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Original Research Article

Vitamin D and vitamin B12 status in children with complicated severe acute malnutrition

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ABSTRACT

Background: Severe acute malnutrition (SAM) is a major public health challenge frequently accompanied by hidden micronutrient deficiencies. This study evaluated the prevalence of vitamin D and vitamin B12 deficiencies and their clinical associations among children hospitalized with complicated SAM.
Methods: A hospital-based cross-sectional study was conducted among 100 children (aged 6–59 months) admitted with complicated SAM at a tertiary care center in eastern Uttar Pradesh. Anthropometric data, clinical complications and feeding practices were documented. Serum 25-hydroxy vitamin D and vitamin B12 levels were quantified using standardized assays.
Results: The cohort (mean age: 33.2±15.6 months; 58% male) exhibited frequent complications, including pallor (72%), convulsions (62%), pneumonia (58%) and acute gastroenteritis (56%). Vitamin D deficiency (<20 ng/ml) was present in 62% of children and vitamin B12 deficiency (<200 pg/ml) was found in 54%. Notably, 38% of the patients exhibited concurrent deficiencies of both micronutrients. Despite these significant overlapping nutritional deficits, standard inpatient nutritional rehabilitation yielded robust clinical recovery rates that were comparable across isolated vitamin D deficiency (83.9%), isolated vitamin B12 deficiency (88.9%) and combined deficiency (86.8%) groups.
Conclusions: Vitamin D and vitamin B12 deficiencies are highly prevalent and frequently coexist among children with complicated SAM. While standard inpatient rehabilitation remains highly effective across all deficiency subgroups, routine micronutrient screening and targeted supplementation should be integrated into SAM management protocols to optimize overall recovery and mitigate long-term health consequences.

Keywords: Micronutrients, Nutritional rehabilitation, Severe acute malnutrition, Vitamin D deficiency, Vitamin B12 deficiency

INTRODUCTION

SAM is a major public health problem and an important cause of morbidity and mortality among children under five years of age, particularly in low- and middle-income countries. The WHO defines SAM in children aged 6–59 months as weight-for-height below −3 standard deviations of the WHO child growth standards, a mid-upper arm circumference (MUAC) below 115 mm or the presence of bilateral pitting edema.[1] Globally, an estimated 45 million children under five years suffer from wasting, including approximately 13.6 million with SAM.[2]

The burden is highest in South Asia and sub-Saharan Africa, where poverty, food insecurity, recurrent infections and inadequate healthcare services contribute to undernutrition.[3] SAM remains a major contributor to childhood mortality worldwide.[4] In India, malnutrition continues to be a significant public health concern. According to the national family health survey (NFHS-5),

32.1% of children under five years are underweight, 19.3% are wasted and 32.1% are stunted.[5] Higher prevalence rates have been reported from states such as Uttar Pradesh, Bihar, Madhya Pradesh and Rajasthan.[6] In Uttar Pradesh, the prevalence of SAM among children under five years is approximately 6%.[7]

The coexistence of poor dietary intake, frequent infections, inadequate breastfeeding practices and suboptimal healthcare utilization further aggravates the situation. Malnutrition not only affects the physical growth of children but also has long-term consequences on cognitive development and economic productivity, emphasizing the need for immediate interventions to address the underlying causes.[8]

SAM is frequently associated with serious complications, including hypoglycemia, hypothermia, dehydration, electrolyte imbalance, pneumonia, diarrhea and septicemia, all of which contribute to increased morbidity and mortality.[9] Alterations in immune function, intestinal integrity and systemic inflammatory responses further increase susceptibility to infections and poor clinical outcomes.[10] In addition to macronutrient deficiency, deficiencies of essential micronutrients are common and may further impair growth, immunity and recovery from illness.

