VOLUME - 10, ISSUE - 07, JULY- 2021 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Paediatrics

"STUDY ON ETIOLOGICAL PROFILE OF ANEMIA IN PRESCHOOL CHILDREN AGE 6 MONTHS TO 60 MONTHS AND RESPONSE OF TREATMENT IN NUTRITIONAL ANEMIAS"

Dr. Parina Dalal* Resident of Department of Pediatrics, Sharda Hospital, Greater Noida, UP, India. *Corresponding Author

Dr Gaytri Koley Professor of Department of Pediatrics, Sharda Hospital Greater Noida, UP, India.

ABSTRACT

***Background*:** Anemia is regarded to be the most common nutrition related deficiency that affects about 1/4th of the world's population, especially the children and women of the reproductive age group. the prevalence of nutritional anemia as well as other types of anemias in my study population.

***Materials and method*:** This cross-sectional observational study was carried out at the pediatric department of School of medical science and research hospital, Greater Noida. The inclusion criteria were all children in the age group of 6-60 months with Hb level < 11.0 gm/ dl. SPSS version 25.0 was used for statistical analysis and chi-square test was used for comparing the categorical variables.

***Results*:** The mean Hb% increased significantly from baseline to at 14th day to at 90th day. The mean Weight increased significantly from Pre-treatment to at 90th day. Mild anemia was found among 38.4%, Moderate among 52.4% and Severe among 9.2% subjects. Stunting (low height for age) was reported among4.0%, Wasting (low weight for height) among 5.0%) and Underweight (Low weight-for-age) among 2.0% patients.

***Conclusion*:** Anemia is still a public health problem in our country. Iron deficiency state was significantly present as detected by low serum hemoglobin levels. Therefore, appropriate and tailored interventional strategies are required to reduce the prevalence of childhood anemia.

KEYWORDS : Anemia, Iron deficiency, Stunting, Underweight, Wasting

INTRODUCTION

Around the world, Anemia is regarded to be the most common nutrition related deficiency that affects about 1/4th of the world's population, especially the children and women of the reproductive age group. Among children, anemia has negative effect on the cognitive development, performance in school, physical growth and immune response.[1]

Its etiology in developing countries is multifactorial thus, the most important risk factors need to be identified for prevention strategy. Anemia is commonly associated with nutritional deficiencies such as iron deficiency, the main factor responsible for microcytic anemia, while folate or vitamin B12 deficiency leads to the macrocytic anemia. In a similar way, the parasitic infections like malaria and ancylostomiasis have been reported to be responsible for the high level of prevalence of anemia during childhood. In sub-Saharan countries, sickle cell disease mainly leads to anemia. However, the relative contributions of these etiologies remain unclear.[2]

The causes of anemia are often multifactorial and are interrelated in a complex way. Anemia can also be chronic - for example, secondary to the iron deficiency, human immunodeficiency virus (HIV) infection, or due to the intestinal worms and might be acute, due to the sickle-cell crisis or plasmodium falciparum infection, or chronic anemia might be a acute exacerbation. The situation is complicated as anemia during the childhood can be due to the iron deficiency among mother and in association due to the impairment of the fetal development and iron-deficient & anemic babies. Socioeconomic status might lead to the anemia by having an impact on the nutrition level, size of family, and interval in child birth, along with the aggravation of the affordability and accessibility of preventive and curative measures[3].

Most children with anemia are asymptomatic, and the condition is detected onscreening laboratory evaluation. Anemia is a serious concern for young children because it can result in impaired cognitive performance, behavioral and motor development, coordination, language development, and scholastic achievement, as well as increased morbidity from infectious diseases.[4]

As anemia accounts for significant morbidity and mortality, and in view of no enough studies being done in school aged children in urban area, there is a need for study to know the prevalence of nutritional anemia as well as other types of anemias in my study population.

MATERIALS & METHODS

This cross-sectional observational study was carried out from 1 January, 2019 to 30 June 2020 among 6 months to 60 months presenting at the pediatric department of School of medical science and research hospital, Greater Noida.

Sample Size

The sample size was calculated using the **nMaster 2.0 software**. The power of the study was taken to be 80% and Confidence Interval (C.I.) of 95% was taken. The sample size was estimated to be 250 cases of anemia.

