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The prevalence of serum Zn levels deficiency and itscorrelation with age and sex in the population of Erbil, Iraq

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Abstract

Background and Objectives: Zinc (Zn) is an important trace element with substantial consequences for health, and its blood levels might fluctuate depending on demographic variables. This study aimed to explore the relationship between serum Zn levels and age and sex in the population ofErbil City, Iraq.

Methods: This cross-sectional study encompassing 844 participants that had referred to Mydia Diagnostic Center from January 2021 to December 2022. Participants were evaluated at baseline and followed up at a specified interval (24 months). Serum Zn concentration was measured using atomic absorption spectrophotometry.

Results:The mean age of participants was 39.789 ± 20.427 years. The mean serum Zn concentration among all participants was 80.678 ± 16.893 µg/dl. The results indicated that despite fluctuations in Zn levels and an overall increase among participants, Zn deficiency remains prevalent. It was observed that Zn levels decreased with age, and females exhibited lower Zn levels than males across different age groups.

Conclusion:The research results showed a generalized lack of Zn in those examined, with this varying considerably by age group and sex. There was a significant difference in children and older adults especially women, which showed the largest deficit.

Keywords:Age, Cross-Sectional Study, Serum Zinc Level, Sex, Zinc

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Introduction

Zinc (Zn) is a micronutrient, which is very abundant in the body of human beings, popularly known for being used as a regulator, a structure, as well as an important catalyst in over 3000 proteins, for example, enzymes and transcription factors (1). This element is an indispensable part of several biochemical, immunological, and clinological reactions (2). Mild zinc deficiency results in problems including the impairments of smell and taste, reduced immunity strength, and a high risk of pneumonia(3), while severe zinc deficiency may cause skin diseases, vision impairment, a lower number of lymphocytes, and poor appetite and diarrhea (2, 4).

There is mounting evidence that also establishes a relationship between Zn deficiency and elevated susceptibility to cardiometabolic disorders (5).More specifically, Zn plays a vital function in the production of insulin and the regulation of glucose levels. A shortage of zinc has been associated with a more severe form of type 2 diabetes mellitus (6, 7). Furthermore, the status of Zn also influences lipid metabolism, encompassing the absorption, production, and breakdown of fatty acids, consequently affecting the composition of circulating lipids and possibly heightening the risk of cardiovascular ailments (8, 9).

Zinc insufficiency is a major public health issue worldwide, especially in low- and middle-income nations where people typically do not get enough zinc in their diet(10). Globally, 17% of people may not consume enough zinc; in Asia and Africa, the percentages might rise as high as 19% and 24%, respectively (11). The prevalence of Zn deficiency varies across different age groups and sexes, with certain populations being more susceptible to deficiency due to factors such as diet, lifestyle, and environmental conditions (12, 13).

Research has shown that the levels of Zn in the blood may be affected by factors such as age and sex. According to research conducted by Yokokawa et al. (2024), the prevalence of zinc insufficiency among patients was shown to rise with age in both sexes (3).In contrast, Kennedy et al. (2020) state that there is no notable difference in serum Zn level based on sex and age (14).

According to these contradictory findings, it is necessary to conduct a comprehensive study on changes in serum Zn levels based on age and sex.Therefore, this study aims to investigate the correlation between zinc levels in the blood and age and sex in Sulaymaniyah, Iraq.

Method

Study Design and Setting

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This cross-sectional study was conducted in the Erbil City, Iraq. The study spanned over a period of two years, starting from January 2021 to December 2022.

Sampling Method and Sample Size

The sample size was calculated using the method for calculating a population percentage with a given level of accuracy. The equation is expressed as:

$$n = \frac{z^2 \times p \times (1-p)}{d^2}$$

Where: *n* is the sample size, *Z* is the Z-score (1.96 for 95% confidence interval), *p* is the estimated percentage of the population that has the specific feature of interest, which in this case is the estimated variance of serum Zn levels in the general population. It is assumed to be 0.5 to maximize the sample size, and *d* is the absolute precision desired (5% in this case).

