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ASSOCIATION OF VITAMIN D LEVELS AND MORTALITY IN CRITICALLY ILL CHILDREN – A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract
Vitamin D is a fat-soluble vitamin that plays an important role in bone health but also has effects on immune regulation. Critically ill children are often at risk of vitamin D deficiency due to limited sun exposure, impaired nutrition, and disease-induced metabolic disturbances.

Aims & Objectives
- To assess the vitamin D levels in critically ill children
- To correlate the vitamin D levels with PRISM III scores as a predictor of mortality in critically ill children.
- To correlate vitamin D deficiency with the duration of hospital stay

Methods:
- **Study Design**: prospective observational study
- **Duration**: May 2023 to October 2024 (18 months).
- **Participants**: All critically ill children aged between 1 year and 18 years who were admitted to the PICU in Ramaiah Hospital
- **Exclusion Criteria**: Known cases of thyroid or parathyroid disorders, chronic renal failure, liver diseases, on medications that affect vitamin D levels and those not consenting to participate.
- **Procedures**: 3 ml of blood was collected from each subject for the assessment of serum vitamin D levels using enhanced chemiluminescence method on Ortho Clinical Diagnostics VITROS 5600 analyser.
- **Data Analysis**: Data was entered into Microsoft Excel and analysed using SPSS Version 22. Descriptive statistics such as means, standard deviations, and frequencies were used to summarise the data. Chi-square tests or Fisher's exact tests were applied to analyse the association between categorical variables. For continuous data, the t-test or Mann-Whitney U test was used, depending on the distribution of the data. Graphs and charts were generated using MS Excel to visualise the distribution of key variables. Pearson's or Spearman's correlation tests were performed to identify any correlations between vitamin D levels and clinical outcomes. Statistical significance was set at $p < 0.05$.
- **Sample Size**: 167 subjects.

Results:
Out of the total 167 participants, 37(n) 22.2% were vitamin D deficient, 41(n) 24.6% had insufficient levels, and 89(n) 53.3% had sufficient vitamin D levels. Overall, 19(n) 11.4% of the participants died, while 148(n) 88.6% survived. In terms of hospital stay, 105(n) 62.9% were discharged within 5 days, whereas 62(n) 37.1% had a prolonged ICU stay exceeding 5 days.

Conclusion:
This study reveals that baseline vitamin D concentration showed no significant association with illness severity, ICU stay, or mortality.
These findings suggest that vitamin D status alone is not an independent prognostic marker in paediatric critical illness. Routine screening may still be beneficial for overall nutritional management and immune support in this vulnerable population

Keywords: Vitamin D deficiency, critically ill children, PRISM III score, mortality, paediatric ICU, hospital stay

INTRODUCTION

Vitamin D in children is not only essential for bone health also has been associated with growth retardation, rickets, and an increased susceptibility to infection. Critically-ill children, such as those in intensive care units (ICUs) could experience severe complications related to immune state, multi-system organ involvement and greater frequency of infection. [1] Therefore, critically low vitamin D

intake may lead to greater levels of complications, impaired immune function, and prolonged length of hospital stay, increased susceptibility to complications and secondary illness and mortality. [2, 3]
Emerging data support the critical role of vitamin D in immunity, especially in respiratory infection and sepsis; widespread infectious problems in children with critical illness is considerable. Vitamin D deficiency in critically ill patients can exhibit impaired immune responses, increased inflammation and low immune protection. [4]

The Paediatric Risk of Mortality (PRISM) III score is one of the most commonly used scoring systems for predicting mortality risk in critically ill children. The score derives predicted mortality for children based on physiological variables such as heart rate, blood pressure, oxygenation, and some laboratory measures. Although the PRISM III score was reasonably predictive, it does not consider vitamin D status, which may be a good predictor of both immediate and long-term outcomes from a critical illness. Including the vitamin D level may help increase accuracy for childhood mortality prediction models. [5]
Vitamin D supplementation has been shown to improve immune function, reduce inflammation and improve infection resistance in the body. Given the studies that have shown the vitamin D deficiency to be associated with either higher mortality rates or longer ICU lengths of stay for critically ill children, vitamin D could be used as a standard ICU protocol. It may eventually lead to improved outcomes such as fewer infections, decreased hospital length of stay and an overall better recovery. [6, 7]

