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*RESEARCH ARTICLE - PHYSICS*

# The Effect of Age on Copper and Zinc Concentrations in Blood Serum among Medical Radiological Workers and the Control Group

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**Abstract**

This study aimed to evaluate the effect of age on serum copper and zinc levels in medical radiation workers, compared to the control group. Copper and zinc concentrations were measured using the atomic absorption spectrometry (AAS) technique on blood samples from 161 participants, 81 of whom were radiation workers and 80 were in the control group. The findings indicate significantly higher zinc and copper concentrations among radiation workers across all age groups compared to the control group.

For zinc, the maximum concentration in radiation workers was observed in the youngest age group (20-29) at 1.7809 mg/L, with an average of 0.9242 mg/L, while the control group recorded 0.6191 mg/L and 0.4546 mg/L for maximum and average concentrations, respectively. The concentration values in radiation workers showed a broader range of variation in younger age groups but were more stable in older groups. For copper, the highest concentrations were also noted among radiation workers, with a maximum of 1.5113 mg/L in the youngest group and an average of 0.4391 mg/L, compared to 1.3123 mg/L and 0.4779 mg/L in the control group. Interestingly, copper concentrations among radiation workers increased with age, reaching an average of 1.0593 mg/L in the 40-49 group, while control group values declined with age.

These findings suggest that occupational exposure to medical radiation may contribute to elevated zinc and copper levels in blood serum. The impact appears to be age-dependent, with younger individuals showing more pronounced increases in zinc, while copper concentrations accumulate over time in older radiation workers. Further studies are recommended to explore the potential health implications of these changes.



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***Keywords:*** Age, copper, zinc, ionizing radiation, medical radiology workers.

## 1. Introduction

The growing significance of the use of advanced technologies in medicne for the diagnosis and remedy of clinical conditions calls for dedication and competence from experts in medical radiation [1]. Due to the growing use of these technologies, employees are exposed to radiation doses [2,3] that can change the concentration of some elements of their bodies because of this exposure [4]. The body requires essential elements, including trace elements such as zinc and copper, to perform its vital functions effectively [5]. Copper is essential for power production, oxygen delivery, connective tissue creation, enzyme characteristics, and numerous organic features [7,6].

Zinc additionally has many capabilities, along with repairing DNA and cell reproduction by appearing as a cofactor for 300 enzymes and growing the immune reaction [8,9]. Because zinc has beneficial properties, it helps the body combat and do away with infections [10]. Therefore, copper and zinc are important in maintaining critical herbal physiological methods and have results on human fitness.

It is necessary to degree the awareness of these elements in the body. To ensure the safety of people and investigate their potential risks [11]. The use of superior strategies in detecting elements inductively coupled plasma spectrometry and atomic absorption spectrometry (AAS) has given promising outcomes in measuring the concentrations of heavy elements and semiconductors, even very small amounts of them in dietary supplements and various meals [12-14]. Testing blood serum samples for an exam is taken into consideration as a biomarker for detecting element concentrations, because elements tend to build up in tissues together with blood. Using those blood serum samples allows researchers to evaluate the health risks for employees within the discipline of radiation and understand the biological effects of radiation [15-17].

This study reviews the cross-sectional evidence on the effect of radiation exposure in the clinical setting on the levels of essential elements (copper and zinc) in blood serum samples. It will also highlight the changes and their impact on the general physical fitness of workers in the field of scientific radiation while reviewing the necessary preventive measures to maintain their safety and health.

## 2. Material and method

This study included 81 medical radiologists who work in the radiology and radiotherapy unit and are regularly exposed to low doses of ionizing radiation in three hospitals in Al-Najaf government: Al-Najaf Al-Ashraf Teaching Hospital, National Hospital for Oncology and Hematology, and Amal Al-Hayat Hospital. This study also included 80 non-medical radiologists (control group) from the same hospitals. Three milliliters of freshly drawn blood was obtained from each participant and placed in a dry, sterile test tube free of any anticoagulant. For clot formation, the test tube was left at ambient temperature (22 ± 2℃) for 45 minutes [18-20]. Centrifugation was used to separate the sera from different patients, which were then collected in test tubes with screw caps. Ideal conditions for the digestion of biological materials include a mixture of $HNO_3$and $HCLO_4$ at a temperature of 120 °C [21]. Atomic absorption spectrometry (AAS) is a sensitive technique used to identify more than 60 elements [22]. It is widely used in various fields, including clinical chemistry, for the quantitative assessment of essential and non-essential components in body fluids and tissues. AAS provides excellent elemental selectivity and has documented methodologies for various samples and matrices [23]. The technique uses a measurement design with a linear source, allowing simultaneous determination of only one element [24].

