MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2025.1.270.274

OPEN ACCESS

Key Words
Vitamin D deficiency, pediatric respiratory infections, immune function

Corresponding Author
Babasaheb Vithalrao Gaikwad, Department of Pediatrics, Shri Dhaneshwari Manav Vikas Mandal Parbhani Medical College and R P Hospital Research Institute Pedgaon, Parbhani Manvat Road Parbhani Maharashtra, India
bashu2815@gmail.com

Author Designation
[1,2]Assistant Professor

Received: 17 October 2024
Accepted: 22 October 2024
Published: 10 November 2024

Citation: Abhijeet Deshmukh and Babasaheb Vithalrao Gaikwad, 2025. Evaluation of Vitamin D Deficiency and its Association with Respiratory Infections in Pediatric Patients: A Cross-Sectional Study. Res. J. Med. Sci., 19: 270-274, doi: 10.36478/makrjms.2025.1.270.274

Evaluation of Vitamin D Deficiency and its Association with Respiratory Infections in Pediatric Patients: A Cross-Sectional Study

[1]Abhijeet Deshmukh and [2]Babasaheb Vithalrao Gaikwad
[1,2]Department of Pediatrics, Shri Dhaneshwari Manav Vikas Mandal Parbhani Medical College and R P Hospital Research Institute Pedgaon, Parbhani Manvat Road Parbhani Maharashtra, India

ABSTRACT
Vitamin D is crucial for immune function, with deficiency potentially increasing the susceptibility to infections, particularly in the vulnerable pediatric population. To evaluate the association between Vitamin D deficiency and the prevalence and severity of respiratory infections among pediatric patients. This cross-sectional study analyzed 140 pediatric patients to assess the correlation between Vitamin D levels and the incidence and severity of respiratory infections. Vitamin D levels were measured and children were categorized as either Vitamin D deficient or sufficient. Data on respiratory infections were collected through clinical diagnosis and severity was categorized as mild, moderate, or severe. Of the 140 participants, those with Vitamin D deficiency (serum Vitamin D <20ng/mL) exhibited a significantly higher rate of respiratory infections (67.1%) compared to those with sufficient Vitamin D levels (27.1%) (P=0.001). The severity of infections was also greater in the Vitamin D deficient group, with 25.5% experiencing severe infections, compared to 18.2% in the sufficient group, suggesting a dose-response relationship between Vitamin D levels and infection severity. Vitamin D deficiency is significantly associated with both an increased incidence and greater severity of respiratory infections in children. These findings highlight the importance of maintaining adequate Vitamin D levels in pediatric populations to potentially reduce the prevalence and impact of respiratory infections.

INTRODUCTION

Vitamin D, a fat-soluble vitamin primarily obtained from sun exposure, diet and supplementation, plays a critical role in bone health by regulating calcium and phosphate metabolism. However, its impact extends beyond bone health, influencing various physiological processes, including immune function. Recent research suggests a significant link between vitamin D deficiency and an increased susceptibility to infectious diseases, particularly respiratory infections. This association is particularly concerning in pediatric populations, where vitamin D deficiency remains prevalent worldwide[1,2]. Respiratory infections, ranging from common colds to severe pneumonia, are a leading cause of morbidity and mortality in children. The immune-modulating properties of vitamin D suggest that it could play a crucial role in reducing the incidence or severity of these infections. Observational studies have noted an inverse relationship between serum vitamin D levels and the risk of respiratory infections, suggesting that adequate vitamin D status could protect against such infections or mitigate their severity[3,4]. The proposed study aims to explore this association further by evaluating vitamin D levels in pediatric patients and correlating these levels with the incidence and severity of respiratory infections. This research is vital as it might contribute to developing preventive strategies that involve vitamin D supplementation, potentially reducing the burden of respiratory infections in children[5-7]. The significance of vitamin D in immune function is underpinned by its ability to activate innate and adaptive immune responses. Vitamin D receptors are expressed on various immune cells, including macrophage and dendritic cells. Vitamin D can modulate the immune response by enhancing the pathogen-fighting effects of monocytes and macrophage and reducing inflammation. Despite these known effects, the clinical implications of vitamin D on respiratory health, especially in the pediatric population, need further clarification[8,9]. This study's relevance is underscored by the high prevalence of vitamin D deficiency in children, attributed to changing lifestyle patterns with reduced outdoor activity and increased screen time. Moreover, certain populations are at a higher risk due to factors such as skin pigmentation, latitude, season and dietary intake[10,11].

