ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

THE PREVALENCE AND TYPES OF ANAEMIA IN SEVERE ACUTE MALNUTRITION CHILDREN WITH AGE GROUP FROM 6 MONTHS TO 59 MONTHS IN NUTRITIONAL REHABILITATION CENTER OF BRD MEDICAL COLLEGE, GORAKHPUR

Dr. Mohit Kumar[1], Dr. Bhoopendra Sharma[2], Dr. Priyanka Singh[3], Dr. Vijay Singh[4], Dr. Archana Bundela[5]

1.Junior Resident, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India
2.Professor & Head, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India
3.Assistant Professor, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India
4.Assistant Professor, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India
5.Associate Professor, Department of Pathology, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India

***Corresponding author: Dr. Bhoopendra Sharma**
Professor & Head, Department of Pediatrics, Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh-273013, India

ABSTRACT

Aim: The aim of the present study was to assess the prevalence and types of anaemia in severe acute malnutrition children with age group from 6 months to 59 months.

Methods: The Cross-Sectional study was conducted at Department of Pediatrics, Nutritional rehabilitation center of BRD Medical College, Gorakhpur for the period of one year (September 2021 to August 2022). 116 cases were included in the study. Permission for Ethical clearance was sought from the institutional human ethics committee of BRD Medical College.

Results: Out of 98 anemic children 64 (65.3%) were mild anemic, 22 (22.4%) were moderate anemic. Out of 116 patients, 65 (56%) were classified as microcytic hypochromic blood picture while 26 (22.4%) were dimorphic blood picture, 18 (15.5%) were distributed as macrocytic blood picture and 7 (6%) were classified as normocytic normochromic blood picture. Out of 116 subjects, there were 62 (53.4%) males and 54 (46.6%) females. Out of 116 neonates, 97 (83.6%) were less than or equal to 2 years and 19 (16.4%) were more than 2 years. Out of 116 patients, 80 (69%) were moderately underweight while 19 (16.4%) were underweight and 17 (14.7%) were severe underweight. Out of 116 patients, 58 (69%) were moderately stunting while 38 (32.8%) were stunting and 20 (17.2%) were severe stunting.

Conclusion: No significant odds of anaemic status were found when associated with the independent parameters. In addition, clinicians working in maternal and child health departments are recommended to strengthen the treatment of HIV infection before causing further damages.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

Keywords: anaemic, maternal and child health, underweight, HIV

1. INTRODUCTION

Anemia contributes to a wide range of health problems like heart failure, poor cognitive performance, and macro- and micronutrient deficiencies.[1,2] The burden is the third top ranked childhood cause of death, which accounted for 8.1% of the total mortalities.[3] Anemia is a hematological disorder that occurs in individuals of all ages though it is most prevalent and severe among reproductive-age women, children younger than five years, sick children, and children suffering from other nutritional deficiency disorders.[4] A sufficient hemoglobin concentration in the human blood is an important indicator of the availability of enough trace minerals, especially iron, as it is a precursor for the synthesis of hemoglobin, which is an important messenger that transports crucial nutrients and oxygen to different parts of the body.[5] A hemoglobin concentration below 11 g/dl is defined as anemia.[6] Anemia is associated with micronutrient deficiencies such as vitamin B-12 and B-9, as well as different infectious diseases that primarily attack the red blood cells.[7,8]

Childhood malnutrition can have long-term physical and cognitive repercussions. The literature indicates that both fetal and childhood malnutrition have a marked effect on adult anthropometric outcomes.[9] Furthermore, malnourished children display a reduced immune response compared with their well-nourished counterparts.[10] Childhood malnutrition also has significant economic repercussions. Evidence suggests that productivity is decreased in individuals who have experienced childhood malnutrition.[11] A Zimbabwean study demonstrated a causal relationship between suboptimal pre-school nutritional status and an estimated loss of lifetime earnings of at least 7–12%.[12] Childhood malnutrition is perhaps the greatest public health concern in Africa, with 60 million pre-school children displaying stunted growth, a figure which is set to rise to 64 million by 2020.[13] Consequently, there is a pressing need to identify children at risk of malnutrition and institute effective nutritional supplementation programmes.