Study population

The study population included the subjects satisfying the inclusion and exclusion criteria. The inclusion criteria were all children in the age group of 6-60 months with Hb level < 11.0 gm/dl. Children with known chronic diseases and severe illness requiring ICU admission. Hb level > 11 gm/dl were excluded.

Method of Collection of Data

This study was being prospective hospital based study. The medical history of the patient was taken along with the dietary records, along with the detailed physical examination. Anthropometry was done along with the requisite investigations. Blood samples were collected from the patient after getting the informed consent of the parent.

After physical examination and anthropometry CBC was performed on day 1. All patients with microcytic hypochromic anemia was given iron daily for 2 weeks. Those with macrocytic and dimorphic anemia, Vitamin B12 and folate level was measured and treatment started accordingly. On day 1, oral therapy for vitamin B12 and folate was given for 3 months and then reassessed. Cases showing aplastic

anemia, leukemia on peripheral smear on day 1, was managed according. Nutritional counseling was done on Day 1. Albendazole was given to all children at the start of treatment at day 1. On day 14, CBC was repeated, if improving continued therapy for 3 months. If not improving, we also accessed for noncompliance and thalassemia /other type of anemia. Repeat Albendazole treatment on day 14. At 3 months, general examination was done along with CBC and weight measurement.

Statistical Analysis

The data was entered into Microsoft Excel and analysed using SPSS (Statistical Package for Social Sciences) package 26.0 for relevant statistical comparisons. Descriptive statistics like mean, percentage and standard deviations was used. Inferential statistics was done using the chi-square test for the categorical variables.

RESULTS

The mean age of the study population was 2.60±1.47 (0.67-5.00) years. The study population consisted of 185 (74.0%) males and 65 (26.0%) females.The mean Weight was 11.01±3.47, mean Height/Length was 85.86±13.90 and mean Mid arm circumference was 12.64±0.89. The mean MCV was 66.14±14.76, MCH was 22.92±5.43, MCHC was 33.48±27.46 and Platelet count was 339.06±137.23. The mean Hb% was 9.24±1.50, PCV was 32.15±5.03, Total Count was 10.02±4.42, RDW was 19.72±2.34 and RBC count was 4.51±0.62. (Table 1)

The mean Hb% increased significantly from baseline to at 14th day to at 90th day. The mean Weight increased significantly from Pre-treatment to at 90th day. (Table 2)

Mild anemia was found among 96 (38.4%), Moderate among 131 (52.4%) and Severe among 23 (9.2%) subjects. Moderate and Severe anemia was more among 0-1 year age group whereas Mild Anemia was more among 1-3 years and 3-5 years age groups with non- significant difference among age groups. No significant difference in the distribution of severity of anemia between males and females. (Table 3)

Dimorphic anemia was found among 50 (20.0%), Microcytic hypochromic anemia among 172 (68.8%) and Normocytic Hypochromic Anemia among 28 (11.2%) subjects. Non-significant difference was found in the distribution of severity of anemia between Dimorphic Anemia, Microcytic hypochromic anemia and Normocytic hypochromic anemia. (Table 4)

The most common signs for anemia were Pallor (100.0%), followed by Dry tongue (2.8%), Lymphadenopathy (2.4%), Dry oral mucosa (1.2%), and Frontal bossing (1.2%). The most commonly reported symptoms were fever (54.0%), cough (29.6%), Vomiting (18.0%), Decreased appetite (11.6%) and Pain abdomen (5.2%). (Table 5)

ESM+ was found among 2.4%, Hepatomegaly among 14.8%, Splenomegaly among 1.2%, Hepatosplenomegaly and Tachycardia among 1.6%, Hypotonia among 3.2%, , Tachypnoea among 7.2%, Bronchial breath sound RUL among 2.8%, Bronchial breath sounds LLL among 2.0% and Crepts+ among 4.0% subjects). (Table 6)

Majority of the children had Iron deficiency anemia (97.6%) followed by Bronchopneumonia (4.8%), Megaloblastic anemia (16.0%), AGE (3.2%), ADD (3.2%), Malaria (3.2%), Pulmonary TB (2.4%), Typhoid (2.0%) and URTI (1.6%). (Table 7)

