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Risk Factors and Clinical Profile of Nutritional Anemia in Children at a Tertiary Care Center of Western Uttar Pradesh, India

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ABSTRACT

Background

Little is known about the burden and clinical characteristics of children with nutritional anemia in the population of western Uttar Pradesh. This research was conducted to assess the risk factors and clinical profile of nutritional anemia in children admitted at a tertiary care center in western Uttar Pradesh, India.

Materials and methods

This hospital based cross-sectional study involved 220 subjects aged 6 months to 12 year presenting with anemia (nutritional) as per WHO definition at our center. Structured questionnaires were used to collect socioeconomic and demographic characteristics of the family and child. Blood samples were collected for estimation of hemoglobin, serum iron, B12 and folate levels. Univariate and Multiple logistic regression was used to calculate adjusted odds ratios and the corresponding 95% confidence intervals.

Results

In our study, the majority of subjects were having moderate anemia (53.64%) followed by severe form (25.46%). Iron deficiency was found in 67.27% of the subjects. Pallor was found to be the commonest sign (71.36%) followed by tachycardia (27.27%). Majority of subjects reported microcytic hypochromic anemia (74.54%) followed by macrocytic anemia. On multiple regression: younger age, higher birth order, lower SES, poor nutritional status and lower serum iron, B12 and folate concentration were significantly associated with moderate to severe nutritional anemia.

Conclusion:

In northern India, nutritional anemia still poses a significant problem not only among younger children but also among older ones. Iron deficiency continues to be the primary cause of this condition, however, B12 and folate deficiencies also have substantial contributions.

Keywords: Anemia, Child, Nutritional Anemia, Iron, Folate

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INTRODUCTION

According to WHO, the global prevalence of anemia in under 5 children is 39.8% with nearly 269 million children impacted. Childhood anemia is a severe public health problem for resource-limited nations in Asia and Africa [1]. Iron deficiency was found to be the cause of around half of all anemia cases [1]. Anemia is defined as a decline in hemoglobin (Hb) concentration, hematocrit, or the number of red blood cells (RBC) below the reference range for normal people of the same characteristics living in the same environment [2]. Based on the Hb level, in children aged 6 to 59 months, anemia is defined as Hb less than 11 g/dL which can be further categorized into mild (Hb 10.0-10.9 g/dL), moderate (Hb 7.0-9.9 g/dL) and severe (Hb <7.0g/dL) [3]. Childhood anemia is still common in India, according to NFHS-5 data (2019-21) the burden of anemic children aged 6-59 months has increased to 67.1% compared to a previous prevalence of 58.6% [4]. A similar trend is seen in the prevalence of anemia in the above age group in the state of Uttar Pradesh, India (NFHS-5, 66.4%; NFHS-4, 63.2%) [4]. The CNNS survey (2016-18) has shown that 41% of preschoolers aged 1–4 years, 24% of school-age children aged 5–9 years and 28% of adolescents aged 10–19 years had some degree of anemia [5]. Anemia in children is caused by a complicated and multifaceted set of factors including social, dietary, biological, environmental, and cultural factors [6]. Many studies have been carried out to demonstrate the factors that are linked to it. However, there is still a knowledge gap, particularly in underdeveloped countries. Given the link between anemia and decreased cognitive as well as psychomotor development with poor productivity, estimating the burden and cause of anemia is of utmost importance [7]. Nutritional anemia results from lack of nutrients required for Hb production and erythropoiesis; e.g. Iron deficiency, folic acid insufficiency, vitamin B12 deficiency, vitamin A deficiency, and protein-energy malnutrition. It can also be caused by toxic heavy metals like lead, as well as deficiency of trace elements like zinc and copper [8]. Low vitamin D level has also been found to be a risk factor especially in school children, according to recent research [9].Despite the fact that anemia is avoidable, it is nevertheless a reason for significant illness & mortality of children below five years [10]. However, minimal literature is available examining anemia among children from northern India, especially in children above 5 years. Therefore, to address this knowledge gap the present study was undertaken, with the aim to study the risk factors and clinical profile of nutritional anemia in children between 6 months and 12 years, presenting to our hospital.