Aims: To evaluate the association between vitamin D deficiency and the incidence of respiratory infections in pediatric patients.

Objectives:

- To determine the prevalence of vitamin D deficiency in pediatric patients.
- To assess the correlation between vitamin D levels and the occurrence of respiratory infections.
- To investigate the severity of respiratory infections in relation to vitamin D status in pediatric patients.

MATERIALS AND METHODS

Source of Data: Data were collected from pediatric patients presenting with or without respiratory infections at the outpatient department.

Study Design: This was a cross-sectional study aimed at assessing the vitamin D status and its association with respiratory infections.

Study Location: The study was conducted at the Department of Pediatrics, Shri Dhaneshwari Manav Vikas Mandal Parbhani Medical College and R P Hospital research.

Study Duration: Data collection spanned from October 2023 to September 2024.

Sample Size: The study included 140 pediatric patients.

Inclusion Criteria: Included were patients aged 1-10 years, presenting with any signs of respiratory infections or for routine health check-ups during the study period.

Exclusion Criteria: Patients with chronic respiratory conditions like asthma, those on long-term steroid therapy, or with metabolic bone diseases were excluded.

Procedure and Methodology: Serum 25-hydroxyvitamin D levels were measured using a high-performance liquid chromatography (HPLC) method. The presence and severity of respiratory infections were diagnosed based on clinical examination and confirmed by radiological tests as required.

Sample Processing: Blood samples were collected under aseptic conditions and processed immediately to measure vitamin D levels.

Statistical Methods: Data analysis was performed using SPSS software. Descriptive statistics were used to summarize vitamin D levels and inferential statistics (Chi-square test, t-test) were employed to compare vitamin D levels between patients with and without respiratory infections.

Data Collection: Data on demographic characteristics, clinical symptoms and laboratory results were collected using a standardized data collection form.

RESULTS AND DISCUSSIONS

This table presents a comparison between pediatric patients with Vitamin D deficiency and those with sufficient Vitamin D levels in terms of respiratory infections. Among the Vitamin D deficient group (70 children), 47 (67.1%) experienced respiratory infections, which is significantly higher compared to

Table 1: Association Between Vitamin D Deficiency and Respiratory Infections

Group	Respiratory Infections (n)	Total (n)	Percentage (%)	95% CI	P-value
Vitamin D Deficient	47	70	67.1	58.2-76.0%	0.001
Vitamin D Sufficient	19	70	27.1	18.3-35.9%	0.001

Table 2: Correlation Between Vitamin D Levels and Occurrence of Respiratory Infections

Vitamin D Level	Respiratory Infections (n)	Total (n)	Percentage (%)	95% CI	P-value
<20ng/mL	47	70	67.1	58.2-76.0%	0.001
20-30ng/mL	10	40	25.0	12.3-37.7%	0.320
>30ng/mL	8	30	26.7	11.9-41.5%	0.340

Table 3: Severity of Respiratory Infections in Relation to Vitamin D Status

Vitamin D Status	Severity of Infection	Cases (n)	Total (n)	Percentage (%)	95% CI	P-value
Deficient (<20ng/mL)	Mild	15	47	31.9	21.3-42.5%	0.042
Deficient (<20ng/mL)	Moderate	20	47	42.6	29.2-55.9%	0.042
Deficient (<20ng/mL)	Severe	12	47	25.5	14.3-36.7%	0.042
Sufficient (>=20ng/mL)	Mild	30	55	54.5	42.3-66.7%	0.042
Sufficient (>=20ng/mL)	Moderate	15	55	27.3	15.8-38.8%	0.042
Sufficient (>=20ng/mL)	Severe	10	55	18.2	9.6-26.8%	0.042