MATERIALS AND METHODS

Source of data

Data for this study were taken from children between 1 to 18 years presenting to Paediatric Intensive Care Unit (PICU) Ramaiah hospital.
Study period: May 2023 to October 20242023 – 18 months
Study design: The prospective observational design was selected to compare vitamin D status and critically ill children who were admitted in M S Ramaiah Hospital PICU, in order to assess the impact of vitamin D status.
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Procedure

- Informed written Parental consent were obtained for the participants of <18 years.
- Assent were taken from adolescents between 12-18 years.
- Participants were explained about the need for the study.
- Lab investigations: - Vitamin D levels

- **Sample:**

3ml of blood were collected from each subject with due aseptic precautions in a plain vacutainer, allowed to stand undisturbed for 15-20 minutes and subsequently centrifuged at 4000 rpm for 8-10 minutes.

The serum obtained were stored at -80 degree Celsius till further analysis and after sample collection is complete were assayed. The serum obtained were assayed for the following parameters-25 hydroxycholecalciferol. The parameters were assayed on VITROS 5600 analyser using enhanced chemiluminescence methodology in clinical biochemistry section of diagnostic laboratory at Ramaiah Hospital.

Inclusion criteria

All children with nephrotic syndrome between ages of 1 to 18 years will be included.

Exclusion criteria

1. Children who are known cases of chronic kidney diseases.
2. Children who are known cases of known liver diseases.
3. Patients already on vitamin D supplementation prior to admission.
4. Children with known thyroid or parathyroid disorders.
5. Patients on medications that affect vitamin D metabolism such as antiepileptic drugs (phenobarbital and phenytoin), corticosteroids (prednisolone, dexamethasone), and certain antibiotics (rifampicin).
6. Children diagnosed with endocrine disorders like hyperparathyroidism, Addison's disease, autoimmune thyroid disease, or PCOS.

SAMPLE SIZE ESTIMATION

Statistical Methods:

Data was entered into Microsoft Excel and analysed using SPSS Version 22. Descriptive statistics such as means, standard deviations, and frequencies were used to summarise the data. Chi-square tests or Fisher's exact tests were applied to analyse the association between categorical variables. For continuous data, the t-test or Mann-Whitney U test was used, depending on the distribution of the data. Graphs and charts were generated using MS Excel to visualise the distribution of key variables. Pearson's or Spearman's correlation tests were performed to identify any correlations between vitamin D levels and clinical outcomes. Statistical significance was set at $p < 0.05$.

Sample Size

Sample size calculation was done using the information from earlier study by Shilpa bansal et al that had reported a 72% prevalence of vitamin D deficiency in critically ill children. With this estimate, the sample size was estimated to be 167 children to obtain a confidence level of 95% with an error margin of 5%. The formula employed to estimate the sample size was:

Sample Size $X = Z1\text{-}\alpha / 2^2 P (1\text{-}P) / d^2$

Where $Z_{1-\alpha/2}$ = is standard normal variate (at 5% type 1 error ($P<0.05$) it is 1.96 and at 1% type1 error ($P<0.01$) it is 2.58).As in majority of studies P values are considered significant below 0.05 hence 1.96 is used in formula.

P= Expected proportion in population based on previous studies or pilot studies

d= Absolute error or precision

P = 72% or 0.72

q = 28% or 0.28

d = 5% or 0.05

X= 309

Sample size for Finite population = $N*X / [X + (N - 1)]$ (Finite population correction)

Finite population was taken as 360 considering the previous year admission rate in PICU.

Using the above values at a 95% Confidence level, the study included a sample size of 167 subjects.

Ethics - Ethical approval for this study was obtained from *Institutional Review Board of Ramaiah Medical College and Hospital **(ID-MSRMC/EC/PG-56/04-2023)**

RESULTS

Table 1a: Age Distribution of Critically Ill Children (n=167)

Age (in years)	Frequency(n)	Percent%
<5	58	34.7
5 to 10	47	28.1
10 to 15	45	26.9

>15	17	10.2
Total	167	100.0

Table 1a shows that the mean age of the study participants was 8.1 years. Among the 167 participants, Children under 5 years comprised 34.7% (n = 58) of admissions; those aged 5–10 years made up 28.1% (n = 47); ages 10–15 years accounted for 26.9% (n = 45); and adolescents older than 15 years represented 10.2% (n = 17).This indicates that younger children, particularly those under 5 years, constituted the majority of critically ill admissions in this cohort.