Vitamin D and vitamin B12 are important micronutrients involved in skeletal growth, immune regulation, hematopoiesis and neurological development. Deficiency of either micronutrient may contribute to anemia, impaired growth, increased susceptibility to infections and delayed recovery from illness.[11,12] Vitamin D plays a crucial role in calcium-phosphorus metabolism, bone health and immune regulation. Reduced vitamin D levels have been reported among children with SAM and may be associated with impaired growth and increased risk of infectious illnesses.[13-15]

Likewise, vitamin B12 deficiency may result in megaloblastic anemia, developmental delay and neurocognitive impairment, particularly in populations with limited intake of animal-source foods.[16] Previous studies have reported lower serum vitamin B12 levels among children with SAM and an association with adverse health outcomes.[17,18]

Need for the study

Despite the recognized importance of these micronutrients, data regarding the prevalence of vitamin D and vitamin B12 deficiencies among children with complicated SAM in eastern Uttar Pradesh remain limited. Therefore, the present study was undertaken to determine the prevalence of vitamin D and vitamin B12 deficiencies among children with complicated SAM and to evaluate their association with clinical and biochemical parameters.

METHODS

Study design and setting

A hospital-based cross-sectional study was conducted from March 2024 to February 2025 at the Nutritional Rehabilitation Centre, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur. The study included hospitalized children aged 6–59 months diagnosed with SAM according to WHO criteria.

Inclusion criteria

Children aged 6–59 months fulfilling WHO criteria for SAM 19, any of the following: severe wasting, weight-for-height/length Z-score <−3 SD of WHO growth standards; MUAC<11.5 cm and Bilateral pitting edema; gross, visible.

Exclusion criteria

Children aged less than 6 months or more than 59 months; premature infants; those with congenital heart disease, cerebral palsy, chromosomal abnormalities, metabolic disorders, malabsorption syndromes, renal disease, malignancy, children receiving folic acid or vitamin B12 supplementation; those without caregiver consent; and children who died within 48 hours of admission or failed to achieve hemodynamic stability were excluded.

Sample size

Sample size was calculated using the formula $n=4pq/d^2$, where p was the prevalence of SAM in Uttar Pradesh (6%) based on (NFHS-4 data 7), $q=1-p$ (0.94) and d=5% precision.[20] A total of 100 children were enrolled.

Study procedure

All admitted children aged 6–59 months were screened for eligibility using WHO SAM criteria. Eligible participants were enrolled after obtaining written informed consent from caregivers.

Demographic and clinical information, including age, sex, socioeconomic status, birth and feeding history, immunization status, previous hospitalizations, history of tuberculosis, HIV infection, chronic illnesses and vitamin supplementation, was recorded using a structured proforma. Clinical examination focused on signs of malnutrition, dehydration, hypoglycemia, hypothermia and associated infections.

Anthropometric measurements were performed using standardized techniques: weight using a calibrated digital scale, length/height using an infantometer or stadiometer and MUAC using a non-stretchable measuring tape.[21]

Biochemical investigations

Sample collection

Within 24 hours of admission, 3 mL of venous blood was collected under aseptic conditions. The samples were allowed to clot in the dark, centrifuged to isolate the serum and stored at -20°C until analysis to ensure analyte stability.

Assay methodology

Serum 25-hydroxy vitamin D (25(OH)D) and vitamin B12 levels were quantified using a Randox semi-automated clinical chemistry analyzer.[22] The tests utilized standard competitive immunoassay and competitive binding protein principles, respectively.

Quality control

Rigorous internal quality control (IQC) procedures were maintained. Multi-point calibration curves were generated before analysis and two-level commercial quality control sera were run with every batch. Intra- and inter-assay coefficients of variation (CV) were strictly maintained below 10%, with acceptable results falling within a ±2 standard deviation (SD) range.

Diagnostic thresholds

Standard clinical cut-offs were applied

<20 ng/ml for vitamin D (Endocrine Society guidelines) and <200 pg/ml for Vitamin B12 (World Health Organization guidelines).

Study variables

Independent variable

Severe acute malnutrition.

Dependent variables

Serum vitamin D and vitamin B12 levels, nutritional status and clinical outcomes.

Potential confounders

Socioeconomic status, maternal health, birth history, feeding practices and co-existing infections.

Ethical approval Obtained from Institutional Human Ethical Committee vide letter serial no. 222/IHEC/2025.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±SD and categorical variables as frequencies and percentages. Qualitative data analyzed by Chi-Square test and p value <0.05, considered as significant.

