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Original Article

Prevalence of vitamin d deficiency and its association with recurrent respiratory infections in children: a hospital-based cross-sectional observational study.

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Abstract

Background

Vitamin D deficiency is a common pediatric nutritional problem and has been linked to impaired innate immune responses and recurrent respiratory morbidity. Children with inadequate sunlight exposure, poor nutritional status, and repeated respiratory illness require focused assessment of vitamin D status.

Objectives

To estimate the prevalence of vitamin D deficiency among children and to evaluate its association with recurrent respiratory infections

Methods

This hospital-based cross-sectional observational study included 100 children evaluated in the Department of Pediatrics, Government Medical College, Kamareddy, Telangana, India, from February 2025 to January 2026. Demographic and clinical variables, nutritional status, sunlight exposure, respiratory infection profile, hospitalization history, and serum 25-hydroxyvitamin D [25(OH)D] levels were recorded. Vitamin D deficiency was defined as serum 25(OH)D <20 ng/mL. Categorical associations were examined using Chi-square tests, and crude odds ratios (ORs) with 95% confidence intervals (CIs) were estimated; no multivariable adjustment was performed.

Results

The mean age was 7.8 +/- 3.4 years, and 56.0% were males. The mean serum vitamin D level was 18.6 +/- 7.4 ng/mL. Vitamin D deficiency was present in 62.0% of children, while recurrent respiratory infections (RRIs) were documented in 51.0%. RRIs occurred in 64.5% of vitamin D-deficient children compared with 28.9% of non-deficient children. Vitamin D deficiency was associated with higher odds of RRI (crude OR 4.46, 95% CI 1.86-10.68; p=0.001). The distribution of RRI differed significantly across vitamin D categories (Pearson chi-square=14.21, df=3; p=0.003). Low sunlight exposure and underweight status were also significantly associated with RRI in crude analyses.

Conclusion

Vitamin D deficiency was highly prevalent among children and showed a significant association with recurrent respiratory infections.

Recommendations

Routine nutritional assessment, sunlight exposure counselling, and targeted vitamin D screening should be considered in children with recurrent respiratory morbidity.

Keywords: *Vitamin D deficiency; recurrent respiratory infections; children; 25-hydroxyvitamin D; sunlight exposure; nutritional status.*
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Introduction

Vitamin D is an essential secosteroid hormone with recognized skeletal and extra-skeletal roles in childhood. Its biological activity extends beyond calcium homeostasis and bone mineralization, as vitamin D receptors are present in several immune cells, including monocytes, macrophages, dendritic cells, and lymphocytes. Through these pathways, vitamin D influences antimicrobial peptide expression, epithelial barrier function, cytokine regulation, and the balance between inflammatory and regulatory immune responses. Deficiency during childhood is therefore clinically relevant not only for rickets and impaired growth, but also for infection susceptibility and repeated respiratory morbidity [1,2].

India continues to report a substantial burden of vitamin D deficiency despite abundant sunlight. Contributing factors include indoor lifestyle, academic routines that reduce outdoor exposure, air pollution, darker skin pigmentation, cultural clothing practices, low dietary intake of vitamin D-rich foods, and limited fortification. National and hospital-based studies from India have shown variable but important levels of deficiency among children and adolescents, with prevalence influenced by age, geography, season, socioeconomic background, and sunlight behavior [3-5]. These findings support the need for local institutional data, especially from pediatric outpatient and inpatient settings where recurrent infections are frequently encountered.

Respiratory tract infections are among the most common causes of pediatric morbidity and health-care utilization. A subset of children experience recurrent upper respiratory infections, repeated lower respiratory tract infections, wheezing-associated illness, school absenteeism, repeated antibiotic use, and occasional hospitalization. Although viral exposure, crowding, malnutrition, allergic airway disease, passive smoke exposure, and immune disorders contribute to recurrence, nutritional deficiencies are increasingly recognized as modifiable risk factors. Observational studies from India and other countries have reported lower serum 25-hydroxyvitamin D levels in children with acute lower respiratory infections and recurrent respiratory symptoms [6-10].

The association between vitamin D and respiratory infections is biologically plausible and clinically important, but published evidence remains heterogeneous. Systematic reviews and supplementation trials suggest a protective effect in some populations, particularly among children with low baseline vitamin D levels, although benefit varies according to dosing pattern, baseline status, age, and setting [11-14]. Therefore, institution-based observational studies remain useful for defining local prevalence and identifying children who require closer nutritional and respiratory evaluation.