Anaemia is a significant illness that has ramifications for cognitive development. The effects of iron deficiency in the first six months of birth can result in irreversible brain damage. A kid that is affected is more likely to be susceptible to illness and have poorer immunity to infection throughout childhood. Additionally, the child's appetite is lowered, and this vicious loop perpetuates a series of occurrences that must be prevented in order to preserve the child's health. Anaemia is typically a slow and progressive condition that is caused by a lack of iron (ID). Poor food habits in early childhood, particularly during the weaning stage, exacerbate the problem. Anaemia usually develops as breast milk is replaced with meals low in iron and other minerals, such as Vitamin B12 and folic acid. Low oxygenation of brain tissues as a result of anaemia may affect cognitive function, growth, and psychomotor development, particularly in youngsters. Infants, children under the age of five, and pregnant women are more vulnerable to anaemia due to increased iron needs caused by fast body growth and red blood cell proliferation.[14] ID is the most prevalent dietary deficit in children that causes anaemia. It usually occurs when daily dietary iron consumption and iron absorption are insufficient to meet physiological needs. As a developing country, India's nutrition and infections are a limiting factor creating this condition.[15] ID is evaluated by ferritin storage, and ferritin depletion is the initial sign of ID anaemia (IDA). IDA is a serious health concern in the country, despite the government's efforts to implement numerous measures for pregnant women and children to keep up with iron storage.[16]

The aim of the present study was to assess the prevalence and types of anaemia in severe acute malnutrition children with age group from 6 months to 59 months.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

2. MATERIALS AND METHODS

The Cross-Sectional study was conducted at Department of Paediatrics, Nutritional rehabilitation centre of BRD Medical College, Gorakhpur for the period of one year (September 2021 to August 2022). 116 cases were included in the study. Permission for Ethical clearance was sought from the institutional human ethics committee of BRD Medical College.

INCLUSION CRITERIA

- Age between 6 months to 59 months whose weight for height/ length was <-3 SD using the Standard World Health Organization (WHO) growth charts, a mid-upper arm circumference (MUAC) <115 mm or had edema of bilateral feet were included in the study.
- The patient should be admitted in NRC of BRD Medical College Gorakhpur
- Patient/ Guardian giving written informed consent will be taken.

EXCLUSION CRITERIA

- Patient with Age <6 months
- Patient with Age >59 months
- Patient / Guardian not giving consent
- Children with clinical signs of systemic illness

DATA COLLECTED

Data was collected from the nutritional rehabilitation centre of BRD medical College and was charted in a preprepared working proforma which was include age, sex, birth order, birth weight, education, Z score and occupation of father.

METHODS

This study was conducted in nutritional rehabilitation centre of pediatric department of BRD medical College Gorakhpur over the period of 12 months. All the consecutive children from OPD and IPD fulfilling the inclusion criteria was enrolled for the study after taking proper consent from parent and the study was done in the patient should follow the SAM criteria.

Severe acute malnutrition (SAM): Defined by low weight-for-height/ length (Z score <- 3 SD of median WHO child growth standards), a mid- upper arm circumference < 115 mm, or presence of bilateral pitting edema. A detailed epidemiological and clinical history of patient was taken.

Table 1: Distribution of anemic patients in SAM patients (N=116)

Hb	Frequency	Percent
Anemic	98	84.5
Non-Anemic	18	15.5

Out of 116 children, 98 (84.5%) were anemic and18 (15.5%) were non-anemic.

INVESTIGATIONS

- CBC (HB level, red cell count, white cell count, Hematocrit, MCV, MCH, MCHC, RDW)
- GBP with Reticulocyte count
- S. Iron
- S. ferritin Vit-B12
- S. folic acid Urine (R/M) Stool Microscopy

STATISTICAL TOOLS

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean and SD. Qualitative variables were compared using Chi-Square test /Fisher's exact test as appropriate. To measure the strength of association between two scale parameters using Spearman correlation coefficient as appropriate. A p value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 23.0.

