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Level of Vitamin D in Children With Asthma Control and Severity in Bronchial Asthma in a Tertiary Care Hospital in Haldwani

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ABSTRACT

Asthma, a chronic inflammatory airway disorder, poses a significant health burden in children, with emerging evidence linking vitamin D deficiency to its severity and control. This cross-sectional study was conducted at a tertiary care hospital in Haldwani to investigate the relationship between serum 25-hydroxyvitamin D levels and asthma severity and control among 71 children under 16 years of age diagnosed with asthma according to GINA guidelines. The study assessed demographic profiles, asthma severity using validated questionnaires (ACT/C-ACT), spirometry and serum vitamin D levels. Results revealed a significant inverse correlation between vitamin D levels and asthma severity. Children with severe persistent asthma exhibited markedly lower vitamin D levels (mean: 19.41ng/mL) compared to those with intermittent asthma (mean: 45.90ng/mL). These findings suggest that addressing vitamin D deficiency could be a pivotal strategy in asthma management, especially in regions with limited sunlight exposure. Further research is warranted to explore vitamin D supplementation as an adjunct therapy in pediatric asthma.

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways, characterized by recurrent episodes of wheezing, breathlessness, chest tightness and cough. These symptoms often occur during the night or early morning, resulting from airway hyper-responsiveness and variable airflow obstruction, which is typically reversible. While asthma affects individuals of all ages, it is particularly burdensome in children, ranking among the leading causes of hospitalizations, emergency visits and school absenteeism[1]. Despite advances in asthma management, its prevalence continues to rise globally, with significant implications for the healthcare system and the quality of life of affected individuals. The pathophysiology of asthma involves a complex interplay of genetic predisposition, environmental exposures and immune dysregulation. It is characterized by chronic airway inflammation, which leads to structural changes such as smooth muscle hypertrophy, goblet cell hyperplasia, and airway remodeling. These changes contribute to the clinical presentation of asthma, which varies in severity from intermittent symptoms to persistent and life-threatening exacerbations. The burden of asthma is exacerbated by inadequate control of symptoms, which is a common challenge in pediatric populations. Vitamin D, traditionally recognized for its role in calcium metabolism and bone health, has gained increasing attention for its immunomodulatory and anti-inflammatory properties. The active form of vitamin D, 1, 25-dihydroxyvitamin D, influences a variety of immune processes, including the regulation of T-helper cell differentiation, suppression of pro-inflammatory cytokines and promotion of antimicrobial peptide production. These mechanisms suggest a potential role for vitamin D in the prevention and management of asthma. Across the globe, many countries report high levels of vitamin D insufficiency[2]. Several studies have highlighted the association between vitamin D deficiency and asthma severity. Vitamin D deficiency, defined as serum 25 -hydroxyvitamin D levels below 20ng/mL, is highly prevalent among children, particularly in regions with limited sunlight exposure, inadequate dietary intake and cultural practices that restrict outdoor activities. Low levels of vitamin D have been linked to increased airway inflammation, reduced lung function and a higher frequency of exacerbations[3]. Moreover, vitamin D deficiency may impair the efficacy of standard asthma treatments, making disease control more challenging.