Using this formula, the calculation was as follows:

$$n = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384.16$$

Considering a non-response rate of 20%, the sample size was increased by that percentage:

$n = 384.16 \times (1+0.20) = 460.992$

Thus, the study's minimum final sample size was approximately 461. Yet the sample size constituted of 844 subjects confirms the high level of power of the study, and the reliability of the achieved conclusions is consequently high.

Inclusion criteria for the study were residents of the Erbil Governorate, individuals of both sexes and all ages, and willingness to participate as indicated by providing informed consent. Exclusion criteria included individuals with a diagnosed Zn metabolism disorder, participants on Zn supplementation, diseases of the orthopedics or conditions known to affect serum Zn levels, and participants who refused to provide written informed consent were also excluded.

Data Collection Procedure

Upon selection, individuals were explained the study objectives and procedures thoroughly and after that informed consent was obtained. Corresponding to it, demographic data, such as age and

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sex, were recorded onto the standardized form. Thereafter, the phlebotomist extracted a small volume of blood from the patient while maintaining strict aseptic.

The serum Zn concentration was measured using an atomic absorption spectrophotometer (Model Z-2000, Hitachi High-Technologies Corporation, Tokyo, Japan), which has been validated for Zn measurement in biological samples. The normal range of serum Zn was defined as 70-120 µg/dl based on established reference values (15).

Two assessments of Zn levels were performed for each participant: an initial presentation and a follow-up visit. The follow-up visit was scheduled at an12-month interval from the initial testing to assess changes in Zn levels over time.

Ethical Endorsement

The study protocol was reviewed and approved by the Ethical Review Board of the Hawler Medical University. All participants provided informed consent, and the study was conducted in accordance with the Declaration of Helsinki and local regulatory guidelines. Privacy and confidentiality of participant data were strictly maintained throughout the study. For minors, permission was acquired from a parent or guardian.

Statistical Analysis

The data was analyzed using SPSS software, specifically version 26 of the Statistical Package for the Social Sciences. Descriptive statistics, such as means, standard deviations, and frequencies, were used to describe the population. The Chi-squared test was used to compare groups based on categorical variables, whilst independent t-tests or ANOVA were utilized for continuous data. A significance level of $P < 0.05$ was used.

Result

This study examined the Zn levels of 844 individuals. The mean age of participants was 39.789 ± 20.427 years. The mean Zn concentration across the cohort was 80.678 ± 16.893 µg/dl. The sex distribution showed that of the 844 individuals, 337 (39.9%) were male and 507 (60.1%) were female (Figure1). These details are presented in Table 1.

Table 1. Socio-demographics in participations in study

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Variable		**Mean±SD**	**Frequency (%)**
Age		39.789 ± 20.427	
Zn		80.678 ± 16.893	
Sex	Male		337 (39.9%)
	Female		507 (60.1%)

