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EFFECT OF HEMODIALYSIS ON SERUM ZINC LEVELS IN PATIENTS WITH END STAGE RENAL DISEASE IN KARBALA

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ABSTRACT

Background: End-stage renal disease (ESRD) patients undergoing hemodialysis are at heightened risk of micronutrient deficiencies, particularly zinc, which plays a crucial role in immune function, tissue repair, and oxidative balance. This study aimed to evaluate the impact of hemodialysis on serum zinc levels in ESRD patients in Karbala, Iraq. **Methods:** A cross-sectional analytical study was conducted from April to November 2024, involving 46 adult ESRD patients receiving maintenance hemodialysis at Al-Hussain Medical City. Serum zinc levels were measured before and after a dialysis session. Demographic data, body mass index (BMI), comorbidities, dietary intake of zinc-rich foods, and dialysis frequency were recorded. Data were analyzed using SPSS version 29, with $p<0.05$ considered statistically significant. **Results:** The study population consisted of 18 males (39.1%) and 28 females (60.9%), with a mean age of 57.04 ± 11.69 years. Post-dialysis zinc levels (92.89 ± 27.15 µg/dL) were slightly higher than pre-dialysis levels (90.33 ± 28.79 µg/dL), though the difference was not statistically significant ($p=0.502$). A significant positive correlation was observed between serum zinc levels and the frequency of zinc-rich food consumption ($p<0.001$). Most patients had comorbid hypertension and/or diabetes, and 34 patients were either overweight or obese. **Conclusion:** Hemodialysis did not significantly alter acute serum zinc levels; however, zinc deficiency remains a common concern. Regular monitoring and individualized nutritional strategies, including dietary counseling and potential supplementation, are recommended to address zinc insufficiency and improve patient outcomes in this population.

KEYWORDS: Effect, hemodialysis, serum zinc, end stage, renal, disease.

INTRODUCTION

End-stage renal disease (ESRD) represents the terminal phase of chronic kidney disease, marked by irreversible loss of kidney function that necessitates renal replacement therapy, most commonly hemodialysis.[1] Hemodialysis is a life-sustaining intervention designed to remove accumulated toxins and excess fluids from the blood; however, it may inadvertently disrupt the balance of essential micronutrients, including zinc.[2] Zinc is a vital trace element involved in a wide range of physiological processes, including immune regulation, enzymatic catalysis, and tissue repair.[3] In patients with ESRD, zinc deficiency is a well-documented concern, arising from various factors such as dietary restrictions, impaired gastrointestinal absorption, and dialysis-related losses.[4] This deficiency can lead to clinically significant consequences, including compromised immune function, delayed wound healing, and increased oxidative stress, which may further complicate the management of ESRD.[5] Several studies have demonstrated a progressive decline in serum zinc concentrations with the advancement of chronic kidney disease, with notably lower levels observed in patients undergoing maintenance hemodialysis compared to healthy individuals.[6] Moreover, low serum zinc levels in hemodialysis patients have been associated with an elevated risk of mortality, highlighting the importance of monitoring and addressing this micronutrient imbalance.[7] Given the multifactorial etiology of zinc deficiency in ESRD patients, including poor dietary intake, the presence of uremic toxins, and nutrient losses during dialysis sessions, maintaining adequate zinc levels remains a clinical challenge.[8] Previous research has also identified a positive correlation between serum zinc levels and nutritional status in hemodialysis patients, as assessed by abdominal fat measurements using computed tomography, reinforcing the link between zinc homeostasis and overall health in this population.[9] The current study aims to investigate the impact of hemodialysis on serum zinc levels in patients with ESRD. By understanding how dialysis influences zinc metabolism, this research seeks to inform future interventions that can mitigate micronutrient deficiencies and ultimately enhance the health outcomes and quality of life in individuals undergoing maintenance hemodialysis.