RESULTS

A total of 100 children meeting the criteria for SAM were included in this study. The mean age of the participants was 33.2±15.6 months, ranging from 6 to 59 months. The cohort exhibited a male predominance, with males comprising 58% (n=58) of the sample and females comprising 42% (n=42). Analysis of socioeconomic status (SES) indicated that the majority of the children belonged to lower or lower-middle-class households, with 52% categorized as Class III-IV and 36% as Class II-III. Only 12% of the cohort belonged to Class I-II.

Baseline anthropometric measurements were consistent with severe undernutrition. The mean weight of the cohort was 6.1±1.8 kg (range: 3.0–8.9 kg) and the mean height was 66.4±11.2 cm (range: 45.6–84.6 cm). The mean MUAC for the sample was severely depleted at 9.7±1.1 cm, with measurements ranging from 8.0 to 11.5 cm. Geographically, the study population was fairly evenly distributed overall, with 54% (n=54) residing in urban settings and 46% (n=46) in rural settings. However, further stratification revealed a distinct and highly significant disparity in presentation based on sex and locality.

Among male children, a substantial majority presented from urban areas (72.4%, n=42), with only 27.6% (n=16) presenting from rural areas. Conversely, female children presented predominantly from rural areas (71.4%, n=30), with only 28.6% (n=12) from urban areas. A Pearson's Chi-square test of independence was conducted to evaluate this observed disparity. The results demonstrated a highly significant statistical association between the sex of the child and their locality (Chi-square=18.84, df=1, p<0.001) (Table 1).

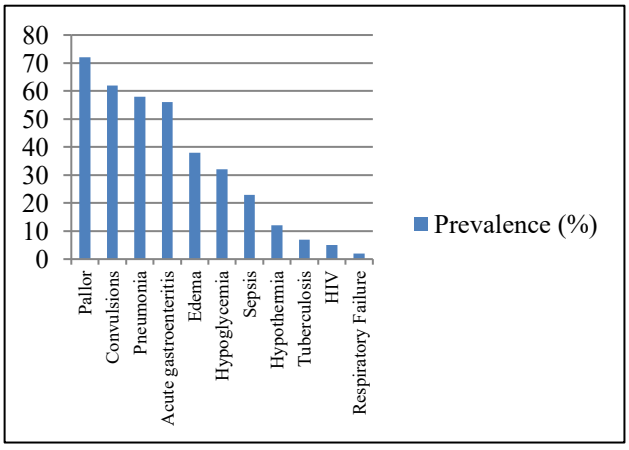

Figure 1: Clinical features in children with complicated SAM.

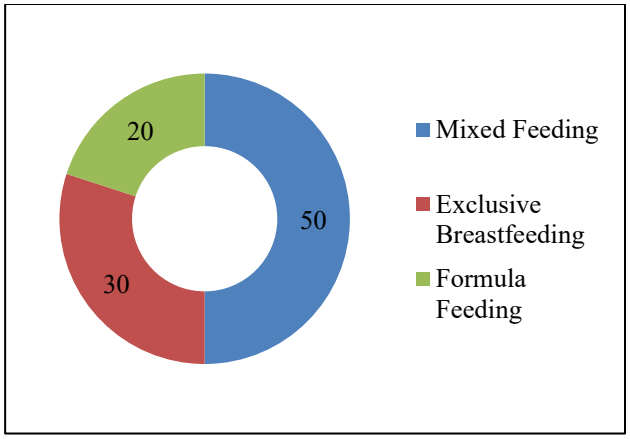

Figure 2: Feeding practices in children with complicated SAM.