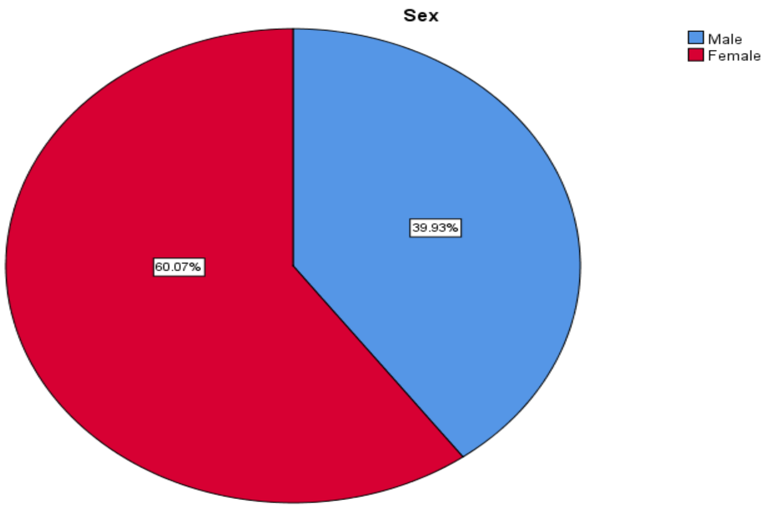

Figure 1. Sex distribution of participants

Zinc levels were assessed at the initial presentation and subsequently during a follow-up visit at a specified time interval (24-month). The Zn values were categorized into three groups: over normal range, within normal range, and under normal range.

Table 2 displays the number of individuals stratified by sex and those whose initial Zn levels were over the normal range. Among males, 17 had Zn levels over the normal range, with 4 (23.52%) aged between 1-9 years and another 4 (23.52%) aged between 30-39 years. In females, 15 had Zn levels over the normal range, with 3 (20%) each in the 1-9 and 10-19 age groups.

Table 2. Frequency of Zn Over Normal Range according to age groups among male and female

Over Normal Range	Male	Female
	n = 17	n = 15
Under 01 year	0	1 (6.66%)
01 - 09 year	4 (23.52%)	3 (20%)
10 - 19 year	2 (11.76%)	3 (20%)
20 - 29 year	0	1 (6.66%)
30 - 39 year	4 (23.52%)	1 (6.66%)
40 - 49 year	2 (11.76%)	1 (6.66%)
50 - 59 year	3 (17.64%)	2 (13.33%)
60 - 69 year	2 (11.76%)	2 (13.33%)
70 - 79 year	0	1 (6.66%)
80 - 89 year	0	0
90 - 99 year	0	0

In the first assessment, among the 388 males with normal Zn levels, 75 (19.32%) were aged 30-39 years, 53 (13.65%) were 1-9 years old, and 41 (10.56%) were 20-29 years old. In the age group less than one year, 2 (0.51%) individuals had normal Zn levels, and in the 80-89 years age group, there was only one individual. Among females, 120 (22.42%) were aged 30-39 years, 97 (18.13%) were 40-49 years, and 76 (14.20%) were 50-59 years with normal Zn levels. These findings are indicated in Table 3.

Table 3. Frequency of Zn Normal Range according to age groups among male and female

Normal Range	Male	Female
	n = 388	n = 535
Under 01 year	2 (0.51%)	2 (0.37%)
01 - 09 year	53 (13.65%)	46 (8.59%)
10 - 19 year	30 (7.73%)	39 (7.28%)
20 - 29 year	41 (10.56%)	63 (11.77%)
30 - 39 year	75 (19.32%)	120 (22.42%)
40 - 49 year	83 (21.39)	97 (18.13%)
50 - 59 year	50 (12.88%)	76 (14.20%)
60 - 69 year	37 (9.53%)	63 (11.77%)
70 - 79 year	16 (4.12%)	25 (4.67%)
80 - 89 year	1 (0.25%)	4 (0.74%)
90 - 99 year	0	0

Among those who had their Zn levels tested for the first time, 93 males and 261 females had Zn levels under the normal range. The age groups among males with low Zn levels, in descending order, were mainly the 40-49 years group, with 17 (18.27%) individuals, and the 50-59 years group with 15 (16.12%) individuals. Among females, the 30-39 years age group had the highest

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frequency of individuals with Zn levels under normal, where 69 (26.43%) were affected, followed by the 40-49 years group with 58 (22.22%) individuals. This data is shown in Table 4.

