



ORIGINAL ARTICLE

Correlation of Vitamin D Levels with Severity of Asthma in Children Between 6 to 12 Years

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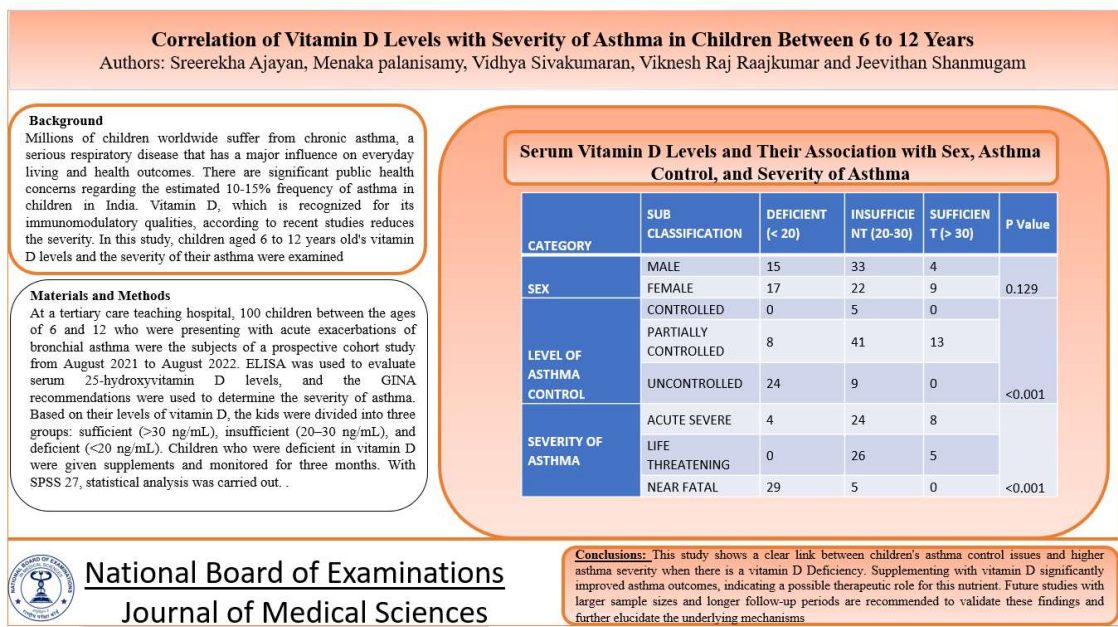
Abstract

Background: Millions of children worldwide suffer from chronic asthma, a serious respiratory disease that has a major influence on everyday living and health outcomes. There are significant public health concerns regarding the estimated 10-15% frequency of asthma in children in India. Vitamin D, which is recognized for its immunomodulatory qualities, according to recent studies reduces the severity. In this study, children aged 6 to 12 years old's vitamin D levels and the severity of their asthma were examined. **Materials and Methods:** At a tertiary care teaching hospital, 100 children between the ages of 6 and 12 who were presenting with acute exacerbations of bronchial asthma were the subjects of a prospective cohort study from August 2021 to August 2022. ELISA was used to evaluate serum 25-hydroxyvitamin D levels, and the GINA recommendations were used to determine the severity of asthma. Based on their levels of vitamin D, the kids were divided into three groups: sufficient (>30 ng/mL), insufficient (20–30 ng/mL), and deficient (<20 ng/mL). Children who were deficient in vitamin D were given supplements and monitored for three months. With SPSS 27, statistical analysis was carried out. **Findings:** The results of the study showed a strong correlation between increased asthma severity and inadequate asthma control and reduced vitamin D levels. Children with the most acute and uncontrollably asthmatic episodes were those with low vitamin D levels (<20 ng/mL). Significant improvements in asthma control, decreased activity limits, and decreased need for rescue medication were noted after three months of vitamin D administration. **Conclusion:** This study shows a clear link between children's asthma control issues and higher asthma severity when there is a vitamin D Deficiency. Supplementing with vitamin D significantly improved asthma outcomes, indicating a possible therapeutic role for this nutrient. Future studies with larger sample sizes and longer follow-up periods are recommended to validate these findings and further elucidate the underlying mechanisms.