METHODOLOGY

This hospital based cross-sectional observational study was done in the Department of Pediatrics at a tertiary care center in Uttar Pradesh, India from November 2019 to April 2021. This study was approved by the institutional ethics committee and all the procedures were performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. Children aged 6 months to 12 years, who presented at our center (in-patient/out-patient) with anemia as per WHO definition were eligible for enrolment [3]. Anemia was defined in children aged 6m-59m as Hb <11 gm/dl and 5-12 y as Hb <11.5 gm/dl. Those who received hematinic and blood transfusion in the past 12 weeks, children with known hematological disorder other than nutritional anemia, children with proven hemolytic anemia and those whose parents refused to give consent were excluded from the study. All included children were studied for basic socio-demographic parameters, symptoms and signs of anemia, nutritional status, feeding practices, Hb level, red cell indices, serum iron, B12 and folic acid (IFA) levels; maternal iron and folic acid intake during pregnancy, education; family details including per capita income, family size, dietary habits, place of residence etc. The twenty-four-hour recall method was used to assess the child's nutritional intake. All data was gathered and entered into a pre-designed and pre-tested proforma.Blood samples for investigations were collected with aseptic precautions in EDTA and plane vacutainers. Hb estimation was done by Automated Machine (Auto-analyzer) within 12 hours of blood sampling. The levels of vitamin B12 and folate in the blood were determined using the Access Immunoassay System's Chemiluminescent Immunoassay (Beckman coulter).

Statistical analysis

The data collected was entered in the statistical package for the social science system version SPSS 23.0 (IBM Corporation Armonk, NY, USA). Categorical data was presented as frequency and proportions, numerical data was summarized using mean and standard deviation. Comparison of categorical data between the groups was done using Chi-squared test or Fisher's exact

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test as appropriate. The P value <0.05 was considered significant. Univariate analysis was done to assess the risk factors for nutritional anemia. Significant variables were entered into multiple regression analysis to determine association.

RESULTS

The baseline characteristics of the enrolled children is presented in table 1. Out of the 220 children enrolled, maximum cases of nutritional anemia were in 6 months to 5 years' age group (n-156;70.9%), majority were females (n-126;57.27%) and nearly half (n-112;50%) belonged to middle socioeconomic class of modifiedppuswamy scale [11]. The birth order of more than half (n-130;56.3%) of the studied subjects was 3 or higher, and the majority were born full term (n-196;89%). During the antenatal period, only 52.72% (n- 116) mothers had taken iron and folate supplements. As regards feeding practices, only 58.2% (n-128) were exclusively breast fed till 6 months, adequate complementary feeding was started in less than half (n-84;38.2%) and most of study subjects were vegetarian (n-146;66.36%). Almost two-third (n-144;65.45%) of the enrolled subjects had deficient calorie intake and 57.27% (n-126) were undernourished.

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Table 1: Baseline sociodemographic and dietary characteristics of the study population

Parameter	Frequency (n)	Percentage (%)
Age group:		
6 month-5 year	156	70.9
6-12 y	64	29.1
Sex:		
Male	94	42.73
Female	126	57.27
Socioeconomic status:[a]		
Upper	12	5.45
Upper middle	24	10.90
Lower middle	88	40.00
Upper lower	56	25.45
Lower lower	40	18.18
Family type:		
Joint	126	57.27
Nuclear	94	42.73
Caregiver's educational status:		
Illiterate	56	25.45
Primary	64	29.09
High school	62	28.18
Graduate and above	38	17.27
Gestational age:		
Term	196	89.09
Preterm	24	10.09
Place of birth:		
Institutional	136	61.81
Home	84	38.18
Birth order:		
1st order	32	14.54
2nd order	64	29.09
3rd order or more	124	56.36

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Exclusively breastfed:[b] Yes No	 128 92	 58.18 41.81
Adequate complementary feeding: Yes No	 84 136	 38.18 61.81
Cow milk intake: Yes No	 134 86	 60.90 39.09
Diet: Veg Mixed	 146 74	 66.36 33.64
Antenatal IFA supplementation: Yes No	 116 104	 52.72 47.27
Calorie deficit: Yes No	 144 76	 65.45 34.54
Nutritional status:[c] Undernourished Normal	 126 94	 57.27 42.72
Maternal age (years): Below 20 20-40 Above 40	 24 150 46	 10.9 68.2 20.9
Mothers occupation: Homemaker Employed	 176 44	 80 20
Attending school: Yes No	 76 144	 34.5 65.5

n, number of subjects; IFA, Iron and folic acid

- a- *Modified Kuppuswamy scale [11]*
- b- *Till the age of 6 months*
- c- *Based on weight for height in children below 6 years and BMI for children 6 years and above*

Weakness & fatigability was the most common symptom (n-208;94.55%) reported followed by irritability (Table 2). Among signs, clinical pallor was the most frequent finding (n-157;71.36%) followed by tachycardia (Table 2).

