Original Research

EVALUATION OF ASSOCIATION BETWEEN ASTHMA AND VITAMIN D DEFICIENCY IN CHILDREN AND ADULT: PROSPECTIVE OBSERVATIONAL STUDY

Dr. Darshan J. Satapara[1], Dr. Rushikesh Ramjibhai Yadav[2], Dr. Daxesh Fulsinh Bamaniya[3], Dr. Prashant M. Parmar[4*]

[1]Assistant Professor, Department ofRespiratory Medicine, C. U Shah Medical College, Surendranagar, Gujarat, India.

[2]M.D. Respiratory Medicine, fellowship in critical care medicine (IDCCM), Pramukh Swami Medical College, Karamsad, Anand, Gujarat, India.

[3]Assistant Professor, Department of General Medicine, Zydus Medical college and Hospital, Dahod, Gujarat, India.

[4*]Associate Professor, Department of Pharmacology, Zydus Medical college and Hospital, Dahod, Gujarat, India.

Email: [1]sataparadj@gmail.com, [2]rushiyadav0510@gmail.com, [3]daxeshbamaniya16@gmail.com, [4*]drprashant.parmar1490@gmail.com

Corresponding Author: Dr. Prashant M. Parmar,
Associate Professor, Department of Pharmacology, Zydus Medical College and Hospital, Dahod, Gujarat, India.

Email: drprashant.parmar1490@gmail.com

ABSTRACT

Introduction: Asthma is a chronic inflammatory airway disease with variable severity and control. Recent evidence suggests a potential role of vitamin D deficiency in influencing asthma outcomes. The aim of the study is to evaluate the association between vitamin D deficiency and asthma severity, control, and lung function in children and adults.

Materials and Methodology: This prospective observational study included 100 patients with bronchial asthma attending a tertiary care hospital. Serum 25-hydroxyvitamin D levels were measured and categorized as deficient, insufficient, or sufficient. Asthma severity was assessed using GINA guidelines, and control was evaluated using the Asthma Control Test (ACT). Pulmonary function tests were performed to assess FEV1, FVC, and FEV1/FVC ratio. Statistical analysis was performed using chi-square test, ANOVA, and correlation analysis.

Results: Vitamin D deficiency was observed in 52% of patients. A significant association was found between vitamin D status and asthma severity ($p = 0.001$) as well as asthma control ($p = 0.002$). Patients with vitamin D deficiency had significantly lower lung function parameters ($p < 0.001$). Positive correlation was observed between vitamin D levels and FEV1 and ACT score, while a negative correlation was noted with asthma severity.

Conclusion: Vitamin D deficiency is highly prevalent in asthma patients and is significantly associated with increased severity, poor control, and reduced lung function. Assessment of vitamin D status may be beneficial in the comprehensive management of asthma.

Keywords: Asthma, Vitamin D Deficiency, Asthma Severity, Lung Function, Asthma Control.

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways characterized by reversible airflow obstruction, airway hyperresponsiveness, and recurrent episodes of wheezing, dyspnea, chest tightness, and cough.

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It affects nearly 300 million individuals worldwide and constitutes a significant public health burden, particularly in developing countries where its prevalence is increasing due to urbanization, environmental pollution, and lifestyle changes [1,2]. Despite advances in management, a substantial proportion of patients continue to experience poor disease control and recurrent exacerbations.

The pathogenesis of asthma involves complex interactions between genetic predisposition, environmental factors, and immune dysregulation. It is primarily mediated by an exaggerated T-helper type 2 (Th2) immune response, resulting in eosinophilic inflammation and increased production

of cytokines such as interleukin (IL)-4, IL-5, and IL-13 [2,3]. These processes contribute to airway inflammation, remodeling, and variable airflow limitation.

Vitamin D, a fat-soluble vitamin synthesized mainly through sunlight exposure, has gained attention for its immunomodulatory and anti-inflammatory properties beyond its classical role in calcium metabolism. It influences both innate and adaptive immunity by suppressing pro-inflammatory cytokines and enhancing anti-inflammatory pathways [4]. These effects suggest a potential role of vitamin D in respiratory diseases, including asthma.