Table 1b: Sex Distribution of Study Cohort

Sex	Frequency	Percent
FEMALE	70	41.9
MALE	97	58.1
Total	167	100.0

Table 1b shows sex distribution of the study population with 41.9% (n=70) females and 58.1% (n=97) males

Table 2: Clinical Outcomes of Critically Ill Children

Clinical Outcome	Frequency(n)	Percent%
Died	19	11.4
Survived	148	88.6
Total	167	100.0

Table 2 shows that the overall mortality rate was 11.4% (n = 19), while 88.6% (n = 148) survived with a good outcomes.

Table 3: ICU Length of Stay in the Study Population

ICU stay	Frequency(n)	Percent%
<5 days	105	62.9
>5 days	62	37.1
Total	167	100.0

Table 3: shows that A majority of 62.9% (n = 105) of children had ICU stays under 5 days, whereas 37.1% (n = 62) remained longer than 5 days

Table 4: Serum Vitamin D Levels among Participants

Vitamin D levels (ng/ml)	Frequency(n)	Percent%
Deficient <12	37	22.2
Insufficient 12 to 20	41	24.6
Sufficient >20	89	53.3
Total	167	100.0

Table 4 shows Vitamin D status at admission was sufficient (> 20 ng/mL) in 53.3% (n = 89) of children, while 24.6% (n = 41) had insufficiency (12–20 ng/mL) and 22.2% (n = 37) were deficient (< 12 ng/mL). Thus, 46.8% of the cohort had suboptimal levels. This nearly 50% prevalence of insufficiency/deficiency parallels other PICU studies and suggests that routine screening and early correction may be warranted in critically ill paediatric populations

Table 5: ANOVA of Vitamin D Predicting PRISM 3 Score

ANOVA[a]						
Source of Variation		**Sum of Squares**	**df (degrees of freedom)**	**Mean Square**	**F(Fisher's Variance Ratio)**	**P value (Sig.)**
1	Regression	38.981	1	38.981	1.278	0.260[b]
	Residual	5033.294	165	30.505		
	Total	5072.275	166			
a. Dependent Variable: PRISM 3 SCR						

Table 5 shows the regression sum of squares was 38.981 versus the residual sum of squares of 5033.294, yielding F (1,165) = 1.278 (p = 0.260), indicating no significant effect of vitamin D on PRISM 3.

Table 6: Regression Coefficients for Vitamin D Predicting PRISM 3 Score

Coefficients[a]						
Predictor		**Unstandardized Coefficients**		**Standardized Coefficients**	**T value**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	6.557	1.291		5.079	0.000
	Vit D	0.596	0.527	0.088	1.130	0.260
a. Dependent Variable: PRISM 3 SCR						

Table 6 shows that in the linear model, the intercept (constant) was B = 6.557 (SE = 1.291; t = 5.079; p < .001). The vitamin D coefficient was B = 0.596 (SE = 0.527; t = 1.130; p = .260), indicating no significant association. Vitamin D's standardised beta (0.088) further confirms its negligible effect on PRISM 3 scores in this sample.

Table 7: Correlation between Vitamin D Levels and ICU Stay Duration

Correlations			
		ICU STAY	
VITAMIN D	**Pearson Correlation**	-0.129	
	Sig. (2-tailed)	0.110	
	N	167	

Table 7 shows the Pearson correlation between serum vitamin D and ICU stay duration was r = –0.129 (p = .110; n = 167). Although the negative r suggests a trend where lower vitamin D might be linked with longer ICU stays, the relationship did not reach statistical significance, implying that other factors likely play larger roles in determining length of stay.