The present study was conducted to estimate the prevalence of vitamin D deficiency among children attending Government Medical College, Kamareddy, Telangana, India, and to assess its association with recurrent respiratory infections. The study also aimed to describe the clinical pattern of respiratory infections and evaluate selected associated factors, including sunlight exposure, nutritional status, residence, and sex.

Methodology

Study design and setting

This hospital-based cross-sectional observational study was conducted in the Department of Pediatrics, Government Medical College, Kamareddy, Telangana, India, over 12 months from February 2025 to January 2026. Government Medical College, Kamareddy is a government teaching institution located at Devanpally Village in Kamareddy district and is linked to the Government General Hospital, Kamareddy. The attached hospital is a several-hundred-bed public teaching facility (approximately 330 beds) that provides outpatient, inpatient, emergency, pediatric, general medical, surgical, obstetric and gynecological, ENT, diagnostic, and supportive clinical services. It functions as an important referral facility for Kamareddy town and surrounding rural and semi-urban communities of the district, providing a mixed pediatric catchment suitable for evaluating nutritional and respiratory morbidity.

Participants and sampling

The study population comprised children aged up to 15 years evaluated in the Department of Pediatrics during the study period who satisfied the eligibility criteria and had the required clinical and biochemical information. A total of 100 children were included in the final analysis.

Study size

For a single-proportion cross-sectional study, the minimum sample size was estimated using n = Z^2 p(1-p)/d^2, where Z=1.96 for a 95% confidence level, p is the expected prevalence, and d is the absolute precision. Because the source manuscript did not record a prior local prevalence used in the original protocol, a conservative prevalence of 50% and an absolute precision of 10% provide n = (1.96)^2 x 0.50 x 0.50/(0.10)^2 = 96.04. Rounding upward and allowing a small operational margin yielded a target of 100 children. These assumptions should be verified against the original study protocol before final submission.

Inclusion and exclusion criteria

Children aged up to 15 years were included when complete demographic, clinical, and biochemical information was available. Children receiving high-dose vitamin D therapy before assessment, children with chronic renal disease, chronic liver disease, known malabsorption syndrome, long-term anticonvulsant therapy, diagnosed primary immunodeficiency, or incomplete records were excluded to reduce confounding in vitamin D interpretation.

Study variables

The recorded variables included age, sex, residence, nutritional status, sunlight exposure, serum 25-hydroxyvitamin D concentration, presence or absence of recurrent respiratory infections, type of respiratory infection, wheezing-associated respiratory illness, and hospitalization history. Recurrent respiratory infections were recorded when repeated physician-diagnosed upper or lower respiratory episodes were documented or when the history was consistent with repeated respiratory illness requiring medical attention.

Data sources and measurement

Age, sex, residence, respiratory infection history, wheezing-associated illness, hospitalization history, nutritional assessment, and sunlight-exposure information were obtained from the pediatric clinical record and the documented caregiver/clinical history available at evaluation. Recurrent respiratory infection was identified from repeated physician-diagnosed upper or lower respiratory episodes or a documented history of repeated respiratory illness requiring medical attention. Serum 25(OH)D values were obtained from laboratory reports and categorized using the thresholds specified below. Nutritional status was taken from the documented anthropometric assessment. Low sunlight exposure was recorded as documented in the clinical assessment.

Vitamin D assessment

Serum 25-hydroxyvitamin D was used for vitamin D status assessment because it reflects body vitamin D stores and is the accepted biochemical marker in clinical and epidemiological studies [1,2]. For analysis, severe deficiency was defined as <10 ng/mL, deficiency as 10-19 ng/mL, insufficiency as 20-29 ng/mL, and sufficiency as >=30 ng/mL. Total vitamin D deficiency was defined as serum 25-hydroxyvitamin D <20 ng/mL.

Bias control

Potential selection bias was addressed by applying the same prespecified eligibility criteria to children considered for inclusion during the study period; the exact sampling approach should be confirmed as noted above. Information bias was reduced by using a biochemical marker, serum 25(OH)D, for vitamin D classification and by applying uniform vitamin D cut-offs to all participants. The same clinical definition of recurrent respiratory infection was used throughout the analysis. Exclusion of children with chronic renal or liver disease, malabsorption, long-term anticonvulsant therapy, primary immunodeficiency, or prior high-dose vitamin D therapy reduced major sources of confounding in interpretation of vitamin D status. However, the reported ORs were crude and residual confounding by unmeasured factors such as diet, socioeconomic status, passive smoke exposure, and season cannot be excluded.