P. vivax was found to be positive among 8 (3.2%), Montoux positive among 6 (2.4%), Urine-pus cells positive among 1 (0.4%) and Widal positive among 5 (2.0%) subjects. (Table 8)

Stunting (low height for age) was reported among 8 (4.0%), Wasting (low weight for height) among 10 (5.0%) and Underweight (Low weight-for-age) among 4 (2.0%) patients. (Table 9)

DISCUSSION

Nutritional anemia is a very common cause of morbidity in children in a developing country like India in the preschool age group. Despite the existence of an effective control measure since as early as 1970 (Nutritional Anemia Prophylaxis Programme) and constant updating by Government e.g. as in 1991 (National Nutritional Anemia Control Program) and later on as a part RCH programme, the prevalence of nutritional anemia is on the rise in the preschool children, both in India and abroad.[2]

Severity of Anemia

In our study, as per the severity of anemia, Mild anemia was found among 38.4%, Moderate among 52.4% and Severe among 9.2% subjects. Our research co-incided with the findings by *Li et al*,[5] majority had mild anemia and then moderate grade of anemia and in similarity with the studies done in Ethiopia [6] and Haiti [7]. There were two possible reasons for the fact. On the one hand, children with mild anemia were mostly asymptomatic and thus did not attract enough attention from their caregivers, so the caregivers might not seek medical intervention and did not give the children prompt and effective treatment.[6]

The higher prevalence of mild anemia among our study was consistent with the findings by Gebreegziabiher et al[8], Muchie[9], and Ngnie-Teta et al.[10]

In a study done by *Kapur D et al*,[11] it was found that only 7.8% of children had severe anemia which is slightly higher than our observation and they also concluded that parasitic infections were not related to prevalence or to severity of anaemia but nutritional deficiency was the main cause. 45% of the babies were found to be taking the diet which was low in iron 18. Our study were also in agreement with the findings by *Saba F et al*.[12]

In current study, moderate and severe anemia was more among 0-1 year age group whereas mild anemia was more among 1-3 years and 3-5 years age groups. The difference between the age groups was found to be non-significant.

Ncogo et al,[13] reported higher prevalence of severe anemia among 2±12 months old and over 5 years old. The increased risk of anemia in children below the age of 12 months is consistent with findings from other countries.[14,15] This vulnerability could be related to more requirement for iron during this stage of the child's development and insufficient supplementation of the iron-rich foods after weaning.[16] Age of the child is known to be a significant factor associated with nutritional anemia in children. Many authors from all over the world have shown that younger age is associated with nutritional anemia.[17,18]

In our study also, majority (75%) of the children were lesser than 2 years age. The possible explanation for this may be, as age increases, the deficient child on account of inappropriate feeding practices becomes more and more deprived of micronutrients making him severely anemic.[2]

Melku et al[6] also reported that younger aged children were more likely to be anemic.

The likelihood of being anemic among children aged 6-11 months was higher as compared to those who were within the age of 48-59 months. This is in agreement with other studies.[9,19] There were more chances of anemia among

children which were 6-23 months old, that is consistent with other studies as well.[20-22] The prevalence of anemia reduced from 22.3% (in the age group of 6-11 months) to 6.2% (in the age group of 60–71 months) which meant that children at younger age were the most vulnerable group for anemia. The chances for anemia among 6-11, 12-23 and 36-47 months age group was 4.71, 1.68 and 1.59 times compared to 60–71 months. Since the age group of 6-23 months is considered to be the main age group for introducing the complementary food and nurturing of the eating habits, the inappropriate introduction of the complementary food or poor eating habits among this age group would lead to the insufficient amount of iron intake and responsible for the iron-deficiency anemia. [23,24]

Etiology

The relationship between anemia and infection remains controversial. However, it is generally accepted that excess or deficiency of iron result in changes in immune response. Anemia occurs most commonly among the children having respiratory tract infections, followed by gastrointestinal diseases. Respiratory tract diseases need more hemoglobin due to both infectious disease process and need for more respiratory effort, whereas the gastro- intestinal diseases is responsible for the blood loss in feces and vomit or due to the degradation by parasites.[25]

In current study, P. vivax was found to be positive among 8 (3.2%), Montoux positive among 6 (2.4%), Urine-pus cells positive among 1 (0.4%) and Widal positive among 5 (2.0%) subjects.

