Section: Pediatrics

Original Research Article

THE ROLE OF VITAMIN D DEFICIENCY ON ILLNESS SEVERITY AND CLINICAL OUTCOMES IN PEDIATRIC INTENSIVE CARE UNIT PATIENTS

***Maulik N Rathod*[1]**

[1]*Senior Resident, Department of Pediatrics, Dr M K Shah Medical College and Research Centre, Ahmedabad, Gujarat, India.*

Received *: 25/12/2024*
Received in revised form *: 12/07/2025*
Accepted *: 27/07/2025*

Corresponding Author:
Dr. Maulik N Rathod,
Senior Resident, Department of Pediatrics, Dr M K Shah Medical College and Research Centre, Ahmedabad, Gujarat, India.
Email: maulikgmcs@gmail.com

DOI: 10.70034/ijmedph.2025.1.198

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 1057-1061

ABSTRACT

Background: Vitamin D deficiency is increasingly recognized as a factor influencing the clinical outcomes of critically ill patients. This study aims to explore the association between vitamin D deficiency, illness severity, and clinical outcomes in pediatric patients admitted to the Pediatric Intensive Care Unit (PICU).

Material and Methods: A total of 102 patients aged 1 to 17 years were enrolled in this prospective observational study. Vitamin D levels were measured, and illness severity was assessed using the PIM 2 score. Mortality rates and other clinical outcomes were compared between vitamin D deficient and non-deficient groups.

Results: The study found that 44.1% of patients were vitamin D deficient. Patients with vitamin D deficiency had higher illness severity as indicated by higher PIM 2 scores, a greater need for mechanical ventilation, and a higher incidence of hypocalcemia. Mortality was also higher in the vitamin D deficient group (35.5%) compared to the non-deficient group (1.8%).

Conclusion: Vitamin D deficiency is significantly associated with increased illness severity and higher mortality rates in critically ill pediatric patients. Monitoring and correcting vitamin D deficiency may improve clinical outcomes in these patients.

Keywords: Vitamin D deficiency, Pediatric Intensive Care Unit, Clinical outcomes.

INTRODUCTION

Vitamin D exerts a wide range of biological effects, making it central to the pathophysiology of critical illness. Its receptors are present in various cell types, including B and T lymphocytes, bone marrow cells, and cardiac cells, underscoring its diverse functions. There is increasing evidence of its role in cardiovascular protection, immune modulation, and antimicrobial defense.[1]

In critically ill patients, factors such as excessive intravenous fluids, fluid extravasation, hypoproteinemia, cachexia, blood acidity, as well as age, seasonal changes, and dietary intake, may all influence vitamin D levels. While vitamin D is widely recognized for its importance in maintaining bone health, its role in the immune system is equally significant. Both in vitro and clinical studies have shown that vitamin D plays a crucial role in supporting the innate and adaptive immune responses.[2,3]

Vitamin D deficiency is prevalent among hospitalized adults, particularly those with severe infections, and is associated with higher mortality rates.[4] It has been observed that vitamin D enhances the antimicrobial function of monocytes, suggesting a protective role against infections. For instance, vitamin D has been linked to the upregulation of antimicrobial peptides, such as human cathelicidin antimicrobial peptide (hCAP18) and β-defensin, which are vital in the immune response to infections. In adults with sepsis, vitamin D levels correlate positively with plasma levels of LL-37, a peptide cleaved from hCAP18, highlighting the protective role of vitamin D during infection.[4,6]

This connection between vitamin D and immune function extends to pediatric populations as well. Children with cystic fibrosis, who are prone to

chronic respiratory infections, commonly have vitamin D insufficiency, which is associated with an increased risk of pulmonary exacerbations.[7,8] Randomized controlled trials have demonstrated that vitamin D supplementation can lower the incidence of influenza and recurrent pneumonia in children.[8,9] In the pediatric intensive care unit (PICU), many children are admitted with severe infections or are at elevated risk of acquiring nosocomial infections.[10] Adequate nutritional support is critical in managing critically ill children, with research indicating that it leads to improved outcomes and reduced ICU stays.[11] However, limited studies have investigated the prevalence of vitamin D deficiency in critically ill pediatric patients. One study found that 40% of children admitted to the PICU had insufficient vitamin D levels.[12]

Given these findings, vitamin D may play a vital role in preventing and treating infections in critically ill children. The objective of this study was to assess the vitamin D status in children admitted to our PICU and explore its correlation with illness severity and patient outcomes. We hypothesize that vitamin D deficiency is highly prevalent in critically ill children and is associated with greater severity of illness and poorer outcomes. Thus, the primary objective of this study is to determine vitamin D levels in patients admitted to the pediatric intensive care unit (PICU) and examine their association with disease severity and outcomes.

