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Original Research Article

SERUM ZINC LEVELS AND ASTHMA: IS THERE A RELATION TO BE EXPLORED? A PILOT STUDY

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ABSTRACT

Background: Asthma is a chronic inflammatory disease with increasing prevalence in developing countries. The role of trace elements such as zinc in the pathophysiology of asthma has been explored due to its antioxidant and immunomodulatory properties. We investigated a possible correlation between serum zinc levels and both the incidence and symptom control in individuals with bronchial asthma. **Materials and Methods:** This cross-sectional observational study was conducted at Government Medical College, Thrissur, Kerala, involving 49 asthmatic patients and 48 age and gender matched healthy controls. Serum zinc levels were measured using Plasma Optical Emission Spectrometry (POES). Data were analysed using SPSS version 27, with independent t-tests and ANOVA for statistical analysis. **Result:** Mean serum zinc levels were significantly lower in asthmatic patients (13.03 ± 3.98 µmol/L) compared to controls (15.06 ± 2.30 µmol/L, $p < 0.05$). However, no significant correlation was observed between serum zinc levels and the degree of asthma control based on GINA classification ($p = 0.093$). **Conclusion:** Asthmatic patients had significantly lower serum zinc levels compared to healthy individuals, but no correlation was found between zinc levels and the degree of asthma control. Further multicentric trials involving larger sample sizes are warranted to investigate serum zinc levels in asthma and their potential therapeutic role.

INTRODUCTION

Asthma, a chronic respiratory disorder characterized by airway inflammation and hyperresponsiveness, affecting an estimated 262 million individuals globally as of 2019.[1] In India, asthma remains a significant public health issue, with a prevalence of 2.05% and an estimated burden of over 17 million cases.[2] The Global Initiative for Asthma (GINA) provides standardized criteria for assessing asthma control and severity, enabling uniform management approaches worldwide.[1]

The aetiology of asthma is multifactorial; involving genetic predisposition, environmental exposures and immunological dysregulation. Oxidative stress plays a crucial role in the pathogenesis of asthma, driven by an imbalance between reactive oxygen species (ROS) and antioxidant defences. Zinc, an essential trace element, is known to contribute to both antioxidant activity and immune function. Zinc deficiency has been linked to increased oxidative stress and an exaggerated T-helper 2 (Th2) immune response, both of which are implicated in airway inflammation and asthma exacerbations.[3]

Several studies have reported lower serum zinc levels in patients with asthma, suggesting a possible role of zinc in asthma pathophysiology and disease control.[4,5] However, the relationship between zinc levels and asthma severity remains unclear. This study aims to explore the relation between serum zinc bronchial asthma and its severity of among the study population.

MATERIALS AND METHODS

Study Design and Participants: After ethical committee and Institutional Review Board approval (IEC/GMCTSR/192/2021), this cross-sectional observational study was conducted during a period of one year [October 2021 to October 2022] at Government Medical College, Thrissur. We included 49 adult asthmatic patients and 48 age and gender matched healthy controls. The inclusion criteria were adult asthmatic patients, who voluntarily participated. Those with Chronic respiratory diseases

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other than asthma, who received Zinc supplementation in the preceding three months of study period, pregnant or lactating mothers and patients with comorbidities altering serum zinc levels were excluded from the study. The severity of asthma was classified using GINA guidelines

Sample Size Calculation: The sample size was calculated using serum zinc levels in study and control population as the primary outcome. Based on previous studies [5,6], mean zinc levels were 10.85 ± 2.60 µmol/L in asthmatics and 12.54 ± 1.83 µmol/L in healthy controls. With 90% power at a 5% significance level, 35 participants per group were required. To allow for possible dropouts, 48 participants were enrolled in each group.

Serum Zinc Measurement: Venous blood samples were collected using trace element-free tubes. Serum was separated via centrifugation (3000 rpm for 10 minutes) and stored at −20°C. Zinc concentrations were determined using Plasma Optical Emission Spectrometry (POES) at College of Veterinary and Animal Sciences Mannuthy, Thrissur, Kerala. POES is known method for the detection of trace elements, it involves the ionization of the sample using plasma and measuring the light emitted at zinc's characteristic wavelength. Calibration was done using certified zinc standards (PerkinElmer India Pvt. Ltd.). Normal reference values ranged from 12-18 µmol/L [6,7]

Statistical Analysis: Statistical analyses were performed using SPSS version 27. Independent t-tests were used for comparing mean serum zinc levels between cases and controls. One-way ANOVA was used to compare the mean values among the different asthma control groups. A p-value <0.05 was considered statistically significant.

