Pettersen SM, et al., J Gerontol Geriatr Med 2024, 10: 214
DOI: 10.24966/GGM-8662/100214

HSOA Journal of Gerontology and Geriatric Medicine

Research Article

Moving Towards Reliable Assessment of Zinc Depletion in Acutely Admitted Geriatric Patients

Sara Marie Pettersen[1], Pernille Holm Ellegaard[1], Parosh Kadir Muhamed[1], Anne Wilkens Knudsen[2] and Cecilia Margareta Lund[1,3,4]*

[1]*Department of Medicine, Copenhagen University Hospital, Herlev and Gentofte, Denmark*

[2]*The Dietitians and Nutritional Research Unit, EATEN, Copenhagen University Hospital, Herlev and Gentofte, Denmark*

[3]*Department of Clinical Medicine, Faculty of Health and Medical Sciences, Copenhagen University, Denmark*

[4]*CopenAge, Copenhagen Center for Clinical Age Research, University of Copenhagen, Denmark*

Abstract

Background: Many admitted geriatric patients are malnourished with insufficient intake of trace elements. Zinc status is crucial to maintaining normal immune function and is assessed using plasma zinc concentration. However, plasma zinc drops with increased systemic inflammation (high CRP and hypoalbuminemia), challenging interpretation in older infected patients. Currently, guidelines are unclear for assessing zinc status and prescribing zinc supplements.

Methods: A cross-sectional study investigating the prevalence of low plasma zinc and low albumin-corrected zinc among older patients admitted to the geriatric ward at Copenhagen University Hospital, Herlev and Gentofte. Prescription of zinc supplements and the association between low levels of zinc and infections, readmissions, and mortality were analyzed.

Results: Of the included 143 patients (median age 84 years), 93 (65%) had low plasma zinc (<10 µmol/L). After adjusting for albumin level, only 56 patients (39%) had low levels of zinc, and thereby possible zinc deficiency. Out of the 93 patients with low plasma zinc, only 36 (39%) received zinc supplements at discharge (22-44 mg/daily). Plasma zinc was found to be negatively correlated with CRP ($p<0.001$) and positively correlated with albumin ($p>0.001$). Low plasma zinc was associated with poorer 1-year mortality (2.17, 95% CI 1.01-4.76). However, after adjustment of albumin level, low zinc levels were not associated with poorer outcomes.

Conclusion: Plasma zinc cannot be used to evaluate zinc status in hospitalized, often infected, geriatric patients. Our study suggests that albumin-corrected zinc is a more reliable assessment of zinc status in hospitalized geriatric patients and should guide zinc supplementation.

Keywords: Albumin-corrected zinc; Infection; Malnutrition; Older

Keypoints

- Zinc is crucial to maintain normal immune function, but zinc status is challenging to determine in hospitalized older patients
- Current guidelines are unclear for assessing zinc status and prescribing zinc supplements
- This cross-sectional study supports that plasma zinc alone cannot be used to evaluate zinc status in hospitalized geriatric patients and that albumin-corrected zinc is likely to be a more correct assessment to diagnose zinc depletion

Introduction

Frail older patients are typically admitted to geriatric wards due to acute illness, common infections, or exacerbation of chronic illness and loss of function. Many older patients are at nutritional risk after long-lasting insufficient nutritional intake or one sided "Tea and toast diet" [1], leading to malnutrition as part of their geriatric syndrome [1]. The risk of malnutrition increases with age and is related to comorbidity [2] and frailty [3], but it is largely underdiagnosed and consequently also undertreated [2,4]. In acutely admitted geriatric patients the majority have nutritional impairments [4] which can lead to increased morbidity, prolonged hospital stays and rehabilitation, loss of function, and decreased quality of life [1,2,5]. Decreased food intake is often accompanied by an insufficient intake of several vitamins and trace elements such as zinc [6].

Zinc deficiency is defined as a state of low intake of zinc, or increased loss of zinc, and simultaneous low plasma zinc, or symptoms [7]. Typical deficiency related symptoms include skin irritation, reduced appetite and decreased healing of wounds [8]. Additionally, even mild zinc deficiency can lead to an impaired immune function, which is associated with increased risk of infectious diseases [6]. Moderate zinc deficiency includes cell-mediated immune dysfunctions and impaired wound healing [9]. Zinc also plays a role in several aspects of the antioxidant defense system [9,10].