Lima et al. fund much more frequency of anemia among the infants having infectious diarrhea.[26] *Ramkrishna K et al* found that children with anemia was 5.75 times more susceptible to LRTI compared to the control group. Prevention of anemia due to whatever etiology will reduce the incidence of LRTI.[27]

Although malaria has a wide range of clinical outcomes, malaria-related anemia is one of the leading causes of death, particularly in children.[28] *Righetti et al*[29] found that infection with P. falciparum was the only risk factor significantly associated with anemia in infants. Our data also suggest that anemia of chronic disease (ACD), also phrased anemia of inflammation, plays a role in the process of anemia for children aged 6-8 years. This result may be explained by other illnesses that can increase inflammatory markers in children during their first years of life. Intestinal and urinary tract infections, respiratory diseases, hepatitis, measles, HIV, and small injuries are among factors that affect the young child and could increase inflammatory markers.[29]

Symptoms

Cough was reported among 29.6%, Passing hard stools among 1.2%, Burning micturition among 4 (1.6%), Decreased appetite among 29 (11.6%), Fever among 135 (54.0%), Vomiting among 45 (18.0%), Weakness in UL and LL among 4 (1.6%), Pain abdomen among 13 (5.2%), Repeated blood transfusion among 3 (1.2%), Seizure disorder among 3 (1.2%), Decreased appetite among 3 (1.2%), Generalized weakness among 4 (1.6%) and Global developmental delay among 4 (1.6%) subjects.

Sahana et al[30] stated that majority of subjects was asymptomatic, mild to moderate anemia among Hospitalized infants (96%), thus emphasizing the importance of nutritional anemia in these infants. Detail assessment of birth history, feeding history and nutritional status of all ad-mitted infants should be done, so that early intervention can be done.

Maternal education regarding Maternal Anemia, breast feeding and complementary feeds along with proper explanation of the nutritive value of weaning foods is essential and is of prime importance.

Type of anemia

Dimorphic Anemia was found among 20.0%, Microcytic hypochromic anemia among 68.8% and Normocytic hypochromic anemia among 28 (11.2%) subjects. There was no significant difference in the distribution of severity of anemia between Dimorphic Anemia, Microcytic hypochromic anemia and Normocytic hypochromic anemia.

Iron deficiency anemia is the most common type of nutritional anemia in children of less than five year age group, cobalamin deficiency being the next most common.[31,32] ray et al reported that 37.5% had only iron deficiency, whereas this figure for VitB12 and folate deficiency are 15% and 4.5% respectively. Combined Iron and VitB12 deficiency was seen in 23% of the children.[33]

Low intake of iron has emerged as a significant determinant for nutritional anemia in several studies around the world.[34,35] This factor remains to be significant, suggesting, improvement in intake of iron via nutrition will definitely improve the hemoglobin level of the child.[2]

Thorne et al[35] reported that males were more susceptible to stunting than their female counterparts. This tendency is well recognised in the literature,[36-38] although it is interesting that this disparity was not seen in the nationwide data from the 2006 MICS.[39] Physiological explanations include males being more predisposed to symptomatic and asymptomatic morbidity, which ultimately results in stunting.[40] A further possible explanation is linked to the propensity of males to have lower haemoglobin concentrations than females (median Hb 9.7 g/dl vs 10.1 g/dl).

There are conflicting reports in the literature: a body of research corroborates this gender disparity[41-44] while others refute it.[45] It has been proposed that males display faster growth velocity accompanied by an increased demand for iron.[46] This, in turn, has the potential to exacerbate levels of anaemia and contribute to stunted growth.

This study supports the idea that anaemia is more prevalent in males, although the implications for this population are negligible as the difference in haemoglobin concentrations is of biochemical but not clinical significance.[35]

Several published studies have confirmed that childhood malnutrition is closely related to anemia.[47,48] Malnutrition often coexists with other micronutrient deficiencies (e.g. iron, zinc, folate, vitamin A, vitamin B12), which may increase the development of anemia by a synergistic association.

