



Research Article

Assessment of vitamin d deficiency in children with recurrent respiratory infection: A hospital-based observational study conducted at North India

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ABSTRACT

Background: Vitamin D plays an important role in immune function and host defense mechanisms. Deficiency of vitamin D has been increasingly recognized as a contributing factor to recurrent respiratory infections in children, especially in developing countries where both malnutrition and limited sunlight exposure are common.

Aim: To assess the prevalence of vitamin D deficiency in children with recurrent respiratory infections and to evaluate its association with severity and clinical outcomes.

Materials and Methods: This hospital-based observational study was conducted over a period of one year (April 2024 to 2025) at LLRM Medical College, Meerut. A total of 100 children, including children aged 1 month to 10 years admitted in pediatric ward and ICU with recurrent respiratory infections, were included. Data regarding demographic profile, nutritional status, clinical presentation, and frequency of infections were collected. Serum 25-hydroxyvitamin D levels were measured and categorized as deficient, insufficient, and sufficient. Statistical analysis was performed using appropriate tests, and p-value <0.05 was considered significant.

Results: Out of 100 patients, 58% were vitamin D deficient, 26% insufficient, and 16% sufficient. The majority of children belonged to the age group of 1–5 years (30%) and were predominantly male (58%). Pneumonia was the most common clinical presentation (40%), followed by upper respiratory tract infections (32%) and bronchiolitis (28%). A significant association was observed between vitamin D deficiency and severity of infection, with 73.3% of severe/ICU cases being vitamin D deficient (p <0.001). Undernutrition was also significantly associated with severe disease (p = 0.008). Children with deficiency had higher frequency of infections and increased need for ICU admission.

Conclusion: Vitamin D deficiency is highly prevalent among children with recurrent respiratory infections and is significantly associated with increased severity and poor clinical outcomes. Early detection and correction of vitamin D deficiency may help in reducing disease burden and improving pediatric health outcomes.

Keywords: Vitamin D deficiency, Recurrent respiratory infections, Children; Pediatric infections, Pneumonia; Immunity, Nutritional status, ICU admission, Serum 25-hydroxyvitamin D, Respiratory morbidity.

INTRODUCTION

Vitamin D is a fat-soluble vitamin that plays a crucial role not only in calcium and bone metabolism but also in immune modulation and protection against infections. It enhances innate immunity by promoting antimicrobial peptide synthesis such as cathelicidin and defensins, which are essential in combating respiratory pathogens [1]. Recent evidence has highlighted the importance of vitamin D in reducing susceptibility to respiratory infections, particularly in children.

Globally, vitamin D deficiency has emerged as a significant public health problem, affecting nearly 1 billion people worldwide. Among children, the prevalence of vitamin D deficiency ranges from 30% to 80% depending on geographic

location, dietary habits, and sun exposure [2]. Respiratory infections remain one of the leading causes of morbidity and mortality in children, accounting for approximately 15% of all deaths in children under five years of age worldwide [3].

Recurrent respiratory infections (RRI) in children are a major clinical concern, defined as repeated episodes of respiratory infections occurring more frequently than expected for age. These infections contribute significantly to hospital admissions, antibiotic use, and healthcare burden. Studies have suggested that vitamin D deficiency may impair immune responses, thereby increasing the frequency and severity of respiratory infections in children [4].

In India, despite abundant sunlight, vitamin D deficiency is highly prevalent due to factors such as poor dietary intake, limited sun exposure, skin pigmentation, and cultural practices. The prevalence of vitamin D deficiency among Indian children has been reported to be as high as 70–90% in various studies [5]. Additionally, acute respiratory infections remain one of the leading causes of pediatric hospital admissions in India, particularly in infants and young children [6].

Young children are particularly vulnerable to infections due to immature immune systems. In intensive care units (ICU), infections such as pneumonia and sepsis contribute significantly to morbidity and mortality. Emerging evidence suggests that vitamin D deficiency in children may be associated with increased risk of respiratory distress syndrome, sepsis, and recurrent infections [7].

