ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at:www.ijmacr.com

Volume – 9, Issue – 3, June – 2026, Page No.: 214 – 220

The Relationship Between Hypocalcemia and Asthma Severity in Children Aged 5 To 15 Years: A Cross-Sectional Analytical Study

[1]A V Srinath, [2]Shylaja C G, [3]Yashodha H T

Corresponding Author: A V Srinath

How to citation this article: A V Srinath, Shylaja C G, Yashodha H T, "The Relationship Between Hypocalcemia and Asthma Severity in Children Aged 5 To 15 Years: A Cross-Sectional Analytical Study", IJMACR – June – 2026, Volume – 9, Issue – 3, P. No. 214 – 220.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Asthma is a chronic inflammatory airway disease characterized by bronchial hyperreactivity and variable airflow limitation. Calcium plays a central role in airway physiology by regulating smooth muscle contraction and inflammatory mediator release through intracellular signaling mechanisms[4]. Increased intracellular calcium promotes bronchoconstriction and mast cell activation, contributing to airway narrowing.

Paradoxically, despite intracellular calcium overload during asthma exacerbations, systemic ionized calcium levels are often reduced in affected children[2]. This hypocalcemia is attributed to multiple mechanisms, including oxidative stress–induced cellular calcium influx[3], respiratory alkalosis due to hyperventilation[2], beta-agonist therapy[7], and underlying vitamin D deficiency impairing calcium metabolism[5].

Reduced ionized calcium increases neuromuscular excitability and may exacerbate bronchospasm[2], while associated hypomagnesemia further enhances airway smooth muscle contraction[8]. Understanding the relationship between systemic hypocalcemia and asthma severity is essential, as it may contribute to disease exacerbation and influence clinical outcomes in pediatric patients.

Methods: A cross-sectional analytical study was conducted over one year including 52 children aged 5–15 years with asthma. Serum calcium levels were measured and compared between intermittent and persistent asthma groups.

Results: Among 52 children, 32 had intermittent asthma and 20 had persistent asthma. Mean serum calcium was significantly lower in the persistent group (7.94 ± 0.39 mg/dl) compared to intermittent group (8.42 ± 0.37 mg/dl) ($p < 0.001$). Hypocalcemia was more prevalent in persistent asthma (85.0%) than intermittent asthma (56.3%) ($p = 0.03$).

Conclusions: Serum calcium levels are significantly lower in children with persistent asthma, with a higher prevalence of hypocalcemia compared to intermittent asthma, indicating a strong association with disease severity. Hypocalcemia may contribute to bronchial hyper responsiveness and worsening clinical outcomes[25]. Routine assessment and timely correction of calcium imbalance, along with evaluation of underlying factors such as vitamin D deficiency[5], may aid in improving asthma control. Further large-scale studies are required to establish causality and assess the impact of correction on clinical outcomes.

Keywords: Asthma, Hypocalcemia, Pediatric, Serum calcium, Asthma severity.

Introduction

Asthma is a chronic inflammatory disease characterized by increased responsiveness of the tracheobronchial tree, which leads to paroxysms of dyspnea, wheezing, and episodic airway narrowing. Among the various physiological factors governing this airway hyperreactivity, calcium plays a central and indispensable role in the control of smooth muscle function and inflammatory responses[4]. The principal pathological features of asthma, including tracheobronchial smooth muscle contraction and the synthesis and release of mediators from mast cells, are fundamentally calcium-dependent processes[4].

The Role of Calcium in Airway Hyperreactivity in airway smooth muscle, calcium is the primary agent for "excitation-contraction coupling," while in mast cells, it is responsible for "stimulus-secretion coupling"[4]. An increase in intracellular calcium ion concentration is triggered by various physical or chemical stimuli. Once inside the cell, calcium binds to calmodulin, which stimulates myosin light chain kinase—an enzyme crucial for regulating actin-myosin interaction and inducing airway smooth muscle contraction[4]. Elevated intracellular calcium also stimulates the enzymes necessary for synthesizing newly generated inflammatory mediators, such as prostaglandins and leukotrienes, within mast cells[4]. Consequently, a defect in calcium mobilization or in the receptor-calcium coupling process at the smooth muscle level is considered a major underlying cause of bronchial hyperreactivity[4].