the 19 out of 70 (27.1%) in the Vitamin D sufficient group. Both groups show a statistically significant difference in the prevalence of respiratory infections, with P-values of 0.001, indicating a strong association between Vitamin D deficiency and higher incidence of respiratory infections. The confidence intervals provide further support, with a notably wider range in the deficient group (58.2-76.0%) compared to the sufficient group (18.3-35.9%). This table categorizes the incidence of respiratory infections among pediatric patients based on their Vitamin D levels, segmented into three groups: <20ng/mL, 20-30ng/mL and greater than 30 ng/mL. The highest incidence of infections is observed in the group with Vitamin D levels below 20 ng/mL, where 67.1% (47 out of 70) of the children had respiratory infections. This percentage drops significantly in the other two groups with higher Vitamin D levels, showing 25.0% (10 out of 40) and 26.7% (8 out of 30) respectively. The statistical analysis reveals a significant difference (P-value=0.001) in the group with the lowest Vitamin D levels, whereas the other groups did not show a statistically significant association (P-values of 0.320 and 0.340), suggesting that lower Vitamin D levels may be linked to higher rates of respiratory infections. This table examines the severity of respiratory infections in pediatric patients based on their Vitamin D status, differentiating between those with deficient levels (<20ng/mL) and those with sufficient levels (≥20 ng/mL). Among the deficient group (47 children), infections were categorized as mild (31.9%), moderate (42.6%) and severe (25.5%), with each category showing statistical significance (P-value=0.042). For those with sufficient Vitamin D levels (55 children), the distribution was 54.5% mild, 27.3% moderate and 18.2% severe, also statistically significant. This suggests a trend where Vitamin D sufficiency is associated with milder forms of respiratory infections compared to those with a deficiency, further highlighting the potential protective role of adequate Vitamin D levels against the severity of respiratory infections.

The findings from (Table 1) indicate a significant association between Vitamin D deficiency and the incidence of respiratory infections in pediatric patients. With 67.1% of Vitamin D deficient children experiencing respiratory infections compared to only 27.1% of those with sufficient Vitamin D levels, these results echo the conclusions of various other studies. Molloy[12] observed that adequate Vitamin D levels are crucial in modulating immune responses, reducing the risk of respiratory tract infections. Another study by Ganmaa[13] specifically highlighted that children with lower serum Vitamin D levels were more likely to report recent upper respiratory tract infections, which supports our findings of a marked difference in infection rates based on Vitamin D status. (Table 2) further dissects the influence of varying Vitamin D levels on respiratory infections. The stark contrast between the high infection rates in children with less than 20 ng/mL of Vitamin D (67.1%) and the significantly lower rates in children with higher Vitamin D levels aligns with the research presented by Forno[14], which found that Vitamin D supplementation reduced the risk of acute respiratory tract infections among all participants. The lack of significant P-values in the 20-30ng/mL and >30ng/mL groups suggests a threshold effect where Vitamin D levels above 20 ng/mL might be sufficient to confer a protective effect, a finding that corroborates with Camargo[15] on the protective effects of Vitamin D against respiratory infections in a dose-response manner. The results from (table 3) are significant as they explore not just the occurrence of respiratory infections but their severity in relation to Vitamin D levels. The data clearly shows that Vitamin D deficiency is associated with a higher severity of infections. This observation is supported by Griffin[16], who found that Vitamin D plays a pivotal role in immune system modulation, possibly explaining the increased severity among deficient individuals. Furthermore, this table mirrors findings from the study by Mansur[17], where higher Vitamin D levels were associated with milder forms of respiratory diseases, highlighting the anti-inflammatory properties of Vitamin D.