One of the studies in China showed that stunting, underweight, and wasting are the major risk factors for suffering from anemia.[47] One of the studies showed association between anemia and malnutrition with lesser level of average hemoglobin among under-weight and stunted children.[48] *Siegal EH et al* have noted that stunting (30.8%) and wasting (18.1%) were prevalent in anemic children studied be-tween 4-17 months where as in our study 39% had PEM with majority having grade 1-2 PEM.[49]

This study has some limitations. Firstly, cause-and-effect relationship is difficult to establish with the cross-sectional study design. Secondly, all the modifiable risk factors were not considered for the infectious diseases that potentially affect the hematopoiesis.

CONCLUSION

Mild anemia was found among 38.4%, Moderate among 52.4% and Severe among 9.2% subjects. Dimorphic anemia was found among 20.0%, Microcytic hypochromic anemia among 68.8% and Normocytic Hypochromic Anemia among 11.2% subjects.

Anemia is still a public health problem in our country. Iron deficiency state was significantly present as detected by low serum hemoglobin levels. Therefore, appropriate and tailored interventional strategies are required to reduce the prevalence of childhood anemia. These include improving women's access to education; providing health education on child feeding practices; and strengthening nutritional and social supports.

Tables

Table 1: Mean weight, height and mid-arm circumference of the study population

	Mean	Std. Deviation	Variance	Minimum	Maximum	Range
Weight	11.0	3.47	12.04	6.20	24.50	18.3
	1					0
Height/Length	85.8	13.90	193.14	62.00	119.00	57.0
	6					0
Mid arm	12.6	0.89	0.78	11.00	15.00	4.00
circumference	4					
Hb%	9.24	1.50	2.26	3.20	11.40	8.20
PCV	32.1	5.03	25.31	13.70	53.10	39.4
	5					0
Total Count	10.02	4.42	19.50	4.19	21.00	16.81
RDW	19.72	2.34	5.47	14.60	25.60	11.00
RBC count	4.51	0.62	0.38	1.73	5.76	4.03

Table 2: Comparison of mean Hb% between Baseline, at 14th day and at 90th day

		Mean	Std. Deviation	p-value	Post-hoc comparisons
Hb%	Pre-treatment	9.24	1.50	< 0.001*	90th day
					>1 4 th
	At 14th day	10.0	1.40		
		9			d a y>
	At 90th day	11.0	1.45		Baselin
		8			e
Weight	Pre-treatment	11.0	3.47	< 0.001*	
		1			
	At 90th day	11.7	3.45		
		1			

Table 3: Distribution of severity of anemia among age groups and gender

		Mild		Moderate		Severe		p- value
Age groups	0-1 year	14	26.4 %	33	62.3 %	6	11.3%	0.334
	1-3 years	46	40.4%	59	51.8%	9	7.9%	
	3-5 years	36	43.4%	39	47.0%	8	9.6%	
Gender	Female	23	35.4 %	33	50.8%	9	13.8	0.314
	Male	73	39.5%	98	53.0%	14	7.6%	

Table 4: Distribution of severity of anemia between DA, MHA and Normocytic Hypochromic Anemia

Severity of Anemia	PS		
	Dimorphic anemia	Microcytic Hypochromic Anemia	Normocytic Hypochromic Anemia
Mild	14	66	16
	28.0%	38.4%	57.1%
Moderate	31	89	11
	62.0%	51.7%	39.3%
Severe	5	17	1
	10.0%	9.9%	3.6%
Total	50	172	28
	100.0 %	100.0 %	100.0 %
$\chi 2$ value = 6.869, p-value = 0.143			

Table 5: Distribution of Systemic examination among the study population

		Frequency	Percent
Signs	Pallor	250	100.0 %
	Dry oral mucosa	3	1.2%
	Lymphadenopathy	6	2.4%
	Dry tongue	7	2.8%
	Frontal bossing	3	1.2%
Symptoms	Cough	74	29.6%
	Passing hard stools	3	1.2%
	Burning micturition	4	1.6%
	Decreased appetite	29	11.6%
	Fever	135	54.0%
	Vomiting	45	18.0%
	Weakness in UL and LL	4	1.6%
	Pain abdomen	13	5.2%
	Repeated blood transfusion	3	1.2%
	Seizure disorder	3	1.2%
	Decreased appetite	3	1.2%
	Generalized weakness	4	1.6%