The Paradox of Systemic Hypocalcemia in Asthma

While intracellular calcium concentrations are elevated during an asthma attack, systemic blood levels—particularly the physiologically active ionized calcium fraction—are often significantly lowered in asthmatic children[2]. This systemic hypocalcemia is driven by multiple overlapping mechanisms:

- Oxidative Stress and Cellular Influx: Airway inflammation in asthma generates reactive oxygen species, which continuously utilize and deplete ascorbic acid (Vitamin C) in lung tissues. The loss of this potent antioxidant compromises tissue integrity and leads to a profound defect in calcium homeostasis[3]. This defect causes the increased permeability, translocation, and influx of extracellular calcium ions into respiratory smooth muscle and mast cells[3]. This intracellular calcium overload directly induces muscle contracture while simultaneously depleting measurable calcium levels in the blood plasma[3].
- Hyperventilation and Respiratory Alkalosis: Acute asthma exacerbations often cause patients to hyperventilate, leading to hypocapnia and respiratory alkalosis. Alkalosis enhances the binding of calcium to plasma albumin, which acutely lowers the fraction of physiologically active ionized calcium in the bloodstream[2]

- Pharmacotoxic Effects of Treatment: Children undergoing routine asthma treatment may inadvertently develop hypocalcemia as a secondary side-effect of beta-agonist therapy[7].
- Vitamin D Deficiency: Recent cohort studies focusing on school-aged children reveal that underlying Vitamin D deficiency is highly prevalent and serves as an independent predictor of poor asthma control[5].

Clinical Consequences of Hypocalcemia The depletion of systemic ionized calcium creates a dangerous physiological feedback loop. Decreased ionized calcium increases neuronal and neuromuscular excitability. Severe hypocalcemia can directly precipitate increased neuromuscular irritability and severe bronchospasm[2].

Synergistic Role of Magnesium The asthmatic state is further complicated by concurrent deficiencies in serum magnesium, which acts as a natural physiological antagonist to calcium within the cells. Magnesium normally helps suppress the excitability of muscle fibers and promotes smooth muscle relaxation. However, asthmatic children frequently exhibit significantly decreased serum magnesium levels[8]. This concurrent hypomagnesemia removes the inhibitory effect on calcium, increasing the overall contractile state of the bronchial smooth muscle and worsening the clinical severity of the disease.

In summary, the interplay between intracellular calcium overload, systemic hypocalcemia, oxidative stress, respiratory alkalosis, and Vitamin D deficiency forms a critical pathophysiological network in pediatric asthma.

Methods

Study design

Cross-sectional analytical study (August 2022 – August 2023)

Setting

Tertiary care hospital PICU

Participants

52 children aged 5–15 years with asthma

Inclusion criteria

- Age 5–15 years
- Diagnosed asthma

Exclusion criteria

- Comorbid illness
- Calcium supplementation

Procedure

Blood samples collected and serum calcium measured using autoanalyzer.

Statistical analysis

- Mean ± SD
- Independent t-test
- Chi-square test
- Significance: $p < 0.05$

Results

A total of 52 children aged between 5 and 15 years with asthma were included in the study. The mean age of the study population was 8.48 ± 2.79 years. The majority of participants (75.0%, n = 39) belonged to the 5–10-year age group, while 25.0% (n = 13) were aged 11–15 years. There was a slight female predominance, with 29 (55.8%) females and 23 (44.2%) males.

Based on asthma severity, 32 children (61.5%) were classified as having intermittent asthma, while 20 children (38.5%) were categorized as having persistent asthma.

Demographics

- Mean age: 8.48 ± 2.79 years
- Male: 44.2%, Female: 55.8%

Asthma type

- Intermittent: 32 (61.5%)

- Persistent: 20 (38.5%)

Table 1: Demographic Profile

Variable	Intermittent (n=32)	Persistent (n=20)	Total
Age (mean ± SD)	8.21 ± 2.65	8.90 ± 2.98	8.48 ± 2.79
Age 5–10 yrs	25 (78.1%)	14 (70.0%)	39 (75%)
Age 11–15 yrs	7 (21.9%)	6 (30.0%)	13 (25%)
Male	15	8	23
Female	17	12	29

The mean age in the intermittent asthma group was 8.03 ± 2.92 years, whereas in the persistent asthma group it was slightly higher at 9.20 ± 2.46 years; however, this difference was not statistically significant ($p = 0.07$). Similarly, no significant difference in gender distribution was observed between the two groups ($p = 0.22$), indicating that age and gender were comparable across both categories.