Several studies have demonstrated an association between vitamin D deficiency and asthma severity. Low serum 25-hydroxyvitamin D levels have been linked to poor asthma control, reduced lung function, increased airway hyperresponsiveness, and frequent exacerbations [5,6]. In children, vitamin D deficiency has been associated with increased hospitalizations and disease severity, while in adults, it is more common in severe and uncontrolled asthma [7]. However, findings remain inconsistent, and the causal relationship is still unclear [8].

Given the high prevalence of vitamin D deficiency and the limited prospective data evaluating both pediatric and adult populations together, this study aims to assess the association between asthma and vitamin D deficiency in children and adults.

MATERIALS AND METHODOLOGY

This prospective observational study was conducted in the Department of Respiratory Medicine at a tertiary care teaching hospital, in western Gujarat, India over a period of 12 months from January 2025 to January 2026, after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all adult participants and from parents or guardians in case of pediatric patients. The study included a total of 100 patients.

Patients diagnosed with bronchial asthma, attending both outpatient and inpatient departments, were enrolled in the study. Diagnosis of asthma was made based on clinical features and spirometry criteria in accordance with Global Initiative for Asthma (GINA) guidelines. Both children (≥5 years) and adults were included. Patients with other chronic respiratory diseases such as chronic obstructive pulmonary disease, bronchiectasis, or interstitial lung disease, those receiving vitamin D supplementation within the past three months, and those with chronic systemic illnesses like renal or hepatic disorders were excluded from the study.

Detailed demographic and clinical data including age, sex, duration of illness, symptom profile, history of exacerbations, and treatment details were recorded using a predesigned structured proforma. Asthma severity and level of control were assessed using GINA classification and Asthma Control Test (ACT) score. Pulmonary function testing was performed using spirometry, and parameters such as forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were recorded.

Venous blood samples were collected from all participants for estimation of serum 25-hydroxyvitamin D [25(OH) D] levels using chemiluminescence immunoassay. Vitamin D status was categorized as deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL).

The primary objective was to evaluate the association between serum vitamin D levels and asthma, while secondary outcomes included correlation with asthma severity, control, and lung function parameters. Data were entered into Microsoft Excel and analyzed using GraphPad version 3.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Appropriate statistical tests such as independent t-test, ANOVA, and chi-square test were applied. Correlation analysis was performed using Pearson or Spearman methods. A p-value of <0.05 was considered statistically significant.

RESULT

A total of 100 patients with bronchial asthma were included in the study, comprising both children and adults.

Table 1. Demographic Profile with Age Subgroup Distribution of Study Participants

Demographic Variable	Subgroup	Frequency (N)	Percentage (%)
Age Group (Years)	5–12	18	18%
	13–17	22	22%
	18–30	24	24%
	31–45	20	20%
	46–60	10	10%
	>60	6	6%
Age Category	Children (<18 years)	40	40%
	Adults (≥18 years)	60	60%
Gender	Male	58	58%
	Female	42	42%

The study included 100 participants, with the majority belonging to the 18–30 years age group (24%), followed by 31–45 years (20%). Among pediatric participants, adolescents (13–17 years) constituted a larger proportion (22%) compared to younger children (18%). Overall, adults (60%) outnumbered children (40%). A male predominance was observed, with males accounting for 58% and females 42% of the study population.

Table 2. Distribution of Study Participants According to Vitamin D Status

Vitamin D Status	Frequency (N)	Percentage (%)
Deficient (<20 ng/mL)	52	52%
Insufficient (20–30 ng/mL)	30	30%
Sufficient (>30 ng/mL)	18	18%

More than half of the participants (52%) were vitamin D deficient, while only 18% had sufficient levels, indicating a high prevalence of hypovitaminosis D among asthma patients.

Table 3. Association between Vitamin D Status and Asthma Severity

Vitamin D Status	Mild	Moderate	Severe	Total	P value
Deficient	8 (15.4%)	20 (38.5%)	24 (46.1%)	52 (52%)	0.001
Insufficient	10 (33.3%)	14 (46.7%)	6 (20.0%)	30 (30%)	
Sufficient	12 (66.7%)	5 (27.8%)	1 (5.5%)	18 (18%)	

Data were expressed as n (%). P<0.05 taken as statistically significant by using chi square test.

