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Original Research Article

Study on serum zinc levels in asthma

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ABSTRACT

Background: Asthma is a chronic inflammatory airway disease characterized by variable respiratory symptoms and reversible airflow limitation. Zinc, an essential trace element with antioxidant and immunomodulatory properties, may influence airway inflammation and asthma outcomes. This study evaluated serum zinc levels in children with asthma and their association with disease severity, asthma control, pulmonary function, and exacerbation frequency.
Methods: This hospital-based cross-sectional comparative study included 120 children aged 6–18 years (60 asthmatic and 60 healthy controls). Asthma diagnosis, severity, and control were assessed according to GINA 2025 guidelines. Serum zinc levels were measured using the colorimetric NITRO-PAPS method, and pulmonary function was evaluated by spirometry. Data were analyzed using SPSS version 28, with $p<0.05$ considered statistically significant.
Results: Mean serum zinc levels were significantly lower in asthmatic children than in controls (69.68±16.41 vs. 84.47±17.87 µg/dl; $p<0.001$), with a higher prevalence of hypozincemia (31.7% vs. 15.0%; $p=0.031$). Lower serum zinc levels were significantly associated with poorer asthma control ($p<0.001$), greater disease severity ($p=0.008$), and impaired pulmonary function (FEV_1 <80% predicted; $p<0.001$). Although hypozincemia increased with exacerbation frequency, the association was not statistically significant ($p=0.151$).
Conclusion: Reduced serum zinc levels are associated with poor asthma control, increased disease severity, and impaired pulmonary function in children with asthma. Serum zinc may serve as a potential biomarker for disease status and a modifiable factor in asthma management.

Keywords: Bronchial asthma, Serum zinc, Hypozincemia, Asthma control, Pulmonary function

INTRODUCTION

Asthma is a heterogeneous chronic inflammatory airway disease characterized by recurrent wheeze, cough, chest tightness, and breathlessness with variable airflow limitation resulting from airway hyperresponsiveness influenced by genetic and environmental factors.[1] Zinc is an essential trace element involved in numerous biological processes, with homeostasis maintained through regulated absorption, transport, distribution, and excretion.[2] Children are particularly susceptible to zinc deficiency because of increased physiological requirements during growth, inadequate dietary intake, and recurrent infections.[3] Zinc deficiency impairs T-lymphocyte maturation, suppresses Th1 responses, promotes Th2 polarization, and increases pro-inflammatory cytokine production, thereby contributing to allergic airway inflammation and hyperresponsiveness.[4]

The 2025 global initiative for asthma (GINA) guidelines emphasize assessment of asthma control, disease severity, exacerbation risk, comorbidities, and modifiable factors affecting outcomes.[5] Evaluating serum zinc levels and their association with asthma severity, control, and exacerbation frequency may identify hypozincemia as a modifiable factor influencing disease outcomes. This study compared serum zinc levels between children with

stable asthma and healthy controls and evaluated their association with asthma severity, control, and exacerbation frequency.

METHODS

The cross-sectional comparative study was conducted at Cheluvamba Hospital, Mysore Medical College and Research Institute (MMC&RI), Mysuru, for a period of 18 months. A minimum of 120 participants were selected for the study comprising 60 asthmatic children (cases) and 60 healthy children (controls).

Inclusion criteria

All children aged 6 years to 18 years diagnosed as having asthma according to GINA guidelines 2025.

Exclusion criteria

Children with a history suggestive of chronic illnesses known to cause hypozincemia such as chronic liver disease, chronic kidney disease, diabetes mellitus, who were on zinc supplementation or had received zinc supplementation in the preceding six months, having acute infections at the time of enrolment.

All children fulfilling the inclusion criteria were enrolled in the study after obtaining written informed consent from parents or guardians and assent from children aged more than 7 years. The diagnosis of asthma was established according to the GINA 2025 criteria, based on a history of variable respiratory symptoms, including wheeze, shortness of breath, chest tightness, and cough, along with objective evidence of variable airflow limitation. Diagnostic confirmation was obtained by one or more of the following: reduced FEV_1 with an FEV_1/FVC ratio <0.9 at least once during the diagnostic process, positive bronchodilator reversibility (increase in FEV_1 >12% of predicted value).

