Baghdad Science Journal

Volume 22 | Issue 7 Article 17

7-18-2025

Assessing the Influence of Radiotherapy on the Level of Zinc in Cancer Patients Serum

Muqdad A. Yousif
Department of Medical Physics, Faculty of Medical Sciences, Jabir ibn Hayyan Medical University, Najaf, Iraq, muqdad.alhilo@jmu.edu.iq

Talib A. Abdulwahid
Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq, taliba.jabir@uokufa.edu.iq

Follow this and additional works at: https://bsj.uobaghdad.edu.iq/home

How to Cite this Article
Yousif, Muqdad A. and Abdulwahid, Talib A. (2025) "Assessing the Influence of Radiotherapy on the Level of Zinc in Cancer Patients Serum," *Baghdad Science Journal*: Vol. 22: Iss. 7, Article 17.
DOI: https://doi.org/10.21123/2411-7986.4997

This Article is brought to you for free and open access by Baghdad Science Journal. It has been accepted for inclusion in Baghdad Science Journal by an authorized editor of Baghdad Science Journal.

BAGHDAD SCIENCE JOURNAL 2025;22(7):2307–2312

Scan the QR to view the full-text article on the journal website

RESEARCH ARTICLE

Assessing the Influence of Radiotherapy on the Level of Zinc in Cancer Patients Serum

Muqdad A. Yousif [1,*], **Talib A. Abdulwahid** [2]

[1] Department of Medical Physics, Faculty of Medical Sciences, Jabir ibn Hayyan Medical University, Najaf, Iraq
[2] Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq

ABSTRACT

Cancer patients often undergo radiation therapy as part of their treatment plan, and certain levels of zinc are essential for repairing DNA and maintaining our immune system. Therefore, this study aimed to determine the extent of the effect of this type of treatment on the level of zinc in blood serum, as 106 samples were collected from both healthy individuals and cancer patients to measure zinc levels in blood serum. Atomic absorption spectroscopy was used after properly preparing the sample, and the results showed that the healthy group had an average zinc concentration of $(1.316 \pm 0.10) \times 10^3$ parts per billion (ppb). In contrast, the group of patients not undergoing radiotherapy had a mean zinc concentration of $(1.357 \pm 0.081) \times 10^3$ (ppb), while the P value did not show any statistical difference between the group of untreated patients and healthy individuals. These results indicate that zinc levels in serum samples are not affected by the presence of the disease. However, statistical analysis revealed a significant variation in zinc concentration levels between patients and healthy groups during sessions from 1 to 10 days and from 31 to 40 days ($P < 0.05$). The other groups did not yield any statistically significant differences ($P > 0.05$). There was also a statistically significant difference in the mean zinc concentration in the patient group across the different radiotherapy sessions. The results suggest that radiation therapy sessions may affect zinc levels in cancer patients.

Keywords: Atomic absorption Spectrophotometer, Cancer patients, Radiotherapy sessions, Serum samples, Zinc

Introduction

Radiotherapy is a common treatment for different types of cancer that are either localized or spread to other parts of the body.[1] Radiotherapy works by using high-energy radiation to destroy cancer cells by damaging their DNA.[2] However, while it offers therapeutic success, radiotherapy can mistakenly destroy noncancerous tissues with an array of undesired side effects.[3] One of the remarkable phenomena is changes in serum zinc concentration during radiotherapy for cancer patients.[4]

Zinc is an essential trace element that plays a role in various physiological processes such as those related to enzymatic function, modulation of immune function, and cell growth and repair.[5] It is also vital in amino acid synthesis, cell generation and for healing wounds, as well as maintaining immunity.[6] Despite zinc has been involved in the pathogenesis and growth of diseases and particularly of cancer. Further, zinc is involved in DNA repair mechanisms and is necessary to maintain genomic stability.[7] Thus, the variations in zinc levels induced by radiotherapy may greatly impact the general condition of cancer patients.[8] Several studies have investigated the influence of radiotherapy on serum zinc levels in patients with cancer.[9,10]

This was first reported in 1998 when it was shown that there is a significant drop in the levels of serum zinc in patients who have cervical cancer and are being treated with radiation therapy. Not only that

Received 4 April 2023; revised 7 May 2024; accepted 9 May 2024.
Available online 18 July 2025

* Corresponding author.
E-mail addresses: muqdad.alhilo@jmu.edu.iq (M. A. Yousif), taliba.jabir@uokufa.edu.iq (T. A. Abdulwahid).