## 3. Results and Discussions

The results of this study, which was conducted on workers in the field of medical radiology, included 161 sample ,81 from workers in the radiation field and 80 a control group from the workers in hospitals, as seen Table 1.

**Table 1**. Classification of sample dependent on age.

| **Worker** | **(20-29)** | **54.32 %** |
|---|---|---|
| | (30-39) | 37.03% |
| | (40-49) | 8.64 % |
| **Control** | (20-29) | 70 % |
| | (30-39) | 22.5 % |
| | (40-49) | 7.5 % |

From Table (1), it is clear that the samples is classified according to age, as the age group (20-29) represents 54.32 % of those workers in the field of radiology and 70 % of the control group, while the age group (30-39) from the workers represents 37.03% and 22.5 % of the control group, and the age group (40-49) represents 8.64 % of the workers and 7.5 % of the individuals in the control group.

### 3.1 Zinc concentration

The zinc concentration values for the age group (20-29) were as shown in Table (2), where the maximum value was 0.6191 mg/L in the control group, while the maximum value for medical radiation workers was 1.7809 mg/L. The minimum value was 0.00004 mg/L in the control group, while it was 0.0493 mg/L in radiation workers.

The average was 0.4546 mg/L in the control group, while it was 0.9242 mg/L in workers, indicating a higher zinc concentration in radiation workers at the expense of individuals in the control group.

**Table 2.** Results of zinc for age group by AAS.

| **Concentration values** | **No. of sample= 80 for Control Group (mg/L)** | | | **No. of sample= 81 for Worker Group (mg/L)** | | |
|---|---|---|---|---|---|---|
| | (20-29) | (30-39) | (40-49) | (20-29) | (30-39) | (40-49) |
| **maximum** | 0.6191 | 0.619 | 0.6042 | 1.7809 | 1.3263 | 1.4171 |
| **minimum** | 0.0004 | 0.2461 | 0.3246 | 0.0493 | 0.0005 | 1.2263 |
| **average** | 0.4546 | 0.4691 | 0.5120 | 0.9242 | 0.6997 | 1.3466 |
| **S.D** | 0.1498 | 0.0915 | 0.1104 | 0.4597 | 0.3528 | 0.0747 |

Table 2 notes that the age group (30-39) The maximum value of zinc concentration in this group in the control group was 0.6190 mg/L compared to 1.3263 mg/L among workers, while the minimum value was 0.2461 mg/L in the control group, while among workers in the field of radiation it was 0.0005 mg/L.

The average value in the control group was 0.4691 mg/L, while it was 0.6997 mg/L among workers, indicating a higher rate of zinc concentration among workers compared to the control group.

The age group (40-49) the maximum value of zinc concentration among the control group members was 0.6042 mg/L compared to 1.4171 mg/L among the workers, while the minimum value was 0.3246 mg/L among the control group members and 1.2263 mg/L among radiation workers.

The average value among the control group members was 0.5120 mg/L compared to 1.3466 mg/L among the workers, indicating a clear increase in the average values among medical radiation workers at the expense of the control group members. Finally, the standard deviation of the control group was 0.1104, while it was higher among the workers at 0.0747, indicating a greater variation in the results of the control group at the expense of the results of radiation workers, which are more stable and have smaller range in this category [25].

From the results, note that the concentration of zinc in the blood serum was generally higher among workers in the field of medical radiation in all age groups (20-29), (30-39) and (40-49), also note that the increase is more evident in the younger age group (20-29) because it is in the growth stage and changes with the surrounding conditions, and the percentages decrease with age, but the percentages of workers in the field of radiation remain higher in all age groups [26]. For more clarification, see **Fig. 1.**