Table 6: Distribution of Systemic examination among the study population

Systemic examination	Frequency	Percent
NS	157	62.8 %
ESM+	6	2.4%
Hepatomegaly	37	14.8 %
Splenomegaly	3	1.2%
Hepatosplenomegaly	4	1.6%
Hypotonia	8	3.2%
Tachycardia	4	1.6%
Tachypnoea	18	7.2%
Bronchial breath sound RUL	7	2.8%
Bronchial breath sounds LLL	5	2.0%
Crepts+	10	4.0%

Table 7: Distribution of diagnosis among study population

Diagnosis	Frequency	Percent
Iron deficiency anemia	244	97.6%
Bronchopneumonia	12	4.8%
Megaloblastic anemia	40	16.0%
Upper respiratory tract infection (URTI)	4	1.6%
AGE	8	3.2%
ADD	8	3.2%
Malaria	8	3.2%
Pulmonary TB	6	2.4%
Typhoid	5	2.0%

Table 8: Distribution of tests among study population

Other tests	Frequency	Percent
No findings	230	92.0%
P. vivax ++	8	3.2%
Montoux-++	6	2.4%
Urine-pus cells++	1	0.4%
Widal++	5	2.0%
Total	250	100.0%

Table 9: Nutritional status division according to height, weight and age

	Frequency	Percent
Stunting (low height for age)	8	4.0%
Wasting (low weight for height)	10	5.0%
Underweight (Low weight- for-age)	4	2.0%

