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ASSESSMENT OF VITAMIN D LEVELS IN CHILDREN WITH SEVERE MALNUTRITION

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Abstract

Objective: *To determine the frequency of Vitamin D deficiency in children with severe acute malnutrition.*

Methods: *A cross-sectional study was conducted in the Department of Pediatric Medicine at Ghulam Muhammad Mahar Medical College (GMC), Sukkur, from 1st August 2024 to 31st January 2025, following ethical approval from the Institutional Review Board of GMC Sukkur. A total of 104 children aged 6 to 59 months, meeting the WHO criteria for severe acute malnutrition (SAM), were enrolled using non-probability consecutive sampling. Serum vitamin D deficiency was assessed by measuring 25-hydroxyvitamin D levels below 20 ng/mL using the electrochemiluminescence (ECL) method. Children with metabolic disorders, chronic kidney or liver disease, or those on vitamin D supplementation in the past three months were excluded. Demographic data, including age, gender, residence (urban/rural), immunization status, parental education, and socioeconomic status, were collected via a structured questionnaire. Anthropometric measurements of weight and height were taken with standardized equipment. Data were analyzed using SPSS version 29.0, and statistical significance was set at $p \leq 0.05$.*

Results: *Out of 104 children with severe acute malnutrition (SAM), 64 were males (61.5%) and 40 were females (38.5%). The mean age was 30.56 ± 15.03 months, with a mean weight of 12.74 ± 2.59 kg and a mean height of 87.52 ± 10.80 cm. Regarding demographics, 48.1% of children resided in urban areas, while 51.9% lived in rural settings. Immunization status was equally divided, with 50% having completed their immunizations. Vitamin D deficiency was found in 56.7% of the children. In terms of parental education, the largest group had intermediate education (26.0%), followed by primary (16.3%), matriculation (16.3%), secondary (15.4%), graduation (13.5%), and illiteracy (12.5%). Socioeconomic status showed that 39.4% were from lower, 31.7% from middle, and 28.8% from upper classes. Further analysis revealed significant associations between vitamin D deficiency and several factors. Females (72.5%) had a higher deficiency rate compared to males (46.9%, $p = 0.010$). Rural children had a higher deficiency rate (66.7%) than urban children (46%, $p = 0.034$). Children with incomplete immunizations had higher deficiency (67.3%, $p = 0.029$). Parental education was also significant, with lower-educated parents linked to*

higher deficiency rates (p = 0.014). No significant association was found with socioeconomic status (p = 0.903).

Conclusion: *This study shows a high prevalence rate of vitamin D deficiency in children with SAM, which was strongly associated with sex, rural place of residence, incomplete immunization, and lower parental education. These results are also consistent with other literature in Pakistan and comparable environments, emphasizing the importance of routine vitamin D screening and supplementation in malnourished children. Correction of this deficiency might benefit and salvage the recovery of these neonates, as well as lessen the associated long-term developmental morbidity in this susceptible population.*

INTRODUCTION

Severe acute malnutrition (SAM) is one of the major public health problems, especially in developing countries, and is one of the most common underlying causes of childhood morbidity and mortality. It is also referred to as when the weight of a child for his/her height falls to 3 standard deviations (z-scores) below the WHO growth standards. SAM is related to immune dysfunction, growth retardation, and cognitive impairment and is a major determinant of health status in children (1). The World Health Organization (WHO) notes that almost 45% of child deaths in the world are associated with undernutrition, and SAM is an important contributor to these statistics. In Pakistan, the prevalence of SAM is unacceptably high; national surveys have shown the prevalence of SAM among children less than 5 years of age at 8.7%, which leads to a high burden of preventable child death and disability (2).

SAM is not just a nutritional problem, however, but a complex health condition determined by a variety of social, environmental, and access to care factors. Poverty, food insecurity, poor health services, and improper hygiene and sanitation practices are some of the leading causes of the burden of SAM in Pakistan (3). The country suffers from socio-economic issues, which add to the risk children face of malnutrition, especially in rural areas where the proportion of poverty is high, and access to basic health services is poor. Moreover, despite advances in child health in some domains, Pakistan continues to struggle with lower levels of undernutrition, and thus, with the burden of malnutrition-related conditions such as SAM (4).

