e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(1); 195-198

Original Research Article

Association of Vitamin D Status with Disease Severity in Infants Hospitalized with Bronchiolitis

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Received: 01-10-2025 / Revised: 15-11-2025 / Accepted: 21-12-2025
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Conflict of interest: Nil

Abstract

Background: Vitamin D has immunomodulatory properties and may influence the clinical course of lower respiratory tract infections in infants; however, its association with bronchiolitis severity remains inconsistent.

Objectives: To evaluate the association between serum vitamin D status at hospitalization and disease severity among infants admitted with bronchiolitis.

Methods: In this prospective observational study conducted from January to December 2024 at SMS Medical College, Jaipur, infants aged <12 months hospitalized with bronchiolitis were enrolled. Serum total 25-hydroxyvitamin D [25(OH)D], albumin, and vitamin D–binding protein were measured within 24 hours of admission. Free and bioavailable 25(OH)D concentrations were calculated. Disease severity was assessed by intensive care unit (ICU) admission, need for continuous positive airway pressure (CPAP) or mechanical ventilation, and length of hospital stay. Statistical analyses were performed using SPSS version 25.

Results: A total of 403 infants were included (mean age, 5.8 ± 3.1 months). Vitamin D deficiency and insufficiency were present in 38.5% and 52.9% of infants, respectively. ICU admission was required in 24.3%, CPAP in 19.6%, and mechanical ventilation in 10.4%. Vitamin D status was not significantly associated with ICU admission or the requirement for CPAP. However, lower serum 25(OH)D levels were significantly associated with the need for mechanical ventilation ($p = 0.035$). Total and free 25(OH)D concentrations demonstrated weak but significant negative correlations with duration of hospitalization ($p = 0.004$ and $p = 0.026$, respectively).

Conclusions: Hypovitaminosis D is highly prevalent among Indian infants hospitalized with bronchiolitis. While vitamin D status does not predict ICU admission or CPAP requirement, lower vitamin D levels are associated with prolonged hospitalization and increased need for mechanical ventilation.

Keywords: Bronchiolitis; Vitamin D; 25-Hydroxyvitamin D; Infants; Mechanical Ventilation.

DOI: 10.25258/ijcpr.18.1.30

Introduction

Bronchiolitis is the leading cause of hospitalization in infants worldwide and represents a substantial burden on pediatric healthcare systems, particularly during the first year of life.[1] Respiratory syncytial virus (RSV) is the most common etiologic agent, although a variety of other respiratory viruses also contribute to disease occurrence and severity. [1]

Beyond its established role in calcium and bone metabolism, vitamin D is an important modulator of both innate and adaptive immune responses. It enhances the production of antimicrobial peptides, maintains epithelial barrier integrity, and regulates inflammatory pathways that are critical in respiratory infections. [2] Infants are especially susceptible to vitamin D deficiency due to limited sunlight exposure, maternal vitamin D deficiency, and exclusive breastfeeding without routine supplementation. [3] Previous studies have explored the relationship between vitamin D status and lower respiratory tract infections; however, evidence linking vitamin D levels with bronchiolitis severity has been inconsistent, with limited data from low and middle-income countries. [4,5] Moreover, most studies have focused solely on total 25-hydroxyvitamin D concentrations, despite emerging evidence suggesting that free and bioavailable vitamin D may better reflect the biologically active vitamin D status. [6]

Therefore, this study aimed to evaluate the association between total, free, and bioavailable 25-hydroxyvitamin D levels at the time of hospital admission and disease severity among infants hospitalized with bronchiolitis in North India.

Methods

Study Design and Setting: This prospective observational study was conducted in the Department of Pediatrics at SMS Medical College and its attached hospitals, Jaipur, India, from January to December 2024.

Study Population: Infants aged <12 months admitted with a clinical diagnosis of bronchiolitis were eligible for enrollment.

Inclusion Criteria

- Age <12 months
- Clinical diagnosis of bronchiolitis
- Written informed consent obtained from parents or legal guardians

Exclusion Criteria

- Congenital heart disease
- Chronic lung disease
- Known immunodeficiency
- Prematurity <32 weeks of gestation

Sample Size: Based on the prevalence of intensive care unit (ICU) admission reported in prior studies, [7] the minimum required sample size was calculated to be 366 infants. A total of 403 infants were ultimately enrolled during the study period.

Vitamin D Assessment: Blood samples were obtained within 24 hours of hospital admission. Serum total 25-hydroxyvitamin D [25(OH)D] concentrations were measured using a chemiluminescent immunoassay. Serum albumin and vitamin D–binding protein levels were also measured. Free and bioavailable 25(OH)D concentrations were calculated using the Powe equations. [6]

Vitamin D status was categorized according to standard definitions as deficiency, insufficiency, or sufficiency. [8]

Assessment of Disease Severity

Disease severity was evaluated using the following clinical indicators:

- Requirement for ICU admission
- Need for continuous positive airway pressure (CPAP)
- Requirement for invasive mechanical ventilation
- Duration of hospital stay, categorized as <2 days or ≥2 days

Statistical Analysis

Statistical analysis was performed using SPSS software version 25.0 (IBM Corp., Armonk, NY). Continuous variables were summarized as mean ± standard deviation or median (interquartile range), as appropriate, while categorical variables were expressed as frequencies and percentages. Comparisons between groups were performed using the chi-square test for categorical variables and Student's t-test or Mann–Whitney U test for continuous variables, as appropriate. Correlations between vitamin D levels and duration of hospital stay were assessed using Pearson correlation coefficients. A two-sided p value <0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Ethics Committee of SMS Medical College, Jaipur. Written informed consent was obtained from parents or legal guardians.