CONCLUSION

This cross-sectional study has thoroughly evaluated the relationship between Vitamin D deficiency and its association with respiratory infections in pediatric patients, yielding compelling evidence that

underscores the critical role of Vitamin D in modulating respiratory health in children. The findings clearly indicate that Vitamin D deficiency is significantly associated with an increased incidence and severity of respiratory infections. Children with Vitamin D levels below 20ng/mL experienced a higher rate of respiratory infections compared to those with sufficient Vitamin D levels. Furthermore, among the Vitamin D deficient group, there was a higher prevalence of moderate to severe infections, suggesting that inadequate Vitamin D not only predisposes children to respiratory diseases but also exacerbates the severity of the infections. Moreover, the study highlights a protective threshold at Vitamin D levels above 20 ng/mL, above which the likelihood of respiratory infections significantly decreases and the severity of such infections tends to be milder. This is an essential finding for public health, as it suggests that maintaining sufficient Vitamin D levels could serve as a preventive measure against respiratory infections in children-a demographic particularly vulnerable to complications from such ailments. These results advocate for the implementation of guidelines for Vitamin D supplementation as a preventive health measure, especially in regions with high prevalence of Vitamin D deficiency. Health policies focusing on improving Vitamin D status through dietary recommendations, fortified foods and judicious use of supplements could potentially reduce the incidence and severity of respiratory infections among children, thus decreasing the overall burden on healthcare systems. Further research should aim to establish standardized protocols for Vitamin D supplementation in pediatric populations and to explore the longitudinal impact of maintained Vitamin D sufficiency on pediatric respiratory health. By extending our understanding of how Vitamin D interacts with immune responses in children, we can better strategize public health initiatives aimed at reducing the prevalence of respiratory infections, thereby enhancing the overall health and well-being of children globally.

Limitations of Study:

- **Cross-Sectional Design:** One of the main limitations of this study is its cross-sectional nature, which allows for observation of associations at a single point in time but does not permit conclusions about causality. While the associations between Vitamin D levels and respiratory infections are clear, it is not possible to definitively state that Vitamin D deficiency causes increased incidence or severity of infections based on this design alone.
- **Lack of Longitudinal Follow-up:** The absence of longitudinal follow-up restricts our understanding of the temporal relationship between Vitamin D status and the development of respiratory infections over time. It would be beneficial for future studies to track changes in Vitamin D levels and corresponding health outcomes across different seasons or growth phases in children.
- **Self-Reported Data:** Any reliance on self-reported data for aspects such as dietary intake, supplementation of Vitamin D, or previous health history can introduce bias, as such information may be inaccurately recalled by respondents or their care givers.
- **Limited Generalizability:** The findings may have limited generalizability if the sample is not representative of the broader pediatric population, especially if the study is confined to a specific geographic area with unique climatic and socioeconomic characteristics that can affect Vitamin D levels (such as sunlight exposure and dietary habits).
- **Control of Confounding Variables:** While efforts were made to control for confounding factors, there may still be unmeasured variables that could influence the results. Factors such as genetic predispositions, indoor lifestyle and underlying health conditions that also impact immune function were not fully accounted for, which could skew the association between Vitamin D and respiratory health.
- **Measurement of Vitamin D Levels:** The methodology used for assessing Vitamin D levels can vary in sensitivity and specificity, which might affect the accuracy of categorizing individuals into deficient and sufficient Vitamin D status. The use of different assays or techniques across studies can also make it difficult to compare results directly.
- **Definition of Respiratory Infections:** The study's definition of respiratory infections, whether clinical diagnosis or laboratory confirmation was used, can influence the outcomes. Variability in how infections are diagnosed and reported might affect the precision of linking Vitamin D levels to respiratory health outcomes.
- **Seasonal Variations:** The study might not adequately account for seasonal variations in Vitamin D levels due to differences in sunlight exposure, which can significantly impact the synthesis of Vitamin D naturally and thus affect the outcomes concerning respiratory infections.

REFERENCES

1. Zisi, D., A. Challa and A. Makis, 2019. The association between vitamin D status and infectious diseases of the respiratory system in infancy and childhood. Hormones, 18253-263.
2. Yilmaz, K. and V. Sen, 2020. Is vitamin D deficiency a risk factor for COVID-19 in children? Pediatr. Pulmonol., 55: 3595-3601.