Apart from SAM, there is increasing concern about vitamin D status in many countries, including Pakistan. Vitamin D is a key micronutrient with critical function on bone health, the immune system and in a myriad of metabolic pathways (5). It is synthesized in the skin when exposed to sunlight, and a lack of sunlight exposure, dietary deficiency, or underlying disease states can compromise its synthesis. Vitamin D insufficiency, defined as 25-hydroxyvitamin D less than 20 ng/mL, causes rickets, osteomalacia, and an excess of infections, especially of the respiratory tract. It's also associated with stunted growth and development in children, and with poor health status among the malnourished (6).

Vitamin D deficiency is known to be very high in children in Pakistan. According to the available data, it is estimated that 50-70% of Pakistani children are vitamin D-deficient or insufficient, particularly those who are residing in urban slums or rural settings. This is because of decreased sun exposure due to cultural practices (including wearing full coverings) and poor dietary intake of vitamin D-containing products such as dairy products and fatty fish (7). In addition, socioeconomic inequalities in Pakistan also result in inequality in accessing adequate nutrition and healthcare, which may lead to increased prevalence of vitamin D deficiency among children of lower socioeconomic status (8).

Even more alarming is the prevalence of vitamin D deficiency among children with SAM. SAM children are more susceptible to those nutritional imbalances, including vitamin D, due to limited dietary intake and poor absorption of essential nutrients (9). Moreover, malnutrition-related immune suppression would further render the children more susceptible to infections and diseases, which would magnify the deleterious consequences of vitamin D deficiency. Lack of vitamin D in malnourished children can also provide insult to their immune system, retard growth

and development, and predispose to severe infections including pneumonia and sepsis, which are major contributors to death in SAM children (10).

In recent years, there has been increased acknowledgement that vitamin D deficiency should be treated as part of the overall care package provided to children with SAM. Thus, the effect of vitamin D on the immune system and its effect on the presence of infection and severity of illness were appealing to deem vitamin D as an important micronutrient, which requires checking and replenishing in children with SAM (11). Although the problem is known to be prevalent, nevertheless, routine screening of vitamin D deficiency is not a common practice in health care across the board in many healthcare centers, and especially in resource-poor countries such as Pakistan (12). The supplementation of children with community management of acute malnutrition (CMAM) with vitamin D has been highlighted, but the detection and treatment of vitamin D deficiency in children with SAM is still mostly neglected in malnutrition programs (13).

This study aims to bridge this gap by examining the link between vitamin D status, growth, and ADs in SAM cases, an issue that has been largely overlooked in malnutrition. Awareness about this association may have the potential to enhance clinical care and child health, with useful lessons in the care of children with SAM.

METHODS

This cross-sectional study was performed in the Department of Pediatric Medicine of Ghulam Muhammad Mahar Medical College (GMC), Sukkur, over six months, 1st August 2024 to 31st January 2025, after getting the approval by the Institutional Review Board of GMC Sukkur. A total of 104 children aged 6- 59 months who had been admitted into the facility and whose measurements complied with the WHO definition of severe acute malnutrition (SAM) (weight-for-height < -3 z-scores of the median WHO growth standards) were enrolled into the study using consecutive convenience sampling. After obtaining consent from the parents or guardians, vitamin D deficiency, which had defined levels of serum 25-hydroxyvitamin D below 20 ng/mL as measured by the electrochemiluminescence (ECL) method, was included. Children who were diagnosed with metabolic disorders, chronic kidney or liver diseases, or who had been prescribed vitamin D supplements within three months before this study were excluded. Data was collected through a structured questionnaire in which demographic variables such as age, gender, urban/rural residence, immunization status, level of education of the mother and father, and socioeconomic status were included. Weight and height were measured using standardized procedures and instruments as anthropometric measurements. Analysis was performed on the data by applying SPSS 29.0Continuous variables were presented as mean and standard deviation, and categorical variables as frequency and percentage using descriptive statistics. Chi-square and Fisher's exact tests were used to assess the relationship of vitamin D deficiency with sociodemographic variables that were found to be statistically significant at $p \leq 0.05$.