3. RESULTS

Table 2: Patient details

Anaemic category	**Frequency**	**Percent**
Mild	64	65.3
Moderate	22	22.4
Severe	12	12.2
Total	98	100.0
GBP		
Dimorphic blood picture	26	22.4
Macrocytic blood picture	18	15.5
Microcytic hypochromic blood picture	65	56.0
Normocytic normochromic blood picture	7	6.0
GENDER		
Male	62	53.4
Female	54	46.6
Age intervals		
<=2 years	97	83.6
>2 years	19	16.4
SOCIO-ECONOMIC STATUS		
Lower	68	58.6
Lower middle	6	5.2
Middle	1	.9
Upper lower	41	35.3
Complications		
fever	47	40.5
Diarrhoea/vomiting	11	9.5
Loss of appetite.	69	59.5
seizure	6	5.2
cough/ difficulty in breathing	28	24.1
DEVELOPMENTAL HISTORY		
Normal	84	72.4
Delayed	32	27.6

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

Out of 98 anemic children 64 (65.3%) were mild anemic, 22 (22.4%) were moderate anemic. Out of 116 patients, 65 (56%) were classified as microcytic hypochromic blood picture while 26 (22.4%) were dimorphic blood picture, 18 (15.5%) were distributed as macrocytic blood picture and 7 (6%) were classified as normocytic normochromic blood picture. Out of 116 subjects, there were 62 (53.4%) males and 54 (46.6%) females. Out of 116 neonates, 97 (83.6%) were less than or equal to 2 years and 19 (16.4%) were more than 2 years. Mean age was 1.33±0.89 years and median were 1.10 years and inter quartile range was 0.70 to 1.70. Out of 116 subjects, the higher majority of subjects (68) were from lower class (58.6%) while 35.3% (41) were from upper lower class, 5.2%. Out of 116 subjects, 47 (40.5%) patients had fever; 11 (9.5%) patients had Diarrhoea or vomiting; 65 (56%) patients were not gaining weight or had lose their appetite; 6 (5.2%) patients had seizures; 28 (24.1%) patients had difficulty in breathing and cough related problems. Out of 116 patients, 84 (72.4%) had normal development while 32 (27.6%) had delayed development.Table 3: Associated factors

TOP FEED	**Frequency**	**Percent**
Yes	33	28.4
No	83	71.6
Immunization		
Immunized	25	21.6%
partial	91	78.4%
PRBC transfusion		
Yes	39	33.6
No	77	66.4
Weight for Age		
<-2SD (Underweight)	19	16.4
-2SD to -3SD (Moderately underweight)	80	69.0
<-3SD (Severe underweight)	17	14.7
Height for Age		
<-2SD(Stunting)	38	32.8
-2SD to -3SD (Moderate stunting)	58	50.0
<-3SD (Severe stunting)	20	17.2
Outcome		
Death	6	5.2
Discharged	110	94.8

Out of 116 patients, 33 (28.4%) had top feed. Out of 116 neonates, 25 (21.6%) were immunized while 91 (78.4%) were partially immunized. Blood transfusion was found in 33.6% patients. Out of 116 patients, 80 (69%) were moderately underweight while 19 (16.4%) were underweight and 17 (14.7%) were severe underweight. Out of 116 patients, 58 (69%) were moderately stunting while 38 (32.8%) were stunting and 20 (17.2%) were severe stunting. Out of 116 patients, 110 (94.8%) were discharged while 6 (5.2%) were expired.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

Table 4: Correlation of Vitamin B12, S. ferritin (ng/ml), S. iron with hemoglobin, MCV and PCV in SAM patients

	Vitamin B12 (pmol/l)	**Hb (gm/dl)**	**MCV**	**PCV**
Spearman's rho Correlation Coefficient	1.000	0.227	-0.004	0.280
p-value	.	**0.015**	0.970	**0.002**
	S. ferritin (ng/ml)	**Hb (gm/dl)**	MCV	**PCV**
Spearman's rho Correlation Coefficient	1.000	**-0.083**	0.139	**-0.135**
p-value	.	**0.376**	0.136	**0.150**

	S Iron (mcg/dl)	**age/sex**	**Hb[gm/dl]**	**MCV**	**PCV**
Spearman's rho Correlation Coefficient	1.000	0.004	0.182	0.176	0.051
p-value	.	0.964	0.052	0.059	0.587

Hemoglobin and PCV shows positive correlation with vit. B12 and PCV showed a significant correlation with vit. B12. Meanwhile MCV shows negative correlation with vit. B12. . Hemoglobin and PCV shows negative correlation with serum ferritin. Meanwhile MCV shows positive correlation with serum ferritin. No significant correlation was found.