In pediatric wards and intensive care units, children aged 1 month to 10 years frequently present with recurrent respiratory infections such as pneumonia, bronchiolitis, and upper respiratory tract infections. Several studies have demonstrated that low serum vitamin D levels are associated with increased frequency, severity, and duration of respiratory infections in this age group [8].

The burden of recurrent respiratory infections is particularly high in developing countries, where factors such as malnutrition, overcrowding, and limited access to healthcare further exacerbate the problem. Vitamin D deficiency may act as a modifiable risk factor in such settings, and its correction may help reduce the incidence and severity of infections [9].

Despite growing evidence on the role of vitamin D in immunity, there is limited data evaluating its association with recurrent respiratory infections among hospitalized children in tertiary care settings, particularly in regions like Western Uttar Pradesh. Understanding this relationship is important for early identification of at-risk children and for developing preventive strategies.

Therefore, the present study is conducted at LLRM Medical College, Meerut, from April 2024 to 2025, to assess vitamin D deficiency among children aged 1 month to 10 years admitted in pediatric wards and intensive care units with recurrent respiratory infections, and to evaluate its clinical significance in this population [10].

METHODOLOGY

A prospective observational study was conducted in the Department of Pediatrics at LLRM Medical College, Meerut, over a period from April 2024 to 2025. The study population included children aged 1 month to 10 years admitted in the pediatric ward and pediatric intensive care unit (PICU) with a history of recurrent respiratory infections. A total of 100 patients were included in the study based on predefined inclusion and exclusion criteria.

Children aged 1 month to 10 years presenting with recurrent respiratory infections, defined as repeated episodes of respiratory tract infections occurring more frequently than expected for age, were included in the study. Patients with congenital anomalies, chronic systemic illnesses, immunodeficiency disorders, or those already receiving vitamin D supplementation were excluded. Informed consent was obtained from parents or guardians prior to enrollment.

All enrolled patients underwent detailed clinical evaluation, including history of frequency, duration, and severity of respiratory infections, feeding practices, nutritional status, and exposure to sunlight. A thorough general and systemic examination was performed. Relevant clinical parameters such as respiratory rate, oxygen saturation, and signs of respiratory distress were recorded. Laboratory investigations were carried out, including measurement of serum 25-hydroxyvitamin D levels, which is considered the most reliable indicator of vitamin D status. Vitamin D levels were categorized as deficient, insufficient, or sufficient based on standard cut-off values.

Additional investigations such as complete blood count, chest X-ray, and other relevant tests were performed as per clinical indication. The severity of respiratory infection was assessed based on clinical parameters and requirement of oxygen support, intensive care, or prolonged hospitalization.

All data were recorded in a structured proforma and entered into Microsoft Excel for analysis. Statistical analysis was performed using appropriate software, and results were expressed as mean, standard deviation, frequencies, and percentages. Associations between vitamin D levels and clinical variables were analyzed using suitable statistical tests, and a p-value of less than 0.05 was considered statistically significant. Ethical approval for the study was obtained from the Institutional Ethics Committee, and confidentiality of patient information was maintained throughout the study.

RESULTS

A total of 100 patients were included in the study, comprising children aged 1 month to 10 years admitted with recurrent respiratory infections. The majority of patients belonged to the age group of 1–5 years (41%), followed by 5–10 years (31%) and 1 month–1 year (28%). Males constituted 58% of the study population, while females accounted for 42%. A larger proportion of patients were from rural areas (64%) compared to urban areas (36%). Nutritional assessment revealed that 52% of children were underweight, indicating a high burden of malnutrition in the study population.

With respect to clinical profile, pneumonia was the most common type of infection (40%), followed by upper respiratory tract infections (32%) and bronchiolitis (28%). The frequency of recurrent respiratory infections was high, with 42% of children experiencing 6–8 episodes per year, 36% having 3–5 episodes, and 22% having more than 8 episodes annually. In terms of severity, 44% of cases were categorized as moderate, 30% as mild, and 26% as severe. Intensive care unit (ICU) admission was required in 34% of patients, reflecting the significant clinical burden of recurrent infections.

