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ORIGINAL ARTICLE

STATUS OF VITAMIN D LEVELS AND ASSOCIATED RISK FACTORS IN SEVERE ACUTE MALNUTRITION IN CHILDREN UP TO 60 MONTHS OF AGE- A CROSS SECTIONAL STUDY FROM NORTH-WEST INDIA

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ABSTRACT

Objective: A prospective study was conducted in a tertiary care centre in north-west India, to determine the status of vitamin D levels and associated risk factors in severe acute malnutrition in children up to 60 months of age.

Methods: Study was done over a period of one year, hundred patients of severe acute malnutrition (SAM) admitted in our tertiary care centre, fulfilling the inclusion criteria were enrolled in the study. After detailed history and examination, patients were evaluated for calcium, phosphorus, alkaline phosphatase and vitamin D levels.

Results: Vitamin D levels were <20 ng/ml in 58% of all studied children, out of which 28% children had inadequate and 30% had deficient levels. Co-relation of vitamin D deficiency (VDD) in SAM patients with various risk factors like age, previous hospitalization, not giving exclusive breastfeeding, protein deficit and lower socioeconomic status were found to be statistically significant.

Conclusion: High prevalence of VDD in patients of SAM needs active surveillance and management.

ARTICLE HISTORY

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KEYWORDS

Vitamin D, severe acute malnutrition, children.

Introduction

Childhood malnutrition is an important public health and development challenge in India. Malnourished children have a significantly higher risk of mortality and morbidity. In addition to increasing the risk of disease and death, malnutrition also causes stunted growth and impaired psychosocial and cognitive development. Severe Acute Malnutrition (SAM) is defined as the presence of severe wasting (weight for height <-3 SD) or mid-upper arm circumference (MUAC) less than or equal to 11.5 cm or bilateral edema.[1] Every year million children die before they reach their fifth birthday. Seven out of every ten of these deaths are caused by diarrhoea, pneumonia, measles, malaria or malnutrition.[2]

SAM children are known to be deficient in vitamins and trace elements.[3] SAM children must also have normal skeletal growth and bone health. Calcium and vitamin D are important nutrients for bone growth and bone health.[4] Insufficient bone mineralization and disruption of growth plates due to vitamin D and calcium deficiency or phosphate metabolism disorder leads to rickets in children.[5]

We hypothesized that malnutrition may mask the clinical features of rickets and other biochemical features associated with severe acute malnutrition. With this background we conducted a study to assess the status of vitamin D levels in children with SAM and risk factors associated with vitamin D deficiency (VDD).

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Objectives of the study:

To determine status of vitamin D levels and associated risk factors in SAM children up to 60 months of age.

Methods & Materials

A cross- sectional descriptive study was conducted in the department of Pediatrics, Dr. Rajendra Prasad medical college Kangra at Tanda, Himachal Pradesh in India over one year i.e. from August 2018 to July 2019 after ethical approval from institutional ethical committee. On the basis of study participant selection criteria, 100 i.e. 3.1% of total patients admitted in pediatric ward were enrolled in our study after getting informed written consent from the parents. Enrolled patients were managed as per standard treatment guidelines of SAM.

Selection criteria:

All the children aged up to 60 months getting admitted in the department of Pediatrics, fulfilling any one out of the four criteria for SAM as per World Health Organization (WHO)[5] guidelines were included in study. Children with other causes of edema for example; nephrotic syndrome and/or associated systemic diseases, congenital heart disease, mal-absorption, cerebral palsy and who have received mega dose of vitamin D in last six months were excluded. A total of 138 children were screened, 38 were excluded based on our exclusion criteria and finally 100 Children were found eligible according to inclusion criteria. (Figure 1) Detailed history regarding the risk factors and examination of all patients was done. Along with

standard set of investigations, all patients were tested for serum calcium, phosphorus, alkaline phosphatase (ALP) and vitamin D levels. Vitamin D levels were done by 5P02 ARCHITECT 25-OH vitamin D reagent kit using electro-chemilumniscense immune assay technique which measure vitamin D concentrations in the range of 0-160 ng/ml. Vitamin D levels ≥20 ng/mL were taken as adequate, 12-20 ng/mL were taken as inadequate and <12 ng/mL were taken as deficiency. Children were treated as per SAM protocol guidelines and their course of stay was monitored periodically (biweekly) and were discharged as per criterias in WHO Guidelines.[6] Data was collected on prescribed precoded performa and was transferred to Microsoft Excel sheet. Microsoft Excel was used in creating the database and producing graphs, while the data was analyzed using Stata software. Percentage, frequency; mean and standard deviation (±SD) were used to describe quantitative data meeting normal distribution. Clinical profile and risk factors for severe acute malnutrition were correlated with vitamin D levels. The level of significance was taken as P <0.05.