Zinc supplements act by improving the reaction of the immune system, instead of suppressing the immune reaction like other anti-inflammatory drugs (e.g., glucocorticoids). It has been shown that zinc supplementation in older adults reduces unspecific preactivated T cells and improves T cell response [11]. Furthermore, the state of

***Corresponding author:** Cecilia Margareta Lund, Department of Medicine, Copenhagen University Hospital, Herlev and Gentofte, Borgmester Ib Juuls Vej 1, 2730, Herlev, Denmark, Tel: +45 38686112; E-mail: Cecilia.Margareta.Lund.01@regionh.dk

Citation: Pettersen SM, Ellegaard PH, Muhamed PK, Knudsen AW, Lund CM (2024) Moving Towards Reliable Assessment of Zinc Depletion in Acutely Admitted Geriatric Patients. J Gerontol Geriatr Med 10: 214.

Received: June 07, 2024; **Accepted:** June 19, 2024; **Published:** June 26, 2024

zinc deficiency and the aging immune system has been shown to have several similarities [12], which is why it has been suggested that even healthy older adults could benefit from zinc supplementation [13]. Low levels of plasma zinc have also been reported in a number of malignancies [14,15], but the potential beneficial effect of zinc supplements in preventing cancers remains unclear [16]. Additionally, there is a lack of consensus of treatment of deficiency conditions among older patients, including optimal doses of zinc and duration of treatment. In clinical practice today, there is a risk of both under- and overtreatment with zinc supplements, decreasing compliance to the patient´s other medications if overtreated [17]. There is also a risk for recurrent deficiency after substitution if the nutritional intake remains insufficient.

Prevalence of low plasma zinc seems higher in older people compared to younger populations [18], and especially in hospitalized subjects [19,20]. However, prevalence of zinc deficiency in geriatric inpatients in general is unknown. Plasma zinc concentration is the most common method of assessment of zinc status because it is cost-effective and easy to analyze [7]. However, zinc is bound to albumin and plasma zinc concentration drops with increased systemic inflammatory response, mediated by lower hepatic production of many zinc carrier proteins, an increased capillary permeability, and an increased deposition of zinc into the liver cells [13,21]. Additionally, clinical laboratory reference values used in clinical practice are based on younger persons and it is known that plasma zinc concentrations fluctuate by as much as 20% during a 24-hour period due to food ingestion [7]. Thus, it is challenging to interpret zinc status from plasma zinc in admitted older patients, since they are likely to possess both an acute inflammatory response, and a more chronic inflammatory level due to comorbidities. A recent study from Jørgensen et al., [22] including patients with short bowel syndrome or cirrhosis, suggested that zinc should be adjusted in relation to hypoalbuminemia to achieve a better interpretation of zinc levels and true zinc deficiency.

There are, to our knowledge, no studies who have investigated the prevalence of low albumin-corrected zinc among geriatric patients. The present study, therefore, aimed to evaluate the prevalence of low plasma zinc and low albumin-corrected zinc among older acutely admitted patients, to investigate occurrence of supplements given, and the association between low levels of albumin-corrected zinc and infections, readmissions, and mortality.

Methods

Study design and participants

The study is a cross-sectional design investigating plasma zinc and albumin-corrected zinc among older patients admitted to the geriatric ward at Copenhagen Hospital University of Herlev and Gentofte during May 2021. All patients admitted to the geriatric ward during the study had extended nutritional blood samples drawn at least one time during their admission, independently of nutritional status.

Data collection and variables

Data were retrospectively collected from the electronic medical record. Baseline characteristics included age, sex, Body mass index (BMI, kg/m^2), any weight loss reported at admission, use of walking aids, living condition, domestic help, comorbidity, polypharmacy and nutritional supplements. Comorbidity was evaluated by using CIRS-G (Cumulative Illness Rating Scale- Geriatric). Readmission within 3 months, and mortality within 3 months and 1 year after discharge was noted.