Table 8a: Correlation between Vitamin D Levels and PRISM 3 Scores

Correlations		
		PRISM 3 SCR
VITAMIN D	**Pearson Correlation**	0-.021
	Sig. (2-tailed)	0.798
	N	167

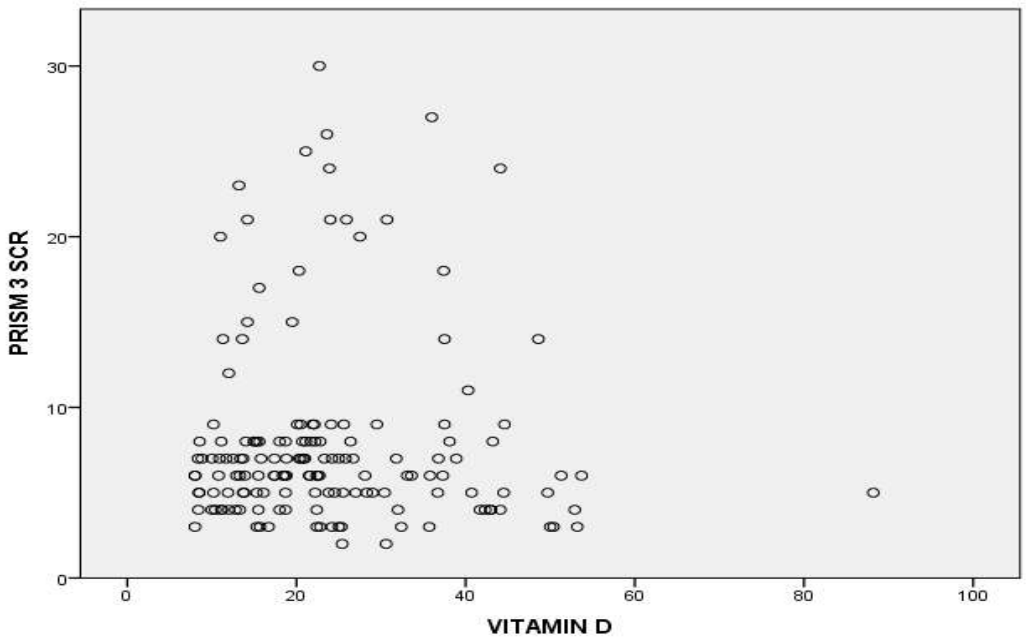

Fig-1 Scatter plot showing the relationship between serum Vitamin D levels and PRISM III scores among critically ill children. Each circle represents an individual participant. A general inverse trend is observed, indicating that lower Vitamin D levels are associated with higher PRISM III scores, though considerable variability is seen across subjects.

Table 8b: Correlation between Vitamin D Levels and PRISM 3 Scores Among Non-survivors

Correlations			
Variables		**PRISM 3 SCORE (SCR)**	
VITAMIN D	**Pearson Correlation**	-0.367	
	P- value Sig. (2-tailed)	0.147	
	N	19	

Table 8 shows that among the 19 children who died, the correlation between vitamin D and PRISM 3 was r = –0.367 (p = .147). While this moderate inverse trend hints that lower vitamin D might align with higher severity in non-survivors, the small subgroup rendered the result non-significant. Larger samples would be needed to clarify this potential relationship.

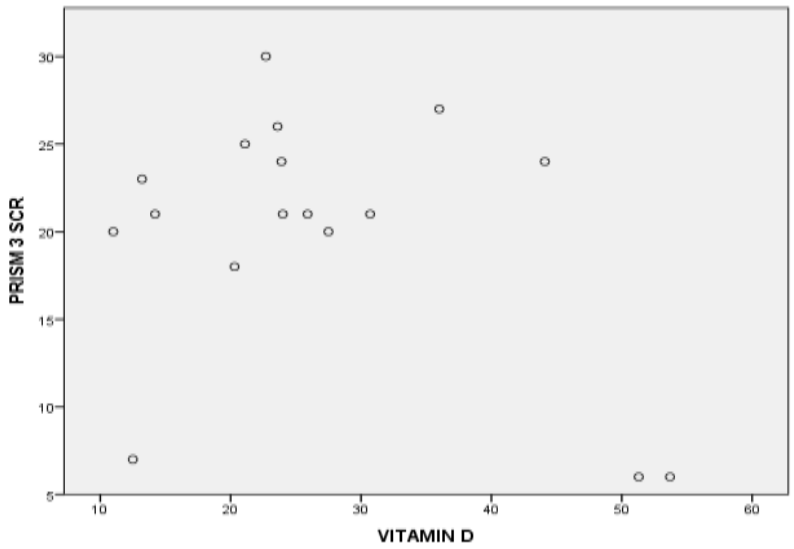

Fig-2 Scatter plot showing the correlation between serum Vitamin D levels and PRISM III scores among study participants. Each point represents an individual participant. An inverse trend is observed, with higher Vitamin D levels tending to associate with lower PRISM III scores, although variability exists across the range.