Table 2: Symptoms and signs of anemia among the study subjects

	n	
Symptoms		%
Weakness & fatigability	208	94.55
Irritability	148	67.27
Poor school performance	84	38.18
Breathlessness	56	25.45
Headache	35	15.90
Dizziness	24	10.90
Palpitations	16	7.27
Chest pain	10	4.54
Signs	n	%
Pallor	157	71.36
Tachycardia	60	27.27
Glossitis	40	18.18
Cheilitis	36	16.36
Skin pigmentation (knuckles)	37	16.81
Koilonychias	30	13.63
Hepatomegaly	27	12.27
Edema	25	11.4
Hemic murmur	11	5.45

Regarding severity of anemia (fig. 1), the majority of subjects were having moderate anemia (n-118;53.64%) followed by severe form (n-56;25.46%). The predominant RBC morphology on peripheral smear was microcytic hypochromic anemia (n-163;74.1%). The commonest micronutrient deficiency reported was iron deficiency (n-148;67.27%) and then B12 deficiency. It was observed that most subjects having iron deficiency had moderate degree of anemia (62.16%) whereas, subjects with B12 deficiency presented with moderate to severe anemia (35.48%) as shown in table 3.

Table 3: Hematopoietic micronutrient deficiency as related to severity of anemia

Micronutrient Deficiency	N	Mild Anemia		Moderate Anemia		Severe Anemia	
		N=46	%	N=118	%	N=56	%
Iron	148	26	21.62	92	62.16	30	20.28