Results

Out of a total of 3278 children admitted who were less than 5 years of age, 138(4.2%) children were severely acute malnourished. On the basis of study participant selection criteria, 100(3.1%) SAM children were enrolled in our study. Forty seven percent children were under 1 year, followed by 27.0% who were in 13-36 months age group and 26.0% were in >36 months age group; while mean age of studied children was 25.31±20.09 months. Out of 100 patients, 66 were males and 34 were females, with male:female ratio of 2:1 (Table1).

Table 1. Demographic Distribution Of Studied Children.

Age(Months)	Frequency(n=100)	Percentage
≤12 Months	47	47.0%
13-36 Months	27	27.0%
36 Months	26	26.0%
Males	66	66%
Females	34	34%

Failure to gain weight was complaint in all patients, fever in 74.0%, followed by cough in 42.0%, diarrhea in 18.0%, convulsion in 14.0%, lethargy in 10.0%, pallor in 7%, bleeding manifestations in 2 %, generalized body swelling and weight loss in 1.0% each. Sixteen percent of patients had history of previous hospitalization, out of which in 37.5% admissions were due to respiratory illness, followed by diarrhoea, seizure disorder, malnutrition, meningitis & tuberculosis. During initial six months of life, 55.0% of studied children were on mixed (breast+ top) feeding, 40% were on breast feeding and 5.0% were on top feeding. Out of all children who were not on exclusive in first 6 months of life, diluted cow's milk (51.6%) was the most common type of milk used, bottle feeding (36.0%) was the most common mode of feeding, but the sterilization technique was improper in all cases. In 8.0% cases complimentary feeding was started before 6 months while 92.0% cases were started on complimentary feeding after 6 months, out of which only 12% were fed as per infant and young child

Figure 1. Inclusion criteria.