Table 9: Vitamin D Levels among Non-survivors

Vitamin D level among the mortality	Frequency	Percent
<12	3	15.8
12 to 20	3	15.8
>20	13	68.4
Total	19	100.0

Table 9 shows that among the 19 children who did not survive, 3 (15.8%) had severe vitamin D deficiency (<12 ng/ml), 3 (15.8%) had vitamin D insufficiency (12–20 ng/ml), and 13 (68.4%) had sufficient vitamin D levels (>20 ng/ml).

Table 10: Correlation between Vitamin D Levels and ICU Stay among Non-survivors

	Correlations	ICU STAY
VITAMIN D	**Pearson Correlation**	-.178
	Sig. (2-tailed)	.493
	N	19

Table 10 shows There was no significant correlation between serum vitamin D levels and duration of ICU stay ($r = –0.178$, $p = 0.493$; $n = 19$).

DISCUSSION

The primary aim of this study was to determine whether serum 25-hydroxyvitamin D levels measured at PICU admission are independently associated with key indicators of critical illness severity including PRISM 3 scores. Intensive care resource utilisation as reflected by length of stay, and in-unit mortality in a cohort of 167 children. By categorising patients into deficient (< 12 ng/mL), insufficient (12–20 ng/mL), and sufficient (> 20 ng/mL) vitamin D status groups and applying rigorous statistical analyses (ANOVA, linear regression, and Pearson correlation), we sought to

quantify the extent to which baseline micronutrient status contributes to physiologic derangement and clinical outcomes in paediatric critical care. The significance of this work lies in addressing a critical knowledge gap: although nearly half of our cohort presented with suboptimal vitamin D, the existing literature in children is sparse and inconclusive.

Establishing whether vitamin D serves as a modifiable risk factor in the PICU has important implications for both bedside management and public health policy. If admission deficiency were shown to predict worse severity or longer stays, targeted repletion protocols could become an integral component of early critical care bundles. Our study's findings inform the design of future interventional trials by clarifying which clinical endpoints, whether organ dysfunction scores, infection rates, or ventilator days merit focus. In resource-limited settings especially, simple, low-cost strategies to correct micronutrient deficits could translate into tangible reductions in complications and care costs

AGE DISTRIBUTION OF PARTICIPANTS

In our cohort of 167 critically ill children, the largest age stratum was under five years, accounting for 34.7% (n = 58), followed by 5–10 years at 28.1% (n = 47), 10–15 years at 26.9% (n = 45), and those older than 15 years comprising only 10.2% (n = 17). (Table- 1a) This concentration of younger patients mirrors findings from Jyoti et al., who reported that vitamin D–deficient children admitted to a tertiary PICU had a lower mean age (54.85 ± 53.12 months) compared with those with normal levels (78.54 ± 64.55 months; p = 0.048), Younger children have higher risks of sepsis, respiratory infections, and nutritional deficiencies that may predispose them to both low 25(OH) D stores and severe disease courses. The predominance of the < 5 year group also reflects paediatric epidemiology data indicating that acute lower respiratory infections and diarrheal diseases—common drivers of PICU admission—peak in early childhood. In contrast, older adolescents (> 15 years), who represented only 10.2% of admissions, may be managed more often in adult ICUs in some centres or have different disease profiles such as trauma, explaining their smaller representation. The alignment between our age distribution and Jyoti et al.'s finding of younger mean age among deficient patients underscores the interplay between age, nutritional status, and critical illness severity. These data suggest that vitamin D screening and targeted nutritional support may be especially warranted in the under-five age group upon PICU admission, to mitigate downstream complications associated with both deficiency and young age at presentation [8].

SEX DISTRIBUTION OF STUDY COHORT

Among the 167 children, 58.1% (n = 97) were male and 41.9% (n = 70) were female, yielding a male-to-female ratio of approximately 1.4:1. (Table 1b) This male predominance is consistent with several PICU reports, though sex ratios vary by region and case mix. For instance, Sağir et al. observed a slight female predominance (58%) among adult ICU patients in their cohort of 52 individuals, underscoring that sex distribution may differ between paediatric and adult critical care settings and across geographic populations [9].