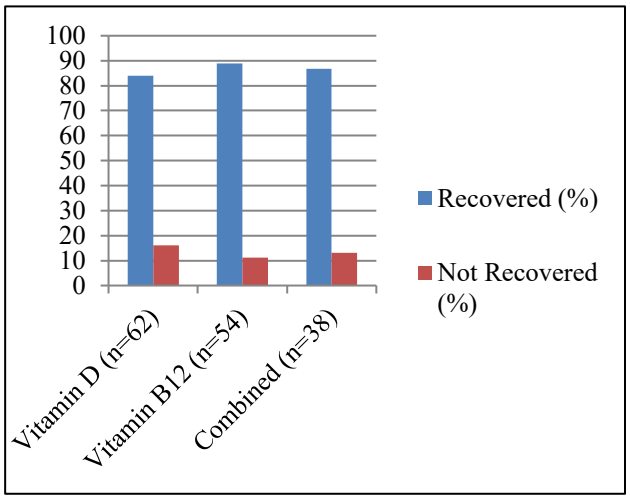

Figure 3: Prevalence of recovery pattern children with complicated SAM.

The most frequent clinical complication recorded was pallor in 72% of cases, followed by convulsions (62%), pneumonia (58%) and acute gastroenteritis (56%). The percentage of children with edema was 38%. Some other complications recorded in some of the cases were hypoglycemia in 32% of cases, sepsis in 23% and hypothermia in 12%. Some other complications noted less frequently included tuberculosis in 7% and HIV infection in 5% of children (Figure 1).

Mixed feeding is the most frequently used feeding method among the studied subjects, being practiced in 50% of cases, compared to exclusive breastfeeding (30%) and formula feeding (20%). There were statistically significant differences between the observed and expected distribution of the feeding methods (p=0.001) (Figure 2).

Among the 100 children evaluated, a high prevalence of specific micronutrient deficiencies was observed. Vitamin D deficiency was the most common, identified in 62 children (62%, 95% CI: 52.3–71.0%). Similarly, Vitamin B12 deficiency was highly prevalent, affecting over half of the study population with 54 cases (54%, 95% CI: 44.2–63.5%). Notably, a substantial proportion of the cohort exhibited concurrent vulnerabilities, with 38 children (38%) presenting with a combined deficiency of both Vitamin D and Vitamin B12. This demonstrates a significant burden of overlapping micronutrient deficiencies within this patient population (Table 2).

Mean serum vitamin D levels in the study subjects were observed to be 16.47±7.12 ng/ml, with a median value of 16.34 ng/ml and a range between 5.92 and 29.67 ng/ml. Using deficiency cut-off values of <20 ng/ml for Vitamin D and <200 pg/ml for Vitamin B12, Vitamin D deficiency was detected in 62% of the study population. The mean serum vitamin B12 level in the study population was found to be 182.6±73.4 pg/ml, with a median value of 183.5 pg/ml and a range of values between 51 and 299 pg/ml. With a deficiency cut-off being less than 200 pg/ml, vitamin B12 deficiency was observed in 54% of the participants (Table 3).

Regarding recovery outcomes, among children with vitamin D deficiency (n=62), 52 (83.9%) recovered, while 10 (16.1%) did not recover during hospitalization. Similarly, among children with Vitamin B12 deficiency (n=54), 48 (88.9%) recovered and 6 (11.1%) did not recover. For children presenting with concurrent deficiencies of both Vitamin D and Vitamin B12 (n=38), 33 (86.8%) recovered, while 5 (13.2%) did not recover. These observations should be interpreted cautiously, as the deficiency groups were not mutually exclusive. However, the data suggests a generally high recovery rate across all subgroups following standard nutritional rehabilitation protocols (Figure 3).

Table 1: Baseline demographic characteristics of hospitalized severe acute malnutrition children (n=100).

Variable	Category	Number (N)	(%)	Mean±SD	Range (Min-Max)
Age (in months)	-	-	-	33.2±15.6	6–59
Sex	Male	58	58	-	-
	Female	42	42	-	-
Urban	Male	42	72.4	-	-
	Female	12	28.6	-	-
Rural	Male	16	27.6	-	-
	Female	30	71.4	-	-
Socioeconomic status*	I-II	12	12	-	-

Continued.

Variable	Category	Number (N)	(%)	Mean±SD	Range (Min-Max)
	II-III	36	36	-	-
	III-IV	52	52	-	-
Weight (kg)	-	-	-	6.1±1.8	3.0–8.9
Height (cm)	-	-	-	66.4±11.2	45.6–84.6
MUAC (cm)	-	-	-	9.7±1.1	8.0–11.5

*BJ Prasad Scale.