Table 3 demonstrates a significant association between vitamin D status and asthma severity (p = 0.001). Among patients with vitamin D deficiency, the majority had severe asthma (46.1%), followed by moderate (38.5%) and mild disease (15.4%). In contrast, patients with sufficient vitamin D levels predominantly had mild asthma (66.7%), with very few cases of severe disease (5.5%). Those with insufficient vitamin D showed an intermediate pattern, with most patients having moderate asthma (46.7%). Overall, the findings indicate that lower vitamin D levels are associated with increasing severity of asthma.

Table 4. Association between Vitamin D Status and Asthma Control (ACT Score)

Vitamin D Status	Controlled	Partly Controlled	Uncontrolled	Total	P value
Deficient	10 (19.2%)	18 (34.6%)	24 (46.2%)	52 (52%)	0.002
Insufficient	12 (40.0%)	10 (33.3%)	8 (26.7%)	30 (30%)	
Sufficient	14 (77.8%)	3 (16.7%)	1 (5.5%)	18 (18%)	

Data were expressed as n (%). P<0.05 taken as statistically significant by using chi square test.

Table 4 shows a statistically significant association between vitamin D status and asthma control (p = 0.002). Among patients with vitamin D deficiency, the majority were in the uncontrolled category (46.2%), followed by partly controlled (34.6%) and controlled asthma (19.2%). In contrast, patients with sufficient vitamin D levels predominantly had well-controlled asthma (77.8%), with very few being uncontrolled (5.5%). Those with insufficient vitamin D demonstrated an intermediate distribution, with a relatively balanced proportion across controlled (40.0%), partly controlled (33.3%), and uncontrolled (26.7%) categories. Overall, these findings suggest that lower vitamin D levels are significantly associated with poorer asthma control.

Table 5. Comparison of Lung Function Parameters

Parameter	Deficient	Insufficient	Sufficient	P-Value
FEV1 (%)	68.4 ± 10.2	74.8 ± 9.5	82.3 ± 8.1	<0.001
FVC (%)	72.1 ± 11.4	78.6 ± 10.2	85.5 ± 9.3	<0.001
FEV1/FVC	0.71 ± 0.05	0.75 ± 0.04	0.80 ± 0.03	<0.001

Data were expressed as Mean ± SD. P value <0.05 taken as statistically significant by using ANOVA with Tukey post hoc test.

Table 5 demonstrated that patients with vitamin D deficiency had the lowest mean FEV1 (68.4 ± 10.2%), FVC (72.1 ± 11.4%), and FEV1/FVC ratio (0.71 ± 0.05), indicating poorer pulmonary function. In contrast, patients with sufficient vitamin D levels showed the highest values for FEV1 (82.3 ± 8.1%), FVC (85.5 ± 9.3%), and FEV1/FVC ratio (0.80 ± 0.03). The insufficient group demonstrated intermediate values. The differences across groups were statistically significant, suggesting that lower

vitamin D levels are associated with reduced lung function in asthma patients.

Table 6. Correlation between Vitamin D Levels and Clinical Parameters

Variable	Correlation Coefficient (r)	P-Value
FEV1 (%)	+0.48	<0.001
ACT Score	+0.42	<0.001
Asthma Severity	-0.51	<0.001

There was a moderate positive correlation between vitamin D levels and lung function (FEV1) as well as asthma control (ACT score). A moderate negative correlation was observed between vitamin D levels and asthma severity, indicating that lower vitamin D levels are associated with more severe disease.