RESULTS

Serum Zinc Levels in Asthmatic Patients vs Controls

[Table 1] presents a comparison of serum zinc levels between asthmatic patients (cases) and healthy individuals (controls). The mean serum zinc level among cases was 13.03 ± 3.98 µmol/L, which was significantly lower than that of controls (15.06 ± 2.30 µmol/L). This difference was statistically significant (t = 3.08, p = 0.0028), indicating that asthmatic individuals tend to have reduced serum zinc levels compared to healthy counterparts. These findings suggest a potential association between lower serum zinc levels and the presence of bronchial asthma.

Serum Zinc and Control of Asthma (GINA Classification)

Based on the GINA classification of asthma control, out of the 49 asthmatic patients evaluated, 14% were classified as well-controlled, 51% as partially controlled, and 35% as uncontrolled.

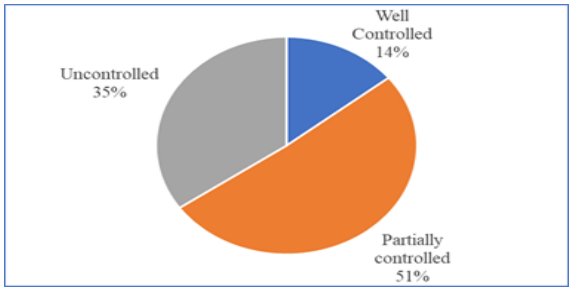

Figure 1: Classification based on degree of asthma control

Table 1: Comparison of Serum Zinc Between Cases and Controls

Group	N	Mean (µmol/L)	SD µmol/L	t-value	p-value
Cases	49	13.03	3.98	3.08	0.0028
Controls	48	15.06	2.30		

Table 2: Comparison of Serum Zinc Based on GINA Classification.

GINA Scoring	N	Mean (µmol/L)	SD (µmol/L)
Well Controlled	7	13.13	3.63
Partially controlled	25	13.55	4.08
Uncontrolled	17	12.20	4.16
F-value =2.51; P-value = 0.093			

[Table 2] depicts the comparison of serum zinc levels among asthmatic patients categorized according to the GINA classification of asthma control. The mean serum zinc level was 13.13 ± 3.63 µmol/L in the well-controlled group, 13.55 ± 4.08 µmol/L in the partially controlled group, and 12.20 ± 4.16 µmol/L in the uncontrolled group. Although the mean serum zinc level was lower in the uncontrolled group, one-way ANOVA revealed no statistically significant difference in serum zinc levels across the three groups (F = 2.51, p = 0.093). This suggests that while a trend toward lower zinc levels with worsening asthma control was observed, the difference did not reach statistical significance.

DISCUSSION

This study investigated the association between serum zinc levels and bronchial asthma, with a focus on both the presence of the disease and its severity as classified by GINA (Global Initiative for Asthma) guidelines. GINA provides detailed criteria for assessing asthma control, categorizing it into well-controlled, partly controlled, and uncontrolled levels. These classifications are based on symptom frequency, activity limitations, nocturnal symptoms, and the need for reliever medications.[8-10] The results

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revealed a statistically significant reduction in mean serum zinc levels in asthmatic patients compared to healthy controls. However, no statistically significant differences were observed when serum zinc levels were compared among asthma severity groups.

Table 3: Asthma Control Levels Based on GINA 2024 Guidelines [9]

In the past 4 weeks, has the patient had:	Yes	No	Well controlled	Partly controlled	Uncontrolled
• Daytime asthma symptoms more than twice/week?	☐	☐			
• Any night waking due to asthma?	☐	☐			
• Short-Acting Beta$_2$-Agonist (SABA) reliever for symptoms more than twice/week?	☐	☐			
• Any activity limitation due to asthma?	☐	☐			
			None of these	1–2 of these	3–4 of these
Exacerbations			None	One or more in past year	Frequent or severe exacerbations

In our observation, asthmatic patients had significantly lower serum zinc levels (13.03 ± 3.98 µmol/L) compared to controls (15.06 ± 2.30 µmol/L) aligns with a growing body of evidence indicating a potential role for trace elements in the pathophysiology of asthma.

Several studies have reported significantly lower serum zinc levels in asthmatic individuals compared to healthy controls, supporting the hypothesis that zinc deficiency may contribute to asthma pathophysiology. A meta-analysis by Chen et al. (2020) revealed a consistent reduction in circulating zinc levels among asthmatic patients, highlighting zinc's potential role in immune regulation and airway inflammation.[11] Similarly, Ghaffari et al. (2021), in a systematic review and meta-analysis of paediatric populations, confirmed lower serum zinc levels in asthmatic children.[12] Mohamed et al. (2018) found significantly reduced zinc levels in atopic asthmatic patients compared to non-atopic individuals, suggesting zinc's influence on allergic mechanisms in asthma.[13] Additionally, Srivastava et al. (2023) identified low serum zinc, selenium, and vitamin D3 as biomarkers associated with poor asthma control and increased airway inflammation.[14]

Conversely, some studies have not demonstrated a clear association between serum zinc levels and asthma. Seo et al. (2017), analysing data from the Korean National Health and Nutrition Examination Survey, found no significant correlation between serum zinc status and allergic sensitization, implying that serum zinc alone may not predict asthma risk.[15] Furthermore, a study by Abdul Wahab et al. (2018) reported that the Zn may not play a major role in the degree of asthma control, indicating that zinc's therapeutic role may be limited or dependent on additional factors.[16] These contrasting findings highlight the complexity of trace element interactions in asthma and underscore the need for further research to clarify zinc's exact role in disease modulation.