Statistical analysis

Data were summarized using descriptive and inferential statistics. Continuous variables were reported as mean +/- standard deviation, and categorical variables as frequency and percentage. The association between the four vitamin D-status categories and RRI was tested using the Pearson Chi-square test. For binary associated factors in Table 5, 2 x 2 contingency tables were evaluated using Chi-square tests with Yates continuity correction, consistent with the displayed p-values. Crude (unadjusted) ORs and 95% CIs were calculated directly from the 2 x 2 tables. No multivariable logistic-regression model was performed; therefore, no adjusted ORs are reported. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Ethical considerations

The study was conducted after approval from the Institutional Ethics Committee of Government Medical College, Kamareddy, Telangana, India. Confidentiality was maintained, and data were anonymized before analysis. The study involved observation of routinely collected clinical and laboratory variables without additional interventional procedures, and patient information was used strictly for research purposes in accordance with institutional ethical requirements.

Results

A total of 100 children were included in the study. The mean age of the study population was 7.8 ± 3.4 years. The largest proportion of children belonged to the 6–10-year age group (48.0%). Males constituted 56.0% of the study population, while 64.0% were from rural areas. Underweight nutritional status was recorded in 32.0% of children (Table 1).

Table 1: *Baseline demographic profile of the study population*

Characteristic	Value
Total children	100 (100.0%)
Age, years, mean ± SD	7.8 ± 3.4
Age <5 years	24 (24.0%)
Age 6–10 years	48 (48.0%)
Age 11–15 years	28 (28.0%)
Male	56 (56.0%)
Female	44 (44.0%)
Rural residence	64 (64.0%)
Urban residence	36 (36.0%)
Normal nutritional status	58 (58.0%)
Underweight	32 (32.0%)
Overweight	10 (10.0%)

Note. Data are presented as n (%) unless otherwise indicated. SD = standard deviation.

The mean serum 25-hydroxyvitamin D [25(OH)D] level was 18.6 ± 7.4 ng/mL. Vitamin D deficiency, defined as serum 25(OH)D <20 ng/mL, was present in 62 children, corresponding to a prevalence of 62.0%. Vitamin D insufficiency was identified in 24.0%, whereas only 14.0% of children had sufficient vitamin D levels. The distribution of vitamin D status is shown in Table 2.

Table 2 *Distribution of serum vitamin D status*

Vitamin D status	Serum 25(OH)D level	n	%
Severe deficiency	<10 ng/mL	18	18.0
Deficiency	10–19 ng/mL	44	44.0
Insufficiency	20–29 ng/mL	24	24.0
Sufficiency	≥30 ng/mL	14	14.0
Total vitamin D deficiency	<20 ng/mL	62	62.0

Note. 25(OH)D = 25-hydroxyvitamin D.

Recurrent respiratory infections (RRI) were observed in 51 children, yielding a prevalence of 51.0%. Recurrent upper respiratory tract infection was the most frequently documented pattern (32.0%), followed by wheezing-associated respiratory illness (18.0%) and recurrent lower respiratory tract infection (14.0%). A history of hospitalization for respiratory illness was reported in 12.0% of children. Low sunlight exposure was recorded in 46.0% of the study population (Table 3).

Table 3: *Clinical profile of respiratory infections*

Clinical variable	n	%
Recurrent respiratory infections present	51	51.0
Recurrent respiratory infections absent	49	49.0
Recurrent upper respiratory tract infection	32	32.0
Recurrent lower respiratory tract infection	14	14.0
Wheezing-associated respiratory illness	18	18.0
History of hospitalization for respiratory illness	12	12.0
Low sunlight exposure	46	46.0

A higher proportion of RRI was observed among children with lower vitamin D status. Among the 62 children with vitamin D deficiency, 40 (64.5%) had RRI; in comparison, RRI was present in 11 of 38 children (28.9%) without vitamin D deficiency. Across the four vitamin D categories, the frequency of RRI declined from 77.8% in severe deficiency to 21.4% in vitamin D sufficiency. The overall association between vitamin D status and RRI was statistically significant (Pearson $\chi^2 = 14.21$, df = 3, $p = 0.003$) (Table 4).