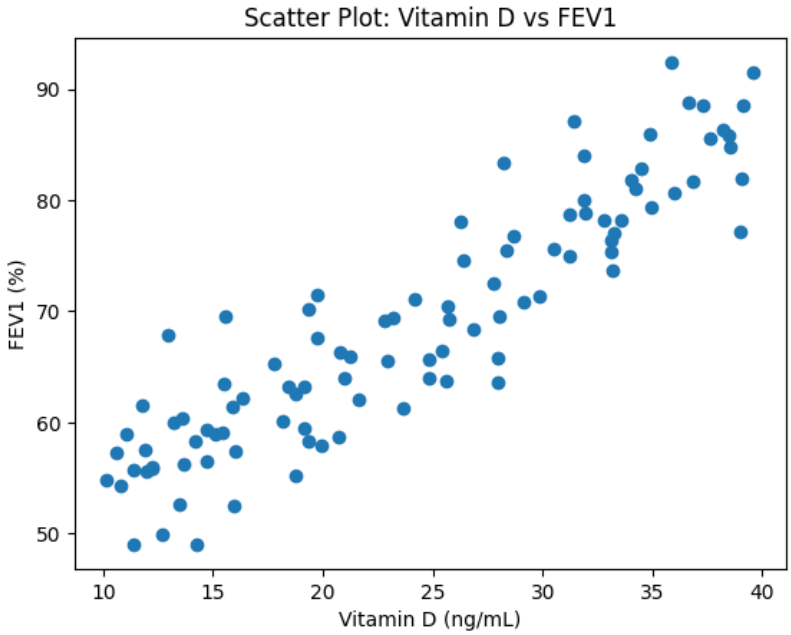

Figure 1. Scatter Plot: Correlation between Vitamin D and FEV1

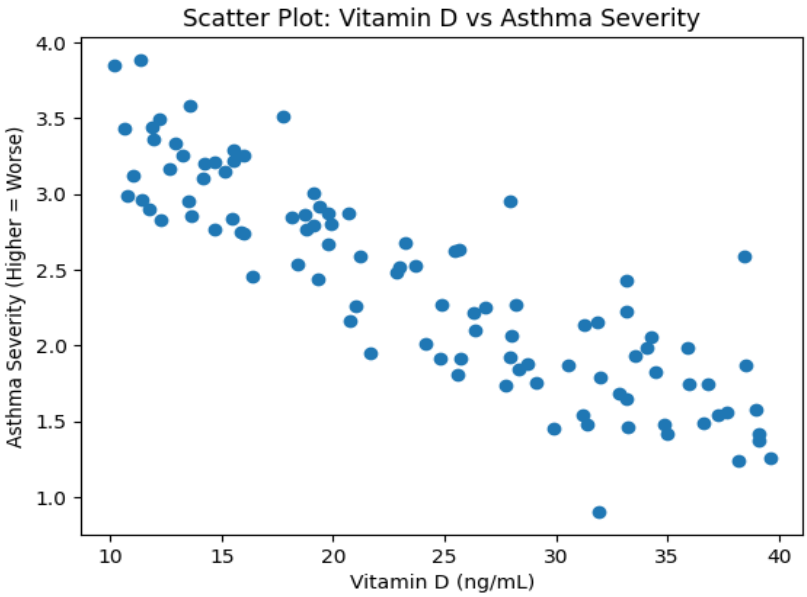

Figure 2. Scatter Plot: Correlation between Vitamin D and Asthma Severity

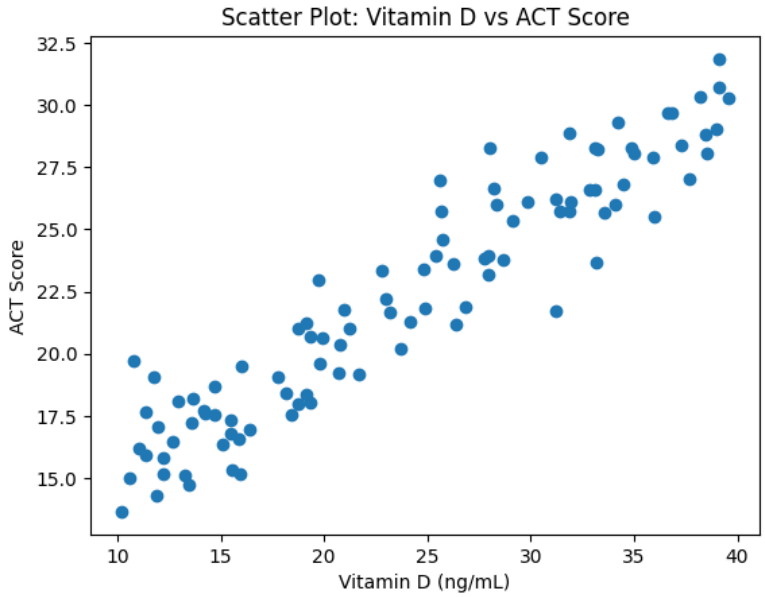

Figure 3. Scatter Plot: Correlation between Vitamin D and ACT Score

The scatter plot analysis demonstrated a positive correlation between serum vitamin D levels and lung function parameters, particularly FEV1, as evidenced by an upward trend, indicating that higher vitamin D levels are associated with better pulmonary function (Figure 1). Conversely, an inverse relationship was observed between vitamin D levels and asthma severity, with a downward trend suggesting that lower vitamin D levels are associated with increased disease severity (Figure 2). The positive correlation between serum vitamin D levels and Asthma Control Test (ACT) score indicates that higher vitamin D levels are associated with better asthma control. In the scatter plot, this is represented by an upward trend, where increasing vitamin D concentrations correspond to higher ACT scores (Figure 3). These graphical findings further support the association between vitamin D status and asthma control, implying that improvement in vitamin D levels may contribute to better clinical outcomes in asthma patients.

In the present study, a high prevalence of vitamin D deficiency (52%) was observed among asthma patients. Statistical analysis revealed a significant association between vitamin D status and asthma severity ($p = 0.001$), asthma control ($p = 0.002$), and lung function parameters ($p < 0.001$). The correlation analysis demonstrated moderate relationships between vitamin D levels and these clinical variables, indicating a clinically meaningful association. These findings suggest that vitamin D deficiency may play an important role in influencing disease severity, control, and pulmonary function in patients with bronchial asthma.

DISCUSSION

The present study demonstrated a high prevalence of vitamin D deficiency (52%) among patients with bronchial asthma, along with a significant association between vitamin D status and asthma severity, control, and lung function. These findings are consistent with several previous studies that have highlighted the role of vitamin D in the pathogenesis and clinical course of asthma.

In the current study, vitamin D deficiency was significantly associated with increased asthma severity ($p = 0.001$). A similar observation was reported by Sharif et al., who found that lower serum vitamin D levels were correlated with higher severity of asthma manifestations [9]. Likewise, Bhat et al. observed that hypovitaminosis D was associated with more severe asthma and poorer symptom control in children [10]. These findings support the hypothesis that vitamin D deficiency may contribute to enhanced airway inflammation and disease progression.