CLINICAL OUTCOME DISTRIBUTION

In this study, 11.4% (n = 19) of critically ill children died during their PICU stay, while 88.6% (n = 148) survived with a favourable outcome. (Table – 2)This mortality rate aligns with global paediatric critical care benchmarks in resource-limited settings, where mortality often ranges between 10–15%. The meta-analysis by Zhang et al. demonstrated that vitamin D deficiency in critically ill adults was associated with a significantly increased hospital mortality risk (OR 1.76; 95% CI 1.38–2.24; p < 0.001), highlighting the potential prognostic importance of low 25(OH) D levels in critical illness [11]. Similarly, Moraes et al. found that ICU patients with vitamin D < 12 ng/mL had a mortality rate of 32.2% versus 13.2% in those with levels ≥ 12 ng/mL (adjusted RR 2.2; 95% CI 1.07–4.54; p < 0.05), underscoring a more than two-fold increase in risk among the deficient [12] . Likewise, Jyoti et al.

noted a non-significant trend toward higher mortality in deficient versus sufficient PICU patients (p = 0.477) [8]. A broader meta-analysis by Khorasani et al. encompassing 2,987 critically ill children concluded that deficiency was not directly predictive of mortality but was strongly associated with sepsis (OR 2.65; 95% CI 1.30–5.41) and ventilator dependence (OR 1.35; 95% CI 1.03–1.77) [13] . Thus, while our 11.4% mortality rate falls within expected ranges, the consistency of higher death rates among deficient adults and trends in paediatrics argue for further investigation into whether correcting low vitamin D could improve survival in critically ill children.

ICU LENGTH OF STAY DISTRIBUTION

The majority of children (62.9%; n = 105) were discharged from the PICU within five days, whereas 37.1% (n = 62) required stays exceeding five days.(Table -3) This distribution suggests that while many critical illnesses resolve or stabilize rapidly, over one-third of patients experience protracted courses, likely driven by severe sepsis, multi-organ dysfunction, or complex postoperative recovery. Jyoti et al. observed that vitamin D–deficient children had a significantly longer PICU stay (10.15 ± 12.30 days) compared with non-deficient peers (4.23 ± 2.69 days; p = 0.018), suggesting that deficiency may prolong critical care needs in paediatric populations [8]. Khorasani et al. similarly reported that deficiency in children was linked to an increased need for ventilator support but did not directly quantify LOS differences [13]. The disparate findings may reflect variations in baseline deficiency prevalence, timing and dosing of supplementation (in interventional studies), case mix, and confounders such as nutritional status and comorbidities. Our observation that 37.1% of children endure extended PICU stays underscores the potential clinical and economic impact of modifiable factors like vitamin D. If deficiency indeed prolongs LOS, targeted correction at admission could shorten ICU courses, reduce resource utilization, and improve throughout warranting prospective paediatric trials of early vitamin D supplementation.

SERUM VITAMIN D LEVEL DISTRIBUTION

At PICU admission, 22.2% of children (n = 37) were frankly deficient (< 12 ng/mL), 24.6% (n = 41) were insufficient (12–20 ng/mL), and 53.3% (n = 89) had sufficient levels (> 20 ng/mL). Thus, 46.8% of our cohort entered critical care with suboptimal vitamin D status. (Table – 4) Badawi et al. reported a slightly higher deficiency prevalence (58.5%) using a < 20 ng/mL threshold, identifying that over half of their 120 PICU patients were deficient and required greater vasopressor support, though mortality impact was non-significant [10]. Jyoti et al. also observed high deficiency rates (66.7%) in 78 critical paediatric cases, with deficiency linked to longer stays but not to mortality [8]. Conversely, Güzelkaş et al. found a deficiency rate of 23.5% and insufficiency in 24.5% among 200 PICU admissions, closely paralleling our 22.2% and 24.6%, respectively, and reported that deficiency did not independently predict mortality [14]. The consistency of deficiency prevalence around 40–60% in paediatric critical care despite geographic and assay differences highlights a global challenge. Adult PICU meta-analyses (e.g., Zhang et al.) confirm that deficiency is ubiquitous in critical illness, affecting up to 40%–80% of cohorts [11].