Table 4. Frequency of Zn Under Normal Range according to age groups among male and female

Under Normal Range	Male n = 93	Female n = 261
Under 01 year	0	0
01 - 09 year	13 (13.97%)	9 (3.44%)
10 - 19 year	10 (10.75%)	17 (6.51%)
20 - 29 year	6 (6.45%)	38 (14.55%)
30 - 39 year	11 (11.82%)	69 (26.43%)
40 - 49 year	17 (18.27%)	58 (22.22%)
50 - 59 year	15 (16.12%)	16 (6.13%)
60 - 69 year	9 (9.67%)	32 (12.26%)
70 - 79 year	9 (9.67%)	15 (5.74%)
80 - 89 year	3 (3.22%)	6 (2.29%)
90 - 99 year	0	1 (0.38%)

In the second assessment, when Zn levels were reassessed, 9 males and 14 females had Zn levels over the normal range. The age groups and the number of individuals with elevated Zn levels are reported in Table 5.

Table 5. Frequency of Zn Over Normal Range according to age groups among male and female

Over Normal Range	Male n = 9	Female n = 14
Under 01 year	0	0
01 - 09 year	3 (33.33%)	5 (35.71%)
10 - 19 year	1 (11.11%)	0
20 - 29 year	0	3 (21.42%)
30 - 39 year	3 (33.33%)	0
40 - 49 year	1 (11.11%)	0
50 - 59 year	1 (11.11%)	1 (7.145)
60 - 69 year	0	5 (35.71%)
70 - 79 year	0	0
80 - 89 year	0	0
90 - 99 year	0	0

Table 6 reveals the number of individuals with normal Zn levels in the second assessment by age group. Among males, 54 (21.17%) in the 40-49 years age group, 42 (16.47%) in the 30-39 years age group, 41 (16.078%) in the 1-9 years age group, and 32 (12.54%) in the 50-59 years age group had normal Zn levels. Among females, 62 (19.43%) in the 40-49 years age group, 53

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(16.61%) in the 50-59 years age group, 51 (15.98%) in the 60-69 years age group, and 49 (15.36%) in the 30-39 years age group had normal Zn levels.

Table 6. Frequency of Zn Normal Range according to age groups among male and female

Normal Range	Male	Female
	n = 255	**n = 319**
Under 01 year	1 (0.39%)	2 (0.62%)
01 - 09 year	41 (16.078%)	31 (9.71%)
10 - 19 year	23 (9.01%)	23 (7.21%)
20 - 29 year	22 (8.62%)	24 (7.52%)
30 - 39 year	42 (16.47%)	49 (15.36%)
40 - 49 year	54 (21.17%)	62 (19.43%)
50 - 59 year	32 (12.54%)	53 (16.61%)
60 - 69 year	27 (10.58%)	51 (15.98%)
70 - 79 year	12 (4.70%)	22 (6.89%)
80 - 89 year	1 (0.39%)	2 (0.62%)
90 - 99 year	0	0

The second phase of Zn testing revealed that 45 males and 125 females had Zn levels under the normal range. Within the male cohort, the 40-49 age group had the highest incidence of low Zn levels, with 10 (22.22%) individuals affected, followed by the 50-59 age group with 7 (15.15%) individuals. The frequency of subnormal Zn levels was greatest among females in the age categories of 30-39 and 40-49, with 30 (24%) persons afflicted in each group. The 20-29 age group had the next highest incidence, with 14 (11.2%) individuals having Zn levels below the normal limit (Table 7).

Table 7. Frequency of Zn Under Normal Range according to age groups among male and female

Under Normal Range	Male	Female
	n = 45	**n = 125**
Under 01 year	0	0
01 - 09 year	9 (20%)	4 (3.2%)
10 - 19 year	4 (8.88%)	6 (4.8%)
20 - 29 year	4 (8.88%)	14 (11.2%)
30 - 39 year	4 (8.88%)	30 (24%)
40 - 49 year	10 (22.22%)	30 (24%)
50 - 59 year	7 (15.15%)	13 (10.4%)
60 - 69 year	4 (8.88%)	20 (16%)
70 - 79 year	2 (4.44%)	4 (3.2%)
80 - 89 year	1 (1.22%)	3 (2.4%)
90 - 99 year	0	1 (0.8%)

Figure 2 indicates the number of individuals who have undergone blood testing. According to the results, a higher proportion of females participated in the blood tests.