https://doi.org/10.21123/2411-7986.4997

2411-7986/© 2025 The Author(s). Published by College of Science for Women, University of Baghdad. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

but also it was correlated the dose of radiation given with how much zinc came to be depleted.[11]

It was indicated in a study published in 2019 that radiation therapy is associated with a depletion of zinc levels in the serum of head and neck cancer patients. Results showed that there is an inverse relationship between the severity of side effects resulting from radiation therapy; mucositis, dermatitis, etc., and the lower serum zinc concentration.[12]

The disease process that causes low zinc levels in the blood of patients getting radiation treatment is not completely known.[13] But, existing ideas indicate that harm from radiation to the lining cells of the intestines may block zinc uptake, which can lead to reduced blood zinc levels.[14] Oxidative stress due to radiation therapy may disrupt zinc homeostasis, leading to lower levels of this essential micronutrients in serum. Radiation can cause more free radicals to form. This alters the way the body uses zinc, and decreases the amount that is available for the body to use.[15]

Low serum zinc levels in cancer patients undergoing radiotherapy has many adverse health consequences that may affect the efficacy of treatment and recovery.[16] Having low zinc levels in the body weakens immune functions, making one more prone to infections and diseases.[17] Not having enough zinc can slow down wound healing. This can be an even bigger problem for patients with cancer who need surgery.[18]

Studies have shown that radiotherapy used to treat cancerous tumors leads to significant changes in serum zinc levels in patients.[16] Due to their impact on the immune system and wound healing efficiency, low serum zinc levels may have a negative influence on the general health status of patients.[19] Therefore, cancer patients undergoing radiotherapy should be monitored closely for changes in serum zinc levels, and appropriate interventions should be undertaken to avoid zinc deficiency. A review of previous studies revealed a lack of adequate relevant studies examining the effect of radiation therapy on zinc levels.

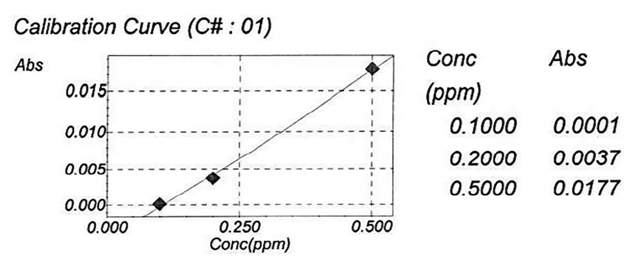
The main purpose of this study is investigating the relationship between the radiotherapy sessions and the zinc levels in the blood serum of patients with cancer, and to identify these levels of zinc.

Materials and methods

A total of 67 cancer patients from the Middle Euphrates Tumor Center and Al-Najaf Teaching Hospital in Najaf, all of these patients underwent a radiotherapy period of 20–30 minutes. as well as 37 healthy individuals from the Najaf Governorate's Main Blood Bank, were considered in this study. Three milliliters of blood were drawn from each participant using a disposable syringe. After removing the redness from the plasma via a centrifuge, it was kept in an Eppendorf tube inside a refrigerator for future analysis and frozen at −20°C for preservation.

The study samples underwent digestion procedures as reported in the literature (the serum samples digested by using high purity deionized water and utilizing 2 mL HNO_3 (35%) and 1 mL 15% H_2O_2 at 100 °C for 30 min.).[20] The samples were then sent to the laboratory for measurement of Zinc using the 7000A Shimadzu F-AAS, Japan, when the sample was exposed to the flame, the solvent evaporated and vapors of metallic species were obtained. The spectrum of specific metal is the emitted radiation of metal due to excitation of this metal; this is the base of flame emission spectrometry. The resulting data were expressed in parts per billion (ppb).[21,22]

The calibration curve was generated using standard solutions of known concentrations of Zinc. The instrument was set to the appropriate wavelength for Zinc and the absorbance values were recorded for each standard solution.[23] The resulting data was used to create a linear regression equation, which was then used to determine the concentration of Zinc in the study samples, as illustrated in the Fig. 1:



Abs=0.044615Conc-0.0047308
r=0.9989

Fig. 1. Calibration of the device for zinc analysis.