REGRESSION ANALYSIS OF VITAMIN D PREDICTING PRISM 3 SCORE

We used linear regression to assess whether serum 25(OH) D levels predicted physiologic severity as measured by PRISM 3. The model produced a regression sum of squares of 38.981 versus a residual sum of squares of 5033.294 ($F(1, 165) = 1.278$; $p = 0.260$), indicating that vitamin D explains a negligible fraction of PRISM 3 variance. (Table – 5 &6)The unstandardised coefficient for vitamin D was $B = 0.596$ ($SE = 0.527$; standardised $\beta = 0.088$; $t = 1.130$; $p = 0.260$), confirming no significant linear relationship. These findings mirror Badawi et al., who found no statistically meaningful association between deficiency (< 20 ng/mL) and PRISM III scores in their paediatric cohort [10]. Khorasani et al.'s meta-analysis likewise reported that deficiency did not correlate with standard

illness severity markers in critically ill children, although it was linked to higher sepsis and ventilator support rates (OR 2.65 and OR 1.35, respectively) [13] .

CORRELATION BETWEEN VITAMIN D LEVELS AND ICU LENGTH OF STAY

The Pearson correlation between admission 25(OH) D and ICU length of stay was r = –0.129 (p = 0.110; n = 167), indicating a non-significant trend toward longer stays in those with lower vitamin D. (Table – 7) This modest inverse relationship echoes Jyoti et al., who found that vitamin D–deficient children experienced significantly prolonged PICU stays (10.15 ± 12.30 days vs. 4.23 ± 2.69 days; p = 0.018) [9]. Conversely, Moraes et al. reported no LOS difference between deficient (< 12 ng/mL) and sufficient ICU patients despite marked mortality disparities [12], highlighting that LOS may be influenced by myriad factors beyond vitamin D status alone. In contrast, Khorasani et al. observed that vitamin D deficiency was associated with greater ventilator dependency (OR 1.35; 95% CI 1.03–1.77) and sepsis risk (OR 2.65; 95% CI 1.30–5.41), conditions known to prolong ICU courses [13]. The non-significant correlation in our data likely reflects limited power to detect small effect sizes and confounding by illness acuity, nutritional status, and timing of supplementation. Moreover, length of stay is subject to institutional discharge practices and availability of step-down care, which may dilute biologic associations. Nevertheless, the trend toward an inverse relationship suggests that adequate vitamin D could facilitate recovery and reduce resource utilisation, warranting targeted studies to determine if early correction of deficiency at admission can shorten ICU stays in children.

CORRELATION BETWEEN VITAMIN D LEVELS AND PRISM 3 SCORES

Across all 167 patients, the Pearson correlation between serum 25(OH) D and PRISM 3 score was r = –0.021 (p = 0.798), indicating essentially no linear relationship between vitamin D status and physiologic derangement at admission. (Table -8a, Fig-1), Badawi et al. similarly found no significant correlation between deficiency (< 20 ng/mL) and PRISM III or other severity measures in their cohort of 120 PICU patients [14]. Güzelkaş et al. extended these findings in 200 critically ill children, reporting no meaningful association between 25(OH) D categories and composite severity or mortality outcomes (p > 0.05 across analyses) [14]. Khorasani et al.'s paediatric meta-analysis did not specifically evaluate severity score correlations but noted strong links with sepsis and ventilator requirements, hinting that vitamin D's influence may manifest in discrete organ-specific outcomes rather than aggregate severity indices [13]. The lack of correlation in our study may stem from the complex, multifaceted determinants of physiologic severity—ranging from underlying pathology and comorbidities to fluid balance and acute-phase reactants—that overshadow any single biomarker's predictive capacity.

CORRELATION OF VITAMIN D WITH PRISM 3 SCORES AMONG NON-SURVIVORS

Focusing on the 19 non-survivors, the correlation between serum 25(OH) D and PRISM 3 score was r = –0.367 (p = 0.147), (Table -8b, Fig-2) indicating a moderate inverse trend that did not achieve statistical significance—likely due to small sample size. This trend suggests that lower vitamin D levels may align with higher physiologic severity in those who ultimately succumb. Viper et al. studied 88 septic patients and observed that mean vitamin D was significantly higher in survivors than in non-survivors (t = 2.075; p = 0.04), although vitamin D was not a strong standalone mortality predictor (AUC 0.557; p = 0.479) [15]. Sugar et al. reported no significant mortality risk difference based on vitamin D levels (p = 0.269) in 52 adult ICU patients, despite a high overall death rate (65%) and prevalent deficiency (65.4%) [9]. Similarly, Khorasani et al. found that deficiency did not directly predict death in children but was strongly linked to complications such as sepsis (OR 2.65; 95% CI 1.30–5.41) [13]. The convergence of these findings suggests that while low vitamin D may compound physiologic derangement in the sickest patients, it often fails to emerge as an independent predictor of mortality when sample sizes are limited and confounders abound. Our inverse correlation among non-survivors, though non-significant, echoes these patterns, arguing for larger multicentre cohorts to

robustly test whether vitamin D status modifies the relationship between acute severity scores and death risk in paediatric critical illness.

