital role in the process of oxygen transport, which combines with iron to provide oxygen to the working muscles and produce the energy during the physical effort in the research sample. Copper-binding enzymes influence the process of energy production within cells. Copper is released from its storage site into the bloodstream in significant amounts due to muscular effort. Increase iron absorption to compensate for the deficiency and increase the rate of oxygen transport by increasing iron absorption.

Based on the research findings, hemoglobin in the blood works to deliver oxygen in combination with iron to the working muscles through the arteries and blood vessels. Consequently, it was necessary to have a metal that works to regulate the balance in the internal environment through which some related interactions are controlled in energy production during continuous training for middle-distance runners [13, 14, 15]. The mineral differences are attributed to the physical effort at a rate of 180 pulse/min, which imposes a burden on the members of the research sample by increasing the blood concentration [18]. This causes a long-lasting blood viscosity in sports, which is reflected in the increased

resistance to blood flow in the blood vessels, including an elevation in blood pressure [systolic and diastolic). This is reflected in the increase in the effects and responses made by the heart muscle to ensure the muscles' need for oxygenated blood and to produce the energy required for these muscles to continue working during physical exertion.

These findings are consistent with the findings of the Lamberts study in that the long-distance athlete had elevated blood pressure after exerting an effort for a period of [10 minutes) on a moving treadmill [19, 20]. Due to the significant correlation between blood concentration and blood viscosity, blood concentration is one of the most important physiological factors in exercising [21, 22]. Sporting activity increases the density and turbulent blood flow in the blood vessels due to the increased speed of the general flow throughout the circulatory system [23, 24].

### Conclusions

- 1- The study aimed to determine the concentration of copper in the blood of middle-distance athletes before and after the implementation of physical activity at a pulse rate of 180 per minute. The average increased from 85.2/100ml before the effort to 99.33/100ml after the effort, according to the results. In addition, copper levels in the blood rose but remained within normal parameters. Due to the increased exposure of athletes to physical exertion, the body undergoes numerous exchanges and responses, including copper, which plays a significant role in oxidation and reduction processes via enzymes that require copper to produce energy in cells and tissues.
- 2- Blood pressure before and after the implementation of physical effort at a rate of

180 beats per minute in athletes leads to an increase in the effects and responses made by the heart muscle to meet the oxygenation needs of the muscles to continue functioning.

- 3- Our study found a positive and nonlinear association between serum copper and elevated blood pressure in athletes.

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The authors of this original article. Collected, organized, and analyzed all of the data utilized in this article and concluded from the results of the data analysis.

## Conflict of interest

The authors declare no conflicts of interest.

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