Plasma zinc and albumin-corrected zinc

Plasma zinc was considered normal between 10-19 µmol/l according to local reference values. Thus, plasma zinc values below 10 µmol/l was considered "low". According to Jørgensen et al., [22], plasma zinc values can be adjusted for hypoalbuminemia, to prevent overestimation of efficiencies. Based on a cohort of healthy blood donors, the correlation between albumin and zinc (β) was found with a linear regression. Reference for albumin was based on Macdonell et al., [23] using the highest value of the lowest decile of albumin in their healthy cohort, which was set to 45. Jørgensen et al., used the following equation to adjust for hypoalbuminemia:

$$Zn_{corrected} = Zn_{measured} - (\beta * (Albumin_{measured} - Albumin_{ref}))$$

The albumin reference used for the present analysis was set to the mean of the normal reference value for persons over 70 years, i.e., 39.5 g/L. The correlation coefficient (β) from the linear regression was calculated for the present cohort, as the correlation between albumin and zinc could be different in older patients compared with healthy blood donors. In the present cohort β was found to be 0.212, establishing the following model:

$$Zn_{corrected} = Zn_{measured} - (0.212 * (Albumin_{measured} - 39.5)$$

Statistics

Baseline characteristics were presented as descriptive data for all patients and for patients depending on normal or low plasma zinc levels. Categorical variables were compared using a Chi-squared test, otherwise Fisher's exact test was used. Differences in distribution of continuous baseline variables were performed with the Wilcoxon rank sum test. Correlation analysis was performed using Pearson´s correlation coefficient.

Frequencies of readmissions and mortality at 3 months and 1 year for patients with low albumin-corrected zinc compared with patients with normal values were analyzed with the chi square test. Binary outcomes were also analyzed by binary logistic regression and presented as Odds Ratios (ORs) and 95% Confidence Intervals (CIs), and validated in a multivariate analysis including age, sex, and BMI.

The correlation coefficient (β) for the albumin corrected model was found in the linear regression. The statistical software IBM SPSS Statistical Viewer version 25 was used for all analyses with a 5% significance level.

Results

In total, 168 patients were admitted to the geriatric ward during May month in 2021. Three of the participants were duplicates as they were readmitted during the period and 22 did not have extended blood samples drawn (missing data). The current study population consisted of 143 participants (Figure 1). The baseline characteristics are displayed in table 1 for all patients and for patients with normal or low plasma zinc levels, with and without adjustments for albumin level. Median age was 84 years (ranged from 65-100) and 89 patients (62%) were women. Most patients lived in their own homes (82%) and 18% were admitted patients from intermediate care or nursing homes. No significant differences in baseline characteristics were seen between patients with low or normal plasma zinc. However, fewer nursing home residents than patients living in their own homes had low albumin-corrected zinc.

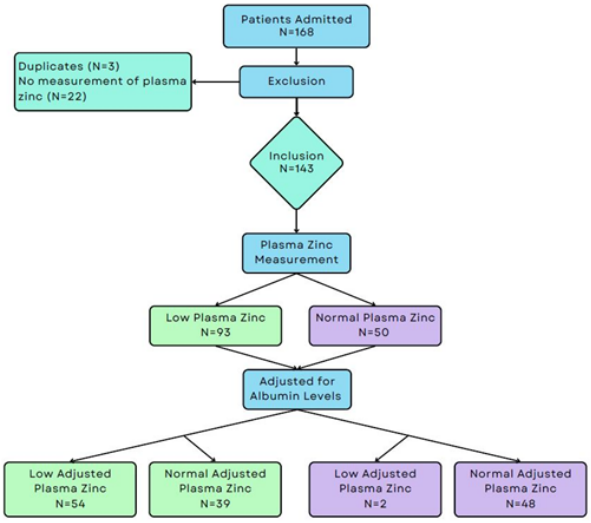

Figure 1: Patient inclusion and results of zinc analyses.

Zinc levels and adjustments for hypoalbuminemia

Overall, 93 patients (65%) had low plasma zinc (<10 µmol/l). After adjusting for albumin based on equation suggested by Jørgensen et al., [22], 56 patients (39%) had low levels of zinc, and thereby possible zinc deficiency. The majority of patients had elevated C-Reactive Protein (CRP) levels >5mg/L 110 (77%), 87 patients (61%) had CRP >20 mg/L, and 49 patients (34%) had hypoalbuminemia. All patients with plasma zinc < 6 µmol/l had albumin-corrected zinc below <10 µmol/l, and thereby possible zinc deficiency. Plasma zinc was found to be negatively correlated with CRP (r= -0.465, p<0.001) and positively correlated with albumin (r= 0.525, p>0.001).

Multivitamin and zinc supplements at admission

A portion of the patients were treated with multivitamin or zinc supplements at admission (15% vs. 7.0%). There was a tendency towards higher frequencies of multivitamins and zinc supplements prescribed among patients admitted from nursing homes compared with patients admitted from own homes (24% vs. 13%, p = 0.147 and 16% vs. 5.1%, p = 0. 052).