In the context of pediatric asthma, vitamin D has been proposed as a modifiable risk factor that could influence disease severity and treatment outcomes. Observational studies have shown that children with higher vitamin D levels tend to have better asthma control, fewer symptoms and reduced hospitalizations. This has led to growing interest in vitamin D supplementation as an adjunct therapy for asthma. However, the evidence remains inconsistent, with some inter ventional studies failing to demonstrate significant benefits. These discrepancies underscore the need for further research to clarify the role of vitamin D in asthma pathogenesis and management. The geographical and climatic conditions of Uttarakhand, characterized by prolonged winters and limited sunlight exposure, may contribute to high rates of vitamin D deficiency among children in this region. Haldwani, a city situated in the foothills of the Himalayas, serves as a hub for medical care in this area, making it an ideal setting for studying the relationship between vitamin D levels and asthma. This study aims to evaluate the serum 25-hydroxyvitamin D levels in children with asthma and explore their association with asthma severity and control. By identifying vitamin D deficiency as a potentially modifiable risk factor, this research seeks to provide insights that could enhance asthma management strategies and improve outcomes for children in this region. Understanding the link between vitamin D levels and asthma could pave the way for novel interventions aimed at reducing the burden of this chronic disease. This study not only adds to the growing body of evidence on the role of vitamin D in respiratory health but also addresses a critical knowledge gap specific to the pediatric population in Haldwani. Through this research, we aim to contribute to the broader goal of improving pediatric asthma care and reducing the long-term impact of this condition on children's lives[4]. Conducted a case-control study revealing a significantly higher prevalence of vitamin D deficiency and insufficiency among African American pediatric asthma patients, suggesting a potential link between low vitamin D levels and asthma. A review by[5] emphasized the growing concern of vitamin D deficiency in children with allergic conditions and highlighted its critical role in lung development and immune function. The review also suggested that vitamin D supplementation could help prevent respiratory infections and improve asthma control, recommending the routine assessment of vitamin D levels in asthmatic children to optimize clinical outcomes. In 2017, Ali and Nanji reviewed epidemiologic and experimental evidence linking vitamin D status to asthma and its exacerbations, identifying protective mechanisms associated with adequate vitamin D levels. They stressed the need for experimental trials to establish clearer guidelines for vitamin D supplementation in asthma prevention and management, including determining optimal dosages for various age groups. A study by[6] explored the molecular aspects of vitamin D's role in asthma, showing reduced vitamin D receptor mRNA and protein levels, along with lower serum 25-(OH) D3

concentrations in asthma patients compared to healthy controls. These findings were accompanied by increased inflammatory markers (IL-6 and TNF-a) and reduced anti-inflammatory markers (IL-10 and TGF-ß) in the asthma group, supporting the link between vitamin D deficiency and heightened airway inflammation. In the Vitamin D to Prevent Severe Asthma Exacerbations (VDKA) Study conducted by[7], high-dose vitamin D3 supplementation (4000 IU/day) in children aged 6–16 years failed to significantly reduce severe asthma exacerbations or improve time to exacerbation compared to placebo. Despite its null findings, the study highlighted the challenges of translating observational associations into clinical interventions and underscored the importance of well-designed trials for understanding vitamin D's role in asthma management.

MATERIALS AND METHODS

This observational cross-sectional study was conducted in the Department of Pediatrics at Government Medical College and Dr. Susheela Tiwari Government Hospital, Haldwani, Uttarakhand, between January 2023 and May 2024. The study included 71 children aged less than 16 years diagnosed with asthma or recurrent wheezing episodes as per GINA guidelines. Participants were recruited consecutively, and written informed consent was obtained from parents or guardians. Children with other causes of wheezing (e.g., congenital malformations, reflux disease), severe systemic illnesses, or unwilling guardians were excluded. Data collection involved a structured questionnaire to document demographic details, environmental and dietary factors, family history and clinical symptoms. Asthma severity was classified as intermittent, mild persistent, moderate persistent, or severe persistent, while control was assessed using the Asthma Control Test (ACT) or Childhood ACT (C-ACT). Serum 25-hydroxyvitamin D levels were measured and categorized as deficient (<20ng/mL), insufficient (20-29ng/mL), or sufficient (>29ng/mL). Additional laboratory investigations included complete blood counts, serum CRP, calcium levels and spirometry for children above five years of age to measure FEV1/FVC ratios. Statistical analysis was performed using JASP software, with continuous variables expressed as mean±SD and categorical variables as percentages. Associations between vitamin D levels and asthma severity or control were analyzed, with significance set at a 95% confidence level.

RESULTS AND DISCUSSIONS

This section delves into the critical findings of the study, exploring associations between vitamin D levels, asthma[8] severity and related clinical parameters. The results are interpreted in the context of existing literature to provide insights into the implications for asthma management and potential interventions. The study evaluated 71 children diagnosed with asthma or recurrent wheezing based on GINA guidelines. The sample consisted of 43.6% males and 56.3% females, showing a slight female predominance. The mean age was 10.07 years (±4.02). Age and sex distribution analysis showed no statistically significant difference (p=0.63), indicating comparable demographics across genders.