Asthma control was assessed using a standardized questionnaire based on GINA 2025 recommendations and categorized as well controlled, partly controlled, or uncontrolled. Asthma severity was classified as intermittent, mild persistent, moderate persistent, or severe persistent according to symptom frequency, nocturnal awakenings, use of short-acting β_2-agonists, activity limitation, and lung function parameters including FEV_1 and FEV_1/FVC ratio.[4]

For estimation of serum zinc levels, 2 ml of venous blood was collected under aseptic precautions by venipuncture. Serum zinc concentration was measured using the colorimetric NITRO-PAPS (5-Nitro-2-pyridylazo-5-N-propyl-3-sulphopropylamino phenol disodium salt) method. In an alkaline medium, zinc reacts with the NITRO-PAPS reagent to form a purple-colored complex, the intensity of which is directly proportional to the zinc concentration. Serum zinc levels were expressed in micrograms per deciliter (µg/dl). A serum zinc concentration of 60–150 µg/dl was considered normal, while values <60 µg/dl were classified as hypozincemia.[6]

Data was entered into Microsoft Excel and analyzed using SPSS for Windows, version 28. Continuous variables were expressed as mean and standard deviation, while categorical variables were expressed as frequency and percentage. A p value <0.05 was considered statistically significant.

RESULTS

No significant difference was observed between asthmatic and control groups with respect to age, gender and BMI category as shown in Table 1. These findings indicate that the case and control groups were well matched with respect to demographic and anthropometric characteristics.

The relatively balanced distribution across control and severity categories as shown in Table 2 ensured adequate representation of the clinical spectrum of asthma, thereby facilitating meaningful evaluation of the relationship between serum zinc levels, asthma control, and disease severity.

The association of treatment compliance with asthma control status was statistically significant (χ^2=14.946, p=0.001) as shown in Table 3, indicating that adherence to prescribed therapy plays an important role in achieving optimal asthma control. Pulmonary function also showed a strong relationship with asthma control as shown in Table 3. The association between FEV_1 and asthma control was highly significant (χ^2=22.750, p<0.001), demonstrating that poorer lung function is closely associated with inadequate asthma control.

Hypozincemia (serum zinc <60 µg/dl) was significantly more prevalent among asthmatic children than healthy controls. In addition, mean serum zinc concentration was significantly lower in the asthma group compared with controls as shown in Table 4. These findings demonstrate a significant association between asthma and reduced serum zinc status, characterized by both a higher prevalence of hypozincemia and lower circulating zinc concentrations.

Well-controlled patients had significantly higher serum zinc levels compared to partly controlled patients and uncontrolled patients as shown in Table 5. The difference was highly significant (F=69.190, p<0.001), indicating that better asthma control is associated with higher serum zinc levels. Low serum zinc (<60 µg/dl) increased with severity as shown in Table 6. The association was statistically significant (χ^2=9.719, p=0.008), suggesting that zinc deficiency correlates with increasing disease severity. The association between serum zinc deficiency and exacerbation frequency was not statistically significant (χ^2=5.294, p=0.151) as shown in Table 7.

These findings suggest that while recurrent exacerbations are closely related to poor asthma control, their association with serum zinc status was not demonstrated in the present study. Children with impaired pulmonary function (FEV_1 <80% predicted) exhibited significantly lower serum zinc concentrations and a markedly higher prevalence of hypozincemia compared with those with preserved lung function ($p<0.001$ for both). These findings demonstrate a significant association between reduced serum zinc status and pulmonary function impairment in paediatric asthma.

Table 1: Baseline characteristics of study participants.

Variables	Asthmatic (n=60)	Control (n=60)	Statistical test
Age category, N (%) (in years)			
6–11	37 (61.7)	27 (45.0)	χ^2=3.348, p=0.067
12–18	23 (38.3)	33 (55.0)	
Gender, N (%)			
Male	32 (53.3)	26 (43.3)	χ^2=1.201, p=0.273
Female	28 (46.7)	34 (56.7)	
BMI category, N (%)			
Underweight	5 (8.3)	4 (6.7)	χ^2=0.597, p=0.897
Normal	50 (83.3)	51 (85.0)	
Overweight	3 (5.0)	4 (6.7)	
Obese	2 (3.3)	1 (1.7)	

Table 2. Distribution of asthma control status and asthma severity among asthmatic children (n=60).

Variables	Category	Frequency (N)	%
Asthma control status	Well controlled	22	36.7
	Partly controlled	18	30.0
	Uncontrolled	20	33.3
Asthma severity	Mild persistent	23	38.3
	Moderate persistent	18	30.0
	Severe persistent	19	31.7

Table 3: Association of treatment compliance and pulmonary function with asthma control status.

Variables	Category	Well controlled N (%)	Partly controlled N (%)	Uncontrolled N (%)	χ^2	P value
Treatment compliance	Good	22 (43.1)	17 (33.3)	12 (23.5)		
	Poor	0 (0.0)	1 (11.1)	8 (88.9)	14.946	0.001
FEV_1	<80% predicted	1 (7.1)	17 (68.0)	18 (85.7)		
	≥80% predicted	13 (92.9)	8 (32.0)	3 (14.3)	22.750	<0.001

Table 4. Comparison of serum zinc levels between asthmatic and control groups.