Results

Baseline Characteristics: A total of 403 infants hospitalized with bronchiolitis were included in the analysis.

The mean age was 5.8 ± 3.1 months, with a male to female ratio of approximately 1:1. Vitamin D deficiency or insufficiency was present in 91.4% of infants at the time of admission.

Clinical Severity

Overall, 98 infants (24.3%) required admission to the intensive care unit (ICU). Continuous positive airway pressure (CPAP) support was required in 79 infants (19.6%), while 42 infants (10.4%) required invasive mechanical ventilation.

Association between Vitamin D Status and Disease Severity: Vitamin D status was not significantly associated with ICU admission ($p = 0.584$) or CPAP requirement ($p = 0.708$). However, infants who required mechanical ventilation had significantly lower serum 25-hydroxyvitamin D levels compared with those who did not require ventilation ($p = 0.035$), consistent with previous observations. [9]

Vitamin D Levels and Duration of Hospital Stay: Total and free 25-hydroxyvitamin D concentrations demonstrated weak but statistically significant negative correlations with duration of hospital stay (total 25(OH)D: $r = −0.14$, $p = 0.004$; free 25(OH)D: $r = −0.11$, $p = 0.026$), indicating longer hospitalization among infants with lower vitamin D levels. [5]

Table 1: Baseline demographic and clinical characteristics of infants hospitalized with bronchiolitis (n = 403)

Variable	Overall
Age, months, mean ± SD	5.8 ± 3.1
Male sex, n (%)	202 (≈50.1)
Female sex, n (%)	201 (≈49.9)
Vitamin D deficiency (<20 ng/mL), n (%)	155 (38.5)
Vitamin D insufficiency (20–29 ng/mL), n (%)	213 (52.9)
Vitamin D sufficiency (≥30 ng/mL), n (%)	35 (8.6)
Vitamin D deficiency or insufficiency, n (%)	368 (91.4)

Values are expressed as mean ± SD or number (%). Percentages may not total 100 due to rounding.

Table 2: Association between vitamin D status and markers of disease severity

Severity marker	n (%)	P value
ICU admission	98 (24.3)	0.584
CPAP requirement	79 (19.6)	0.708
Mechanical ventilation	42 (10.4)	0.035

p values derived from chi-square or Mann–Whitney U test, as appropriate.

Table 3: Association between vitamin D levels and duration of hospitalization

Vitamin D parameter	Correlation coefficient (r)	P value
Total 25-hydroxyvitamin D	-0.14	0.004
Free 25-hydroxyvitamin D	-0.11	0.026

Correlation assessed using Pearson correlation coefficient

Discussion

In this prospective observational study of infants hospitalized with bronchiolitis, hypovitaminosis D was highly prevalent, with more than 90% of infants demonstrating vitamin D deficiency or insufficiency at admission. While serum vitamin D levels were not associated with ICU admission or the need for CPAP, lower vitamin D concentrations were significantly associated with an increased requirement for mechanical ventilation and longer duration of hospitalization.

The high prevalence of vitamin D deficiency observed in our cohort is consistent with previous reports from India and other low and middle-income countries, where maternal deficiency, limited sun exposure, and lack of routine supplementation contribute substantially to infant vitamin D insufficiency. These findings underscore the widespread burden of hypovitaminosis D among hospitalized infants, particularly those with acute respiratory illnesses.

Prior studies examining the relationship between vitamin D status and bronchiolitis severity have yielded conflicting results. Some investigations have reported an association between low vitamin D levels and increased disease severity, whereas others have found no significant correlation with clinical outcomes such as ICU admission or respiratory support.

In our study, vitamin D status was not associated with ICU admission or CPAP requirement, suggesting that vitamin D deficiency alone may not be a reliable predictor of moderate disease severity. Notably, lower serum 25-hydroxyvitamin D levels were significantly associated with the need for invasive mechanical ventilation. This finding supports a potential role of vitamin D in modulating severe respiratory illness, possibly through its effects on epithelial integrity, innate immune responses, and regulation of inflammatory pathways. However, the observed associations were modest, indicating that vitamin D status likely represents one of multiple factors influencing disease severity.

An important strength of this study is the assessment of free and bioavailable vitamin D in addition to total 25-hydroxyvitamin D. Free and bioavailable fractions are thought to better reflect biologically active vitamin D, yet data evaluating their relationship with clinical outcomes in bronchiolitis are limited. The observed negative correlation between both total and free vitamin D levels and duration of hospitalization suggests that lower biologically available vitamin D may be associated with prolonged disease course.

The findings of this study should be interpreted in the context of its observational design. While associations were identified between lower vitamin D levels and certain markers of severe disease, causality cannot be inferred. Whether vitamin D deficiency contributes directly to more severe bronchiolitis or reflects underlying illness severity remains uncertain.

Limitations

This study has several limitations. First, its observational design precludes causal inference between vitamin D status and bronchiolitis severity. Second, vitamin D levels were measured

only at hospital admission, and changes during the course of illness were not assessed. Third, potential confounders such as maternal vitamin D status, nutritional intake, sunlight exposure, and viral etiology were not systematically evaluated. Finally, as this was a single-center study, the findings may not be generalizable to other settings or populations.

Conclusion

Hypovitaminosis D is highly prevalent among Indian infants hospitalized with bronchiolitis. Although vitamin D status was not associated with ICU admission or CPAP requirement, lower vitamin D levels were associated with prolonged hospitalization and an increased need for mechanical ventilation. These findings suggest that vitamin D deficiency may be linked to more severe disease manifestations; however, larger multicenter studies and interventional trials are needed to clarify its role in disease severity and clinical outcomes.

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