Table 1: Age and Sex Distribution of Study Subjects

Variable	Sex		
	Males (n=31)	Females (n=40)	Total
Age (in years)	9.81 ± 4.33	10.28 ± 3.81	10.07± 4.02
Independent T-test		T=0.588, p-value=0.63	
Age group	Female n=40 and	%	Male n=31 and	%
< 5 yrs.	4	36%	7	63%
5-10 yrs.	10	62%	6	37%
11-16 yrs.	26	59%	18	40%

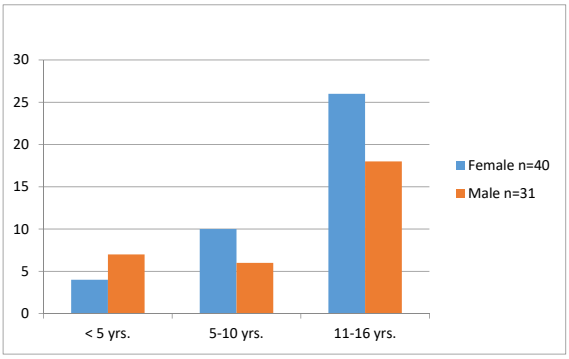

Fig. 1: Age and Sex Distribution of Study Subjects

The majority of participants (71.8%) had a normal BMI, while 9.9% were obese, 9.9% undernourished, and 8.5% overweight. The diverse BMI distribution highlights the need to address both obesity and under nutrition in managing asthma and vitamin D status. This has been presented in (Fig. 2).

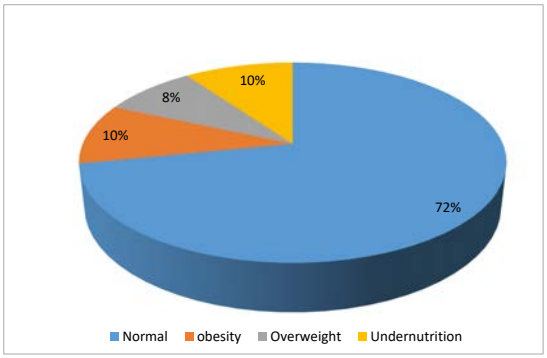

Fig. 2: Distribution of Study Subjects as Per BMI

The analysis of daytime and night-time asthma symptoms reveals gender-based differences in both frequency and severity among the study participants.

For daytime symptoms, males more frequently reported milder patterns, with 32.3% experiencing symptoms <once per week, compared to only 5% of females. Conversely, severe symptoms were more prevalent in females, with 50% experiencing symptoms more than once per week and 17.5% reporting continuous symptoms, compared to 22.6% and 6.5% of males, respectively. Nighttime symptoms followed a similar trend, with 16.1% of males reporting no symptoms compared to none among females. While mild symptoms occurring <once per week were slightly more common in females (17.5%) than males (6.5%), severe patterns were more prominent in females, with 40% experiencing daily symptoms compared to 19.4% of males. Continuous night-time symptoms were also slightly more prevalent in females (17.5%) than males (16.1%). These findings suggest that females in this study experience a greater asthma burden both during the day and at night, particularly in terms of symptom severity, which may necessitate tailored management approaches to address their higher symptom burden.

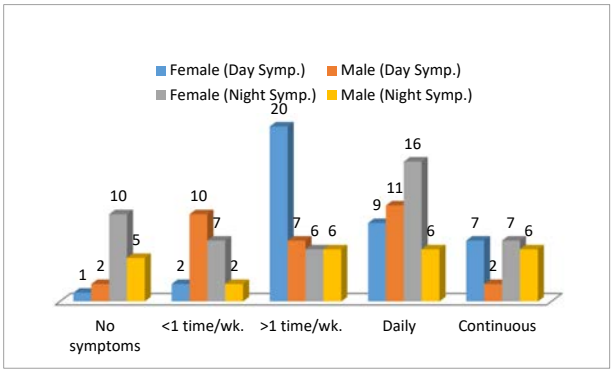

Fig. 3: Day-Time and Night-Time Symptoms of Study Subjects in Both the Study Group

Asthma severity was predominantly moderate persistent (47.9%), followed by severe persistent (29.6%). Intermittent asthma was the least common (9.9%). This severity distribution suggests the need for enhanced management strategies for moderate to severe cases.