Table 5: Univariate analysis of aetiological parameters: dependent on anaemic status in SAM patients

		Anaemic Status				**Unadjusted OR (95% CI)**	**p-value**
		Anaemic		Non-Anaemic			
		N	%	N	%		
Age intervals	<=2 years	83	84.7%	14	77.8%	ref	
	>2 years	15	15.3%	4	22.2%	1.58 (0.46 to 5.46)	0.469
Sex	Male	52	53.1%	10	55.6%	ref	
	Female	46	46.9%	8	44.4%	0.90 (0.33 to 2.49)	0.845

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

Loss of appetite	Yes	54	55.1%	11	61.1%	ref	
	No	44	44.9%	7	38.9%	0.78 (0.28 to 2.18)	0.637
Developmental history	Normal	71	72.4%	13	72.2%	ref	
	Delayed	27	27.6%	5	27.8%	1.01 (0.33 to 3.11)	0.984
Top feed	Yes	27	27.6%	6	33.3%	ref	
	No	71	72.4%	12	66.7%	0.76 (0.26 to 2.23)	0.618
Immunization	Immunized	24	24.5%	1	5.6%	ref	
	Un immunized	74	75.5%	17	94.4%	5.51 (0.69 to 43.6)	0.106
PRBC transfusion	Yes	33	33.7%	6	33.3%	ref	
	No	65	66.3%	12	66.7%	1.02 (0.35- to 2.95)	0.978
Weight for Age	<-2SD	17	17.3%	2	11.1%	ref	
	-2SD to -3SD	67	68.4%	13	72.2%	1.65 (0.34 to 8.02)	0.535
	<-3SD	14	14.3%	3	16.7%	1.82 (0.27 to 12.5)	0.541
Height for Age	<-2SD	34	34.7%	4	22.2%	ref	
	-2SD to -3SD	47	48.0%	11	61.1%	1.99 (0.58 to 6.78)	0.272
	<-3SD	17	17.3%	3	16.7%	1.5 (0.30 to 7.48)	0.621
Weight for height	<-2SD	23	23.5%	3	16.7%	ref	
	-2SD to -3SD	59	60.2%	13	72.2%	1.69 (0.44 to 6.48)	0.445
	<-3SD	16	16.3%	2	11.1%	0.96 (0.14 to 6.40)	0.965

On univariate binary logistic regression with anaemia projected as a dependent of age, sex, loss of appetite, developmental history, top feed, immunisation, PRBC transfusion, weight for age, height for age, weight for height as independent parameters. Immunization was associated with slightly higher odds of anaemic status [OR=5.51 (95% CI=0.69-43.6) p-value=0.106]. Other than immunization, developmental history, PRBC transfusion, weight for age, height for age and weight for height were associated with higher odds of anaemic presence. Meanwhile sex, loss of appetite and top feed were associated with lower odds of anaemic presence. No significant odds of anaemic status were not found when associated with the above independent parameters.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

4. DISCUSSION

This cross-sectional observational study includes 116 diagnosed patients of SAM, 53.4% males and 46.6% female children, aged between 6 months to 59 months with a mean age of 1.33±0.89 year whose weight for height/ length was < 3 SD using the Standard WHO growth charts, a MUAC <115 mm or had edema of bilateral feet. Out of 116 children, the majority were less than or equal to 2 years, similar to that reported in another hospital- based prospective observational study by Jangid et al. (2020).[17] As reported by Bharati et al. (2020), the most common age group affected with anaemia were 12–23 months with prevalence rate of 68.1%, followed by 9–11 months (prevalence, 67.2%) and 6–8 months (prevalence, 65.9%).[18]