RESULTS

Out of 104 children presented with severe acute malnutrition (SAM), 64 were males and 40 were females, constituting about 61.5% and 38.5%, respectively. The mean age of the children was 30.56 ± 15.03 months, while the mean weight was 12.74 ± 2.59 kg, and the mean height was 87.52 ± 10.80 cm (Table-1).

Regarding their demographic distribution, 48.1% of the children resided in urban areas, while a slightly higher proportion, 51.9%, belonged to rural settings. Immunization status was equally divided, with 50% of the children completing their immunization schedules and the remaining 50% having incomplete immunizations. Vitamin D deficiency was observed in 56.7% of the children, whereas 43.3% had sufficient levels. In terms of parental educational status, the highest proportion of parents had attained intermediate education (26.0%), followed by primary and matriculation levels (both 16.3%), secondary education (15.4%), graduation (13.5%), and a minority were illiterate (12.5%). Socioeconomic stratification revealed that 39.4% of the children came from lower socioeconomic backgrounds, 31.7% from middle, and 28.8% from upper socioeconomic classes. These distributions suggest a relatively balanced representation across residential and educational backgrounds, but highlight notable concerns regarding immunization coverage and

vitamin D deficiency prevalence in the population (Table-1).

Socio-Demographics	N (%) / Mean ± SD Total=104
Gender	
Male	64 (61.5%)
Female	40 (38.5%)
Anthropometric measurements	
Age (in months)	30.56 ± 15.03
Weight (in kg)	12.74 ± 2.59
Height (in cm)	87.52 ± 10.80
Residential status	
Urban	50 (48.1%)
Rural	54 (51.9%)
Immunization status	
Complete	52 (50%)
Incomplete	52 (50%)
Vitamin D deficiency	
Yes	59 (56.7%)
No	45 (43.3%)
Parental Education Level	
Illiterate	13 (12.5%)
Primary	17 (16.3%)
Secondary	16 (15.4%)
Matriculation	17 (16.3%)
Intermediate	27 (26.0%)
Graduate	14 (13.5%)
Family socioeconomic status	
Lower	41 (39.4%)
Middle	33 (31.7%)
Upper	30 (28.8%)

Table 1: Socio-demographic, clinical, and anthropometric characteristics of the children presenting with severe acute malnutrition (N = 104).

Further analysis revealed statistically significant associations between vitamin D deficiency and several sociodemographic variables. A significant relationship was found between gender and vitamin D deficiency ($p = 0.010$), with females (72.5%) being more frequently deficient compared to males (46.9%). Similarly, residence was significantly associated with vitamin D deficiency ($p = 0.034$), where children from rural areas showed a higher prevalence (66.7%) than those from urban settings (46%). Immunization status also showed a significant association with vitamin D levels ($p = 0.029$); children with incomplete immunizations had a higher rate of deficiency (67.3%) compared to those with complete immunizations (46.2%) (Table-2).

Moreover, a significant association was found between parental educational status and vitamin D deficiency ($p = 0.014$). Children of less-educated parents, particularly those with only primary education (76.5%) or intermediate education (74.1%), exhibited a higher prevalence of deficiency compared to those whose parents were graduates (42.9%) or had secondary education (43.8%). In contrast, no statistically significant association was found between

socioeconomic status and vitamin D deficiency (p = 0.903), indicating that deficiency was similarly prevalent across upper, middle, and lower socioeconomic groups. These findings underscore the multifactorial nature of vitamin D deficiency and highlight the need for targeted public health interventions addressing gender disparities, rural health inequities, immunization efforts, and parental education (Table-2).

Variables	Categories	Vitamin D Deficiency		P-value
		Yes (n = 59)	No (n = 45)	
Gender	Male	30 (50.8%)	34 (75.6%)	0.010*
	Female	29 (49.2%)	11 (24.4%)	
Place of Residence	Urban	23 (39.0%)	27 (60.0%)	0.034*
	Rural	36 (61.0%)	18 (40.0%)	
Immunization Status	Complete	24 (40.7%)	28 (62.2%)	0.029*
	Incomplete	35 (59.3%)	17 (37.8%)	
Parental Educational Status	Illiterate	3 (5.1%)	10 (22.2%)	0.014*
	Primary	13 (22.0%)	4 (8.9%)	
	Secondary	7 (11.9%)	9 (20.0%)	
	Matriculation	10 (16.9%)	7 (15.6%)	
	Intermediate	20 (33.9%)	7 (15.6%)	
	Graduate	6 (10.2%)	8 (17.8%)	
Family Socioeconomic Status	Upper	16 (27.1%)	14 (31.1%)	0.903
	Middle	19 (32.2%)	14 (31.1%)	
	Lower	24 (40.7%)	17 (37.8%)	