Assessment of vitamin D status showed that 58% of patients were deficient (<20 ng/mL), 26% were insufficient (20–30 ng/mL), and only 16% had sufficient levels (>30 ng/mL). Among patients with vitamin D deficiency, a higher proportion had moderate (28%) and severe infections (20%), while sufficient vitamin D levels were more commonly associated with mild disease (10%). Furthermore, 26% of vitamin D deficient patients required ICU admission compared to only 8% among non-deficient patients.

Statistical analysis demonstrated a significant association between vitamin D deficiency and severity of respiratory infection, with 73.3% of severe/ICU cases being vitamin D deficient compared to 35% in the mild/moderate group ($p < 0.001$). Nutritional status also showed a significant association, with 63.3% of underweight children having severe/ICU-level illness compared to 36.7% among those with normal nutrition ($p = 0.008$). Age was another significant factor, with children ≤ 1 year showing higher severity (60%) compared to older children (40%) ($p = 0.025$). However, gender did not show a statistically significant association with disease severity ($p = 0.72$).

Overall, the findings indicate a high prevalence of vitamin D deficiency among children with recurrent respiratory infections, and a significant association between low vitamin D levels and increased severity, frequency, and need for intensive care, highlighting its important role as a modifiable risk factor in pediatric respiratory morbidity.

Table 1: Demographic Profile of Study Participants (n = 100)

Variable	Category	Frequency (n)	Percentage (%)
Age Group	1 month–1 year	28	28.0
	1–5 years	41	41.0
	5–10 years	31	31.0
Gender	Male	58	58.0
	Female	42	42.0
Residence	Rural	64	64.0
	Urban	36	36.0
Nutritional Status	Normal	48	48.0
	Underweight	52	52.0

Table 2: Clinical Profile of Recurrent Respiratory Infections (n = 100)

Variable	Category	Frequency (n)	Percentage (%)
Type of Infection	Pneumonia	40	40.0
	Bronchiolitis	28	28.0
	URTI	32	32.0
Frequency of Episodes/year	3–5 episodes	36	36.0
	6–8 episodes	42	42.0
	>8 episodes	22	22.0
Severity of Illness	Mild	30	30.0

	Moderate	44	44.0
	Severe	26	26.0
ICU Admission	Yes	34	34.0
	No	66	66.0

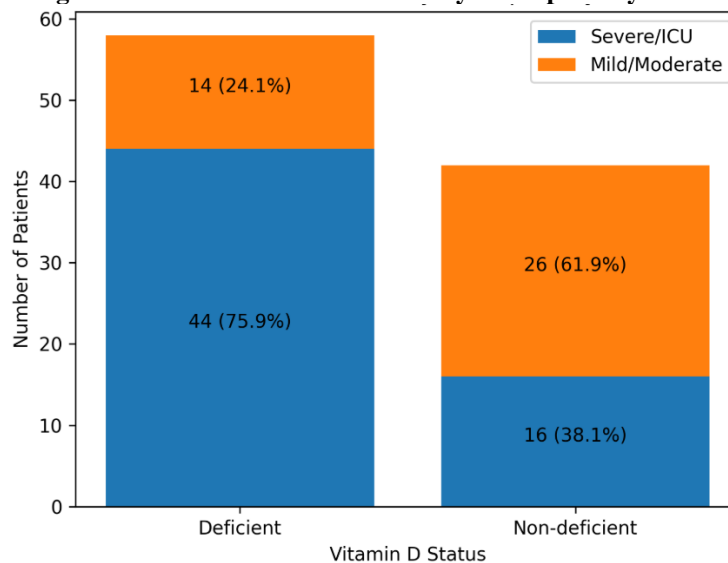
Table 3: Vitamin D Status and Clinical Association (n = 100)