Zinc is a crucial micronutrient involved in numerous biological processes, including antioxidant defence, immune modulation, and regulation of inflammatory responses. Its deficiency has been associated with increased oxidative stress, impaired T-cell function, and an upregulated pro-inflammatory state all of which are recognized contributors to asthma pathogenesis.[17] Reduced serum zinc levels in asthma may be a consequence of chronic inflammation leading to increased consumption or redistribution of zinc within tissues.[18] It is also plausible that dietary insufficiencies, poor absorption, or zinc sequestration during acute or chronic immune activation could contribute to these findings.[19]

The significantly lower levels observed in this study reinforce the hypothesis that zinc deficiency may either predispose individuals to asthma or exacerbate existing disease through immune dysregulation. A comprehensive review by Rajkumar et al. (2022) highlights that zinc deficiency disrupts the T-helper 1 (Th1) / T-helper 2 (Th2) balance, favouring Th2 responses, which are associated with allergic conditions like asthma. This imbalance leads to increased eosinophil counts and elevated IgE levels, exacerbating airway inflammation3. In a murine model by Bao et al. (2011) zinc supplementation prior to allergen exposure resulted in decreased neutrophil infiltration and TNF-α release in the airways. This effect was mediated through the inhibition of the NF-κB pathway, suggesting zinc's potential in modulating inflammatory responses in asthma.[20]

Interestingly, the analysis of zinc levels in relation to asthma severity as per GINA classification did not reveal statistically significant differences ($F = 2.51$, $p = 0.093$). Although mean zinc levels tended to be lower in the "Uncontrolled" group (12.20 ± 4.16 µmol/L) compared to the "Well-Controlled" (13.13 ± 3.63 µmol/L) and "Partially Controlled" (13.55 ± 4.08 µmol/L) groups, the variation did not reach statistical significance.

This lack of significant association between serum zinc and asthma control status could be due to several factors. First, the relatively small sample size within each subgroup particularly "Well-Controlled" ($n = 7$) and "Uncontrolled" ($n = 17$) categories may have limited the power to detect subtle but clinically relevant differences. Second, asthma severity is multifactorial and may not be solely influenced by micronutrient status. Environmental triggers, adherence to treatment, comorbidities, and genetic predispositions also play critical roles.[21,22]

Moreover, while serum zinc measurement is a commonly used biomarker, it may not fully reflect

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total body zinc status or the functional availability of zinc at the cellular level.[3] Intracellular zinc levels or other markers of zinc-dependent enzyme activity could potentially provide a more accurate assessment of zinc's role in disease severity.

Clinical and Research Implications: The significant difference in zinc levels between cases and controls suggests that zinc may have a protective or modulatory role in asthma.[23,24] This opens avenues for further research into whether zinc supplementation could benefit asthmatic individuals, particularly those with documented deficiencies. However, the lack of a clear relationship between serum zinc and asthma severity underscores the need for larger, longitudinal studies that explore zinc status in conjunction with other biomarkers of inflammation and oxidative stress.

Additionally, future studies should investigate whether serum zinc levels change with asthma exacerbations, treatment responses, or during periods of remission, to better elucidate the dynamic role of zinc in disease progression.

CONCLUSION

Asthmatic patients in this study exhibited significantly lower serum zinc levels compared to healthy controls, indicating a possible protective role of zinc in asthma pathophysiology. However, no correlation was found between zinc levels and asthma severity. Further studies are required to understand the underlying mechanisms and to assess whether zinc supplementation might serve as a supportive therapy in asthma management.