Statistical analysis

Statistical analysis is one of the methodological pillars to give reliable results in scientific research to give reliable results. The data in the study will be analyzed using SPSS statistical package (version 23.0) which is advanced and helps for easy and reliable data analysis. Each sample was separately tested, with the P-value being the primary measure of significance. When P values are less than 0.05, accepted statistical standards interpret them as indicating a significant association between study variables. It is important to test the hypotheses to verify that conclusions made from the data are valid and credible.[24]

The mean ± standard deviation is a common statistical technique to demonstrate the results. In short, it contributes to giving a more correct and accurate indication of the standard distribution of the data. This will increase clarity and help analysis and interpretation by researchers. The mean is the central point of the measurements. Standard deviation measures how much the individual measurements deviate from the mean. Therefore, mean and standard deviation together describe the characteristics of the sample taken.

Results and discussion

Zinc levels were determined in the serum samples of healthy individuals (control group) and the patient group who had not received treatment. The mean zinc concentration for the control group $(1.316 \pm 0.10) \times 10^3$ (ppb), whereas mean for untreated group was $(1.357 \pm 0.081) \times 10^3$ (ppb), as shown in Fig. 2.

Suitable test was applied for confirming the difference was significant between the groups. The resulting probability (P) value shows no significant difference ($P > 0.05$) between the zinc concentration of the two groups. Serum zinc level does not differ significantly between healthy individuals and untreated patients in the study sample.

These findings suggest that zinc levels in serum samples are not affected by the presence of illness. Further research is needed to determine if zinc levels are affected by other factors such as medication or individual's lifestyle.

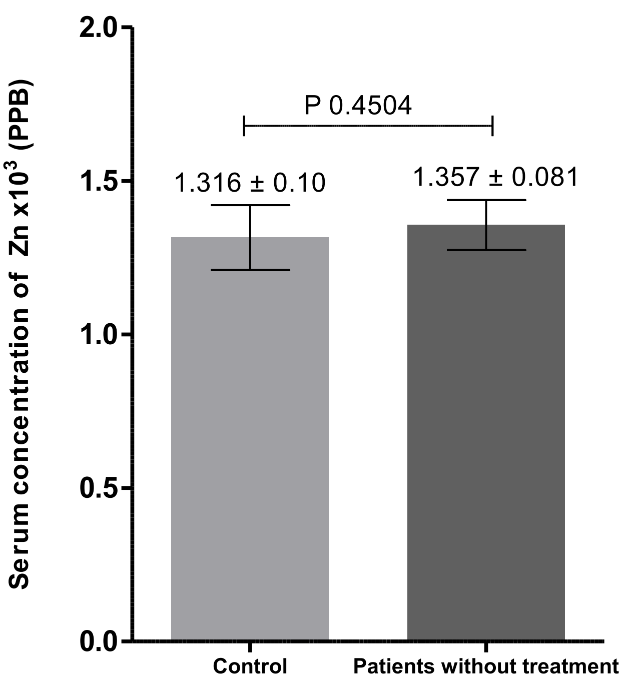


Fig. 2. Zinc concentrations in serum samples from both the control (healthy) group and the untreated patient group.

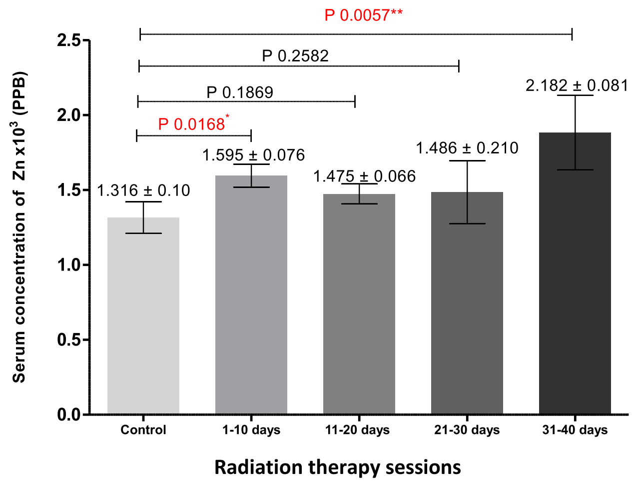


Fig. 3. Comparing serum Zinc concentrations between those receiving radiation therapies versus those in a control group.

From the data presented in Fig. 3, it can be inferred that the healthy group has a relatively stable Zinc concentration with a mean of $(1.316 \pm 0.10) \times 10^3$ (ppb). However, for the patients group, there was a significant variation in mean Zinc concentrations across different sessions. For sessions 1–10 days, the mean Zinc concentration was higher at $(1.595 \pm 0.06) \times 10^3$ (ppb), which could indicate an initial response to radiotherapy treatment or medication. However, for sessions 11–20 days and 21–30 days, the mean Zinc concentrations decreased to $(1.475 \pm 0.066) \times 10^3$ (ppb) and $(1.486 \pm 0.210) \times 10^3$ (ppb), respectively, suggesting that the treatment may not have been as effective in these later stages or that other factors were influencing Zinc levels.