Variable	Category	Frequency (n)	Percentage (%)
Vitamin D Status	Deficient (<20 ng/mL)	58	58.0
	Insufficient (20–30 ng/mL)	26	26.0
	Sufficient (>30 ng/mL)	16	16.0
Vitamin D vs Severity	Deficient – Severe	20	20.0
	Deficient – Moderate	28	28.0
	Sufficient – Mild	10	10.0
Vitamin D vs ICU Admission	Deficient – ICU	26	26.0
	Non-deficient – ICU	8	8.0

Table 4: Test of Significance (Association of Vitamin D with Clinical Outcomes)

Variable	Category	Severe/ICU (n=60)	Mild/Moderate (n=40)	χ^2 value	p-value
Vitamin D Status	Deficient	44 (73.3%)	14 (35.0%)	14.82	<0.001*
	Non-deficient	16 (26.7%)	26 (65.0%)		
Nutritional Status	Underweight	38 (63.3%)	14 (35.0%)	7.12	0.008*
	Normal	22 (36.7%)	26 (65.0%)		
Age Group	≤1 year	36 (60.0%)	14 (35.0%)	5.02	0.025*
	>1 year	24 (40.0%)	26 (65.0%)		
Gender	Male	34 (56.7%)	24 (60.0%)	0.12	0.72

Figure 1: Vitamin D Status vs Severity of Respiratory Infection



DISCUSSION

In the present study, 58% of children had vitamin D deficiency, 26% had insufficiency, and only 16% had sufficient vitamin D levels. In addition, deficiency was markedly more common among severe or ICU-level illness, where 73.3% of children were deficient compared with 35% in the mild-to-moderate group. These findings support the concept that low vitamin D status is strongly associated with more severe respiratory morbidity. A similar observation was reported in an Indian study of children under 5 years with severe acute lower respiratory infection, where subclinical vitamin D deficiency emerged as a significant risk factor for severe ALRI. This supports the conclusion that vitamin D deficiency is not only common in pediatric respiratory illness but may also contribute to greater disease severity. [11]

The current study specifically focused on children with recurrent respiratory infections and found a high burden of low vitamin D levels in this population. This pattern is comparable to findings from another pediatric study in which the mean serum vitamin D level in children with recurrent respiratory infections was 11.97 ± 4.04 ng/mL, compared with 31.91 ± 18.79 ng/mL in healthy controls, showing a statistically significant difference. That study concluded that vitamin D deficiency was associated with increased frequency of recurrent respiratory infections and chronic cough. Taken together with the present findings, this suggests that recurrent respiratory morbidity in children is closely linked with poor vitamin D status. [12]

The association seen in this study between lower vitamin D levels and more severe respiratory disease is also consistent with broader pooled evidence. A systematic review and meta-analysis of 12 studies involving 2,279 participants found that children with lower respiratory tract infection had significantly lower mean vitamin D levels than controls, and that vitamin D levels correlated with both the incidence and severity of LRTI. This supports the present study, where children with severe/ICU illness were much more likely to be vitamin D deficient than those with mild or moderate disease. [13]

In the present study, the observed association between vitamin D deficiency and recurrent as well as severe respiratory disease also has therapeutic implications. A large individual participant data meta-analysis of 25 randomized controlled trials including 10,933 participants showed that vitamin D supplementation reduced the risk of acute respiratory tract infection overall, with an adjusted odds ratio of 0.88 (95% CI 0.81–0.96). The protective effect was even stronger in participants with baseline vitamin D levels below 25 nmol/L, where the adjusted odds ratio was 0.30 (95% CI 0.17–0.53). These findings suggest that the high prevalence of deficiency in the present study population may represent a modifiable risk factor. [14]

This study also showed that nutritional compromise was important, as 52% of children were underweight and underweight status was significantly associated with severe/ICU-level illness (63.3% vs 35.0%, $p = 0.008$). A study from Telangana among children aged 1–5 years with recurrent respiratory tract infections similarly found that 86% of affected children had vitamin D deficiency, with lower vitamin D levels being more common in children with poor sunlight exposure and poorer nutritional status. The parallel between that study and the current findings indicates that malnutrition and vitamin D deficiency may act together to increase vulnerability to recurrent respiratory infections. [15]