Variables	Asthmatic (n=60)	Control (n=60)	Test statistic	P value
Serum zinc category, N (%)			**χ^2 = 4.658**	**0.031**
<60 µg/dl	19 (31.7)	9 (15.0)		
≥60 µg/dl	41 (68.3)	51 (85.0)		
Serum zinc level (µg/dl), Mean±SD	69.68±16.41	84.47±17.87	t=-4.720	<0.001

Table 5: Comparison of serum zinc with asthma control status.

	Serum_zinc			
	N	**Mean**	**Std. deviation**	**Std. error**
Well controlled	22	86.4545	11.12152	2.37112
Partly controlled	18	66.5556	7.48506	1.76425
Uncontrolled	20	54.0500	7.55663	1.68971
Total	60	69.6833	16.40948	2.11845
F=69.190, p<0.001				

Table 6: Comparison of serum zinc levels with asthma severity.

			Severity			Total
			Mild_persis	Moderate_persis	Severe persis	
SERUM_ZN_C	<60	Count	1	6	12	19
		% within severity	5.9%	30.0%	52.2%	31.7%
	>60	Count	16	14	11	41
		% within severity	94.1%	70.0%	47.8%	68.3%
Total		Count	17	20	23	60
		% within severity	100.0%	100.0%	100.0%	100.0%
			χ^2=9.719, p=0.008			

Table 7. Association of exacerbation frequency with asthma control status and serum zinc levels.

Number of exacerbations	Well controlled N (%)	Not well controlled N (%)	Total N (%)	Zinc <60 µg/dl N (%)	Zinc ≥60 µg/dl N (%)
0	11 (50.0)	8 (21.1)	19 (31.7)	4 (22.2)	14 (77.8)
1	5 (22.7)	13 (34.2)	18 (30.0)	6 (24.0)	19 (76.0)
2	3 (13.6)	10 (26.3)	13 (21.7)	7 (50.0)	7 (50.0)
≥3	3 (13.6)	7 (18.4)	10 (16.6)	2 (66.7)	1 (33.3)
Statistical significance	p=0.032			χ^2=5.294	p=0.151

Table 8: Association between serum zinc levels and pulmonary function (FEV_1).

FEV_1 category	N	Mean serum zinc (µg/dl)±SD	Serum zinc<60 µg/dl N (%)	Serum zinc≥60 µg/dl N (%)
<80% predicted	36	60.00±10.19	18 (50.0)	18 (50.0)
≥80% predicted	24	84.21±12.88	1 (4.2)	23 (95.8)
Statistical test		t=-8.107	χ^2 = 13.979	
P value		<0.001	<0.001	

DISCUSSION

The present study evaluated serum zinc levels in children with bronchial asthma and their correlation with disease severity and control. Baseline characteristics, including age, gender, socioeconomic status, and BMI, were comparable between asthmatic and control groups, minimizing confounding. Similar findings have been reported by Rajkumar et al and Ghotar et al.[7,8] The inclusion of children across a broad spectrum of asthma control and severity enabled evaluation of serum zinc status in different clinical phenotypes, consistent with previous studies.[7,10] Treatment adherence and pulmonary function were significantly associated with asthma control, supporting the importance of regular therapy and objective lung function assessment, as recommended by GINA.[5] Asthmatic children had significantly lower serum zinc levels and a higher prevalence of hypozincemia than controls, consistent with previous reports.[9,11,12] Zinc deficiency may contribute to airway inflammation through its effects on antioxidant defense, immune regulation, and airway epithelial integrity.[13,14]

Lower serum zinc levels were significantly associated with poor asthma control and greater disease severity, consistent with earlier studies.[10,15,16] Although hypozincemia showed an increasing trend with recurrent exacerbations, the association was not statistically significant.[17] Children with impaired pulmonary function (FEV_1 <80% predicted) also had significantly lower serum zinc levels, supporting serum zinc as a potential biomarker of disease severity and lung function.[7]

Strengths of the study include comparable case-control groups, objective assessment of serum zinc and spirometry, and evaluation of multiple clinically relevant outcomes. Limitations include the cross-sectional design, single-time-point zinc measurement, and single-centre setting, which may limit causal inference and generalizability.

CONCLUSION

The present study demonstrated significantly lower serum zinc levels in asthmatic children compared with healthy controls. Serum zinc concentrations declined progressively with increasing asthma severity and were significantly lower in children with poorly controlled disease. A positive association was also observed between serum zinc levels and pulmonary function, particularly FEV_1%, with lower zinc concentrations associated with impaired lung function.

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