Keywords: Asthma, vitamin D, children, asthma severity, immunomodulation

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Graphical Abstract

**Introduction**

Chronic asthma is a respiratory disease that causes wheezing, coughing, and shortness of breath among other symptoms. It is characterized by hyperresponsiveness of the airway, inflammation and bronchoconstriction. It has a major effect on everyday activities, academic achievement, and general quality of life among children. About 7.5% of children worldwide suffer from asthma, which translates to millions of affected people and a significant financial burden on families and healthcare systems. The estimated frequency in India is between 10-15%, which raises serious public health concerns [1].

Asthma pathophysiology is a result of intricate interactions between environmental and genetic factors. Hyperresponsiveness, airway remodeling, and chronic inflammation are all influenced by these variables. Allergens, respiratory illnesses, exertion, and chilly air are common triggers. Because asthma is a chronic condition, frequent hospital visits,

missed school days, and a reduced quality of life are common [2].

Although vitamin D has long been known for its benefits to bone health, its immunomodulatory properties have drawn more attention. It has a role in controlling both adaptive and innate immune responses. T-lymphocytes and dendritic cells are among the immune cells that have vitamin D receptors, suggesting that the nutrient may have a role in regulating inflammation and immunological function [3,4]. Recent data points to a link between vitamin D deficiency and an increase in the frequency and severity of asthma flare-ups. Research has demonstrated that vitamin D can boost the synthesis of anti-inflammatory cytokines, lessen airway inflammation, and strengthen immune system performance in general [5,6].

Given the significant incidence of vitamin D insufficiency worldwide, especially in children, the possible function of vitamin D in managing asthma is especially pertinent. Vitamin D insufficiency is a common condition in

India due to variables like skin pigmentation, eating habits, and insufficient sun exposure. Given its possible effects on asthma outcomes and respiratory health, this deficit is cause for concern [7].

The purpose of this study is to investigate the relationship between vitamin D levels and asthma severity in children aged 6 to 12 years, taking into account the significant burden of asthma in children as well as the high incidence of vitamin D deficiency. We can more accurately evaluate the possible advantages of vitamin D supplementation as a therapeutic approach for enhancing asthma management and lowering exacerbations by comprehending this association.

Materials and Methods

The purpose of this prospective cohort study is to investigate the association between children's asthma control, severity and vitamin D levels. Children between the ages of 6 and 12 who arrived at a tertiary care teaching hospital with an acute exacerbation of bronchial asthma made up the study population. An estimated sample size of 100 was obtained by applying a suitable statistical method with a 5% level of significance to establish the sample size. August 2021–August 2022 was the study's one-year period of conduct.

Children under the age of six or older than twelve, individuals who had recently had vitamin D treatment, kids whose conditions affected their vitamin D levels in the previous six months, who declined to give consent, and who were unwilling to follow up were all excluded. The parents of the participants (LARs, Legally Acceptable Representatives) gave their informed consent after being fully informed about the procedures and

techniques of the study. Participants in the study gave their consent. The hospital's institutional ethical committee also provided ethical clearance.

Following the children's informed consent (assent) when they presented with an acute asthmatic exacerbation, pertinent data from each case chosen for the study was entered into a pre-structured Performa. Thorough clinical tests were carried out, and over the course of four weeks, the degree of asthma control was evaluated and classified in accordance with GINA recommendations. Using a Performa in Tamil, a thorough history was taken as part of the data collection process. Important details included the child's age at the onset of bronchial asthma, the time since the last attack, acute severe exacerbation, status asthmaticus, hospitalization history, history of other atopic diseases, drug history, socioeconomic history, and family history. Vital indicators like heart rate, respiratory rate, and saturation were monitored throughout medical exams, and a thorough chest examination was performed as well. ELISA was used to measure serum 25-hydroxyvitamin D as part of the investigation. In accordance with the Vitamin D Standardization Program, blood samples were taken under aseptic precautions upon presentation in order to estimate serum 25-hydroxyvitamin D levels. These samples were then analyzed using a fully automated luminescent immunoassay. Next, using statistical techniques, vitamin D levels and asthma severity were connected. In order to examine the impact of vitamin D supplementation on asthma control and severity, children with vitamin D insufficiency were given vitamin D supplements and followed up for three months.

Based on the results of the initial measurement of vitamin D levels, the asthmatic group was split into three categories: inadequate (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL). Following a three-month period of vitamin D supplementation, the treatment's impact on asthma-related symptoms and control was assessed.