B12	62	18	29.03	22	35.48	22	35.48
Folate	10	2	20	4	40	4	40

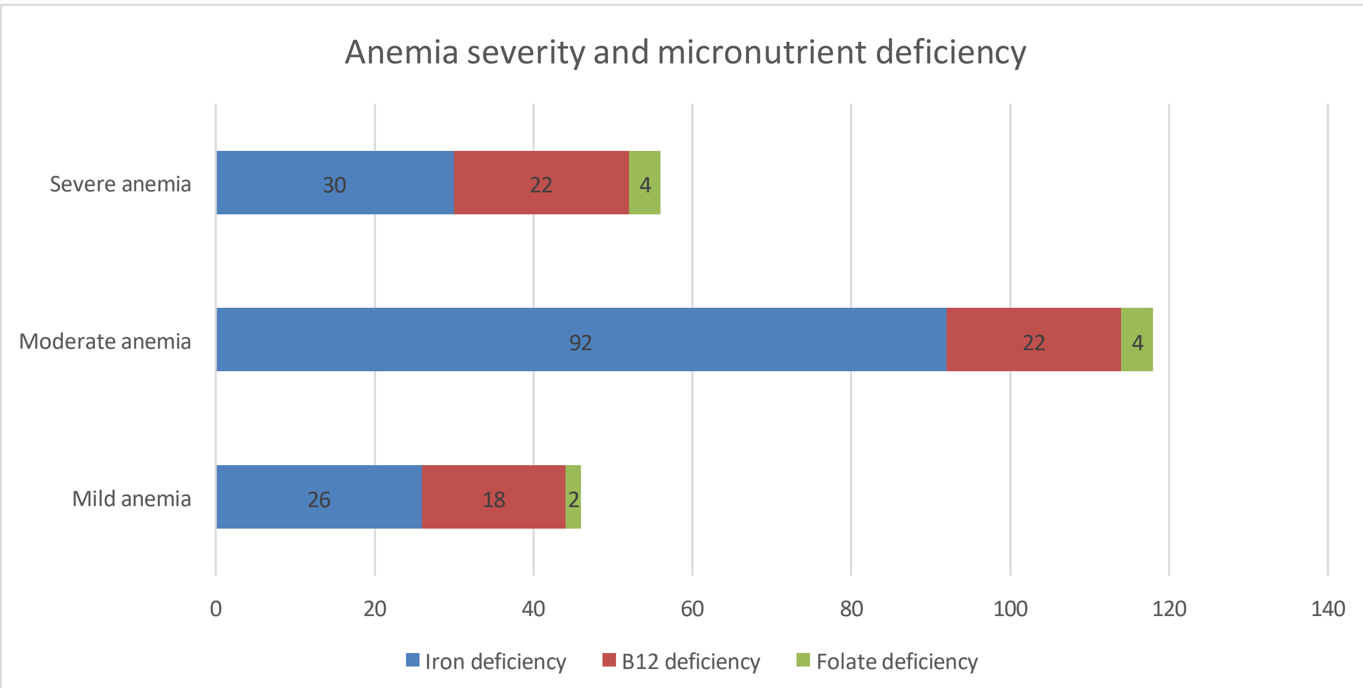

Figure 1: Hematopoietic micronutrient deficiency as related to severity of anemia

On univariate analysis of risk factors for moderate to severe anemia; younger age of the child, higher birth order, lower parental education level, lower SES, vegetarian diet, joint family type, calorie deficit, poor nutritional status and low serum iron, B12 and folate concentrations were significantly associated with lower Hb level (Table 4). On multiple regression, younger age, higher birth order, lower SES, poor nutritional status and lower serum iron, B12 and folate concentration were significantly associated with moderate to severe nutritional anemia (Table 5).

Table 4: Univariate analysis of risk factors for moderate to severe nutritional anemia

Parameters	OR	p value
Age	2.87	0.041*
Birth order	4.13	0.002*
Caregivers' educational status	2.82	0.044*
Socioeconomic status	2.89	0.036*

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Maternal age	0.42	0.682
Mothers occupation	0.74	0.734
Gestational age	0.24	0.376
Breastfeeding	1.17	0.382
Place of birth	1.94	0.274
Family type	3.11	0.038*
Blood in stool	0.93	0.584
Cow milk intake	1.14	0.542
Diet	2.72	0.042*
Calorie deficits	3.19	0.040*
Nutritional status	3.56	0.014*
Serum iron	5.03	0.006*
Serum B12	4.96	0.010*
Serum folate	3.57	0.012*

Table 5: Multiple regression analysis of risk factors for moderate to severe nutritional anemia

Parameters	OR	p value
Age	2.82	0.048*
Birth order	4.02	0.012*
Caregivers' educational status	2.71	0.068
Socioeconomic status	2.84	0.048*
Diet	2.61	0.092
Family Type	2.97	0.524
Calorie deficits	3.02	0.226
Nutritional status	3.51	0.042*
Serum iron	4.93	0.010*

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Serum B12	4.71	0.018*
Serum folate	3.44	0.022*

DISCUSSION

In a developing country like India, nutritional anemia is one of the major reasons for morbidity in children. Despite the existence of an effective control measure dating back to 1970 and various current programmes, the prevalence of nutritional anemia in children is on the rise in both India and abroad [4]. The present study was conducted to study risk factors and clinical profile of nutritional anemia in children at a tertiary care center of northern India.

In our study, almost two-thirds (70.9%) of the anemic children were between 6 months and 5-year of age, which is similar to most of the previous studies reporting maximum prevalence of nutritional anemia in younger age groups [5]. Faulty feeding methods in infancy including top feeding with predominantly diluted milk, continued exclusive breastfeeding beyond 6 months and inadequate weaning have been implicated as risk factors for nutritional anemia in this age group [12]. High iron demand due to rapid growth and erythropoiesis, as well as a lack of iron supplements in mother leading to low iron reserve are other contributing factors [12].

We found the proportion of female subjects with anemia (57.27%) to be higher than males, though not statistically significant. Similar gender-wise distribution with female predominance (55%) was observed in the study conducted by Gebreweld et al and others [4-5, 13-14]. However, other studies have reported a higher prevalence of anemia among boys [15-17]. These variable results could be due to prevalent social norms in the differential intake of iron-rich foods between genders in different regions of the world. Moreover, there is a possibility that treatment for anemia is more frequently sought for boys compared to girls.