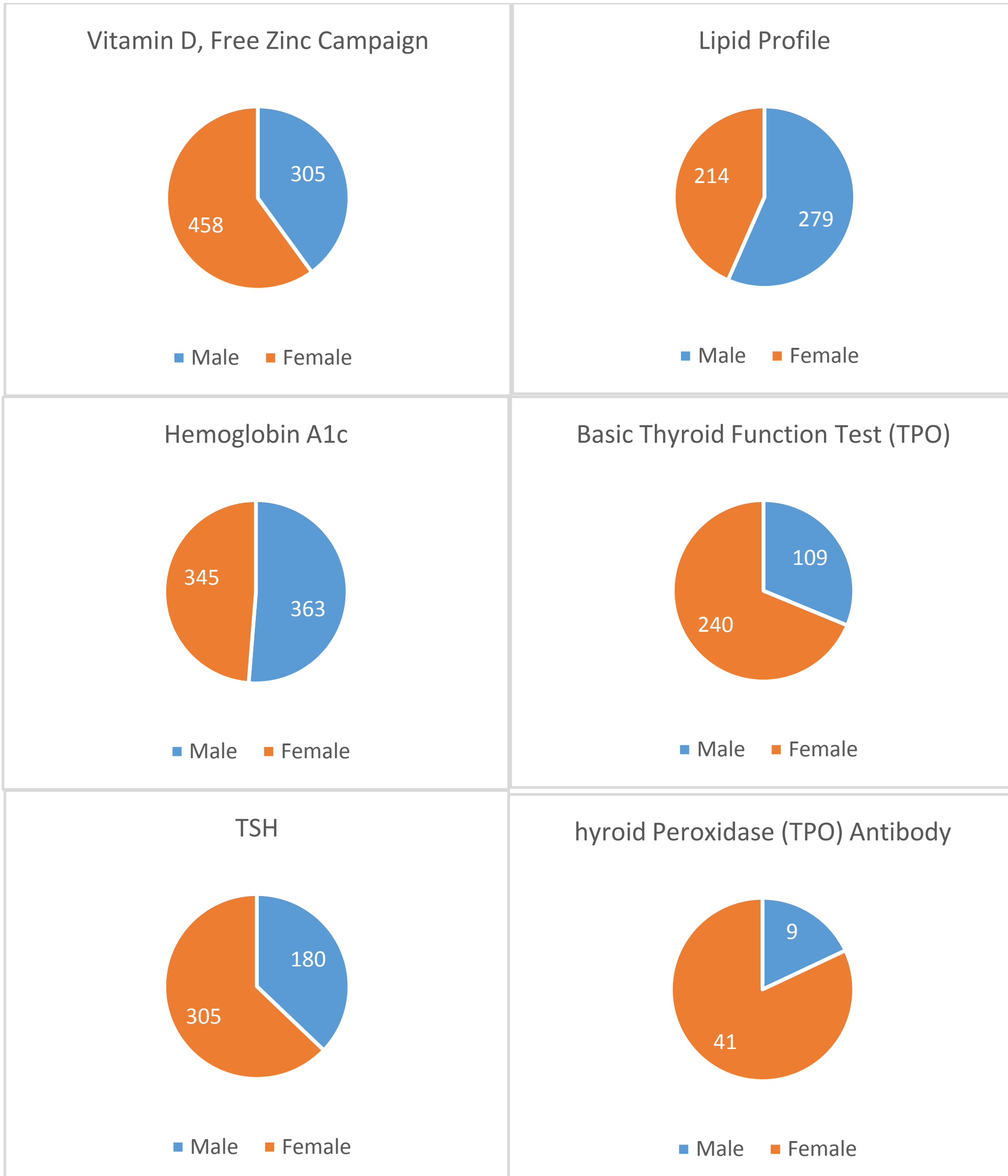

Figure 2. Blood tests along with clinical parameters in people participating in the study

Discussion

This study was conducted to investigate the changes in serum Zn levels. The examination of serum Zn variations in the subjects across two tests revealed that despite some alterations in serum Zn levels, many individuals still exhibit suboptimal levels. Additionally, the Zn content varied among males and females, and across different age groups.