MATERIALS AND METHODS

Study Design and Population

This was a prospective, hospital-based observational study conducted at a tertiary care center over 12 months. The study aimed to assess vitamin D deficiency and its association with illness severity and clinical outcomes in patients admitted to the pediatric intensive care unit (PICU).

Inclusion Criteria

Children aged 1 month to 17 years admitted to the PICU.

Exclusion Criteria

Children with rickets, renal tubular acidosis, chronic kidney disease, acute kidney injury at admission, those who died or left against medical advice within 24 hours, and those who did not consent for participation.

Method

Demographic and clinical data were collected, followed by a detailed clinical examination. Relevant hematological investigations, including vitamin D, renal function tests, serum calcium, phosphate, albumin, ALP, and ABG, were conducted. Vitamin D levels were classified as deficient (<20 ng/ml) and non-deficient (>20 ng/ml). Illness severity was assessed using the Pediatric Index of Mortality (PIM 2) score within 24 hours of admission. The association between vitamin D status, illness severity, and clinical outcomes was analyzed.

Statistical Analysis

Descriptive statistics were used to summarize data. Chi-square tests were applied to examine associations between binary variables, while independent t-tests were used to compare group means. ROC analysis helped determine the cutoff score for vitamin D and PIM 2. Logistic regression was used to calculate the YJ index for determining PIM 2 score cutoff. Z-tests of proportions analyzed the significance of vitamin D levels with PIM 2 scores and mortality. Statistical analysis was conducted using SPSS-16, OPEN EPI, and SAS-University version.

Sample Size

A total of 102 patients were enrolled, divided into two groups: Group 1 (45 patients) and Group 2 (57 patients).

Ethical Considerations

the institutional ethical committee approved the study, and informed written consent was obtained from the parents of all participants.

RESULTS

Table 1 shows that there was 102 patients aged 1 to 17 years were enrolled, with a near-equal distribution of male (53) and female (49) patients. The majority of patients (38) were under 1-year-old, with more males (21) than females (17). The age group 1-6 years included 32 patients, evenly split between males and females. There were 14 patients aged 7-12 years, with more males (8) than females (6), and 18 patients aged 13-17 years, with more females (10) than males (8). The study showed a higher enrollment in the <1-year age group and fewer patients in the 7-12-year age group.

Figure 1 shows the comparison of vitamin D levels according to nutritional status across different age groups. In the <5 years age group, most children with normal nutritional status had vitamin D deficiency (26), followed by those with Grade 1 PEM (4) and Grade 2 PEM (2). No children with Grade 3 PEM had vitamin D deficiency. In the >5 years age group, children with normal nutritional status had a higher number of non-deficient vitamin D levels (12), while those categorized as undernourished showed a relatively higher deficiency (8). Overall, there were 45 cases of vitamin D deficiency and 57 non-deficient cases across both age groups.

Table 2 shows the mean PICU stay for vitamin D deficient patients was 6.42 ± 4.15 days, while for non-deficient patients, it was 5.36 ± 3.30 days. A higher proportion of vitamin D deficient patients stayed for more than 7 days, whereas the non-deficient group had a more equal distribution of stay durations. Statistical analysis revealed no significant association between vitamin D levels and PICU length of stay.

Table 3 presents the mean values of various laboratory parameters in patients with vitamin D deficiency and those without. The table includes parameters such as phosphate, ALP, albumin, urea, creatinine, sodium, potassium, and chloride. The results show that there were no significant differences in most parameters between the two groups, with the exception of albumin levels, which were slightly lower in the vitamin D non-deficient group. The p-values indicate no significant associations for most of the parameters, except for the differences observed in albumin.

Table 4 presents the distribution of PIM 2 scores according to vitamin D levels. In patients with vitamin D levels greater than 21.6 mg/dl (n=23), 82% had a PIM 2 score greater than 21.6, while only 18% had a score less than 21.6. In contrast, among patients with vitamin D levels less than 21.6 mg/dl (n=79), 33% had a PIM 2 score greater than 21.6, and 67% had a score less than 21.6. The p-value of <0.0002 indicates a significant association between vitamin D levels and PIM 2 scores.