In total, 9 patients (18%) of the 50 patients with normal plasma zinc received multivitamins compared with 12 (13%) of the 93 patients with low plasma zinc (Table 1). Additionally, 4 (8.0%) of 50 patients with normal plasma zinc and 6 (7%) of the 93 patients with low plasma zinc, had zinc supplements. When adjusting for hypoalbuminemia, 7 (13%) of the 56 patients with low albumin-corrected zinc and 14 (16%) of the 87 patients with normal albumin-corrected zinc were treated with multivitamins. Furthermore, 3 (5.4%) of the 56 patients with low albumin-corrected zinc and 7 (8.0%) of the 87 patients with normal albumin-corrected zinc, were already in treatment with zinc supplements.

Zinc supplements at discharge

Totally 36 (39%) of patients with low plasma zinc, received zinc supplements (22-44 mg/daily). Of the 56 patients with low albumin-corrected zinc, 28 (50%) received zinc supplements at discharge. At discharge, a total of 38 (27%) out of the entire population had zinc supplements added to their medication list compared with at admission.

Prognosis

Overall, 51 (37%) patients were readmitted at least once within three months, and 31 (22%) patients died within three months. One year mortality was 35%. In addition, five patients died during hospitalization, and all of them had low plasma zinc. Furthermore, 41% of patients with low plasma zinc died within the 1st year of follow up, compared with only 24% among patients with normal plasma zinc (P = 0.044) (Table 2). However, when using albumin-corrected zinc no difference was seen in 1-year mortality.

No difference in 3-months readmission rates and 3-months mortality was seen between patients with low vs. normal levels of plasma zinc or albumin-corrected zinc. More patients with elevated CRP (>5 mg/L) died within the 1st year, compared with patients with normal CRP (40% vs. 18%, p = 0.021). No difference in outcomes was seen at 3 months. Patients with hypoalbuminemia, had higher 3-months´ and 1-year mortality compared with patients with normal albumin levels (43% vs. 11%, p<0.001) and (51% vs. 27%, p= 0.004, respectively). Low plasma zinc was associated with increased 1-year mortality (2.17, 95% CI 1.01-4.76), but could not be validated in the multivariate model. After adjustment of albumin level, low zinc level was not associated with poorer outcomes (Table 3).

Hypoalbuminemia was found to be associated with higher mortality at 3 months and 1 year in the univariate analysis and confirmed in the multivariate analysis (2.86, 95% CI 1.39-5.88 and 4.00, 95% CI 1.69-9.09 respectively). Elevated CRP (>5 mg/L) was also found to be associated with increased 1-year mortality (3.03, 95% CI 1.15-7.87), but could not be confirmed in the multivariate analysis.

Discussion

In this cross-sectional study of 143 acutely admitted geriatric patients, we found that more than half of the patients had low plasma zinc based on plasma zinc concentration. When adjusting zinc measurements for albumin levels, the prevalence of zinc depletion decreased from 65% to 39% of patients. The high prevalence of low plasma zinc is in line with Girodon et al., [24] who found low plasma zinc in 61% of older admitted patients. In addition, it has long been known that zinc concentration is lower among older adults compared to younger adults [18,25] and in hospitalized patients compared to healthy adults [26]. However, we found the prevalence of patients with low plasma zinc to be lower in patients admitted from care homes than in patients admitted from their own home. This could be due to the tendency found towards more frequent use of supplements but also more sufficient nutritional intake.

Low albumin can be caused by a low intake of protein. Furthermore, a prevalent reason for low albumin in hospitalized patients is high levels of CRP. A major reason for admission in the present study was infection with most patients' CRP levels over 20 mg/L, indicating an active systemic immune response. We found a significant association between plasma zinc and CRP, in line with Duncan et al., [21] who found that plasma zinc concentration decreased when CRP increased. Systemic inflammatory response is known to decrease plasma zinc concentrations independently of the actual zinc status [21]. However, plasma zinc is usually normalized after clinical improvement [27,28].