Table 4 *Association between vitamin D status and recurrent respiratory infections*

Vitamin D status	Total, n	RRI present, n	RRI absent, n	RRI, %
Severe deficiency	18	14	4	77.8
Deficiency	44	26	18	59.1
Insufficiency	24	8	16	33.3
Sufficiency	14	3	11	21.4
Total	100	51	49	51.0

Note. RRI = recurrent respiratory infections. Pearson chi-square test across the four vitamin D-status categories: $\chi^2 = 14.21$, df = 3, $p = 0.003$.

Children with RRI had a lower mean serum vitamin D level than children without RRI (15.8 ± 6.4 ng/mL vs. 21.5 ± 7.2 ng/mL). In univariable 2 × 2 analyses, vitamin D deficiency, low sunlight exposure, and underweight nutritional status were significantly associated with RRI. The odds ratios presented in Table 5 are crude (unadjusted) estimates because no multivariable regression model was performed.

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Table 5: *Factors associated with recurrent respiratory infections*

Factor	RRI present, n	RRI absent, n	Crude OR	95% CI	p value
Vitamin D deficiency	40	22	4.46	1.86–10.68	0.001
Low sunlight exposure	30	16	2.95	1.30–6.67	0.015
Underweight nutritional status	22	10	2.96	1.22–7.20	0.026
Rural residence	37	27	2.15	0.94–4.96	0.108
Male sex	30	26	1.26	0.57–2.79	0.705

Note. OR = odds ratio; CI = confidence interval; RRI = recurrent respiratory infections. ORs are crude (unadjusted) estimates. p values for binary factors were obtained using chi-square tests with Yates continuity correction.

Overall, vitamin D deficiency was common (62.0%), and RRI affected 51.0% of the study population. Children with vitamin D deficiency had approximately 4.5-fold higher crude odds of RRI than children without vitamin D deficiency (crude OR = 4.46, 95% CI 1.86–10.68). Low sunlight exposure (crude OR = 2.95, 95% CI 1.30–6.67) and underweight nutritional status (crude OR = 2.96, 95% CI 1.22–7.20) were also significantly associated with RRI. These findings represent unadjusted associations and should not be interpreted as independent effects.

Discussion

The present study identified three principal findings. First, vitamin D deficiency, defined as serum 25(OH)D <20 ng/mL, was present in 62.0% of the 100 children, with a mean serum vitamin D level of 18.6 +/- 7.4 ng/mL. Second, RRI was documented in 51.0% of participants. Third, RRI was substantially more frequent among vitamin D-deficient children (40/62; 64.5%) than among non-deficient children (11/38; 28.9%), corresponding to a crude OR of 4.46 (95% CI 1.86-10.68). The proportion with RRI also declined across vitamin D categories, from 77.8% in severe deficiency to 21.4% in sufficiency (Pearson chi-square=14.21, df=3; p=0.003).

These findings suggest that poorer vitamin D status is associated with a greater burden of recurrent respiratory morbidity in this pediatric clinical population. The gradient across vitamin D categories strengthens the interpretation of a biologically coherent association, although the cross-sectional design cannot establish temporal sequence or causality. The ORs in this study are crude estimates; therefore, vitamin D deficiency should be interpreted as an associated marker rather than an independently proven risk factor after adjustment for nutrition, season, socioeconomic status, crowding, passive smoke exposure, or other respiratory determinants.

The observed association is broadly consistent with earlier pediatric studies. Wayse et al. reported an association between subclinical vitamin D deficiency and severe acute lower respiratory infection in Indian children [6]. McNally et al. and Roth et al. likewise described lower vitamin D status in young children with serious lower respiratory infections [7,8]. In children with recurrent respiratory morbidity, Dabrowska-Leonik et al. reported vitamin D deficiency among children with recurrent respiratory infections, including those with and without immunoglobulin deficiency [9], while Ozdemir et al. found lower vitamin D concentrations in children with recurrent respiratory infections and chronic cough [10]. Jaybhaye et al. also documented a substantial burden of vitamin D deficiency among children with recurrent respiratory infections [11]. Differences in prevalence across studies may reflect variation in age distribution, season, latitude, nutritional status, laboratory thresholds, and referral patterns.