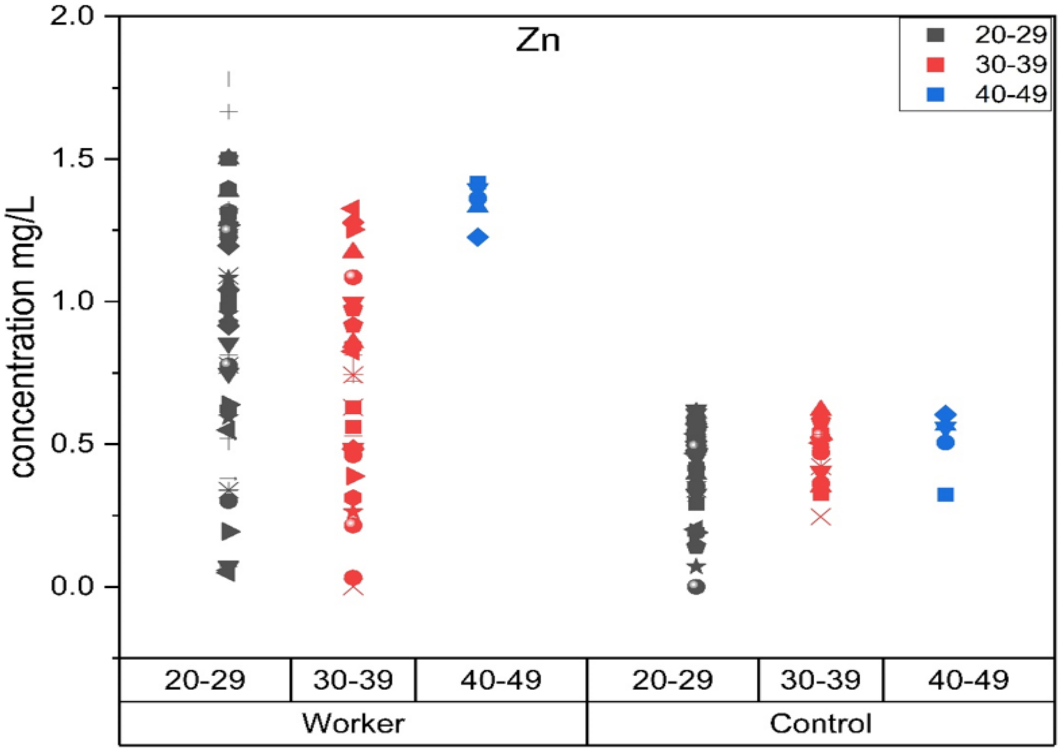


**Fig. 1.** Distribution zinc concentration depends on the age group.

It is noted from the figure that the distribution of zinc concentration values among workers in the categories (20-29) and (30-39) had a wider distribution range than the distribution of values in the control group, where they were less widespread. As for the older age group (40-49), it is noted that the distribution between workers and the control group was narrow and limited within narrow limits, but the concentration value among workers was greater than its value in the control group.

### 3.2. Copper concentration

The zinc concentration values for the age group (20-29) were as shown in Table (2), where the maximum value was 1.3123 mg/L in the control group, while the maximum value for medical radiation workers was 1.5113 mg/L. The minimum value was 0.0221 mg/L in the control group, while it was 0.0105 mg/L in radiation workers.

The average was 0.4779 mg/L in the control group, while it was 0.4391 mg/L in workers, indicating a lower copper concentration in radiation workers at the expense of individuals in the control group.

**Table 3.** Results of copper for age group by AAS.

| Concentration values | No. of sample= 80 for Control Group (mg/L) | | | No. of sample= 81 for Worker Group (mg/L) | | |
|---|---|---|---|---|---|---|
| | (20-29) | (30-39) | (40-49) | (20-29) | (30-39) | (40-49) |
| **Maximum** | 1.3123 | 1.1621 | 0.8784 | 1.5113 | 1.3921 | 1.2300 |
| **Minimum** | 0.0221 | 0.1988 | 0.2118 | 0.0105 | 0.0944 | 0.9154 |
| **Average** | 0.4779 | 0.3098 | 0.3586 | 0.4391 | 0.6412 | 1.0593 |
| **S.D.** | 0.3733 | 0.2540 | 0.2915 | 0.3280 | 0.3936 | 0.4888 |

**Table 3** notes that the age group (30-39) the maximum value in the control group was 1.1621 mg/L compared to 1.3921 mg/L among workers, while the minimum value was 0.1988 mg/L in the control group, while among workers in the field of radiation it was 0.0944 mg/L.