Table 2: Prevalence of serum vitamin D and vitamin B-12 deficiency.

Deficiency type	Number of cases (n=100)	Prevalence (%)
Vitamin D deficiency (95% CI: 52.3–71.0%)	62	62
Vitamin B-12 deficiency (95% CI: 44.2–63.5%)	54	54
Combined deficiency (both)	38	38

Table 3: Serum vitamin D and B12 levels in severe acute malnutrition children (n=100).

Variable	Mean±SD	Median	Range (Min-Max)	Deficiency threshold	% Below threshold
Serum vitamin D (ng/ml)	16.47±7.12	16.34	5.92-29.67	<20 ng/ml (deficient)	62
Serum vitamin B-12 (pg/ml)	182.6±73.4	183.5	51-299	<200 pg/ml (deficient)	54

DISCUSSION

This hospital-based study was carried out at Baba Raghav Das Medical College, Gorakhpur, U.P, India among 100 hospitalized children with SAM to study their demographic variables, clinical features, biochemical profile and various nutrient deficiencies. The results of this study contribute significantly to the understanding of the nutritional and biochemical status of children with SAM.

The male children constituted 58% (n=58) of all cases studied in this investigation and majority of children were belongs to lower socioeconomic status, similar to national demographics trends and possibly due to gender differences in terms of access to health care services and nutritional status.[23] Anthropometric evaluation showed the existence of under-nutrition in the children as evidenced by mean weight, height and MUAC of 6.1 kg, 66.4 cm and 9.7 cm, respectively. These results concur with WHO definition of SAM, that is weight-for-height z-score < −3 SD, MUAC <11.5 cm and/or bilateral nutritional edema.[24]

Infections and metabolic complications, including pneumonia, diarrhea, severe anemia, septicemia and hypoglycemia, were common, supporting previous reports and emphasizing the need to follow WHO management guidelines for SAM.[24,25] The prevalence of convulsions (62%) was notably high compared with other studies on complicated SAM, warranting further investigation into possible causes such as electrolyte disturbances, hypoglycemia, infections or neurological disorders. Vitamin D is important not only for healthy bones but also for proper functioning of immune system and cells. It affects macrophage activity, cytokines behavior and secretion of antimicrobial peptides. Thus,

Vitamin D deficiency was detected in 62% of children. It seems possible that the mechanisms listed above cause frequent cases of pneumonia and sepsis in patients with Vitamin D deficiency 26. Likewise, the rate of Vitamin B12 deficiency in the cohort was rather high (54%) serum vitamin B12 level in children was 182.6 pg/ml. Vitamin B12 has an important role in synthesis of DNA, erythropoiesis and brain maturation.[27] Children deficient in Vitamin B12 may suffer from megaloblastic anemia, developmental delays and cognitive impairment. This suggests that a large percentage of Vitamin B12 deficiency in this group of children poses significant risks in terms of adverse hematologic and neurodevelopmental outcomes. All these factors highlight the importance of early screening and adequate Vitamin B12 supplementation among children with SAM.[28] More importantly, 38% of the patients had a deficiency of both Vitamins D and B12.

The joint existence of such nutritional deficiencies could contribute to a higher likelihood of infections. Synergistic negative impacts on immune system function and blood cell production may contribute to worse clinical presentation in patients with both deficiencies compared to those having either deficiency. More often, Vitamin D and Vitamin B12 deficiencies existed simultaneously in cases involving children with multiple health complications and hospitalization lasting for longer periods of time, indicating the additive effects of such deficiencies on disease progression. Thus, joint diagnosis and treatment of such deficiencies should be considered an important part of the integrated management of SAM. The inclusion of routine Vitamin D and Vitamin B12 evaluation in the management of the condition might be instrumental in identifying the at-risk patients and providing appropriate treatment. Nevertheless, due to its observational nature, no causal relationship can be

derived from the study. More extensive prospective investigations will be necessary to confirm the findings and establish the clinical cutoffs for use in resource-poor environments. From the analysis, it was discovered that only 30% were exclusively breastfed, 50% practiced mixed feeding while 20% were exclusively formula-fed, showing that there is an inadequacy in the breastfeeding pattern amongst infants. According to the World Health Organization (WHO), a mother should practice exclusive breastfeeding for the first six months and then add complementary feeds and continue to breastfeed until two years and even more. It is evident from the information that a failure to do so could lead to complications such as malnutrition, diseases and underdevelopment. From the information provided above, the inadequate level of breastfeeding among children could be one of the reasons why the children are vulnerable to SAM. This study shows that the community should put more efforts into the education of optimal IYCF to reduce malnutrition amongst infants.