In our study, the majority of subjects (58.6%) were from the lower class, followed by the upper lower class (35.3%), lower middle class (5.2%) and middle class (0.9%). These findings are consistent with case–control studies from India, Pakistan, Iran, Vietnam, and Ethiopia.[19-22] This could be explained by the fact that children from families of low socioeconomic status have limited access to food, health services, hygiene and sanitation. In the present study, the mean weight, height, MUAC, and HC were 5.73±2.04, 69.10±11.34, 10.95±1.28 and 41.12±4.24, respectively. Eighty (69%) were moderately underweight while 19 (16.4%) were underweight and 17 (14.7%) were severely underweight. The majority were moderately stunting followed by stunting and severe stunting. The majority (62.1%) were moderately wasting followed by 26 (22.4%) were wasting and 18 (15.5%) were severe wasting. In the Current study majority had normal development, out of 116 SAM patients 32(27.5%) are developmental delayed. Most of patients belongs to gross motor domain delay and 22 patients (18.9%) patient categorized as global developmental delayed. 33 (28.4%) had a top feed and most (78.4%) were partially immunized. In another study, Shukla et al. (2023) reported that 61.61% of children were immunized completely while 38.38% were partially immunized.[23] In the present study, 47 (40.5%) patients had a fever 11 (9.5%) patients had diarrhoea or vomiting 65 (56%) patients were not gaining weight or had lost their appetite 6 (5.2%) patients had seizures and 28 (24.1%) patients had difficulty in breathing and cough related problems. Madhusudan et al. (2018) observed that the most common presenting complaint was fever followed by cough/cold seen in 54.78% and 55.78% of total patients respectively. Many patients presented with cardiac congestive failure in the form of tachycardia, increased JVP, gallop rhythm and hepatomegaly.[24] During the present study, most subjects (94.8%) were discharged while 6 (5.2%) were expired. In a study conducted by Muoneke et al. (2012), it was observed that 83.60% of patients recovered while 2.80% left against medical advice whereas 13.60% died.[25]

In the current study, most (84.5%) children were anemic. Out of 98 anemic children, 64 (65.3%) had mild anaemia, 22 (22.4%) had moderate anaemia and 12 (12.2%) had severe anaemia. Six (6.1%) Expired from the anemic subjects while in non-anemic subjects there were no expiry. In the study by Jain et al. (2000), 24.3% had severe anaemia, 49.8% of children had moderate anaemia, and 26.8% had mild anaemia.[26] During our study, 33.6% children required blood transfusion. This is an indication that nutritional anaemia is a very common comorbidity of SAM and its severity may demand hospital admission with blood transfusion. Thakur et al. (2014) found that more cases of severe anaemia increase the requirement for blood transfusion in children. In their study, 25% children required blood transfusion.[27]

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

In the present study, hemoglobin and PCV show a positive correlation with vitamin B12 and PCV shows a significant correlation with vitamin B12. Meanwhile, MCV shows a negative correlation with vitamin B12. Our findings showed that hemoglobin and PCV negatively correlate with serum ferritin. Meanwhile, MCV shows a positive correlation with serum ferritin where no significant correlation was found. The correlation between hemoglobin and serum ferritin levels was different from the results of Van den Bosch et al. (2001), which showed a significant correlation between ferritin and hemoglobin levels towards a negative correlation ($r=0.5522$; $p<0.0001$).[28] This difference is due to age, inflammation and infection, especially worm infestation which can increase serum ferritin levels. Similar to our study, Kusumastuti et al. (2014) showed that there were negative relationships between hemoglobin and serum ferritin levels ($r=-0.220/p=0.043$).[29]

In the current study, age, hemoglobin, MCV and PCV show a positive correlation with S. Iron. Hemoglobin shows a significant correlation with S. Iron. Hemoglobin level is a sensitive tool for detecting iron deficiency anaemia but not for iron deficiency.[30] Iron is one crucial micronutrient. If iron reserves are insufficient for erythrocyte formation, the erythrocyte numbers will decline resulting in low hemoglobin levels or anaemia.[31] On univariate binary logistic regression compared with anemic immunization was associated with slightly higher odds of anemic status [OR=5.51 (95% CI=0.69-43.6) p-value=0.106]. Other than immunization, developmental history, PRBC transfusion, weight for age, height for age and weight for height were associated with higher odds of anaemic presence. Meanwhile, sex, loss of appetite and top feed were associated with lower odds of anaemic presence. No significant odds of anaemic status were found when associated with the above independent parameters.