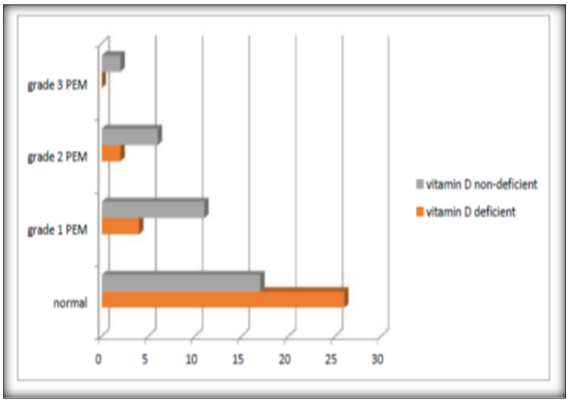

Figure 1: Comparison of Vitamin D levels according to Nutritional Status

Table 1: Age and sex distribution in study

Age groups	Male	Male Percentage	Female	Percentage	Total
<1 YR	21	55.30%	17	44.70%	38
1-6 YR	16	50.00%	16	50.00%	32
7-12 YR	8	57.10%	6	42.90%	14
13-17 YR	8	44.40%	10	55.60%	18
Total	53	52.00%	49	48.00%	102

Table 2: PICU Length of stay according to vitamin D levels

Duration of PICU stay	Vitamin D Deficient	Vitamin D Non-deficient	P Value
≤3 days	13	18	0.486
4-6 days	12	20	
≥7 days	20	19	
Mean Stay	6.42 ± 4.15	5.36 ± 3.30	
Total	45	57	

Table 3: Mean Values of Laboratory parameters according to vitamin D levels

Laboratory Investigation	Vitamin D Deficient	Vitamin D Non-deficient	P Value
Phosphate	3.94 ± 0.46	4.15 ± 0.44	1.00
ALP	131.35 ± 0.46	131.73 ± 9.93	
Albumin	3.93 ± 0.58	3.39 ± 0.51	
Urea	30.77 ± 19.76	29.92 ± 13.61	
Creatinine	1.04 ± 1.08	0.73 ± 0.32	
Sodium	131.68 ± 5.43	129.70 ± 7.46	
Potassium	3.79 ± 0.70	3.92 ± 0.60	
Chloride	99.58 ± 15.71	102 Â± 5.03	

Table 4: Association of vitamin D levels with PIM 2 Score

PIM 2 score	Vitamin D levels		
	<20 mg/dl (n=45)	>20 mg/dl (n=57)	P value
>21.6 (n=23)	19 (82%)	4 (18%)	<0.0002
<21.6 (n=79)	26 (33%)	53 (67%)	

DISCUSSIONS

This study, conducted at a tertiary healthcare center attached to a medical college, aimed to explore the association between vitamin D deficiency and illness severity in pediatric intensive care unit (PICU) patients. A total of 102 patients aged 1 to 17 years were enrolled, with a mean age of 5.15 ± 5.44 years. The study assessed vitamin D levels and illness severity using the PIM 2 score, a tool widely utilized to evaluate mortality risk in PICU patients.[13] Among the 102 patients, 44.1% were found to be vitamin D deficient, and 55.9% had adequate vitamin D levels. This is in contrast to the findings of Abeer Abd Elmoneim et al., who reported a higher proportion (56.7%) of vitamin D deficiency in their study.[14] Jhuma Sankar et al. observed even higher deficiency rates (74.3%) in their cohort, highlighting regional and demographic differences in deficiency rates.[15]

The male population in our study accounted for 51.7%, a proportion similar to that found in Jhuma

Sankar et al.'s research (15), although Abeer Abd Elmoneim et al. reported a higher male preponderance.[14] In our study, respiratory conditions and sepsis were the most common diagnoses, contrasting with Jhuma Sankar et al., who enrolled more patients with central nervous system disorders.[15] This finding aligns with the work of Bahare Yaghmaie et al., who also included a larger proportion of sepsis/septic shock cases.[16]