Characteristics		All patients N (%)	Normal plasma zinc N = 50 n (%)	Low plasma zinc N = 93 n (%)	p	Normal albumin-corrected zinc N = 87 n (%)	Low albumin-corrected zinc N = 56 n (%)	p
Sex	Female Male	89 (62%) 54 (38%)	33 (66) 17 (34)	56 (60%) 37 (40%)	0.496	56 (64) 31 (36)	33 (59) 23 (41)	0.513
Age	Years median (range)	84 (65 - 100)	82 (65 - 100)	85 (65 - 97)	0.424	83 (65 - 100)	85.5 (69 - 97)	0.325
BMI	Median (range)	24.7 (15.5 - 42)	29 (24.7 - 33.5	25 (15.5 - 42)	0.570	24.2 (16.5 - 40.8)	23.7 (16.2 - 36.6	0.595
Living condition	Own Home Intermediate or nursing home	118 (82) 25 (18)	39 (78) 11 (22)	79 (85) 14 (15)	0.297	67 (77) 20 (23)	51 (91) 5 (8.9)	0.031
Walking aid	No walking aid Walking aid Wheelchair bound NA	38 (27) 78 (55) 25 (17) 2 (1.4)	17 (34) 24 (48) 9 (18)	21 (23) 54 (58) 16 (17) 2 (2.2)	0.350	22 (25) 46 (53) 18 (21) 1 (1.1)	16 (29) 32 (57) 7 (13) 1(1.8)	0.646
CIRS - G	Score (range)	8 (1 - 16)	8 (1 - 16)	8 (1 - 14)	0.357	8 (1 -16)	8 (1 - 14)	0.994
Daily medication	No. (range)	8 (0 - 25)	9.5 (1 - 25)	7 (0 - 17)	0.120	8 (0 -25)	7 (0 -16)	0.420
Daily intake of pills	No. (range)	12 (0 - 38)	13 (1 - 38)	11 (0 - 28)	0.466	12 (0 -38)	10.5 (0 - 27)	0.551
Multivitamin at admission	Yes	21 (15)	9 (18)	12 (13)	0.412	14 (16)	7 (13)	0.554
Zinc supplement at admission	Yes	10 (7.0)	4 (8.0)	6 (7.0)	0.740	7 (8.0)	3 (5.4)	0.538
Weight loss N=136	No Yes	96 (71%) 40 (29%)	37 (79%) 10 (21%)	59 (66%) 30 (34%)	0.130	61 (70) 22 (25)	35 (67) 18 (32)	0.635

Table 1: Baseline characteristics.

	Readmission < 3 months N = 138*			3-months mortality N = 143			1-year mortality N = 143		
	Readmission N = 56	No readmission N = 82		Dead N = 31	Alive N = 112		Dead N = 50	Alive N = 88	
	n (%)	n (%)	P	n (%)	n (%)	P	n (%)	n (%)	P
Normal plasma zinc **Low plasma zinc**	20 (40) 36 (41)	30 (60) 52 (59)	0.917	8 (25) 23 (75)	42 (38) 70 (63)	0.227	12 (24) 38 (41)	38 (76) 55 (59)	0.044
Normal albumin-corrected zinc **Low albumin-corrected zinc**	35 (41) 21 (19)	50 (59) 32 (81)	0.857	21 (24) 10 (18)	66 (76) 46 (82)	0.374	31 (35) 19 (34)	56 (64) 37 (66)	0.835
Normal albumin **Low albumin**	38 (41) 18 (39)	54 (59) 28 (61)	0.806	10 (11) 21 (43)	84 (89) 28 (57)	<0.001	25 (27) 25 (51)	69 (73) 24 (49)	0.004
Normal CRP **> CRP 5 mg/L**	13 (39) 43 (41)	20 (61) 62 (59)	0.874	3 (9.7) 28 (25)	30 (91) 82 (75)	0.054	6 (18) 44 (40)	27 (82) 66 (60)	0.021
Normal CRP **> CRP 20 mg/L**	22 (39) 34 (41)	34 (61) 48 (59)	0.789	10 (18) 21 (24)	46 (82) 66 (76)	0.374	15 (27) 35 (40)	41 (73) 52 (60)	0.100

Table 2: Outcomes depending on baseline blood results.