SPSS 27 was used to analyze the data once it was imported into Microsoft Excel. The fundamental clinical and sociodemographic data were tallied and presented as Mean \pm SD or Frequency/Percentage. To determine whether there was any correlation between the three categories of vitamin D levels and contributing factors, the chi square test was used. $P < 0.05$ was regarded as significant.

Results

The information offered gives a thorough picture of the patient circumstances, treatment options, and symptoms associated with asthma in a sample group. The study participants' average age was 8.36 ± 1.39 years. Over 80% of the study participants were between the ages of 7 and 10. Nine percent more were eleven years old. Boys made up 52% of the study participants, while girls made up the remaining 48%. With 51% of patients reporting less than two episodes per week, the majority of patients experienced symptoms during the day less

frequently. The frequency of nocturnal awakenings was slightly lower, as only 52% of patients reported having them. Of the patients, 42% experienced limitations in their activities, and a significant majority (91%) needed rescue therapy. There were differences in the patients' levels of asthma control: only 5% had their asthma under control, 62% had it moderately controlled, and 33% had it uncontrolled. 59% of those with a hospitalization history had fewer than five admissions prior. 33% of patients were lethargic, and 62% of patients were hyperalert, according to the sensorium status. 75 percent of the patients had fast breathing. According to oxygen saturation levels, 57% of people were less than 92% saturated. In 57% of the cases, the perfusion was sufficient. The percentage of children with severe asthma was high: 36% had acute asthma, 31% had asthma that was life-threatening, and 33% had asthma that was almost fatal. 54% of hospital visits lasted fewer than five days, which is a very balanced percentage. A combination of bronchodilators, steroids, adrenaline, and magnesium sulphate were used as therapy options; 39% of patients received the most thorough care. Serum vitamin D levels showed that a significant percentage of patients (55%) had insufficient levels, with only 13% having appropriate levels. Oxygen delivery modalities varied, with 48% adopting HFNC (Table 1).

Table 1. Clinical Characteristics of the study population

Parameter	Subclassification	No of Patients	Percentage
Day time symptoms	> 2 times per week	49	49%
	< 2 times per week	51	51%
Nocturnal awakening	Yes	48	48%
	No	52	52%
Limitation of activity	Yes	42	42%

	No	58	58%
Rescue therapy	Required	91	91%
	Not required	9	9%
Level of asthma control	Controlled	5	5%
	Partially controlled	62	62%
	Uncontrolled	33	33%
Number of previous hospitalisation	Less than 5	59	59%
	More than 5	41	41%
Sensorium	Alert	5	5%
	Hyperalert	62	62%
	Lethargic	33	33%
Fast breathing	Present	75	75%
	Absent	25	25%
Oxygen saturation	Less than 92	57	57%
	More than 92	43	43%
Perfusion	Adequate	57	57%
	Not adequate	43	43%
Severity of asthma	Moderate	0	0%
	Acute severe	36	36%
	Life threatening	31	31%
	Near fatal	33	33%
Duration of hospital stay	Less than 5 days	54	54%
	More than 5 days	46	46%
Treatment modalities	Bronchodilator + steroid	0	0%
	Bronchodilator + steroid + s.c. Adrenaline	33	33%
	Bronchodilator + steroid + s.c. Adrenaline + mgso4	39	39%
	Aminophylline infusion	28	28%
Mode of oxygen delivery	O2 mask	13	13%
	Hfnc	48	48%
	Ventilator/cpap	41	41%
Serum vitamin d levels	Deficient (< 20)	32	32%
	Insufficient (20-30)	55	55%
	Sufficient (> 30)	13	13%

Age and vitamin D levels do not significantly correlate in the research sample. The distribution of serum vitamin D levels by category, such as sex, degree of asthma control, and asthma severity, is shown in Table 2. The distribution of vitamin D levels between males and females revealed no discernible difference ($P = 0.129$). There was a substantial correlation ($P < 0.001$) between vitamin D levels (20–30 ng/mL) and asthma control,

with most controlled cases falling into this category. Likewise, a noteworthy association was discovered ($P < 0.001$) between the intensity of asthma and Vitamin D levels, emphasizing that the majority of instances that were close to death had low Vitamin D levels (< 20 ng/mL). These results imply that more severe and poorly controlled asthma episodes may be linked to decreased vitamin D levels.