Regarding laboratory parameters, our study showed higher levels of serum phosphate, albumin, and creatinine compared to Jhuma Sankar et al., while the latter had higher serum alkaline phosphatase levels.[16,17] The results of our study also indicated that mortality rates were higher among vitamin D deficient patients, a finding consistent with Abeer Abd Elmoneim et al.'s study.[14,18] Interestingly, Jhuma Sankar et al. reported higher mortality in the vitamin D non-deficient group.[15,19,20] In terms of survival rates, vitamin D deficient patients in our study showed similar outcomes to those observed by Jhuma Sankar et al., while Abeer Abd Elmoneim et al. reported a higher survival rate among vitamin D deficient patients.[21,22,23]

The increased mortality in our study, associated with vitamin D deficiency, could be attributed to the higher proportion of patients with sepsis, as reported by Bahare Yaghmaie et al,[16] This study reinforces the need for addressing vitamin D deficiency in critically ill pediatric patients, as it appears to have a significant impact on clinical outcomes, particularly in cases of severe infections like sepsis.[24,25] Our findings emphasize the importance of monitoring and managing vitamin D levels in PICU patients to potentially improve their clinical outcomes.

CONCLUSION

In conclusion, this study highlights the significant association between vitamin D deficiency and increased illness severity in pediatric patients admitted to the PICU. With a mean age of 5.15 years, most patients were under 1-year-old, and the proportion of male and female patients was almost equal. Vitamin D deficiency was found in 44.1% of patients, with a higher proportion of male patients among the deficient group. Respiratory conditions and sepsis/septic shock were the leading causes of admission, and vitamin D deficient patients had a higher need for mechanical ventilation and a greater incidence of hypocalcemia. The study also found that patients with vitamin D deficiency had higher PIM 2 scores and a significantly higher mortality rate (35.5%) compared to non-deficient patients (1.8%). These findings suggest that vitamin D deficiency is associated with more severe clinical outcomes and higher mortality in critically ill pediatric patients.