Zinc is a cofactor for 3,000 human proteins and participates in various molecular mechanisms (16).Zn deficiency may possibly participate in the biogenesis of diverse diseases using various mechanisms including emotional disorders, increased inflammation, impaired immune response, delayed healing, decreased epithelial barrier function, and taste disorders(17-19).Zn deficiency remarkably impairs cellular immunity with its 'T lymphocyte responses' (20). In conditions of Zn deficiency, the function, development, and polarization of T cells are affected resulting in a lower count of T cells and a reduced ratio of type 1: type 2 T-helper cells which, in turn, leads to a reduction in the production of type 1 cytokines (21).

In Iran, research done by Eslami et al. (2023) sought to evaluate the occurrence of zinc deficiency and compare it to that of other nations. This study, accessing various databases and employing a search strategy over twenty years, included 20 studies that met the necessary criteria. The findings revealed that the general occurrence of zinc insufficiency in Iran was 16%, which falls below the threshold of 20% specified by the International Zinc Nutrition Consultative Group (ZiNCG). Therefore, intervention is not required based on the established criteria (22).

A study by Abid et al. (2023) in Iraq was done and it focused on determining the Zn level deficiency in the adult population and deriving a normal range for this value. This research, which encompassed 1305 men and 700 women, used an atomic absorption spectrophotometer to assess the mean Zinc level. Zn concentration was a little bit higher in men and the Zn levels varied in different age groups but the Zn level was consistent. The overall frequency of insufficiency was 22. The obesity rate was 9% in men while it was slightly less in women at 18.5% (23).

Another study carried out in Dohuk, Iraq, by Rasool et al. (2020), examined serum Zn levels and their association with iron-deficiency anemia in pregnant women. The study involved 86 pregnant women who visited private clinics in Dohuk. The women were divided into three groups: those with iron-deficiency anemia, those with anemia due to other causes, and healthy individuals. Demographic data and laboratory measurements were taken across the groups. The findings indicated that pregnant women with insufficient iron levels had decreased levels of Zn in their blood serum. Furthermore, a considerable proportion of women in all three groups had a shortage in Zn(24).

A retrospective cross-sectional research was conducted in Sulaymaniyah, Iraq to investigate the serum zinc concentrations in female patients. The study included 299 female patients aged between 16-48 years. The findings revealed that 33.11% of the women had Zn deficiency, 3.69% had elevated Zn levels, and 63.2% had normal levels, with the highest serum concentrations observed in the 29-30 age group. Given the variations in Zn concentration across age groups, further intervention appears necessary (25).

Lastly, a study in Dohuk by Ibrahim et al. (2016) evaluated the relationship between intestinal parasites and serum levels of Zn and copper in children. The study involved 15 children infected with the entamoeba parasite and 31 healthy controls. Stool tests along with blood samples were conducted for all participants. The results indicated that children with reduced Zn concentrations or those facing Zn deficiency were more likely to have parasitic infections (26, 27).

Conclusion

The research showed that most people had Zn deficiencies, which were higher in the young and females. Significantly, they showed significant deficiencies both in children and with age, and women were more deficient in Zn. Thus, needed strategies to combat the problem will be created and implemented following these findings. In the same way, health and sanitary measures can dampen the negative effects of Zn deficiency.

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Data availability: The data of this study are available from the corresponding author upon reasonable request.

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