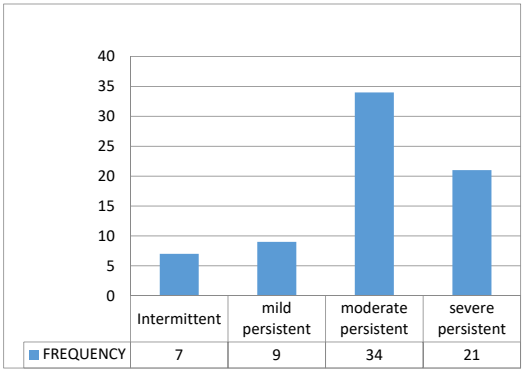

Fig. 4: Distribution of Severity of Bronchial Asthma in Study Participants

Vitamin D levels decreased with increasing asthma severity. Participants with intermittent asthma had the highest mean vitamin D level (45.9ng/mL), while those with severe persistent asthma had the lowest (19.4ng/mL). These findings align with previous studies that associate vitamin D deficiency with worsening asthma control and severity.

Table 2: Measure of Vitamin D Levels and Severity of Asthma in Study Subjects

Severity of Asthma Grading	Mean	N	Std. Deviation
Intermittent	45.8957	7	7.75576
Mild Persistent	38.7633	9	23.10245
Moderate Persistent	28.9409	34	11.37696
Severe Persistent	19.4133	21	6.91299
Total	29.0396	71	14.46375

CRP levels increased with asthma severity, showing a significant association ($p<0.001$). Severe persistent asthma had the highest mean CRP (15.86mg/L), indicating elevated systemic inflammation in more severe cases.

Table 3: Measure of CRP Levels and Severity of Asthma in Study Subjects

Severity of Asthma Grading	Mean	Sample Size	Std .Deviation	Minimum	Maximum
Intermittent	5.14	7	2.968	2	11
Mild Persistent	3.89	9	2.369	2	9
Moderate Persistent	6.88	34	3.929	2	18
Severe Persistent	15.86	21	5.633	6	26
Total	8.99	71	6.235	2	26

Anova test applied, F value- 26.60, p value- <0.001*
Note: Value with * indicates that the results are significant.

Lung function tests revealed declining FEV1/FVC ratios with increasing severity. Participants with severe persistent asthma had the lowest mean ratio (0.5065), reflecting substantial airway obstruction.

Table 4: Measure of CRP Levels and Severity of Asthma in Study Subjects

Severity of Asthma Grading	Mean	Sample Size	Std .Deviation	Minimum	Maximum
Intermittent	.8717	6	.01835	.85	.90
Mild Persistent	.8200	6	.01789	.80	.84
Moderate Persistent	.7235	31	.05083	.60	.78
Severe Persistent	.5065	17	.04873	.42	.57
Total	.6865	60	.13180	.42	.90

Anova test applied, F value- 142.01, p value<0.01*
Note: Value with * indicates that the results are significant.

The analysis of (Table 4) highlights the correlation between vitamin D levels and key lung function parameters-FEV1 and the FEV1/FVC ratio. The first table shows a weak positive correlation between vitamin D levels and FEV1, with a correlation coefficient (R) of 0.322 and an R^2 value of 0.104, indicating that only 10.4% of the variability in vitamin D levels can be explained by FEV1. The adjusted R^2 value of 0.088 accounts for sample size and the p-value of 0.012 signifies that the relationship is statistically significant. In contrast, the second table reveals a stronger positive correlation between vitamin D levels and the FEV1/FVC ratio, with an R value of 0.491 and an R^2 value of 0.241, suggesting that 24.1% of the variability in vitamin D levels is explained by the FEV1/FVC ratio. The adjusted R^2 of 0.228 and a highly

Table 5: Correlation of Vit D Levels with FEV1 and FEV1/FVC in Study Participants Aged Above 5 Years

Model	Correlation Coefficient (R)	R^2	Adjusted R2	Std. Error of the Estimate	P value
Predictors: (Constant), FEV1					
1	0.322[a]	0.104	0.088	14.05894	0.012
Predictors: (Constant), FEV 1/FVC					
1	0.491[a]	0.241	0.228	12.93456	<0.001