REFERENCES

1. Pasricha SR, Black J, Muthayya S, Shet A, Bhat V, Nagaraj S, et al. Determinants of Anemia among young children in rural India. Pediatrics. 2010;126(1):140–e9.
2. Ray S, Chandra J, Bhattacharjee J, Sharma S, Agarwala A. Determinants of nutritional anaemia in children less than five years age. Int J Contemp Pediatr 2016;3:403-8.
3. Rao NP, Singh D, Swaminathan MC. Nutritional Status of Preschool children of rural communities near Hyderabad city. Ind J Med Res. 1969;57:2132-48.
4. Gupta N, Agarwal KN. Hematological Investigations and plasma proteins in pre-school children. Ind Jour Pediatr. 1972;39:48-51.
5. Li H, Xiao J, Liao M, Huang G, Zheng J, Wang H, Huang Q, Wang A. Anemia prevalence, severity and associated factors among children aged 6-71 months in rural Hunan Province, China: a community-based cross-sectional study. BMC Public Health. 2020;20(1):989.
6. Melku M, Alene KA, Terefe B, Enawgaw B, Biadgo B, Abebe M, et al. Anemia severity among children aged 6-59 months in Gondar town, Ethiopia: a community- based cross-sectional study. Ital J Pediatr. 2018;44(1):107.
7. Ayoya MA, Ngnie-Teta I, Séraphin MN, Mamadoultaibou A, Boldon E, Saint-Fleur JE, et al. Prevalence and risk factors of anemia among children 6-59 months old in Haiti. Anemia. 2013;2013:502968.
8. Gebreegziabiher G, Etana B, Niggusie D. Determinants of Anemia among children aged 6–59 months living in Kilte Awulaelo Woreda. Volume: Northern Ethiopia. Anemia; 2014.
9. Muchie KF. Determinants of severity levels of anemia among children aged 6–59 months in Ethiopia: further analysis of the 2011 Ethiopian demographic and health survey. BMC Nutr. 2016;2:51.
10. Ngnie-Teta I, Receveur O, Kuate-Defo B. Risk factors for moderate to severe anemia among children in Benin and Mali: insights from a multilevel analysis. Food Nutr Bull. 2007;28(1):76–89.
11. Kapur D, Aggarwal KN. Iron status of children aged 9-36 months in an urban slum ICDS Project in Delhi. Indi-an Ped. 2002;39:136-44.
12. Saba F, Poornima S, Balaji P A, Varne SRR, Krishna-murthy J. Anemia Among Hospitalized Children at a Multispecialty Hospital, Bangalore (Karnataka). India J Family Med Prim Care. 2014;3(1):48-53.
13. Ncogo P, Romay-Barja M, Benito A, Aparicio P, Nseng G, Berzosa P, et al. Prevalence of anemia and associated factors in children living in urban and rural settings from Bata District, Equatorial Guinea, 2013. PLoS One. 2017;12(5):e0176613.
14. Austin AM, Fawzi W, Hill AG. Anaemia among Egyptian Children between 2000 and 2005: trends and predictors. Matern Child Nutr. 2012;8:522-32.
15. Semedo RM, Santos MM, Baião MR, Luiz RR, da Veiga GV. Prevalence of anaemia and associated factors among children below five years of age in Cape Verde, West Africa. J Health Popul Nutr. 2014;32:646.
16. Muhimbula HS, Issa-Zacharia A. Persistent child malnutrition in Tanzania: Risks associated with traditional complementary foods (A review). Afr J Food Sci. 2010;4:679-92.
17. Schneider JM, Fujii ML, Lamp CL, Lönnerdal B, Dewey KG, Zidenberg-Cherr S. The use of multiple logistic regression to identify risk factors associated with anemia and iron deficiency in a convenience sample of 12–36-mo-old children from low-income families. Am J Clin Nutr. 2008;87(3):614-20.
18. Cotta RM, Oliveira Fde C, Magalhães KA. Social and biological determinants of iron deficiency anemia, Cad Saude Publica. 2011;27(2):S309-20.
19. Khanal V, Karkee R, Adhikari M, Gavidia T. Moderate-to-severe anaemia among children aged 6–59 months in Nepal: an analysis from Nepal demographic and health survey, 2011. Clin Epidemiol Glob Health. 2016;4:57–62.
20. Ag Ayoya M, Ngnie-Teta I, Séraphin MN, Mamadoultaibou A, Boldon E, Saint-Fleur JE, et al. Prevalence and risk factors of Anemia among children 6–59 months old in Haiti. Volume: Anemia; 2013.
21. Oso'rio MM, Lira PI, Ashworth A. Factors associated with Hb concentration in children aged 6–59 months in the state of Pernambuco. Brazil Br J Nutr. 2004;91(2):307–14.
22. Khan JR, Awan N, Misu F. Determinants of anemia among 6–59 months aged children in Bangladesh: evidence from nationally representative data. BMC Pediatr. 2016;16:3.
23. Yang W, Li X, Li Y, Zhang S, Liu L, Wang X, et al. Anemia, malnutrition and their correlations with socio-demographic characteristics and feeding practices among infants aged 0-18 months in rural areas of Shaanxi province in northwestern China: a cross-sectional study. BMC Public Health. 2012;12:1127.
24. da Silva LLS, Fawzi WW, Cardoso MA. ENFAC Working Group. Factors associated with anemia in young children in Brazil. PLoS One. 2018;13(9):e0204504.