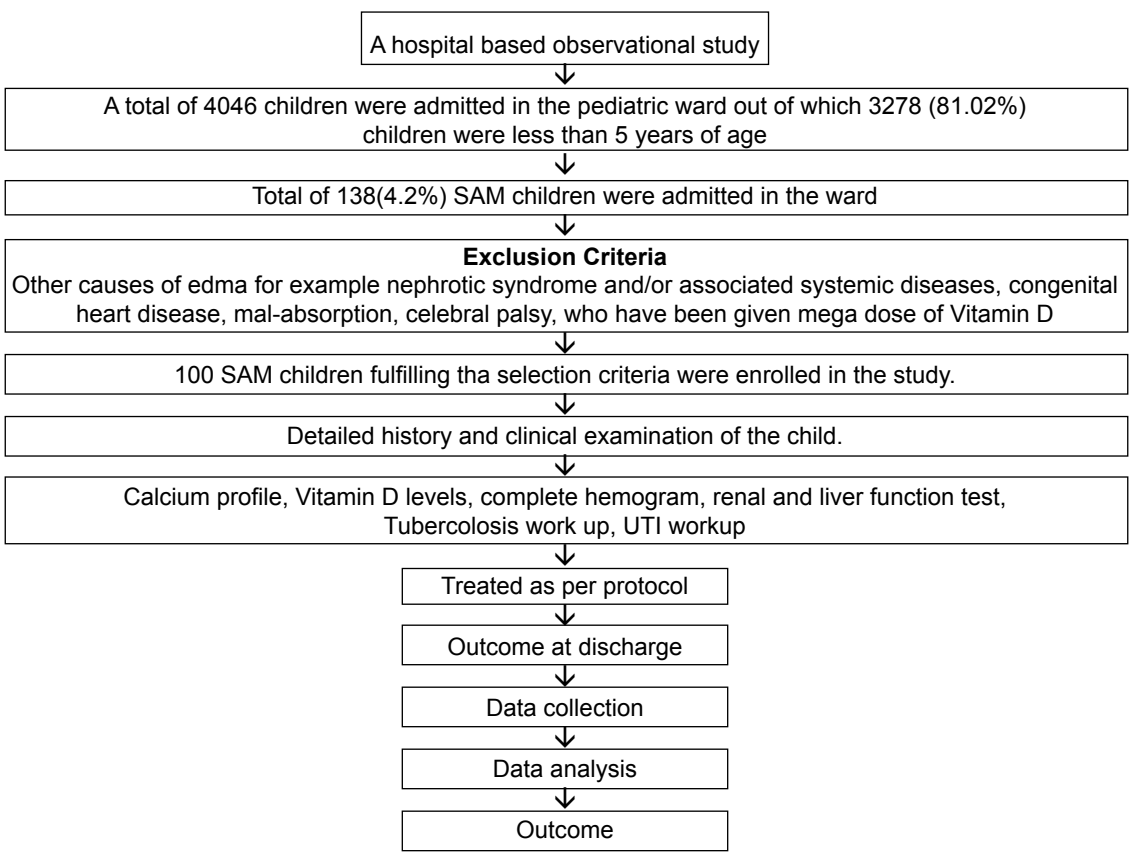

Table 2. Distribution of Children on Basis of Calcium Profile.

	Calcium Profile	Frequency(n=100)	Percentage
Calcium Profile	Hypocalcaemia(<9 mg/dl)	39	39.0
	Normal(9-11 mg/dl)	61	61.0
Phosphorus	Phosphorus Deficient(<4 mg/dl)	16	16.0
	Normal(4-7 mg/dl)	74	74.0
	Phosphorus Excess(>7 mg/dl)	9	9.0
ALP	≤383 U/L	94	94.0
	>383 U/L	6	6.0

Table 3. Distribution of Studied Children on the Basis of Vitamin-D Profile.

	Vitamin D	Frequency(n=100)	Percentage
<12 ng/ml	Deficiency	30	30.0%
12-20 ng/ml	Inadequate	28	28.0%
>20 ng/ml	Adequate	30	30.0%
>50 ng/ml	Toxicity	12	12.0%

feeding (IYCF) guidelines. All children were found to be calorie deficit and 95% had protein deficit. Most of the studied children were receiving sufficient time of sunlight exposure in both (summers & winters) seasons and all children were partially covered. As per modified Kuppuswamy scale, 90.0% children belonged to upper lower class, followed by lower middle (8.0%) and upper middle (2.0%). Thirty nine percent (39%) of the mothers were educated till high school, 35% till intermediate, followed by 15% upto primary/middle school, 6% were illiterate and 5.0% were graduate. Ninety nine percent children utilized anganwadi services. Eighty two percent (82%) children were small for date (SFD) at birth, while 18% were appropriate for date (AFD). Weight for age was <-3SD in 88% children, weight for height was <-3SD in 100% children; while 22.0% had MUAC ≤11.5 cm, 64% had visible wasting and 10% had pedal edema. Mean age was 25.31±20.09 months, birth weight was 2.34±0.44 Kg, present weight was 7.41±2.76 Kg, height was 76.50±17.57 cm, occipito-frontal circumference (OFC) was 43.98±4.4cm and MUAC was 12.78±1.83 cm. Laboratory examination showed evidence of hypocalcaemia in 39%, low phosphorus levels in 16% and high alkaline phosphate levels of >383 U/L in 6% children (Table 2). Vitamin D levels were <20ng/ml in 58% of all studied children, out of which 28% children had inadequate and 30 % had deficient levels (Table 3). Clinical signs of rickets present in 10% of the patients. Co-relation of vitamin D deficiency in SAM patients with various risk factors like age, previous hospitalization, not exclusive breastfeed, protein deficit and lower socioeconomic status, were found to be statistically significant (Table 4).