Table 6: Morbidity and Severity of Bronchial Asthma in Study Participants

		Severity of Asthma Grading				
		Intermittent	Mild Persistent	Moderate Persistent	Severe Persistent	Total
Previous Life	-	7	9	33	16	65
Threatening Event	+	0	0	1	5	6
Total		7	9	34	21	71

Chi-square value-9.21, p value-<0.001*

Note: Value with * indicates that the results are significant.

significant p-value (<0.001) further support the robustness of this relationship. These findings suggest that vitamin D levels may have a more pronounced influence on airway obstruction, as indicated by the FEV1/FVC ratio, compared to overall lung function as measured by FEV1. This underscores the potential role of vitamin D in improving lung function and reducing airway obstruction in asthmatic patients[9].

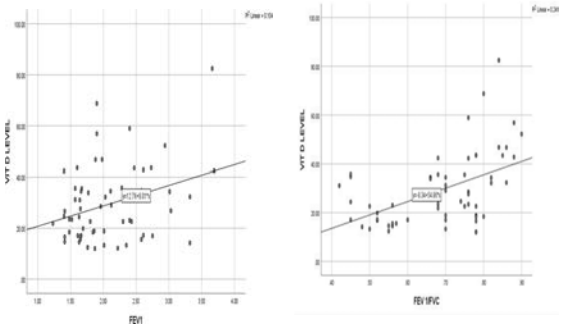

Fig. 5: Correlation of Vit D Levels with FEV1 and FEV1/FVC in Study Participants Aged

Participants with severe asthma had a higher incidence of previous life-threatening events (p<0.001). This underscores the importance of early identification and aggressive management in high-risk groups. The table examines the relationship between the severity of asthma and the occurrence of previous life-threatening events among the study participants[10]. Of the 71 participants, 65 (91.5%) had no history of life-threatening events, while 6 (8.5%) had experienced such events. Notably, no participants with intermittent or mild persistent asthma reported life-threatening events, while only one participant (2.9%) with moderate persistent asthma had such an event. However, the prevalence of life-threatening events was significantly higher (23.8%) among those with severe persistent asthma[11]. The chi-square value of 9.21 and a p-value of <0.001 indicate a statistically significant association between asthma severity and the occurrence of life-threatening events. These findings suggest that patients with severe persistent asthma are at a markedly higher risk of experiencing life-threatening exacerbations, underscoring the need for aggressive monitoring and management strategies for this high-risk group.

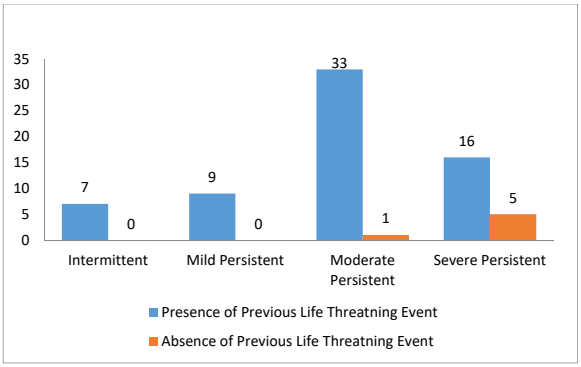

Fig. 6: Morbidity and Severity of Bronchial Asthma in Study Participants

CONCLUSION

This study highlights a significant inverse relationship between serum vitamin D levels and asthma severity in children, with lower vitamin D levels associated with more severe asthma symptoms and reduced lung function. Participants with severe persistent asthma had the lowest vitamin D levels and the highest frequency of life-threatening events, underscoring the critical role of vitamin D in asthma management. The findings also revealed gender-based differences in symptom severity, with females experiencing a greater asthma burden, particularly during the night. The strong correlation between vitamin D levels and lung function parameters, such as the FEV1/FVC ratio, emphasizes the potential role of vitamin D supplementation in improving airway function and reducing disease severity. These results suggest that addressing vitamin D deficiency could serve as an effective adjunct strategy in managing pediatric asthma, particularly in regions with limited sunlight exposure. Further research, including interventional studies, is warranted to explore the therapeutic potential of vitamin D supplementation in reducing

asthma morbidity and improving overall quality of life in affected children.

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