REFERENCES

1. Wang Z, Li Y, Gao Y, Fu Y, Lin J, Le X, "et al." Global, regional, and national burden of asthma and its attributable risk factors from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. Respir Res 24, 169 (2023).
2. Singh S, Salvi S, Mangal DK, Singh M, Awasthi S, Mahesh PA, "et al." Prevalence, time trends and treatment practices of asthma in India: the Global Asthma Network study. ERJ Open Res. 2022 May 30;8(2):00528-2021.
3. Rajkumar S, Bhat NK, Kumar V, Bolia R, Verma PK, Kumar M, "et al.". Association of serum zinc levels and symptom control of asthma in children and adolescents- a prospective observational study. Eur J Pediatr. 2023 Jan;182(1):141-147.
4. Srivastava S, Tiwari V, Singh S, Karoli R, Bhattacharya P, Gupta N. Low Serum Levels of Zinc, Selenium, and Vitamin D3 Are Biomarkers of Airway Inflammation and Poor Asthma Control: A Two-Centre Study. Cureus. 2023 Jun 28;15(6):e41082
5. Kakarash, T.A.; Al-Rabat, A. Zinc Status in Children with Bronchial Asthma. IPMJ 2012, 11, 698–703
6. Ryu M-S, Aydemir TB. Zinc. In: Marriott BP, Birt DF, Stallings VA, Yates AA, eds. Present Knowledge in Nutrition. 11th ed. Cambridge, Massachusetts: Wiley-Blackwell; 2020:393-408.
7. Ghasemi A, Zahediasl S, Hosseini-Esfahani F, Azizi F. Reference values for serum zinc concentration and prevalence of zinc deficiency in adult Iranian subjects. Biol Trace Elem Res. 2012 Dec;149(3):307-14.
8. Reddel HK, Bacharier LB, Bateman ED, Brightling CE, Brusselle GG, Buhl R"et al.". Global Initiative for Asthma Strategy 2021: Executive Summary and Rationale for Key Changes. Am J Respir Crit Care Med. 2022 Jan 1;205(1):17-35.
9. Global Initiative for Asthma. (2024). GINA 2024 Summary Guide for Asthma Management and Prevention.
10. Global Initiative for Asthma. (2023). GINA 2023 Main Report.
11. Chen M, Sun Y, Wu Y. Lower circulating zinc and selenium levels are associated with an increased risk of asthma: evidence from a meta-analysis. Public Health Nutr. 2020 Jun;23(9):1555-1562.
12. Ghaffari J, Alizadeh-Navaei R, Dabaghzadeh A, Ghaffari N. Serum zinc level and children`s asthma: A systematic and meta-analysis review article. Caspian J Intern Med. 2021 Apr;12(3):236-242.
13. Mohamed NA, Rushdy M, Abdel-Rehim ASM. The immunomodulatory role of zinc in asthmatic patients. Cytokine. 2018 Oct; 110:301-305.
14. Srivastava S, Tiwari V, Singh S, Karoli R, Bhattacharya P, Gupta N. Low Serum Levels of Zinc, Selenium, and Vitamin D3 Are Biomarkers of Airway Inflammation and Poor Asthma Control: A Two-Centre Study. Cureus. 2023;15(6):e41082.
15. Zajac D. Mineral Micronutrients in Asthma. Nutrients. 2021 Nov 10;13(11):4001.
16. Morgan CI, Ledford JR, Zhou P, Page K. Zinc supplementation alters airway inflammation and airway hyperresponsiveness to a common allergen. J Inflamm (Lond). 2011 Dec 7; 8:36
17. Maywald M. Rink L. Zinc Deficiency and Zinc Supplementation in Allergic Diseases. Biomolecules 2024, 14, 863.
18. Suzuki M, Suzuki T, Watanabe M, Hatakeyama S, Kimura S, Nakazono A, "et al.". Role of intracellular zinc in molecular and cellular function in allergic inflammatory diseases. Allergol Int. 2021 Apr;70(2):190-200.
19. Foster M, Samman S. Zinc and regulation of inflammatory cytokines: implications for cardiometabolic disease. Nutrients. 2012 Jul;4(7):676-94.
20. Bao S, Liu M, Lee B, Besecker B. Lai J, Guttridge D, "et al." Zinc modulates the innate immune response in vivo to polymicrobial sepsis through regulation of nf-κb. American Journal of Physiology-Lung Cellular and Molecular Physiology, 298(6), L744-L754.21.
21. Raby BA. Asthma severity, nature or nurture: genetic determinants. Curr Opin Pediatr. 2019 Jun;31(3):340-348.
22. Sheehan WJ, Phipatanakul W. Difficult-to-control asthma: epidemiology and its link with environmental factors. Curr Opin Allergy Clin Immunol. 2015 Oct;15(5):397-401.
23. Seo HM, Kim YH, Lee JH, Kim JS, Park YM, Lee JY. Serum Zinc Status and Its Association with Allergic Sensitization: The Fifth Korea National Health and Nutrition Examination Survey. Sci Rep. 2017 Oct 3;7(1):12637.
24. Abdul Wahab A, Zeidan A, Avades T, Chandra P, Soliman A. Serum Zinc Level in Asthmatic and Non-Asthmatic School Children. Children (Basel). 2018 Mar 16;5(3):42.

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