Table-2: - Table: Association between vitamin D deficiency and socio-demographic variables among children with severe acute malnutrition (n = 104)

DISCUSSION

This study was conducted to find out the prevalence of vitamin D deficiency among children having severe acute malnutrition (SAM). The findings indicated that 56.7% of the SAM children had vitamin D deficiency, meaning that over half of the malnourished pediatric population in this context suffered from this micronutrient deficiency. This is a clinically important finding and highlights the need to incorporate micronutrient assessment, particularly vitamin D status, in the routine evaluation and management of children with SAM.

The high magnitude of vitamin D deficiency (VDD) found in this study is in line with reports from former studies done in Pakistan and elsewhere in low to middle-income countries. For instance, Moorani et al. (2019) found a proportionate prevalence of vitamin D deficiency in under-five children from different communities of Karachi, substantiating the global phenomenon of the public health problem in both rural and urban populations (14). In addition, the literature has reported that Vitamin D deficiency not only contributes to bone growth retardation and rickets but also may worsen malnutrition, reducing immunological response, calcium metabolism, and general health resistance (15).

Concerning gender differences, the gender-based analysis in our study showed a statistically significant correlation that females had a higher prevalence (72.5%) of VDD than males (46.9%). This is consistent with the regional literature in which girls are commonly reported to be at higher risk given cultural and social behavior norms that restrict girls' sunlight exposure and favor male children in dietary practices (16). This difference between the genders has been confirmed by Mahar B et al in their study, which documented that urban Pakistani girls were most influenced in this regard (17).

Place of residence was also a prominent factor related to vitamin D deficiency. Rural residents (66.7% and

46%) had a greater prevalence of deficiency than urban residents. This may be a reflection of the disparities between health services, nutrition, fortified food, as well as sunshine practice-related lifestyle differences (18). Contact with sunlight in rural areas should provide more exposure, however, cultural factors, including clothing, indoor activities, and pollution, may inhibit effective sunlight exposure (19).

Moreover, incomplete vaccination status was significantly higher among those with VDD. The relationship could be seen as a tracer of general inadequate health-care access or neglect, such that children not receiving routine immunizations may also be vulnerable to deficiencies in general health, including micronutrient inadequacies. It raises the fact that one should see immunization coverage as a monitor for child health surveillance and an indicator for the effectiveness of public health outreaches (16).

Parental education was another important predictor of vitamin D insufficiency. Children of parents with primary (76.5%) or intermediate (74.1%) education were more often inadequate serum vitamin D, whilst those with higher educated parents (graduates) had a lower prevalence (42.9%). This underscores the importance of the views of parents in the healthy behavior of children. It is consistent with other regional studies that have reported that, if any, parents with a higher level of education can recognize malnutrition, seek prompt treatment, and make dietary amendments or supplementations (20).

Interestingly, in this study there was no significant association between serum vitamin D levels and socioeconomic status. Although reported low socioeconomic status has been considered a risk factor for vitamin D deficiency in the existing literature, our data stem from a relatively homogeneous socioeconomic profile among SAM patients, irrespective of declared income strata (21). Or it may indicate that other factors are more immediate determinants of vitamin D status than income alone (e.g., level of education, access to healthcare).

CONCLUSION

The present study revealed a high burden of vitamin D deficiency among SAM-children, and it is significantly associated with sex, rural residence, incomplete immunization, and parental education status. These findings are generally consistent with previous literature coming mainly from Pakistan and similar contexts, together bolstering the reason for routine screening and vitamin D supplementation in undernourished children. The correction of hypovitaminosis D in these vulnerable individuals could impact recovery by enhancing the potential for recovery and diminishing the likelihood of long-term developmental consequences.

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