Table 2: Serum Calcium Comparison

Group	Mean Calcium (mg/dl)	p-value
Intermittent	8.42 ± 0.37	
Persistent	7.94 ± 0.39	<0.001

The mean serum calcium level in children with persistent asthma was significantly lower (7.94 ± 0.39 mg/dl) compared to children with intermittent asthma (8.42 ± 0.37 mg/dl). The mean difference between the two groups was 0.48 mg/dl, which was statistically highly significant ($p < 0.001$). This finding suggests a strong association between lower serum calcium levels and increased asthma severity.

Table 3: Hypocalcemia Prevalence

Group	Hypocalcemia	Normal	p-value
Intermittent	18 (56.3%)	14	
Persistent	17 (85.0%)	3	0.03

Hypocalcemia was observed in 35 out of 52 children (67.3%) overall. When stratified by asthma severity, hypocalcemia was present in 17 out of 20 children (85.0%) in the persistent asthma group, compared to 18 out of 32 children (56.3%) in the intermittent asthma group. This difference was statistically significant ($p = 0.03$), indicating that hypocalcemia is more prevalent in children with persistent asthma.

Table 4:

Age	Hypocalcemia	Intermittent	Persistent	p-value
5–10 yrs	Present	13 (52.0%)	13 (92.9%)	

Age	Hypocalcemia	Intermittent	Persistent	p-value
5–10 yrs	Present	13 (52.0%)	13 (92.9%)	
	Absent	12	1	0.009*
11–15 yrs	Present	5 (71.4%)	4 (66.7%)	
	Absent	2	2	0.85

Further subgroup analysis based on age revealed that among children aged 5–10 years, hypocalcemia was significantly more prevalent in the persistent asthma group (92.9%) compared to the intermittent group (52.0%), and this difference was statistically significant (p = 0.009).

In contrast, among children aged 11–15 years, hypocalcemia was present in 66.7% of persistent asthma cases and 71.4% of intermittent asthma cases, with no statistically significant difference between the groups (p = 0.85). This suggests that the association between hypocalcemia and asthma severity is more pronounced in younger children.

Table 5: Gender-wise Comparison of Hypocalcemia by Asthma Type

Gender	Hypocalcemia	Intermittent Asthma (n=32)	Persistent Asthma (n=20)	p-value
Male	Present	9 (75.0%)	10 (90.9%)	0.32
	Absent	3 (25.0%)	1 (9.1%)	
Female	Present	9 (45.0%)	7 (77.8%)	0.10
	Absent	11 (55.0%)	2 (22.2%)	

Gender-based analysis showed that among males, hypocalcemia was present in 75.0% of children with intermittent asthma and 90.9% of those with persistent asthma; however, this difference was not statistically significant (p = 0.32).

Among females, hypocalcemia was observed in 45.0% of intermittent asthma cases and 77.8% of persistent asthma cases, but this difference also did not reach statistical significance (p = 0.10).

These findings indicate that while hypocalcemia is more frequent in persistent asthma across both genders, gender itself does not significantly influence this association.

Discussion

This study demonstrates a significant association between serum calcium levels and asthma severity in children aged 5–15 years. The findings indicate that children with persistent asthma have significantly lower mean serum calcium levels compared to those with intermittent asthma (7.94 ± 0.39 mg/dl vs 8.42 ± 0.37 mg/dl, p < 0.001), suggesting a strong correlation between hypocalcemia and disease severity.

Furthermore, the prevalence of hypocalcemia was markedly higher in the persistent asthma group (85.0%) compared to the intermittent group (56.3%), and this difference was statistically significant (p = 0.03). These findings reinforce the hypothesis that hypocalcemia may play a contributory role in the pathophysiology and progression of asthma severity rather than being merely an incidental finding.

One of the key observations in this study was the age-wise variation in hypocalcemia prevalence. Among children aged 5–10 years, hypocalcemia was significantly more common in persistent asthma (92.9%) compared to intermittent asthma (52.0%) (p = 0.009). However, this association was not observed in the older age group (11–15 years), where the difference was not statistically significant (p = 0.85). This may suggest that younger children are more vulnerable to electrolyte imbalances due to immature physiological regulatory mechanisms, higher metabolic demands, and increased susceptibility to nutritional deficiencies, particularly vitamin D deficiency[5].