* 5 patients died during hospitalization

	Readmission < 3 months N = 138*			3-months mortality N = 143			1-year mortality N = 143		
	Readmission N = 56	No readmission N = 82		Dead N = 31	Alive N = 112		Dead N = 50	Alive N = 88	
	n (%)	n (%)	P	n (%)	n (%)	P	n (%)	n (%)	P
Normal p-zinc **Low p-zinc**	20 (35) 36 (65)	30 (37) 52 (63)	0.917	8 (26) 23 (74)	42 (38) 70 (63)	0.227	12 (24) 38 (76)	38 (43) 55 (57)	0.044
Zinc sufficient **Zink deficiency****	35 (63) 21 (37)	50 (61) 32 (39)	0.857	21 (68) 10 (32)	66 (59) 46 (41)	0.374	31 (62) 19 (38)	56 (64) 37 (36)	0.835
Normal albumin **Low albumin**	38 (68) 18 (32)	54 (67) 28 (33)	0.806	10 (32) 21 (68)	84 (75) 28 (25)	<0.001	25 (50) 25 (50)	69 (78) 24 (22)	0.004

Normal **> CRP 5 mg/L**	13 (23) 43 (77)	20 (24) 62 (76)	0.874	3 (9.7) 28 (90)	30 (27) 82 (73)	0.054	6 (12) 44 (88)	27 (31) 66 (69)	0.021
Normal CRP **> CRP 20 mg/L**	22 (39) 34 (61)	34 (41) 48 (59)	0.789	10 (32) 21 (68)	46 (41) 66 (59)	0.374	15 (30) 35 (70)	41 (47) 52 (53)	0.100

Table 3: Outcomes depending on blood results.

* 5 patients died during hospitalization ** adjusted for albumin level

Measurement of zinc-dependent cell-mediated immune function, has demonstrated mild zinc deficiency despite normal plasma zinc [29]. Therefore, laboratory characterization of mild zinc deficiency, and the interpretation of plasma zinc concentration is difficult. Duncan et al., [21] stated that plasma zinc concentrations could not be interpretated clinically when CRP levels were above 20 mg/L. Accordingly, the ESPEN micronutrient guideline [7] recommends that plasma zinc should be used to confirm suspicion of clinical zinc deficiency and monitoring provision, and that measurement of CRP and albumin is necessary for interpretation.

We found that patients with low plasma zinc concentration had significantly higher occurrence of hypoalbuminemia. Jørgensen et al., [22] also found a strong association between hypoalbuminemia and low levels of zinc and suggested that zinc levels should be adjusted for level of albumin before interpreted and used for diagnosis of zinc deficiency. In a following study, Hedegaard et al., [28] found that albumin-corrected zinc values in acutely admitted patients with infections were comparable to the patients´ plasma zinc at 14 days follow up after admission. The authors suggest that the assay could be a proper way to assess zinc depletion during infection. When adjusting zinc measurements for albumin levels in the present study, prevalence of zinc depletion decreased from 65% to 39% of patients. Thus, the prevalence matches well with insufficient zinc intake in half of older adults [30], thus supporting that albumin-corrected zinc may be a more accurate method to evaluate zinc status in older admitted patients with elevated CRP. However, the former study only evaluated zinc intake through nutrition, not including zinc-containing supplements.

In the present study few patients were already receiving multivitamin or zinc supplementation at admission and only zinc supplementation seemed to reduce the number of patients with low albumin-corrected zinc. The total number of patients receiving multivitamins at admission or at discharge were small, considering that all older adults >70 years in Denmark with reduced appetite are recommended to receive daily multivitamin supplementation [31]. At discharge, 25% of the patients received zinc supplements. Although this must be considered an overtreatment for those who did not have low albumin-corrected zinc, there might have been a beneficial effect with improved immune function. Prasad et al., [32] found significantly fewer signs of infections among older, but healthy, participants recruited from a senior center, after intake of 45 mg zinc daily. Furthermore, zinc supplements have been found to have a positive impact on survival in the COVID pandemic independent of their plasma zinc status [33].

Low plasma zinc and low albumin-corrected zinc in the present study were not associated with readmissions or mortality within 3-months. However, there was an observed link between low levels of zinc and one-year mortality. This association, however, could not be verified through the multivariate analysis. Therefore, the inclination toward an adverse outcome is likely influenced by other factors, such as hypoalbuminemia. Additionally, it has been shown that patients with COVID-19 and low serum zinc concentration had worse outcomes [34]. The authors did not take plasma albumin into account, and poorer outcome could again be driven by hypoalbuminemia. This highlights the need for correct laboratory methods of assessment of zinc status such as albumin-corrected zinc. Due to the multifactorial reasons for low zinc levels, plasma zinc might be considered a biomarker for frailty as it also may contribute to immune senescence [6].