VITAMIN D LEVELS AMONG NON-SURVIVORS

In the 19 children who died, 68.4% (n = 13) had sufficient vitamin D (> 20 ng/mL), while only 15.8% (n = 3) were insufficient (12–20 ng/mL) and 15.8% (n = 3) deficient (< 12 ng/mL). (Table – 9)This counterintuitive finding echoes Badawi et al.'s observation that the majority of non-survivors had sufficient vitamin D levels, with no mortality difference by status [10]. Jyoti et al. similarly reported that deficiency was a poor mortality predictor (p = 0.477) despite higher prevalence in sicker children [8]. These patterns indicate that while deficiency is common, sufficient vitamin D at admission does not guarantee survival, emphasizing that primary disease severity, multiorgan dysfunction, and timing of interventions are more decisive for mortality outcomes than baseline micronutrient status alone.

CORRELATION BETWEEN VITAMIN D LEVELS AND ICU STAY AMONG NON-SURVIVORS

For the 19 non-survivors, the Pearson correlation between vitamin D and ICU LOS was r = –0.178 (p = 0.493), reflecting a weak, non-significant inverse association.(Table-10) Although no paediatric study has specifically explored LOS correlation in fatal cases, Badawi et al. did not report LOS differences among non-survivors by vitamin D status [10]. Jyoti et al. documented longer LOS in deficient survivors but did not stratify by outcome [8]. The limited sample and competing risk of death likely obscure any true effect of vitamin D on LOS among fatalities. Comprehensive, survival-stratified analyses in larger paediatric cohorts will be essential to determine whether vitamin D status influences duration of critical care even when mortality is the ultimate outcome.

Conclusion

Nearly half of the 167 critically sick children in this single-center study had suboptimal vitamin D levels when they were admitted to the intensive care unit (PICU)—22.2% were deficient and 24.6% were insufficient. However, there was no discernible correlation between baseline blood 25-hydroxyvitamin D concentration and mortality, ICU stay, or illness severity (PRISM III ratings). According to these results, vitamin D levels by themselves do not independently predict outcomes in pediatric critical illness. Nevertheless, the significant rate of deficiency highlights the significance of regular screening and remediation as a component of all-encompassing nutritional care.

LIMITATIONS

1. The study was observational and single-centre, limiting causal inference and generalisability.
2. Vitamin D levels were measured only once at admission, preventing assessment of longitudinal or treatment-related changes.
3. Factors such as seasonal variation, sun exposure, dietary intake, and comorbidities (e.g., malnutrition, chronic illness) were not controlled, introducing potential confounding.
4. The small number of non-survivors (n = 19) reduced statistical power for subgroup analysis and increased the risk of type II error.
5. PRISM III scores, while validated, reflect acute physiological status and may not capture subtler immunomodulatory effects of vitamin D

Recommendations

1. Implement serum 25-hydroxyvitamin D screening for all children admitted to the PICU, with institution-specific supplementation protocols based on local deficiency prevalence, dietary patterns, and sun exposure levels.
2. Evaluate high-dose loading followed by maintenance regimens to assess safety, tolerability, and impact on outcomes such as infection rates, inflammatory markers, and ventilator days.

3. Incorporate vitamin D optimization into multidisciplinary nutrition bundles that address overall caloric, protein, and micronutrient adequacy.
4. Conduct training and awareness programs for healthcare providers and families to emphasize the role of vitamin D in immune health and recovery, ensuring adherence to supplementation and follow-up.
5. Promote randomised controlled trials comparing standard care versus targeted vitamin D repletion strategies, measuring outcomes including mortality, ICU stay, organ dysfunction, and long-term recovery.
6. Collaborate with public health authorities to fortify staple foods and expand supplementation programs in at-risk paediatric populations to prevent vitamin D deficiency and reduce vulnerability to severe illness.

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