Several mechanisms may explain the present findings. Vitamin D influences innate and adaptive immunity through vitamin D receptors expressed on immune cells, supports epithelial barrier integrity, and promotes antimicrobial peptide responses. Deficiency may therefore weaken mucosal defense and increase susceptibility to repeated viral or bacterial respiratory illness. In the current dataset, low sunlight exposure was associated with RRI (crude OR 2.95, 95% CI 1.30-6.67), which is compatible with reduced cutaneous vitamin D synthesis as one pathway linking lifestyle and vitamin D status. Underweight children also had higher crude odds of RRI (OR 2.96, 95% CI 1.22-7.20), suggesting that broader nutritional vulnerability may coexist with vitamin D deficiency and contribute to recurrent infection risk.

The findings also agree with systematic evidence linking vitamin D deficiency with pediatric lower respiratory tract infection [12]. However, association does not automatically imply that supplementation will prevent recurrent infections in every child. Meta-analyses of supplementation trials have shown modest or context-dependent protection against acute respiratory infections, with benefits influenced by baseline vitamin D status and dosing regimen [13,14]. Accordingly, the present results support targeted assessment of vitamin D and nutritional risk in children with repeated respiratory morbidity, while therapeutic decisions should continue to follow pediatric guidelines rather than rely on observational associations alone.

Generalizability is greatest to similar government teaching hospitals and tertiary-care pediatric settings serving mixed rural and urban populations in Telangana and comparable regions. The single-center sample of 100 children limits precision for population-level prevalence estimates. In addition, the cross-sectional design, crude rather than adjusted ORs, incomplete measurement of dietary vitamin D intake, seasonal exposure, passive smoke exposure, socioeconomic status, and detailed infection frequency leave potential residual confounding. Larger multicenter studies with standardized exposure definitions and multivariable analyses are needed to determine whether vitamin D deficiency independently predicts recurrent respiratory morbidity.

Conclusion

This study showed that vitamin D deficiency was highly prevalent among children, affecting 62.0% of the study population. Recurrent respiratory infections were documented in 51.0% of children and were significantly more common among those with vitamin D deficiency. Children with deficient vitamin D levels had approximately 4.5 times higher odds of recurrent respiratory infections compared with non-deficient children. Low sunlight exposure and underweight nutritional status were also significantly associated with recurrent respiratory morbidity. These findings indicate that vitamin D assessment should be considered during clinical evaluation of children with repeated respiratory infections, especially when nutritional risk factors or poor sunlight exposure are present.

Limitations

This study was conducted in a single institution with a sample size of 100 children, limiting external validity. Seasonal variation, dietary vitamin D intake, passive smoke exposure, socioeconomic status, and detailed infection frequency were not fully quantified. The cross-sectional design identifies association but does not establish temporal sequence or causality. The reported ORs were crude and were not adjusted in a multivariable model, so residual confounding is possible. Longitudinal follow-up after correction of vitamin D deficiency was not included. These constraints should guide interpretation and future multicenter research.

Recommendations

Children with recurrent respiratory infections should undergo structured nutritional assessment, including evaluation of vitamin D status when clinical risk factors are present. Counselling on safe sunlight exposure, balanced diet, adequate protein intake, and correction of undernutrition should be included in routine pediatric care. Vitamin D supplementation should follow standard pediatric guidance and avoid unsupervised high-dose therapy. Schools and community health programs can promote outdoor activity and nutrition education. Larger multicentric studies with seasonal assessment, dietary analysis, and follow-up after correction of deficiency are recommended to clarify the preventive value of vitamin D optimization in recurrent respiratory morbidity and guide locally applicable prevention strategies.

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Abbreviations

ALRI - Acute lower respiratory infection
ARI - Acute respiratory infection
CI - Confidence interval
LRTI - Lower respiratory tract infection
OR - Odds ratio
RRI - Recurrent respiratory infection
RTI - Respiratory tract infection
URTI - Upper respiratory tract infection
VDD - Vitamin D deficiency
25(OH)D - 25-hydroxyvitamin D

Conflict of Interest

None declared.

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Author Contributions

Dr. Dharavath Devendar contributed to the conception and design of the work, literature review, clinical interpretation, manuscript drafting, and critical revision of the article for important intellectual content. **Dr. Muthyapu Shravan** contributed to study planning, data interpretation, manuscript preparation, literature review, and final editing of the manuscript.

Dr Naga Nayak.J contributed to data interpretation, manuscript preparation, literature review, and final editing of the manuscript

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