Table 2. Serum Vitamin D Levels and Their Association with Sex, Asthma Control, and Severity of Asthma

CATEGORY	SUB CLASSIFICATION	DEFICIENT (< 20)	INSUFFICIENT (20-30)	SUFFICIENT (> 30)	P Value
Sex	Male	15	33	4	0.129
	Female	17	22	9	
Level of asthma control	Controlled	0	5	0	<0.001
	Partially controlled	8	41	13	
	Uncontrolled	24	9	0	
Severity of asthma	Acute severe	4	24	8	<0.001
	Life threatening	0	26	5	
	Near fatal	29	5	0	

Frequency and Percentage are the same.

88% of the children who were hospitalized to the hospital received vitamin D supplements, whereas 12% did not because their vitamin D levels were enough. Following a three-month course of therapy, additional measurements of the symptoms were taken and compared to the initial ones. The number of nighttime awakenings dropped from 48% to 39%, yet $P = 0.129$ indicates that this drop was not statistically significant. Significant

improvements were noted in the number of children reporting restrictions of activity ($P < 0.001$), which decreased from 42% to 4%. Additionally, from 91% to 54% children, there was a significant ($P < 0.001$) drop in the need for rescue therapy. After therapy, there was a significant improvement in asthma control, as evidenced by the rise in controlled cases from 5 to 36 and the absence of uncontrolled ($P < 0.001$). (Table 3)

Table 3. Impact of Treatment on Asthma-Related Symptoms and Control

CONDITION	STATUS	BEFORE TRT	AFTER TRT	P VALUE
Nocturnal awakening	Present	48	39	0.129
	Absent	52	61	
Limitation of activity	Yes	42	4	<0.001
	No	58	96	
Rescue therapy	Required	91	54	<0.001
	Not required	9	46	

Level of asthma control	Controlled	5	36	<0.001
	Partially controlled	62	64	
	Uncontrolled	33	0	

Frequency and Percentage are the same.

Discussion

The goal of this cross-sectional study was to determine how vitamin D affects asthma. Our study's results are consistent with other research, showing a strong link between elevated asthma severity and inadequate asthma control and reduced vitamin D levels (6–11). According to our findings, a significant fraction of kids with severe asthma had low vitamin D levels. In particular, it was discovered that 32% of study participants lacked sufficient amounts of vitamin D. Furthermore, these individuals exhibited the greatest frequencies of severe and unmanaged asthma. After taking vitamin D supplements for three months, 88% of the hospitalized children's asthma symptoms and control significantly improved (Table 3).

Similar correlations between the severity of asthma and vitamin D insufficiency have been shown in several investigations. Children with severe asthma had considerably lower serum vitamin D levels than children with mild asthma, according to a research by Searing et al. [8]. Furthermore, Brehm et al. showed that reduced vitamin D levels were linked to a higher chance of hospitalizations and severe asthma exacerbations in children [9]. Our results are further supported by a Turkish study that found a strong inversely proportional association between elevated asthma severity and low vitamin D levels [10].

In contrast, other research has shown contradictory findings. For example, a Spanish study indicated that there was no statistically significant correlation between children's vitamin D levels and the severity of their asthma, indicating that additional factors might also contribute to the pathophysiology of asthma [11].

The function of vitamin D in immune modulation and inflammation is one of the pathophysiological processes underpinning the correlation between the severity of asthma and vitamin D deficiency. Antimicrobial peptides are better expressed when vitamin D is present, and it also affects how immune cells—such as macrophages, dendritic cells, and T lymphocytes—activate. It increases the production of anti-inflammatory cytokines like IL-10 and decreases the production of pro-inflammatory cytokines like IL-6, IL-9, and IL-17 [12,13]. This immunomodulatory impact aids in preserving the balance of the airways while lowering inflammation and hyperresponsiveness.

By increasing the expression of genes related to preserving epithelial integrity and lowering airway remodelling, vitamin D also improves lung function. Research has demonstrated that vitamin D can enhance lung function metrics like FEV1 and FVC, which are essential for managing asthma [14]. These scientific discoveries clarify why, as our study showed, vitamin D administration can

result in notable improvements in asthma control and symptom reduction.

Conclusion

This study shows a strong relationship between 6 to 12 years children's vitamin D levels and the severity and control of their asthma. The results imply that vitamin D administration may enhance symptom control and decrease the frequency of exacerbations, therefore improving asthma outcomes. It is advised that future studies be conducted with bigger sample sizes and longer follow-up times in order to confirm these results and thoroughly examine the underlying mechanisms.

Statements and Declarations

Conflicts of interest

The authors declares that they do not have conflict of interest.

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