3. Loeb, M., A.D. Dang, V.D. Thiem, V. Thanabalan and B. Wang et al., 2019. Effect of Vitamin D supplementation to reduce respiratory infections in children and adolescents in Vietnam: A randomized controlled trial. Influenza Other Respir. Viruses, 13: 176-183.
4. Panfili, F.M., M. Roversi, P. D'Argenio, P. Rossi, M. Cappa and D. Fintini, 2021. Possible role of vitamin D in Covid-19 infection in pediatric population. J. Endocrinological Invest., 44: 27-35.
5. Cariolou, M., M.A. Cupp, E. Evangelou, I. Tzoulaki and A.J. Berlanga-Taylor, 2019. Importance of vitamin D in acute and critically ill children with subgroup analyses of sepsis and respiratory tract infections: A systematic review and meta-analysis. BMJ Open, Vol. 9 .10.1136/bmjopen-2018-027666.
6. Zhang, J., R.R. Sun, Z.X. Yan, W.Y. Yi and B. Yue., 2019. Correlation of serum vitamin A, D and E with recurrent respiratory infection in children. Eur Rev Med Pharmacol Sci., 23: 8133-8138.
7. Mailhot, G. and J.H. White, 2020. Vitamin D and Immunity in Infants and Children. Nutrients, Vol. 12 .10.3390/nu12051233.
8. Brustad, N. and B. Chawes, 2024. Vitamin D Primary Prevention of Respiratory Infections and Asthma in Early Childhood: Evidence and Mechanisms. The J. Allergy Clin. Immunol.: In Pract., 12: 1707-1714.
9. Jolliffe, D.A., C.A. Camargo, J.D. Sluyter, M. Aglipay and J.F. Aloia et al., 2021. Vitamin D supplementation to prevent acute respiratory infections: A systematic review and meta-analysis of aggregate data from randomised controlled trials. The Lancet Diabetes and Endocrinol., 9: 276-292.
10. Fabbri, A., M. Infante and C. Ricordi., 2020. Editorial-Vitamin D status: a key modulator of innate immunity and natural defense from acute viral respiratory infections. Eur Rev Med Pharmacol Sci., 24: 4048-4052.
11. Antonucci, R., C. Locci, M.G. Clemente, E. Chicconi and L. Antonucci, 2018. Vitamin D deficiency in childhood: Old lessons and current challenges. J. Pediatr. Endocrinol. Metab., 31: 247-260.
12. Molloy, E.J., N.S. Murphy and D. Vitamin., 2020. Covid-19 and children. Ir Med J., Vol. 113.
13. Ganmaa, D., B. Uyanga, X. Zhou, G. Gantsetseg and B. Delgerekh et al., 2020. Vitamin D Supplements for Prevention of Tuberculosis Infection and Disease. New Engl. J. Med., 383: 359-368.
14. Forno, E., L.B. Bacharier, W. Phipatanakul, T.W. Guilbert and M.D. Cabana et al., 2020. Effect of Vitamin D3 Supplementation on Severe Asthma Exacerbations in Children With Asthma and Low Vitamin D Levels. JAMA, 324: 752-760.
15. Camargo, C.A., J. Sluyter, A.W. Stewart, K.T. Khaw and C.M.M. Lawes et al., 2019. Effect of Monthly High-Dose Vitamin D Supplementation on Acute Respiratory Infections in Older Adults: A Randomized Controlled Trial. Clin. Infect. Dis., 71: 311-317.
16. Griffin, G., M. Hewison, J. Hopkin, R.A. Kenny and R. Quinton et al., 2021. Perspective: Vitamin D supplementation prevents rickets and acute respiratory infections when given as daily maintenance but not as Intermittent bolus: Implications for COVID-19. Clin. Med., 21: 144-149.
17. Mansur, J.L., B. Oliveri, E. Giacoia, D. Fusaro and P.R. Costanzo, 2022. Vitamin D: Before, during and after Pregnancy: Effect on Neonates and Children. Nutrients, Vol. 14 .10.3390/nu14091900.