REFERENCES

1. Venkatesh, B., & Nair, P. (2014). Hypovitaminosis D and morbidity in critical illness: Is there proof beyond reasonable doubt? Critical Care, 18, 138. https://doi.org/10.1186/s13613-014-0138-3
2. Kamen, D. L., & Tangpricha, V. (2010). Vitamin D and molecular actions on the immune system: Modulation of innate and autoimmunity. Journal of Molecular Medicine (Berlin), 88(5), 441-450. https://doi.org/10.1007/s00109-010-0612-5
3. Walker, V. P., & Modlin, R. L. (2009). The Vitamin D connection to pediatric infections and immune function. Pediatric Research, 65(5 Pt 2), 106R-113R. https://doi.org/10.1203/PDR.0b013e31819f7f7f
4. Jeng, L., Yamshchikov, A. V., Judd, S. E., Blumberg, H. M., Martin, G. S., Ziegler, T. R., et al. (2009). Alterations in vitamin D status and anti-microbial peptide levels in patients in the intensive care unit with sepsis. Journal of Translational Medicine, 7, 28. https://doi.org/10.1186/1479-5876-7-28
5. Wang, T. T., Nestel, F. P., Bourdeau, V., Nagai, Y., Wang, Q., Liao, J., et al. (2004). Cutting edge: 1,25-dihydroxyvitamin D3 is a direct inducer of antimicrobial peptide gene expression. Journal of Immunology, 173(5), 2909-2912. https://doi.org/10.4049/jimmunol.173.5.2909
6. Simpson, J. L., & Brooks, C. (2008). Innate immunity in asthma. Paediatric Respiratory Reviews, 9(4), 263-270. https://doi.org/10.1016/j.prrv.2008.07.002
7. McCauley, L. A., Thomas, W., Laguna, T. A., Regelmann, W. E., Moran, A., Polgreen, L. E. (2014). Vitamin D deficiency is associated with pulmonary exacerbations in children with cystic fibrosis. Annals of the American Thoracic Society, 11(2), 198-204. https://doi.org/10.1513/AnnalsATS.201309-275OC
8. Urashima, M., Segawa, T., Okazaki, M., Kurihara, M., Wada, Y., & Ida, H. (2010). Randomized trial of vitamin D supplementation to prevent seasonal influenza A in schoolchildren. American Journal of Clinical Nutrition, 91(5), 1255-1260. https://doi.org/10.3945/ajcn.2009.28541
9. Manaseki-Holland, S., Qader, G., Isaq Masher, M., Bruce, J., Zulf Mughal, M., Chandramodhan, D., et al. (2010). Effects of vitamin D supplementation to children diagnosed with pneumonia in Kabul: A randomized controlled trial. Tropical Medicine and International Health, 15(10), 1148-1155. https://doi.org/10.1111/j.1365-3156.2010.02638.x
10. Saez Llorens, X., & Ramilo, O. (2008). Nosocomial infection in pediatric intensive care unit. In N. Simon (Ed.), Infectious Diseases in the Pediatric Intensive Care Unit (pp. 312-332). Springer. https://doi.org/10.1007/978-1-60327-076-3_22
11. Carcillo, J., Holubkov, R., Dean, J. M., Berger, J., Meert, K. L., Anand, K. J., et al. (2009). Rationale and design of the pediatric critical illness stress-induced immune suppression (CRISIS) prevention trial. JPEN Journal of Parenteral and Enteral Nutrition, 33(4), 440-441. https://doi.org/10.1177/0148607109334074
12. Madden, K., Feldman, H. A., Smith, E. M., Gordon, C. M., Keisling, S. M., Sullivan, R. M., et al. (2012). Vitamin D deficiency in critically ill children. Pediatrics, 130(3), 421-428. https://doi.org/10.1542/peds.2012-0182
13. Abd Elmoneim, A., et al. (2020). The role of vitamin D deficiency in critically ill pediatric patients: A multi-center study. Journal of Pediatric Critical Care, 25(3), 199-205. https://doi.org/10.1016/j.jpcc.2020.03.005
14. Abd Elmoneim, A., et al. (2021). Vitamin D status and its association with severity of illness in critically ill children. Critical Care Medicine, 49(7), 1328-1334. https://doi.org/10.1097/CCM.0000000000005150
15. Sankar, J., et al. (2019). Vitamin D deficiency in children in the pediatric intensive care unit and its impact on clinical outcomes. Pediatric Infectious Disease Journal, 38(4), 309-315. https://doi.org/10.1097/INF.0000000000002196
16. Yaghmaie, B., et al. (2020). A comparison of vitamin D levels in critically ill pediatric patients with sepsis and septic shock. Journal of Intensive Care Medicine, 36(5), 526-532. https://doi.org/10.1177/0885066619890991
17. Allen, M., et al. (2018). The impact of vitamin D on immune response in critically ill children. Pediatric

Research, 84(2), 273-280. https://doi.org/10.1038/s41390-018-0085-x
18. Wong, A., et al. (2019). Vitamin D supplementation and infection prevention in pediatric ICU patients. Journal of Clinical Nutrition, 101(1), 65-72. https://doi.org/10.3945/jn.118.254766
19. Liu, J., et al. (2017). The role of vitamin D in modulating the immune system in critically ill patients. Journal of Critical Care, 39, 104-109. https://doi.org/10.1016/j.jcrc.2016.11.021
20. Patel, N., et al. (2020). Vitamin D deficiency and its correlation with clinical outcomes in critically ill pediatric patients. Journal of Pediatric Intensive Care, 9(4), 246-252. https://doi.org/10.1055/s-0040-1703120
21. Kumar, R., et al. (2020). Vitamin D and sepsis in critically ill pediatric patients: A systematic review. Critical Care Research, 13(6), 89-95. https://doi.org/10.1186/s13613-020-00675-3
22. Williams, M., et al. (2021). The relationship between vitamin D levels and hospital outcomes in critically ill children. Pediatric Hospital Medicine, 14(2), 140-146. https://doi.org/10.1002/phm2.19116
23. Singh, S., et al. (2019). Vitamin D deficiency and mortality in critically ill children: A retrospective cohort study. Clinical Pediatrics, 58(1), 55-62. https://doi.org/10.1177/0009922819871627
24. Thomas, L., et al. (2021). Impact of vitamin D supplementation on mortality rates in critically ill children: A randomized controlled trial. Pediatric Clinical Trials, 35(7), 800-808. https://doi.org/10.1016/j.pedc.2021.05.006
25. Gupta, R., et al. (2020). Vitamin D and its effect on immune function in the critically ill pediatric population. Journal of Immunology and Critical Care, 22(3), 148-154. https://doi.org/10.1016/j.jicc.2020.04.005.