METHOD

This cross-sectional analytical study was conducted to assess the impact of hemodialysis on serum zinc levels in patients with end-stage renal disease (ESRD). A total of 46 adult patients undergoing regular hemodialysis were recruited from the Hemodialysis Unit at Al-Hussain Medical City, Karbala, Iraq. The study period extended from April 2024 to November 2024. **Ethical Consideration**: Ethical approval was obtained from the Arab Board of Medical Specialization Research Ethics Committee prior to the initiation of the study. All participants (or their legal guardians, where applicable) provided written informed consent. The study procedures adhered to the ethical principles outlined in the Declaration of Helsinki. **Inclusion and Exclusion Criteria**: Eligible participants met the following inclusion criteria: adults aged 18 years or older, receiving effective hemodialysis (defined as blood flow rate >300 mL/min, duration of 4 hours per session, minimum of two sessions per week, with arteriovenous fistula access and dialysate flow of 500 mL/min), and not taking zinc supplementation. Patients were excluded if they had acute kidney injury requiring temporary dialysis or if their dialysis sessions were deemed inefficient. **Data Collection**: All patients underwent comprehensive clinical evaluation, including detailed history and physical examination. Demographic and clinical data were recorded. Anthropometric measurements such as height and weight were obtained to assess nutritional status. Laboratory investigations included serum zinc measurement both before and after a hemodialysis session to evaluate the immediate impact of the procedure on zinc levels. **Statistical Analysis**: Data were entered, coded, and analyzed using IBM SPSS Statistics for Windows, version 29 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized using frequencies and percentages. Fisher's Exact test or Monte Carlo correction was used for comparing qualitative variables where appropriate. Continuous variables were presented as mean ± standard deviation (SD). The independent samples t-test was employed for comparisons between two groups with normally distributed data, while the Mann–Whitney U test was used for non-parametric comparisons. The Chi-square test (χ^2) was applied to assess differences in categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 46 patients were included in the study, consisting of 18 males (39.1%) and 28 females (60.9%). The age of the patients ranged from 32 to 80 years, with a mean age of 57.04 ± 11.69 years (Table 1). The mean weight of the patients was 72.98 ± 16.92 kg, with a range from 44 kg to 140 kg. The mean height was 161.07 ± 10.26 cm, ranging from 130 cm to 183 cm (Table 1).

Table 1: Demographic Characteristics of the Patients.

Characteristic	Mean ± SD	Range
Age (years)	57.04 ± 11.69	32 - 80
Weight (kg)	72.98 ± 16.92	44 - 140
Height (cm)	161.07 ± 10.26	130 - 183

Gender and Weight Distribution

The distribution of patient weight showed that males had a higher average weight (78.17 ± 20.67 kg) than females (69.64 ± 13.37 kg), with greater variability in the male group (Table 2).

Table 2: Distribution of Weight Among Male and Female Patients (n=46).

Gender	Mean Weight (kg) ± SD	Range
Male	78.17 ± 20.67	50 - 140
Female	69.64 ± 13.37	44 - 98

Body Mass Index (BMI)

The distribution of BMI showed that one patient was underweight, 12 patients had a normal BMI, 18 patients were overweight, and 15 patients were obese (Figure 1, Table 3). No significant difference in BMI between males and females was observed (p = 0.052). The mean BMI for male patients was 27.31 ± 6.73, while for female patients it was 28.51 ± 4.37 (Table 3).

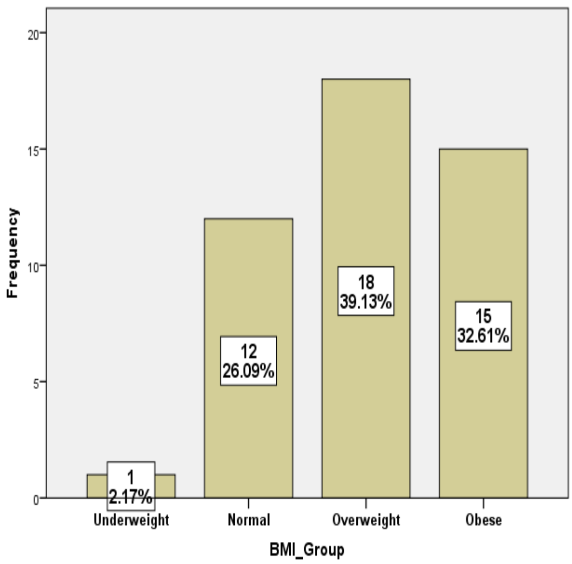

Figure 1: Distribution of BMI Among End-Stage Renal Failure Patients (n=46).