Discussion

Nutrition is essential for human development during first five years, it not only affects growth and morbidity, but also determines nutritional status of adolescents and adults. The incidence of SAM was found to be higher in younger children i.e. 74.0% in the children less than 3 years of age. The reason may be the fact that growth and the nutritional needs are maximum in younger age group.[7]

We found that, the incidence of children under SAM among all hospitalized children was 4.2%. Our findings showed marked increase in prevalence as compared with the study performed by Bhadoria AS et al[8] who reported a prevalence of SAM as 2.20%. But prevalence of SAM in our study was lower as compared to national prevalence (7.9%).[9] Reason of disparity could be-lower parental education and poor occupation of the head of family predispose a child to SAM. In a similar study from Puducherry by Shewade HD et al[10], reported the prevalence of SAM among children from slums in the similar age group (6 months–5 years) as 3.60% and Pravana NK et al[11] reported the prevalence of SAM among children under the age of 5 years was 4.14%. So the results of studies done by Shewade HD et al[10] and Pravana NK et al[11] are comparable with the results of our study.

In the present study, chief complaints of studied children were failure to gain weight in 100%, fever in 74.0%, followed by cough in 42.0%, diarrhea in 18.0%, convulsion in 14.0%, lethargy in 10.0%, pallor in 7%, bleeding manifestations in 2%, generalized body swelling and weight loss in 1.0% each. Fifty five percent of the studied children were on Mixed (breast+ top) feeding, 40% were on Breast feeding and 5.0% were on top feeding in first 6 months of life. Similar findings were reported by Pravana NK et al[11] and Prashanth MR et al[12] in their respective studies. This showed that feeding practices are not effective and may be a contributory factor for malnutrition. All the studied patients were found to be calorie deficient and 95% had protein deficit. Prashanth MR et al[12] reported calorie deficit in 79.6% and protein deficit in 66.0% patients. There is considerable uncertainty regarding the estimated calorie and protein intakes of breastfed children and the interpretation of dietary intakes has to be viewed with caution.

Ninety percent children belonged to upper lower class, followed by lower middle (8.0%) and upper middle (2.0%). Pravana NK et al[11] reported the majority of their patients of lower group. Studies conducted

Table 4. Risk Factors Associated With Vitamin D Deficiency.

S. No.	Risk Factors associated	Frequency(n=100)	Vitamin D Deficiency Mean + SD		P value
1	Age	<12 Months	47	35.44+35.97	0.050*
		13-36 Months	27	24.99+13.09	
		>36 Months	26	19.02+8.59	
2	Sex	Male	66	28.44+26.41	0.956
		Female	34	28.79+28.37	
3	Previous Hospitalization	Yes	16	49.22+44.79	0.002*
		No	84	24.51+20.34	
4	Feeding	Breastfeeding	40	27.99+26.60	0.883
		Top feeding	5	22.94+16.49	
		Mixed (breast+top)	55	29.22+28.29	
5	Exclusive Breastfeeding	Given	40	27.99+26.60	0.043**
		Not Given	60	52.16+44.78	
6	Milk Dilution	With dilution	100	30.58+31.41	0.530
		Without dilution	0	0.0+0.0	
7	Complementary Feeding	After 6 months As per IYCF guidelines	12	29.50+15.19	0.598
		After 6 months Poor adherence	80	29.11+29.15	
		Before 6 months	8	17.53+11.13	
8	Calorie Deficit	Yes	100	6.31+11.09	-
		No	0	0.0+0.0	
9	Protein Deficit	Yes	95	28.90+26.90	0.024*
		No	5	4.95+5.44	
10	Socioeconomic Status	Upper Middle	2	84.25+91.57	0.010*
		Lower Middle	8	25.64+14.69	
		Upper Lower	90	27.11+24.39	
11	Maternal Education	Illiterate	6	23.0+18.44	0.803
		Primary/Middle school	15	28.86+18.65	
		High School	39	26.45+24.61	
		Intermediate	35	32.23+34.41	
		Graduate	5	18.36+6.68	
12	Utilization Of Aganwadi Centre	Yes	99	28.59+26.89	0.421
		No	1	6.70+0.0	
13	Birth weight	<2.5 kg	82	30.19+28.80	0.175
		>2.5 kg	18	19.78+11.94	
14	Weight for age	<-3SD	88	29.31+28.43	0.187
		>-3SD	12	22.48+13.15	
15	Height for age	<-3SD	39	29.87+27.51	0.697
		>-3SD	61	27.47+26.67	
16	Weight for Height	<-3SD	100	28.33+26.83	-
		>-3SD	0	0.0+0.00	
17	Mid-Upper Arm Circumference (MUAC)	<11.5cm	22	31.03+41.76	0.622
		>11.5cm	78	27.54+20.98	