The average value in the control group was 0.3098 mg/L, while it was 0.6412 mg/L among workers, indicating a higher rate of copper concentration among workers compared to the control group.

In the age group (40-49) the maximum value among individuals in the control group reached 0.8784 mg/L compared to 1.2300 mg/L among workers, while the minimum value reached 0.2118 mg/L among individuals in the control group and 0.9154 mg/L among workers in radiation.

The average value among individuals in the control group reached 0.3588 mg/L compared to 1.0593 mg/L among workers, which indicates a clear increase in the average values among workers in medical radiation at the expense of individuals in the control group [27].

From result of copper concentration in the blood serum was generally higher among workers in the field of medical radiation in all age groups (20-29), (30-39) and (40-49). It was also noted that the average copper concentration among workers in the field of radiation increases with age, i.e. the older the person gets, the higher his copper concentration, while among the individuals in the control group, note that the average decreases with age, and from this we conclude that radiation exposure may increase the accumulation of copper in the body the older the worker in the field of radiation. For more clarification, see **Fig. 2.**

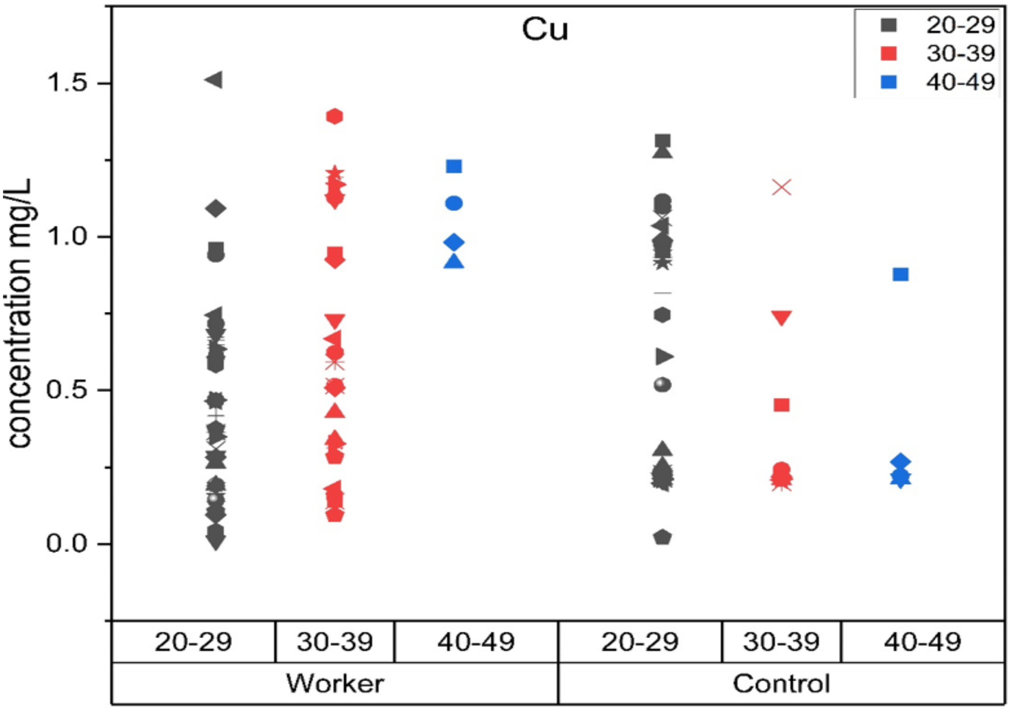


**Fig. 2.** Distribution copper concentration depends on the age group.

It is noted from the figure that the distribution of copper concentration values for workers in the categories (20-29) and (30-39) had a wider distribution range than the distribution of values in the control group, where they were less widespread. As for the older age group (40-49), it is noted that the distribution among workers was narrow and limited within narrow limits, but the distribution in the control group was wider and more widespread, but the concentration value for workers was greater than its value in the control group [28-30].

The results suggest that radiation exposure may have a cumulative effect that is more pronounced in older age groups.

## 4. Conclusions

1. Copper and zinc levels were higher in radiation workers compared to the control group, particularly in older age groups.
2. Age significantly influences the physiological changes induced by radiation exposure, with markedly elevated concentrations observed in older individuals.
3. These findings highlight the necessity of regularly monitoring copper and zinc levels in radiation workers, with special attention to older age groups, to ensure their health and safety.

## 5. Acknowledgments

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