Table 3: BMI Distribution Among Male and Female Patients.

Gender	Mean BMI ± SD	Range
Male	27.31 ± 6.73	20.55 - 47.32
Female	28.51 ± 4.37	17.97 - 38.28

Comorbidities

Among the 46 patients, 2 (4.3%) had no comorbidities. The most common comorbidities were hypertension (39.1%, n=18), followed by both hypertension and diabetes (56.5%, n=26) (Table 4).

Table 4: Distribution of Concomitant Diseases Among Patients (n=46).

Comorbidity	Frequency (%)
No comorbidities	2 (4.3%)
Hypertension only	18 (39.1%)
Diabetes and Hypertension	26 (56.5%)

Serum Zinc Levels Before and After Hemodialysis

The comparison of serum zinc levels before and after hemodialysis was performed using a paired t-test. The results showed an increase in the mean zinc level after dialysis (92.89 ± 27.15), compared to before dialysis (90.33 ± 28.79). However, this increase was not statistically significant ($p = 0.502$, $t = -0.62$, $df = 45$) (Table 5).

Table 5: Serum Zinc Levels Before and After Hemodialysis.

Time Point	Mean ± SD (µg/dL)	Range
Before Dialysis	90.33 ± 28.79	44 - 162
After Dialysis	92.89 ± 27.15	50 - 158

Table 5: Zinc Level Comparison Before and After Hemodialysis.

- **t-value**: -0.62
- **p-value**: 0.502
- **No significant difference** found in serum zinc levels before and after dialysis.

Zinc-Rich Food Consumption

More than half of the patients reported consuming zinc-rich foods (such as meat, shellfish, and legumes) once a week, while one-quarter of patients consumed these foods on a daily basis (Figure 2). A highly significant positive correlation was found between serum zinc levels and the frequency of zinc-rich food consumption ($p < 0.001$).

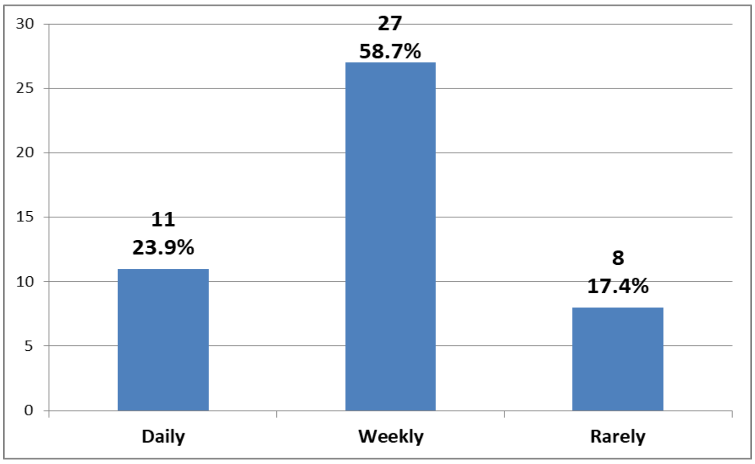

Figure 2: Frequency of Consuming Zinc-Rich Foods Among Patients foods among End Stage Renal Failure Patients in Karbala Governorate/Iraq (n=46).

Frequency of Dialysis Sessions

Most patients (58.7%, n=27) underwent two dialysis sessions per week, while 39.1% (n=18) had 3 sessions weekly (Figure 3).