A strength of the study is the discussion of different methods to assess whether an acutely infected geriatric patient needs zinc supplementation. Limitations include a small sample size. Additionally, there was no data on nutritional status including nutritional and sufficient zinc intake. Furthermore, potential symptoms of zinc deficiency were not described, and could not be collected retrospectively. Furthermore, it is challenging to assess symptoms of mild zinc deficiency especially among older patients who often present with infections and malnutrition at admission [4]. Thus, making the ESPEN guidelines [7] of diagnosing clinical zinc deficiency difficult to use when treating older hospitalized adults due to lack of reliable methods in the general clinical practice for measuring zinc deficiency. We believe that a strength of this study is its contribution to the discussion of how to use the available methods in geriatric patients.

Ultimately, the prevalence of low levels of plasma zinc was 65% among acutely admitted geriatric patients in the present study. After adjusting for albumin level, the prevalence was only 39%, although still a significant number. Plasma zinc alone cannot be used to evaluate zinc status in hospitalized geriatric patients, who often have high CRP and low albumin. Our study supports the suggestion that albumin-corrected zinc is likely to be a more correct assessment to diagnose “true” zinc depletion in hospitalized patients with high CRP. Further trials investigating the association between albumin-corrected zinc, zinc intake and symptoms of zinc deficiency in older medical patients are needed.

Acknowledgment

We would like to thank Delaney Evering for her work with layout and manuscript preparation and review. We also would like to thank Katarina Hörnqvist Rasmussen for her work with ensuring blood samples from admitted patients in the geriatric ward.

References

1. Agarwal E, Miller M, Yaxley A, Isenring E (2013) Malnutrition in the elderly: A narrative review. Maturitas 76: 296-302.

2. Norman K, Pichard C, Lochs H, Pirlich M (2008) Prognostic impact of disease-related malnutrition. Clin Nutr 27: 5-15.

3. Lorenzo-López L, Maseda A, de Labra C, Regueiro-Folgueira L, Rodríguez-Villamil JL, et al. (2017) Nutritional determinants of frailty in older adults: A systematic review. BMC Geriat 17: 108.

4. Buurman BM, Hoogerduijn JG, de Haan RJ, Abu-Hanna A, Lagaay AM, et al. (2011) Geriatric conditions in acutely hospitalized older patients: Prevalence and One-Year survival and functional decline. PLoS One 6: 26951.

5. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Goisser S, et al. (2019) ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr 38: 10-47.

6. Haase H, Rink L (2009) The immune system and the impact of zinc during aging. Immun Ageing 6: 9.

7. Berger MM, Shenkin A, Schweinlin A, Amrein K, Augsburger M, et al. (2022) ESPEN micronutrient guideline. Clin Nutr 41: 1357-1424.

8. Andersen AL, Nielsen RL, Houlind MB, Tavenier J, Rasmussen LJH, et al. (2021) Risk of malnutrition upon admission and after discharge in acutely admitted older medical patients: A prospective observational study. Nutrients 13: 2757.

9. Prasad AS (2013) Discovery of human zinc deficiency: Its impact on human health and disease. Adv Nutr 4: 176-190.

10. Kambe T, Tsuji T, Hashimoto A, Itsumura N (2015) The physiological, biochemical, and molecular roles of zinc transporters in zinc homeostasis and metabolism. Physiol Rev 95: 749-784.

11. Kahmann L, Uciechowski P, Warmuth S, Plümäkers B, Gressner AM, et al. (2008) Zinc supplementation in the elderly reduces spontaneous inflammatory cytokine release and restores T cell functions. Rejuvenation Res 11: 227-237.

12. Haase H, Mocchegiani E, Rink L (2006) Correlation between zinc status and immune function in the elderly. Biogerontology 7: 421-428.

13. Mocchegiani E, Romeo J, Malavolta M, Costarelli L, Giacconi R, et al. (2013) Zinc: Dietary intake and impact of supplementation on immune function in elderly. Age (Dordr) 35: 839-860.

14. Prasad AS, Beck FW, Doerr TD, Shamsa FH, Penny HS, et al. (1998) Nutritional and zinc status of head and neck cancer patients: An interpretive review. J Am Coll Nutr 17: 409-418.

15. Lin S, Yang H (2021) Ovarian cancer risk according to circulating zinc and copper concentrations: A meta-analysis and Mendelian randomization study. Clin Nutr 40: 2464-2468.

16. Prasad AS, Beck FW, Snell DC, Kucuk O (2009) Zinc in cancer prevention. Nutr Cancer 61: 879-887.

17. Gellad WF, Grenard JL, Marcum ZA (2011) A systematic review of barriers to medication adherence in the elderly: Looking beyond cost and regimen complexity. Am J Geriatr Pharmacother 9: 11-23.