The data presented in Fig. 3 emphasizes the notable variations in average Zinc levels between the healthy and patient groups with radiotherapy. While the patient group's with radiotherapy mean Zinc concentration varied significantly across the different sessions. The highest mean Zinc concentration was observed during sessions 31–40 days, with a value of $(2.182 \pm 0.081) \times 10^3$ (ppb).

The statistical analysis has revealed a significant discrepancy in Zinc concentration levels between the groups of patients and healthy subjects during the 1–10 day and 31–40 day sessions (p-value < 0.05). However, the other groups yielded no statistically significant divergence (p-value > 0.05).

The data depicted in Table 1 emphasizes the noteworthy variations in average Zinc concentrations among the patient groups. There were significant differences in the mean Zinc concentrations of different sessions of patient groups. The mean Zinc

Table 1. Comparison of arithmetic means of zinc concentration between groups undergoing radiotherapy sessions.

participants group	Radiation	Mean ± SD	P-Value
A	1–10 Days	1.595 ± 0.07	AB 0.1908
B	11–20 Days	1.475 ± 0.06	AC 0.2963
C	21–30 Days	1.486 ± 0.21	AD 0.0112*
D	31–40 Days	2.182± 0.081	BC 0.4754
			BD 0.0173*
			CD 0.0201*

SD: Standard deviation.

concentration was highest in the period from 31–40 days, which is $(2.182 + 0.081) \times 10^3$ (ppb).

The analyses indicate a clear correlation between the length of treatment sessions and the average zinc concentration in the patient's body. The peak in zinc concentration recorded during some sessions is likely the result of a combination of factors, including dietary variations from patient to patient, drug interactions, or even difficult-to-control external environmental conditions.

These results indicate a need for monitoring the zinc levels of patients, especially when under chronic treatment. In addition, they mention a gap in the research, which means studies are needed to determine why the outcome is different.

Through statistical analysis, a significant difference in zinc levels was observed between the treatment groups (AD), (BD), and (CD), with (p-value < 0.05), supporting clear statistical significance. In contrast, the other groups did not show statistically significant differences (p-value > 0.05).

Conclusion

The study revealed a potential link between radiotherapy sessions and changes in body zinc levels, which could impact treatment planning and patient follow-up. Although further research is needed to unravel this relationship, the preliminary findings open new horizons.

It is noteworthy that zinc levels-whether high or low-can negatively impact patients' health, warranting greater focus on this aspect. The most important thing here is to understand the underlying causes of these changes, which will subsequently help improve treatment protocols.

What is striking in the data is that zinc may be a factor influencing patients' health during critical stages of treatment, highlighting the need for regular monitoring. The results also demonstrate an urgent need for additional research to monitor the factors that lead to these differences among patients.

Acknowledgment

We extend our sincere thanks and appreciation to everyone who contributed and worked diligently and sincerely at the Middle Euphrates Oncology Center, as well as the team at Najaf Teaching Hospital in Najaf. We also greatly appreciate the efforts of the staff at the main bank in Najaf Governorate, Iraq, for their continued cooperation and support. Our research would not have been possible without the invaluable support of the calculator unit, the dedicated doctors, and most importantly, the center director. We are deeply appreciative of their unwavering commitment to our project.

Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been included with the necessary permission for republication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- Authors sign on ethical consideration's approval.
- Ethical Clearance: The project was approved by the local ethical committee at Jabir ibn Hayyan Medical University.

Authors' contribution statement

M. A. Y. Conceptualization, Methodology, Formal analysis, Writing - original draft, Investigation, Data curation, Writing - review and editing. T. A. A. Visualization, Supervision, Project administration.