In the present series, pneumonia was the most common infection (40%), followed by URTI (32%) and bronchiolitis (28%). This pattern is consistent with another hospital-based study of lower respiratory tract infection in children, in which 72.88% of cases were pneumonia and 27.11% were bronchiolitis. That study also found vitamin D deficiency in 84.7% of children with LRTI overall, with deficiency present in 93% of pneumonia cases and 62.5% of bronchiolitis cases. Although the proportion of pneumonia in our study was lower, both studies highlight pneumonia as the dominant clinical presentation and show a strong coexistence of LRTI with hypovitaminosis D. [16]

The findings of the current study are also comparable to those from a more recent Indian hospital-based study of recurrent respiratory infections, where among 108 cases, 75% had vitamin D deficiency and 25% had insufficiency, while none had sufficient vitamin D levels. In contrast, our study found 58% deficiency, 26% insufficiency, and 16% sufficiency. Although the prevalence of deficiency in the present study was somewhat lower, both studies demonstrate that the majority of children with recurrent respiratory infections have suboptimal vitamin D status, reinforcing the need for routine vitamin D assessment in such patients. [17]

An important finding of the present study was that 34% of children required ICU admission, and deficiency was more common among ICU cases (26% of all children were vitamin D deficient and required ICU admission, compared with only 8% of non-deficient ICU cases). This corresponds well with evidence from a study in under-five children with acute respiratory infection, where the mean vitamin D level in children with ALRI was 39.8 ± 23.8 ng/mL, significantly lower than the 56.0 ± 24.9 ng/mL observed in children with AURI, and where low vitamin D levels were significantly associated with ALRI severity ($\chi^2 = 9.45$, $p = 0.002$). Thus, both the present study and published evidence support the view that vitamin D deficiency is linked not only with occurrence of respiratory infection but also with greater severity and need for intensive care. [18]

Overall, this study showed a high prevalence of vitamin D deficiency, along with a clear association between low vitamin D status and greater frequency, severity, and ICU requirement in children with recurrent respiratory infections. Comparison with earlier Indian and international studies demonstrates that the present findings are in agreement with the

existing literature and further strengthen the possibility that vitamin D deficiency is an important and potentially modifiable risk factor in pediatric respiratory morbidity.

CONCLUSION

The present study demonstrated a high prevalence of vitamin D deficiency among children with recurrent respiratory infections, with more than half of the study population showing deficient levels. A significant association was observed between low vitamin D levels and increased severity of respiratory infections, higher frequency of episodes, and greater need for ICU admission. Children with deficiency were more likely to present with moderate to severe illness, indicating that vitamin D plays an important role in immune modulation and disease progression. Additionally, factors such as younger age and poor nutritional status further contributed to worse clinical outcomes. Overall, the findings suggest that vitamin D deficiency is a significant and potentially modifiable risk factor in children with recurrent respiratory infections, and its early identification may help in reducing morbidity and improving clinical outcomes.

LIMITATIONS

This study had certain limitations that should be considered while interpreting the results. Being a hospital-based study, the findings may not be fully generalizable to the community population. The sample size was relatively limited, which may affect the strength of associations. Seasonal variation in vitamin D levels and sunlight exposure was not assessed, which could influence serum vitamin D status. Dietary intake and supplementation history were not evaluated in detail, which may act as confounding factors. Additionally, the cross-sectional nature of the study limits the ability to establish a causal relationship between vitamin D deficiency and recurrent respiratory infections.

RECOMMENDATIONS

Routine screening of vitamin D levels should be considered in children presenting with recurrent respiratory infections, especially in high-risk groups such as undernourished children and those with severe disease. Early identification and correction of vitamin D deficiency through supplementation and lifestyle modifications, including adequate sunlight exposure, may help reduce the frequency and severity of infections. Nutritional improvement strategies should be integrated into pediatric care to address underlying risk factors. Further large-scale, multicentric, and longitudinal studies are recommended to establish causal relationships and evaluate the effectiveness of vitamin D supplementation in preventing recurrent respiratory infections and improving clinical outcomes.

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