Regarding asthma control, the present study showed a significant association between low vitamin D levels and poor asthma control ($p = 0.002$), with a higher proportion of uncontrolled cases among vitamin D deficient patients. This is in agreement with observational studies summarized by Jat et al., which demonstrated that low vitamin D levels are associated with poor asthma control and increased exacerbations in children [11]. Additionally, Abi-Ayad et al. reported that vitamin D deficiency was more common in patients with uncontrolled asthma, suggesting a negative relationship between vitamin D levels and disease control [12].

The present study also demonstrated a significant positive correlation between vitamin D levels and lung function parameters such as FEV1, FVC, and FEV1/FVC ratio ($p < 0.001$). These findings are supported by previous studies showing that vitamin D deficiency is associated with reduced lung

function and increased airway obstruction [13]. Furthermore, interventional studies have suggested that vitamin D supplementation may improve FEV1, particularly in patients with baseline deficiency or severe disease [14].

Despite these consistent findings, some studies have reported conflicting results. A meta-analysis by Liu et al. found no significant improvement in ACT scores or lung function with vitamin D supplementation, although benefits were observed in certain subgroups [15]. Similarly, randomized controlled trials have shown inconsistent effects of vitamin D supplementation on asthma outcomes, indicating that the relationship may be influenced by factors such as baseline vitamin D status, dosage, and patient characteristics [16]. These discrepancies highlight the complexity of the relationship and suggest that vitamin D may play a modulatory rather than a causal role in asthma.

Overall, the findings of the present study are in concordance with the majority of observational studies, supporting a significant association between vitamin D deficiency and increased asthma severity, poor control, and reduced lung function. Given the high prevalence of vitamin D deficiency and its potential impact on asthma outcomes, routine screening and appropriate correction of deficiency may be beneficial as part of comprehensive asthma management.

CONCLUSION

The present study shows a high prevalence of vitamin D deficiency among asthma patients and demonstrates a significant association with increased disease severity, poor asthma control, and reduced lung function. These findings suggest that vitamin D may play an important role in asthma outcomes, and its assessment could be useful in routine clinical evaluation.arly identification and correction of vitamin D deficiency could potentially contribute to better disease control and improved pulmonary function. However, further large-scale prospective and interventional studies are required to establish causality and to determine the therapeutic benefits of vitamin D supplementation in asthma management.

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