References

1. AL-Azzawi SN, Shihab FA. Modified mathematical model of tumor treatment by radiotherapy. Baghdad Sci J. 2020;17(3):0841–0848. http://dx.doi.org/10.21123/bsj.2020.17.3.0841.
2. Maayah Y, Nusrat H, Pang G, Tambasco M. Assessing the DNA damaging effectiveness of ionizing radiation using plasmid DNA. Int J Cell Sci Mol Biol. 2022;23(20):12459.
3. Majeed H, Gupta V. Adverse effects of radiation therapy. In: StatPearls. Treasure Island (FL): StatPearls. 2023 [updated 2023 Aug 14].
4. Hoppe C, Kutschan S, Dörfler J, Büntzel J, Büntzel J, Huebner J. Zinc as a complementary treatment for cancer patients: a systematic review. Clin Exp Med. 2021;21(2):297–313. http://dx.doi.org/10.1007/s10238-020-00677-6.
5. Hmood AM, Alwan IF, Alzahera NA, Abaas R, Mohsen G, Mohmed T, *et al.* Determination oxidant-antioxidant enzyme and some trace elements in breast cancer in Baghdad city.

Baghdad Sci J. 2014 Jun 1;11(2):350–3. https://doi.org/10.21123/bsj.2014.11.2.350-357.

6. Chasapis CT, Ntoupa PSA, Spiliopoulou CA, Stefanidou ME. Recent aspects of the effects of zinc on human health. Arch Toxicol. 2020;94(5):1443–1460. https://doi.org/10.1007/s00204-020-02702-9.
7. Kaźmierczak-Barańska J, Boguszewska K, Wski BT. Nutrition can help DNA repair in the case of aging. Nutrients. 2020;12(11):3364. https://doi.org/10.3390/nu12113364.
8. Fazilatpanah D, Tafti H, Rasta S, Masudian M, Angani A. Comparative evaluation of serum zinc level in head and neck cancer patients before and after radiation therapy, Caspian J Intern Med. 2023;14(1):128–132. http://dx.doi.org/10.22088/cjim.14.1.128
9. Rao S, Kalekhan F, Hegde SK, Rao P, Suresh S, Baliga MS. Serum zinc status and the development of mucositis and dermatitis in head-and-neck cancer patients undergoing curative radiotherapy: A pilot study. J Cancer Res Ther. 2022;18(1):42–48. http://dx.doi.org/10.4103/jcrt.JCRT_344_20
10. Hoppe C, Kutschan S, Dörfler J, Büntzel J, Büntzel J, Huebner J. Zinc as a complementary treatment for cancer patients: a systematic review. Clin Exp Med. 2021;21(2):297–313. http://dx.doi.org/10.1007/s10238-020-00677-6.
11. Okada M, Kigawa J, Minagawa Y, Kanamori Y, Shimada M, Takahashi M, *et al.* Indication and efficacy of radiation therapy following radical surgery in patients with stage IB to IIB cervical cancer. Gynecol Oncol. 1998;70(1):61–64. http://dx.doi.org/10.1006/gyno.1998.5005.
12. Balázs K, Kis E, Badie C, Bogdándi EN, Candéias S, Garcia LC, *et al.* Radiotherapy-induced changes in the systemic immune and inflammation parameters of head and neck cancer patients. Cancers (Basel). 2019;11(9):1324. Published 2019 Sep 6. http://dx.doi.org/10.3390/cancers11091324.
13. Maxfield L, Shukla S, Crane JS. Zinc deficiency. [Updated 2023 Jun 28]. In: Stat Pearls. Treasure Island (FL): StatPearls. 2024 Jan.
14. Lu L, Li W, Chen L, Su Q, Wang Y, Guo Z, *et al.* Radiation-induced intestinal damage: latest molecular and clinical developments. Future Oncol. 2019;15(35):4105–4118. http://dx.doi.org/10.2217/fon-2019-0416.
15. Liu R, Bian Y, Liu L, Liu L, Liu X, Ma S. Molecular pathways associated with oxidative stress and their potential applications in radiotherapy (Review). Int J Mol Med. 2022;49(5):65. http://dx.doi.org/10.3892/ijmm.2022.5121.
16. Tuncer GS, Demir H, Izmirli M, Cakir T, Yilmazer G, Demir C. Effect of radiotherapy on erythrocyte catalase, and carbonic anhydrase activities, serum levels of some trace elements and heavy metals (Zn, Cu, Pb, Cd, Mn, Fe, Mg and Co) in cancer patients. Int J Radiat Res. 2022;20(1):97–102.
17. Maywald M, Rink L. Zinc in human health and infectious diseases. Biomolecules. 2022;12(12):1748. Published 2022 Nov 24. http://dx.doi.org/10.3390/biom12121748.
18. Grada A, Phillips TJ. Nutrition and cutaneous wound healing. Clin Dermatol. 2022;40(2):103–113. https://doi.org/10.1016/j.clindermatol.2021.10.002.
19. Chasapis CT, Ntoupa PA, Spiliopoulou CA, Stefanidou ME. Recent aspects of the effects of zinc on human health. Arch Toxicol. 2020;94:1443–1460. http://dx.doi.org/10.1007/s00204-020-02702-9.
20. Martínez-Peinado M, Rueda-Robles A, Nogueras-López F, Villalón-Mir M, Oliveras-López MJ, Navarro-Alarcón M. Serum zinc and copper concentrations and ratios in cirrhotic patients: correlation with severity index. Nutr Hosp. 2018;35(3):627–632. http://dx.doi.org/10.20960/nh.1579.
21. Hussein HH, Alsabari EK, Kadhim BA, Hatif KH, AL-Khafaji QS, Hamidi SAK. Study the impact of the trace elements between the healthy females and who take chemotherapy for samples of sera. Res J Pharm Technol. 2017;10(10):3323–3325. https://doi.org/10.5958/0974-360X.2017.00589.3.
22. Garner WE, Handy RW. Determination of zinc in biological samples by flame atomic absorption spectrometry. Anal Chem. 1964;36(13):2407–2411. https://doi.org/10.1021/ac60219a009.
23. Cabré N, Luciano-Mateo F, Arenas M, Martí N, Gerard B-G, Anna H-A, *et al.* Trace element concentrations in breast cancer patients. Breast. 2018;42:142–149. http://dx.doi.org/10.1016/j.breast.2018.09.005.
24. Abdullah, SS. Dosimetric Verification of Gamma Passing Rate for Head and Neck Cases Treated with Intensity Modulated Radiation Therapy (IMRT) Treatment Planning Technique. Baghdad Sci J. 2021;18.4(Suppl.):1514–1514. https://doi.org/10.21123/bsj.2021.18.4(Suppl.).1514.