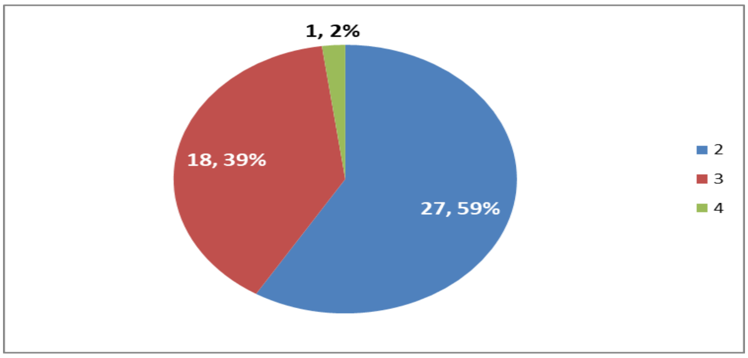

Figure 3: Frequency of Dialysis Sessions per Week Among Patients (n=46).

DISCUSSION

This study aimed to investigate the impact of hemodialysis on serum zinc concentrations in patients with end-stage renal disease (ESRD), and to explore the influence of demographic characteristics, comorbidities, nutritional patterns, and dialysis regimens on zinc status. Serum zinc levels showed wide variability both before and after dialysis, with pre-dialysis levels ranging from 48.1 µg/dL to 178.3 µg/dL and post-dialysis levels ranging from 55.6 µg/dL to 159.7 µg/dL. Although a slight increase in mean serum zinc was observed post-dialysis (90.33 µg/dL to 92.89 µg/dL), the change was not statistically significant ($p = 0.502$), suggesting that hemodialysis did not have a marked immediate effect on serum zinc levels. Previous studies have shown mixed results regarding changes in zinc levels with hemodialysis. Some reported a significant increase in zinc concentrations after dialysis compared to pre-dialysis levels[10,11], while others found no statistically significant difference.[12] Despite these fluctuations, zinc levels tend to be higher after dialysis than before[13], possibly due to hemoconcentration or the release of intracellular zinc during the procedure.[14] Zinc levels in patients undergoing hemodialysis are generally lower than those in healthy individuals.[15–17] The underlying mechanism for the slight elevation in zinc post-dialysis remains unclear, though one hypothesis involves the role of transporter proteins such as albumin, prealbumin, and transferrin, which bind zinc and may prevent its filtration during hemodialysis.[18] This may explain the paradox of increased post-dialysis zinc levels despite an overall zinc-deficient state in chronic kidney disease (CKD) patients. Numerous studies have identified a significant prevalence of zinc deficiency among CKD patients, whether on conservative treatment or dialysis.[19,20] The causes are multifactorial and include protein-energy malnutrition, low dietary intake, impaired absorption and transport mechanisms, and increased urinary or dialysis-related losses.[21] Even with different dialysis techniques, a consistent decline in serum zinc levels is reported.[22] Most researchers agree that chronic renal failure (CRF) patients on either dialysis or conservative management have reduced serum zinc concentrations.[23,24] However, some studies have noted elevated zinc levels in cellular compartments such as red blood cells and lymphocytes[25], while a few have reported increased blood levels of several trace elements, including zinc, in ESRD patients compared to controls.[25] Demographically, the study cohort was predominantly middle-aged to elderly, with a mean age of 57.04 years and a female majority (60.9%). Hypertension and diabetes were the most common comorbidities—both known to disrupt zinc metabolism.[22] Nutritionally, 23.9% consumed zinc-rich foods daily, while none used zinc supplements, highlighting a reliance on dietary intake alone. Dialysis regimens varied, with most patients receiving two or three sessions weekly. Although increased dialysis frequency may be linked to greater zinc loss, our findings suggest that baseline nutritional status and comorbidities play a more substantial role. Gender-based analysis revealed higher zinc levels in females than males both pre- and post-dialysis, though not statistically significant. These differences may reflect hormonal, dietary, or metabolic variations rather than anthropometric factors, as no significant difference in height or weight was found between genders.[24,25]

CONCLUSION

Hemodialysis does not appear to cause significant acute changes in serum zinc levels, zinc deficiency remains prevalent among patients with ESRD due to multifactorial causes. Given the important role of zinc in immune function, wound healing, and oxidative balance, personalized dietary strategies and supplementation may be warranted to improve the nutritional and clinical status of these patients. Continued research is necessary to better understand zinc metabolism in the hemodialysis setting and to develop effective interventions to mitigate deficiency-related complications.

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