The high prevalence of pneumonia (58%) and sepsis (23%) underscores the close relationship between infection and malnutrition. The presence of severe acute malnutrition leads to immunocompromised children, who become vulnerable to infections. Infections further deteriorate the situation due to increased demands, poor appetite, inadequate absorption of nutrients and loss of nutrients. Furthermore, HIV infection was observed among 5% patients making the management more difficult due to immune-compromising effects. The correlation between biochemical markers and clinical presentations makes it clear that assessing micronutrients should be an integral part of the routine assessment and monitoring of children with SAM. The addition of serum Vitamin D and Vitamin B12 assessments to the routine screening process of admission could help predict and manage the risks involved in these conditions. Based on the results, it becomes evident that a comprehensive micronutrient profile should be added to the current protocol for the management of SAM in hospitals.

Ultimately, these findings emphasize the importance of comprehensive nutritional assessment in children with complicated SAM. Routine evaluation of vitamin D and vitamin B12 status facilitates the early identification of at-risk children. Incorporating targeted micronutrient screening and supplementation strategies into standard SAM management protocols could further improve long-term clinical recovery and reduce the overall disease burden in developing regions. Furthermore, addressing these dual nutritional deficits should remain a public health priority.

Limitations

The present study has several key limitations. First, it was conducted at a single tertiary care center with a relatively small sample size, which limits the generalizability of the findings and reduces the statistical power for subgroup analyses. Second, the evaluation was restricted to vitamin D and vitamin B12; other important micronutrients like iron, folate, zinc and vitamin A were not assessed, precluding a comprehensive understanding of multiple overlapping deficiencies. Third, clinical outcomes were only monitored until discharge. The lack of long-term follow-up data restricts the ability to evaluate prolonged impacts on growth, neurodevelopment, recurrence of malnutrition or post-discharge mortality. Finally, as an observational study where the deficiency groups were not mutually exclusive, the results can only highlight associations rather than establish independent, cause-and-effect relationships between specific micronutrient deficiencies and clinical outcomes.

CONCLUSION

This study demonstrates a high prevalence of both isolated and concurrent vitamin D (62%) and vitamin B12 (54%) deficiencies among children hospitalized with complicated SAM. These nutritional deficits are frequently accompanied by severe infectious and neurological complications, including pneumonia, acute gastroenteritis and convulsions. Encouragingly, standard inpatient nutritional rehabilitation yielded high clinical recovery rates across all patient subgroups, proving effective even for children burdened by concurrent micronutrient deficiencies. To further optimize clinical recovery and reduce the overarching disease burden, routine micronutrient screening and targeted supplementation should be integrated into standard SAM management protocols. Additionally, strengthening community-level infant feeding practices and breastfeeding promotion remains essential for the primary prevention of SAM and its associated complications.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. World Health Organization (WHO). Severe acute malnutrition: towards a framework for urgent action. Geneva: WHO. 2009.
2. UNICEF, WHO, World Bank. Levels and trends in child malnutrition: Key findings of the 2021 edition. New York: UNICEF. 2021.
3. Black RE, Victora CG, Walker SP. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427-51.
4. UNICEF. The State of the World's Children 2019: Children, Food and Nutrition. New York: UNICEF. 2019.
5. International Institute for Population Sciences (IIPS), Macro International. National Family Health Survey (NFHS-5), 2019-2021. Mumbai: IIPS. 2021.