تقييم تأثير العلاج الإشعاعي على مستوى الزنك في مصل مرضى السرطان

مقداد عبد الحميد يوسف[1]، طالب عبد الرضا عبد الواحد[2]

[1]قسم الفيزياء الطبية، كلية العلوم الطبية، جامعة جابر بن حيان للعلوم الطبية والصيدلانية، النجف، العراق.
[2]قسم الفيزياء، كلية العلوم، جامعة الكوفة، النجف، العراق.

الخلاصة

غالبًا ما يخضع مرضى السرطان للعلاج الإشعاعي كجزء من خطة العلاج الخاصة بهم، كما أن مستويات معينة من الزنك ضرورية لإصلاح الحمض النووي والحفاظ على نظام المناعة لدينا. لذلك هدفت هذه الدراسة إلى تحديد مدى تأثير هذا النوع من العلاج على مستوى الزنك في مصل الدم، حيث تم جمع 106 عينات من كل من الأفراد الأصحاء ومرضى السرطان لقياس مستويات الزنك في مصل الدم. تم استخدام مطيافية الامتصاص الذري بعد تحضير العينة بشكل صحيح، وأظهرت النتائج أن المجموعة السليمة كان متوسط تركيز الزنك فيها $10^3 \times (1.316 \pm 0.10)$ جزء لكل مليار (ppb). في المقابل، كان لدى مجموعة المرضى الذين لا يخضعون للعلاج الإشعاعي متوسط تركيز الزنك (ppb) $10^3 \times (1.357 \pm 0.081)$، بينما لم تظهر قيمة P أي فرق إحصائي بين مجموعة المرضى غير المعالجين و الأفراد الأصحاء. وتشير هذه النتائج إلى أن مستويات الزنك في عينات المصل لا تتأثر بوجود المرض. ومع ذلك، كشف التحليل الإحصائي عن اختلاف كبير في مستويات تركيز الزنك بين المرضى والمجموعات الصحية خلال الجلسات من 1 إلى 10 أيام ومن 31 إلى 40 يومًا ($P < 0.05$). ولم تسفر المجموعات الأخرى عن أي فروق ذات دلالة إحصائية ($P > 0.05$). كما كان هناك فرق ذو دلالة إحصائية في متوسط تركيز الزنك في مجموعة المرضى خلال جلسات العلاج الإشعاعي المختلفة. تشير النتائج إلى أن جلسات العلاج الإشعاعي قد تؤثر على مستويات الزنك لدى مرضى السرطان.

الكلمات المفتاحية: مقياس الامتصاص الذري، مرضى السرطان، جلسات العلاج الإشعاعي، عينات المصل، الزنك.