by Dwivedi et al[13] and Avachat et al[14] came up with similar inferences. Better socioeconomic conditions are associated with more spending capacity, better living conditions and better-updated knowledge of the parents, hence could result in reduction of malnutrition. In our study, 39% of the mothers were educated till high school, 35% till intermediate, followed by 15% upto primary/middle school, 6% were illiterate and 5.0% were graduate. Sahoo DP et al[15] reported almost the similar data as in present study. It is the fact that mother's education is associated with the awareness about the proper child-rearing practices, better health-seeking attitude and better knowledge about feeding and immunization.

We found that, 99.0% of the cases have utilized the services of Anganwadi Centre. This showed the health seeking behavior of the studied population, although there was delay in seeking tertiary health care services. This could be because of poor socioeconomic status, difficult terrain and local beliefs and taboos prevailing in our studied population.

In present study 82% children were SFD at the time of birth, while 18% were AFD. Weight for age was <-3SD in 88% children, weight for height was <-3SD in 100% children; while 22.0% had MUAC ≤11.5 cm, 64% had visible wasting and 10% had pedal edema. Sahoo DP et al[15] reported 37.8% of the children were underweight (weight for age) and 14.4% were severely underweight. Stunting (height for age) was present in 37% of the children and 5.2% were severely stunted. Wasting (weight for age) was present in 35.6% of the children and 14.8% were severely wasted which was similar to the present study. In our study the anthropometric parameters (i.e. W/A, W/H) are more affected as compared to other studies. This could be because of low birth weight, poor socioeconomic status, local beliefs and taboos regarding feeding practices in our studied population.

In our study, 39% of children were hypocalcemic, 16% had low phosphorus levels and 6% had Alkaline e phosphate levels >383U/L. Fifty eight percent of all studied children were having Vitamin D levels<20 ng/ml, out of which 28% children had inadequate and 30% had deficient levels. Prevalence of VDD in malnourished children in study conducted by Mehta S[16] was 32%. These findings were similar to those seen in Pakistan (33.6%).[17] VDD in children from other countries shows variable prevalence, for instance the prevalence among 12–24 month-olds in China was 65.3%.[18] This may be because all other studies had different age groups of children. Our data is comparable to the data from these studies which indicate that VDD is prevalent in SAM children. This could be related to poor nutritional intake, poor sunlight exposure and possibly impaired absorption due of enteric dysfunction or a disease process.

We found that age, previous hospitalization, not giving exclusive breastfeeding, protein calorie deficit and lower socioeconomic status were statistically significant ($p<0.05$) risk factors associated with vitamin D deficiency in SAM children. There were no such extensive previous studies which showed the association of risk factors in SAM patients having deficiency of vitamin-D. So our study is novel to do the extensive evaluation of association of risk factors in SAM patients having deficiency of vitamin-D.

Nutrition is essential for human development during first five years, it not only affects growth and morbidity, but also determines nutritional status of adolescents and adults. The incidence of SAM was found to be higher in younger children i.e. 74.0% in the children less than 3 years of age. The reason may be the fact that growth and the nutritional needs are maximum in younger age group.[7]

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Limitations:

Study was conducted in single centre with small sample size. There were confounding factors in the study, those were not analysed like children who were small for gestation infants who can be in there catch growth period, associated comorbid conditions which is not included in exclusion criteria and infants <6 months were also included in the study. Hence multicentric detailed studies with larger sample size are recommended.

Conclusion

The clinical signs of rickets are unlikely to present in SAM patient and thus vitamin D deficiency is often under diagnosed. On initiation of nutritional rehabilitation the overt signs of rickets develop if vitamin D deficiency is not treated. As per this study, significant percentage (58%) of SAM patients had vitamin D deficiency. Hence, there is a need for active surveillance and management of the same.

Compliance with Ethical Standards

Funding : None

Conflict of Interest : None

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