5. CONCLUSION

The present study includes 116 diagnosed patients of SAM where males outnumbered females aged between 6 months to 59 months with a mean age of 1.33±0.89, whose weight for height/ length was < 3 SD, a MUAC <115 mm or had edema of bilateral feet. No significant odds of anaemic status were found when associated with the above independent parameters. In addition, clinicians working in maternal and child health departments are recommended to strengthen the treatment of HIV infection before causing further damages.

6. REFERENCES

1. Thorne CJ, Roberts LM, Edwards DR, Haque MS, Cumbassa A, Last AR. Anaemia and malnutrition in children aged 0–59 months on the Bijagos Archipelago, Guinea-Bissau, West Africa: a cross-sectional, population-based study. Paediatrics and international child health. 2013 Aug 1;33(3):151-60.
2. Halterman JS, Kaczorowski JM, Aligne CA, Auinger P, Szilagyi PG. Iron deficiency and cognitive achievement among school-aged children and adolescents in the United States. Pediatrics. 2001 Jun 1;107(6):1381-6.
3. Related H PE. Federal Ministry of Health Health and Health Related Indicators. 2005 E.C (2012/2013). 2014.
4. Stoltzfus RJ, Chwaya HM, Tielsch JM, Schulze KJ, Albonico M, Savioli L. Epidemiology of iron deficiency anemia in Zanzibari schoolchildren: the importance of hookworms. The American journal of clinical nutrition. 1997 Jan 1;65(1):153-9.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

5. Allen LH, Rosado JL, Casterline JE, López P, Muñoz E, García OP, Martinez H. Lack of hemoglobin response to iron supplementation in anemic Mexican preschoolers with multiple micronutrient deficiencies. The American journal of clinical nutrition. 2000 Jun 1;71(6):1485-94.
6. World Health Organization, Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. Vitamin and Mineral Nutrition Information System, World Health Organization, Geneva, Switzerland, 2011.
7. Duque X, Flores-Hernández S, Flores-Huerta S, Méndez-Ramírez I, Muñoz S, Turnbull B, Martínez-Andrade G, Ramos RI, González-Unzaga M, Mendoza ME, Martínez H. Prevalence of anemia and deficiency of iron, folic acid, and zinc in children younger than 2 years of age who use the health services provided by the Mexican Social Security Institute. BMC Public Health. 2007 Dec;7:1-8.
8. Schneider JM, Fujii ML, Lamp CL, Lönnerdal B, Dewey KG, Zidenberg-Cherr S. Anemia, iron deficiency, and iron deficiency anemia in 12–36-mo-old children from low-income families. The American journal of clinical nutrition. 2005 Dec 1;82(6):1269-75.
9. Karlberg J, Luo ZC. Foetal size to final height. Acta Paediatrica. 2000 Jun;89(6):632-6.
10. Oppenheimer SJ. Iron and its relation to immunity and infectious disease. The Journal of nutrition. 2001 Feb 1;131(2):616S-35S.
11. Strauss J, Thomas D. Health, nutrition, and economic development. J Econ Lit. 1998; 36:766–817.
12. Alderman H, Hoddinott J, Kinsey B. Long term consequences of early childhood malnutrition. Oxford economic papers. 2006 Jul 1;58(3):450-74.
13. World Health Organization. Estimated numbers of stunted preschool children 1990–2020 with 95% confidence intervals by UN regions and subregions. 2010.
14. Santos RF, Gonzalez ES, Albuquerque EC, Arruda IK, Diniz AD, Figueroa JN, Pereira AP. Prevalence of anemia in under five-year-old children in a children's hospital in Recife, Brazil. Revista brasileira de hematologia e hemoterapia. 2011;33:100-4.
15. Onyeneho NG, Ozumba BC, Subramanian SV. Determinants of childhood anemia in India. Scientific reports. 2019 Nov 12;9(1):16540.
16. Kapil U, Kapil R, Gupta A. National Iron Plus Initiative: current status & future strategy. The Indian journal of medical research. 2019 Sep;150(3):239.
17. Jangid RK, Kumar A, Mahapatra C, Yadav M, Singhal S, Laxminarayan K. To study the prevalence and types of nutritional anemia in under-five children with severe acute malnutrition. Indian Journal of Child Health. 2020 Jun 26:270-3.
18. Dwivedi D, Singh V, Singh J, Sharma S. Study of anaemia in children with severe acute malnutrition. Journal of Nepal Paediatric Society. 2017;37(3):250-3.
19. Mishra K, Kumar P, Basu S, Rai K, Aneja S. Risk factors for severe acute malnutrition in children below 5 y of age in India: a case-control study. The Indian Journal of Pediatrics. 2014 Aug;81:762-5.
20. Sharghi A, Kamran A, Faridan M. Evaluating risk factors for protein-energy malnutrition in children under the age of six years: a case-control study from Iran. International journal of general medicine. 2011 Aug 17:607-11.
21. Demissie S, Worku A. Magnitude and factors associated with malnutrition in children 6-59 months of age in pastoral community of Dollo Ado district, Somali region, Ethiopia. Sci J Public Health. 2013;1(4):175-83.
22. Niraula SR, Barnwal SP, Paudel S, Mishra S, Dahal S, Das S, Pradhan S, Ghimire S, Khanal S, Sharma S, Rajput S. Prevalence and associated risk factors with malnutrition