6. Bhutta ZA, Salam RA, Das JK. Meeting the challenges of micronutrient malnutrition in the developing world. Br Med Bull. 2013;104(1):37-47.
7. International Institute for Population Sciences (IIPS), Macro International. National Family Health Survey (NFHS-4), 2014-15: India. Vol. I. Mumbai: IIPS. 2016.
8. Hoddinott J, Alderman H, Behrman JR. The economic rationale for investing in stunting reduction. Matern Child Nutr. 2013;9(2):69-82.
9. Manary MJ, Sandige HL. Management of acute moderate and severe childhood malnutrition. BMJ. 2008;337:2180.
10. Sturgeon JP, Njunge JM, Bourke CD, Gonzales GB, Robertson RC, Bwakura-Dangarembizi M, et al. Inflammation: the driver of poor outcomes among children with severe acute malnutrition. Nutr Rev. 2023;81(12):1636-52.
11. Rasmussen SA, Fernhoff PM, Scanlon KS. Vitamin B12 deficiency in children and adolescents. J Pediatr. 2001;138:10-17.
12. Matoth Y, Zehavi I, Topper E, Klein T. Folate nutrition and growth in infancy. Arch Dis Child. 1979;54:699-702.
13. Nair R, Maseeh A. Vitamin D: The "sunshine" vitamin. J Pharmacol Pharmacother. 2012;3(2):118-26.
14. Saleem J, Zakar R, Zakar MZ, Belay M, Rowe M, Timms PM, et al. High-dose vitamin D3 in the treatment of severe acute malnutrition: a multicenter double-blind randomized controlled trial. Am J Clin Nutr. 2018;107(5):725-33.
15. Maurya M, Sharma P, Srivastava A, Rai R, Singh DK. Effect of vitamin D supplementation in children with severe acute malnutrition in a nutritional rehabilitation centre: a randomized controlled trial. Int J Pediatr Res. 2018;5(5):278-83.
16. Allen LH. Causes of vitamin B12 and folate deficiency. Food Nutr Bull. 2008;29(2):20-34.
17. Stabler SP. Vitamin B12 deficiency. N Engl J Med. 2013;368(2):149-60.
18. Atiq A, Shah D, Sharma S, Meena RK, Kapoor S, Gupta P. Prevalence and predictors of vitamin B12 deficiency in children with severe acute malnutrition and its association with development. Indian J Pediatr. 2025;92(1):15-21.
19. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization. 2006. Available at: http://www.who.int/childgrowth/standards/technical_report/en/index.html. Accessed on 21 December 2025.
20. Daniel WW, Cross CL. Biostatistics: A Foundation for Analysis in the Health Sciences. 11th ed. Hoboken, NJ: John Wiley & Sons. 2018.
21. World Health Organization. WHO child growth standards: training course on child growth assessment. Geneva: WHO. 2008. Available at: https://www.who.int/publications/i/item. Accessed on 21 January 2026.
22. Randox Laboratories. Randox RX Series Semi-Automated Clinical Chemistry Analyzer: Operator and System Manual. Crumlin, County Antrim, UK: Randox Laboratories Ltd. 2018.
23. Ezzat S, Ghaly M, El Sayed H. Electrolyte imbalances and their impact on recovery from severe acute malnutrition in children. J Pediatr Endocrinol Metab. 2015;28(2):115-21.
24. World Health Organization. Guideline: Updates on the management of severe acute malnutrition in infants and children. Geneva: WHO. 2013.
25. Ashworth A, Khanum S, Jackson A, Schofield C. Guidelines for the inpatient treatment of severely malnourished children. Geneva: World Health Organization. 2003.
26. Chisti MJ, Salam MA, Ashraf H. Clinical risk factors of death from pneumonia in children with severe acute malnutrition in an urban critical care ward of Bangladesh. PLoS One. 2013;8(9):73728.
27. Ahmed T, Hossain M, Sanin KI. Global burden of maternal and child undernutrition and micronutrient deficiencies. Ann Nutr Metab. 2012;61(1):8-17.
28. Sadler K, Myatt M, Feleke T. A comparison of the programme coverage of two therapeutic feeding interventions implemented in neighbouring districts of Malawi. Public Health Nutr. 2007;10(9):907-13.

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