25. Dos Santos RF, Gonzalez ES, de Albuquerque EC, de Arruda IK, Diniz Ada S, Figueroa JN, Pereira AP.. Prev-alence of anemia in under five-year-old children in a children's hospital in Recife, Brazil. Rev Bras Hematol Hemoter 2011; 33(2): 100 doi: 10.5581/1516-8484.20110028
26. Lima AC, Lima MC, Guerra MQ, Romani SA, Eickmann SH, Lira PI. Impact of weekly treatment with ferrous sulfate on hemoglobin level, morbid and nutritional sta- tus of anemic infants. J Pediatr (Rio J). 2006; (82): 452-7 Comment in: J Pediatr (Rio J). 2007; 83(1):95
27. Ramakrishnan K, Harish PS. Hemoglobin Level as a Risk Factor for Lower Respiratory Tract Infections. Indian J Pediatr. 2006;73(10):881-88313.
28. Murphy SC, Breman JG, 2001. Gaps in the childhood malaria burden in Africa: cerebral malaria, neurological sequelae, anemia, respiratory distress, hypoglycemia, and complications of pregnancy. Am J Trop Med Hyg 64(1-2):57–67.
29. Righetti AA, Koua AY, Adiossan LG, Glinz D, Hurrell RF, N'goran EK, Niamké S, Wegmüller R, Utzinger J. Etiology of anemia among infants, school-aged children, and young non-pregnant women in different settings of South-Central Cote d'Ivoire. Am J Trop Med Hyg. 2012;87(3):425-34.
30. Sahana KS, Ghaliyah K, Anitha P, Prakash S. A study of anemia in hospitalised infants at a tertiary care hospital. National Journal of Community Medicine. 2016;6(2):155-60.
31. Sharma A, Sharma SK, Grover AK, Tewari AD, Abrol P. Anemia in protein-energy malnutrition. Indian Pediatr. 1985;22(11):841-4.
32. Monarrez J, Martinez H, Martinez V, Greiner T. Nutritional status of indigenous children at boarding schools in Nortern Mexico. Eur J. Clin Nutr. 2004;58:532-40.
33. Pasricha SR, Black J, Muthayya S. Determinants of Anemia Among Young Children in Rural India. Pediatrics. 2010;126;e140-9.
34. Halileh S, Gordon NH. Determinants of Anemia in Pre-School Children in the Occupied Palestinian Territory ; J Trop Pediatr. 2006;52(1):12-8.
35. Thorne CJ, Roberts LM, Edwards DR, Haque MS, Cumbassa A, Last AR. Anaemia and malnutrition in children aged 0-59 months on the Bijagós Archipelago, Guinea-Bissau, West Africa: a cross-sectional, population-based study. Paediatr Int Child Health. 2013;33(3):151-60.
36. Mahgoub S, Nnyepi M, Bandeke T. Factors affecting prevalence of malnutrition among children under three years of age in Botswana.Afr J Food Agric Nutr Dev.2006;6:3–15.
37. Ramli, Agho KE, Inder KJ, Bowe SJ, Jacobs J, Dibley MJ. Prevalence and risk factors for stunting and severe stunting among under-fives in North Maluku province of Indonesia. BMC Pediatr. 2009; 9:64.
38. Wamani H, Astrom AN, Peterson S, Tumwine JK, Tylleskar T. Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. BMC Pediatr. 2007;7:17.
39. Government of Guinea Bissau & UNICEF. Multiple Indicator Cluster Survey 3. Guinea-Bissau: 2006. Available from: http://www.childinfo.org/files/maternal/DI%20Profile%20-%20Guinea-Bissau.pdf
40. Green MS. The male predominance in the incidence of infectious diseases in children: a postulated explanation for disparities in the literature. Int J Epidemiol. 1992;21:381-6.
41. Amine EK, Al-Awadi FA. Nutritional status survey of preschool children in Kuwait. East Med Health J. 1996; 2:386–95.
42. Wieringa FT, Berger J, Dijkhuizen MA, Hidayat A, Ninh NX, Utomo B, et al. Sex differences in prevalence of anaemia and iron deficiency in infancy in a large multi- country trial in South-East Asia. Br J Nutr. 2007; 98:1070–6. [PubMed: 17537292]
43. Thorsdottir I, Gunnarsson BS, Atladottir H, Michaelsen KF, Palsson G. Iron status at 12 months of age–effects of body size, growth and diet in a population with high birth weight. Eur J Clin Nutr. 2003; 57:505-13.
44. Hay G, Sandstad B, Whitelaw A, Borch-Iohnsen B. Iron status in a group of Norwegian children aged 6–24 months. Acta Paediatr. 2004;93:592-8.
45. Sales IM,de Queiroz E II, Paiva A.Association between anemia and subclinical infection in children in Paraíba State,Brazil. Rev Bras Hematol Hemoter.2011;33:96–9.
46. Zetterstrom R. Iron deficiency and iron deficiency anaemia during infancy and childhood. Acta Paediatr. 2004; 93:436–9.
47. Ehrhardt S, Burchard GD, Mantel C, Cramer JP, Kaiser S, Kubo M, et al. Malaria, anemia, and malnutrition in african children--defining intervention priorities. J Infect Dis. 2006;194:108-14.
48. Shally A, Rohini D, Tuhina V, Sheila V. Anaemia and undernutrition among preschool children in uttar Pradesh, India Indian pediatrics 2003:40:9985-990
49. Siegel EH, Stoltzfus RJ, Khatry SK, LeClerq S, Katz J, Tielsch JM. Epidemiology of anaemia among 4-17month children living in south central Nepal. Eur J Clin Nutr. 2006;60(2):228-35.