18. Bunker VW, Hinks LJ, Lawson MS, Clayton BE (1984) Assessment of zinc and copper status of healthy elderly people using metabolic balance studies and measurement of leucocyte concentrations. Am J Clin Nutr 40: 1096-1102.

19. Senapati A, Jenner G, Thompson RPH (1989) Zinc in the elderly. Q J Med 70: 81-87.

20. Stafford W, Smith RG, Lewis SJ, Henery E, Stephen PJ, et al. (1988) A study of zinc status of elderly institutionalized patients. Age Ageing 17: 42-48.

21. Duncan A, Talwar D, McMillan DC, Stefanowicz F, O'Reilly DS (2012) Quantitative data on the magnitude of the systemic inflammatory response and its effect on micronutrient status based on plasma measurements. Am J Clin Nutr 95: 64-71.

22. Jørgensen LH, Sørensen MD, Lauridsen MM, Rasmussen LM, Alfiler RM, et al. (2022) Albumin-corrected Zn and available free Zn-binding capacity as indicators of Zn status - potential for clinical implementation. Scand J Clin Lab Invest 82: 261-266.

23. MacDonell SO, Miller JC, Harper MJ, Reid MR, Haszard JJ, et al. (2018) A comparison of methods for adjusting biomarkers of iron, zinc, and selenium status for the effect of inflammation in an older population: A case for interleukin 6. Am J Clin Nutr 107: 932-940.

24. Girodon F, Blache D, Monget AL, Lombart M, Brunet-Lecompte P, et al. (1997) Effect of a two-year supplementation with low doses of antioxidant vitamins and/or minerals in elderly subjects on levels of nutrients and antioxidant defense parameters. J Am Coll Nutr 16: 357-365.

25. Ravaglia G, Forti P, Maioli F, Nesi B, Pratelli L, et al. (2000) Blood micronutrient and thyroid hormone concentrations in the oldest-old. J Clin Endocrinol Metab 85: 2260-2265.

26. Belbraouet S, Biaudet H, Tébi A, Chau N, Gray-Donald K, et al. (2007) Serum Zinc and Copper Status in Hospitalized vs. Healthy Elderly Subjects. J Am Coll Nutr 26: 650-654.

27. Roohani N, Hurrell R, Kelishadi R, Schulin R (2013) Zinc and its importance for human health: An integrative review. J Res Med Sci 18: 144-157.

28. Hedegaard CV, Soerensen MD, Jørgensen LH, Schaffalitzky de Muckadell OB (2022) Investigating hypozincemia and validity of plasma zinc measurements in infected patients. Scand J Clin Lab Invest 82: 371-377.

29. Prasad AS, Kaplan J, Beck FW, Penny HS, Shamsa FH, et al. (1997) Trace elements in head and neck cancer patients: Zinc status and immunologic functions. Otolaryngol Head Neck Surg 116: 624-629.

30. Vural Z, Avery A, Kalogiros DI, Coneyworth LJ, Welham SJM (2020) Trace mineral intake and deficiencies in older adults living in the community and institutions: A systematic review. Nutrients 12: 1072.

31. Sundhedsstyrelsen (2022) Underernæring: Opsporing, behandling og opfølgning af borgere og patienter i ernæringsrisiko. Sundhedsstyrelsen, København, Denmark.

32. Prasad AS, Beck FW, Bao B, Fitzgerald JT, Snell DC, et al. (2007) Zinc supplementation decreases incidence of infections in the elderly: Effect of zinc on generation of cytokines and oxidative stress. Am J Clin Nutr 85: 837-844.

33. Tabatabaeizadeh SA (2022) Zinc supplementation and COVID-19 mortality: A meta-analysis. Eur J Med Res 27: 70.

34. Maares M, Hackler J, Haupt A, Heller RA, Bachmann M, et al. (2022) Free Zinc as a Predictive Marker for COVID-19 Mortality Risk. Nutrients 14: 1407.

HERALD

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752

Submit Your Manuscript: https://www.heraldopenaccess.us/submit-manuscript

Herald Scholarly Open Access, 2561 Cornelia Rd, #205, Herndon, VA 20171, USA.
Tel: +1 202-499-9679; E-mail: info@heraldsopenaccess.us
http://www.heraldopenaccess.us/