In contrast, gender-wise analysis did not reveal any statistically significant difference in hypocalcemia prevalence between intermittent and persistent asthma groups (p > 0.05). This indicates that gender does not appear to influence calcium homeostasis in asthmatic children, and the observed hypocalcemia is more likely related to disease severity rather than demographic factors.

The pathophysiological basis of hypocalcemia in asthma is multifactorial. Calcium plays a crucial role in airway smooth muscle contraction by regulating actin–myosin interaction through calcium-calmodulin pathways[4]. In asthma, inflammatory mediators and oxidative stress lead to increased intracellular calcium influx into airway smooth muscle cells, resulting in bronchoconstriction[3]. This intracellular shift may reduce measurable extracellular serum calcium levels.

Additionally, acute asthma exacerbations are often associated with hyperventilation-induced respiratory alkalosis, which reduces ionized calcium levels[2]. This decrease in biologically active calcium further enhances neuromuscular excitability and may aggravate bronchospasm.

Another contributing factor is the use of beta-agonists, which are commonly administered in asthma management. These drugs can cause intracellular shifting of electrolytes, including calcium and magnesium[7], potentially leading to transient hypocalcemia.

Vitamin D deficiency further compounds this problem by reducing intestinal calcium absorption and impairing immune regulation[5].

Magnesium deficiency also contributes by enhancing bronchial hyperreactivity[8].

The findings of this study are consistent with previous research that has reported lower serum calcium levels in asthmatic children and a higher prevalence of electrolyte disturbances[6].

However, this study has certain limitations. The sample size was relatively small (n = 52). Serum ionized calcium was not measured. Vitamin D levels were not assessed.

Conclusion

This study demonstrates that serum calcium levels are significantly lower in children with persistent asthma compared to those with intermittent asthma, with a substantially higher prevalence of hypocalcemia in the persistent group. These findings suggest that hypocalcemia is closely associated with increased asthma severity.

The significantly higher prevalence of hypocalcemia in younger children highlights the need for increased clinical vigilance in this age group. Although no gender differences were observed, the strong association with disease severity underscores the potential role of calcium imbalance as an important pathophysiological factor in asthma.

Given the role of calcium in airway smooth muscle function and neuromuscular excitability, hypocalcemia may contribute to bronchial hyperresponsiveness and worsening of symptoms[25]. Therefore, routine assessment of serum calcium levels in pediatric asthma patients may be beneficial.

Early identification and correction of hypocalcemia, along with evaluation of underlying causes such as vitamin D deficiency[5], could improve asthma control.

Further large-scale studies are recommended.

Abbreviations

PICU – Pediatric Intensive Care Unit

SD – Standard Deviation

p-value – Probability value

Ca^{2+} – Calcium ion

Mg^{2+} – Magnesium ion

ICS – Inhaled Corticosteroids

SABA – Short-Acting Beta Agonist

FEV1 – Forced Expiratory Volume in 1 second

SpO_2 – Peripheral Oxygen Saturation

References

1. Bilan N, Ghaffari S. Association of asthma and epilepsy. Res J Biol Sci. 2008;3(12):1370–2.
2. Jain N, Kumari K, Roy S, Syal R. Hypocalcaemia-induced acute exacerbation of bronchial asthma. Indian J Anaesth. 2020;64(9):820–1.
3. Nagdeote AN, et al. Oxidative stress and calcium homeostasis in asthmatic children. Sch J App Med Sci. 2016;4(5):1698–702.
4. Fanta CH. Role of calcium in airway smooth muscle contraction. J Asthma. 1984;21(6):387–405.
5. Dong L, Li Y. Vitamin D deficiency and asthma morbidity. Front Public Health. 2025; 13:1717912.
6. Puneem US, et al. Hypocalcemia in pediatric respiratory infections. Clin Pediatr. 2025;64(8):1138–43.
7. Singh PK, Parveen M, Sinha RR. Serum electrolytes in bronchial asthma. Int J Acad Med Pharm. 2023;5(2):330–3.
8. Somashekar AR, Ramakrishnan KG, Gowda V. Serum magnesium in asthma. Arch Asthma Allergy Immunol. 2018; 2:3–5.
9. Philip J. Effects of inhaled corticosteroids on growth. Open Respir Med J. 2014; 8:66–73.