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE7, 2023

among under-five Nepalese children of Borbote village, Ilam. Health Renaissance. 2013 Jun 19;11(2):111-8.

23. Shukla P, Pandey SK, Singh J, Bajaj N, Tripathi G, Dwivedi S. Clinico-Etiopathogenesis of Vitamin B12, Folic Acid and Iron Deficiency in Severe Acute Malnutrition Children: A Tertiary Care Hospital Experience from Central India. Indian Journal of Clinical Biochemistry. 2023 Jan 3:1-5.
24. Madhusudan SR, Devi MK, Ahuja S, Nagaraj N. Clinical profile of anemia among 6–60-month children living in South Karnataka–A cross sectional study. Indian Journal of Child Health. 2018 Feb 24:133-6.
25. Muoneke VU, Ibekwe RC, Nebe-Agumadu HU, Ibe BC. Factors associated with mortality in under-five children with severe anemia in Ebonyi, Nigeria. Indian pediatrics. 2012 Feb 1;49(2):119.
26. Takele WW, Baraki AG, Wolde HF, Desyibelew HD, Derseh BT, Dadi AF, Mekonnen EG, Akalu TY. Anemia and contributing factors in severely malnourished infants and children aged between 0 and 59 months admitted to the treatment centers of the Amhara region, Ethiopia: a multicenter chart review study. Anemia. 2021 Mar 27;2021.
27. Thakur N, Chandra J, Pemde H, Singh V. Anemia in severe acute malnutrition. Nutrition. 2014 Apr 1;30(4):440-2.
28. Van den Bosch G, Van den Bossche J, Wagner C, De Schouwer P, Van De Vyvere M, Neels H. Determination of iron metabolism-related reference values in a healthy adult population. Clinical chemistry. 2001 Aug 1;47(8):1465-7.
29. Kusumastuti FD, Sutaryo S, Mulatsih S. Correlations between hemoglobin, serum ferritin, and soluble transferrin receptor levels in children aged 6-59 months. Paediatrica Indonesiana. 2014 Apr 30;54(2):122-6.
30. Brugnara C. A hematologic “gold standard” for iron-deficient states?. Clinical Chemistry. 2002 Jul 1;48(7):981-2.
31. Wang W, Knovich MA, Coffman LG, Torti FM, Torti SV. Serum ferritin: past, present and future. Biochimica et Biophysica Acta (BBA)-General Subjects. 2010 Aug 1;1800(8):760-9.