As regards SES, maximum study subjects (40%) were from lower-middle SE class whereas upper class subjects comprised mere 5%. Other studies from India have also reported similar findings [18-19]. The prevalence of anemia is higher among children belonging to financially disadvantaged families, indicating that anemia is a manifestation of socioeconomic disadvantage [20]. Unfavorable socioeconomic conditions contribute to living environments that increase the vulnerability of children to diarrhea, respiratory illnesses, and intestinal parasite infestations. Additionally, these conditions compromise the intake, absorption, and utilization of iron, thereby exacerbating the likelihood of anemia [16].

Only, half of the study subjects' mothers took antenatal iron and folic acid supplementation. Proportion reported in the current study is quite low in comparison to results reported by Ray et al where nearly all mothers took antenatal iron-folate supplements [15]. The reason for such disparity could be lack of awareness in mothers about the importance of antenatal iron and folic acid supplementation.

In our study, 65.5% of the anemic subjects were having dietary calorie deficit and 57.3% were undernourished . This is consistent with the findings of Gebreweld et al who reported that more than half of the children were underweight [13]. Similar conclusion was reached by the studies done in Northern Ethiopia and India [18,21]. Anemia and undernutrition are usually caused by the same factors, which are exacerbated by poverty and food insecurity. Food insecurity has an impact on children's nutritional status by lowering the quantity and quality of their dietary intake, contributing to the development of anemia [21]. This finding highlights the importance of adequate and timely nutritional intervention in prevention of nutritional anemia.

Regarding the severity of anemia, the majority were having moderate anemia (53.64%) followed by severe form which is similar to the results of Ray et al. and others [15,17]. Gebreweld et al also reported moderate anemia in the majority of the anemic children under the age of five [13]. However, our findings differ from those of the EDHS 2016 report and a research conducted at Ghana's Volta Regional Hospital, which found high prevalence of mild anemia [22-23].

Microcytic hypochromic anemia (74.54%) was the most common pathological finding in our cohort which is

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coherent with the results of other investigators [17-18,23]. In line with this, the most common micronutrient deficiency in our study was iron, followed by B12 and folate. This is consistent with previous studies from different parts of the world [17-19,23-24]. However, we would like to emphasize the substantial contribution of B12 and folate deficiencies in childhood nutritional anemia as well which needs to be addressed.

On univariate analysis of predictive risk factors for moderate to severe anemia were younger age of the child, higher birth order (three or more), lower parental education, lower SES, vegetarian diet, joint family type, poor nutritional status and lower serum iron, B12 and folate concentration. On multiple regression, younger age, increasing birth order, lower SES, poor nutritional status and serum iron, B12 and folate concentration were significantly associated with moderate to severe nutritional anemia. Ray et al reported age, birth order, parental education and number of family members to be significantly associated with Hb level [15]. Onyeneho NG et al found that children's Hb was influenced by their diet intake, maternal hemoglobin levels, and household affluence [25].

In various research conducted around the world, low iron consumption has been identified as a significant driver of nutritional anemia. This conclusion was confirmed in our study as low serum iron remained significant after multiple regression analysis, implying that increasing iron consumption through nutrition will undoubtedly enhance the child's hemoglobin level. On multivariate analysis, birth order was also a significant predictor. Increased birth order could be linked to nutritional deficiency in the mother resulting in anemia and should be considered while developing family planning and child welfare policies.

Our findings indicate that current public-health approaches, such as iron supplementation, are necessary but insufficient in reducing childhood anemia. This study reveals that multiple contributing factors can coexist within an individual or population, influencing the severity of anemia. Therefore, in addition to introducing iron and iodine-fortified salt to address anemia, the National Nutrition Strategy should also consider implementing public health intervention strategies to tackle deficiencies in folic acid and vitamin B12. Moreover, for optimal improvement in children's hemoglobin levels, it is recommended to combine iron supplementation and food-fortification programs with efforts to reduce maternal anemia, alleviate family poverty, and address food insecurity. To achieve this, it is crucial to strengthen infrastructures and health institutions, control infectious diseases, and provide anemia-related health education. These measures, when implemented collectively, can lead to more effective interventions against childhood anemia.

However, it is important to acknowledge certain limitations regarding the findings of our study. Firstly, our study was cross-sectional in nature. Secondly, we could have improved the detection of iron deficiency as well as functional deficiencies of folate and vitamin B12 by measuring additional laboratory variables such as serum ferritin, soluble transferrin receptor, methyl-malonic acid, and homocysteine. Additionally, we did not assess the levels of lead or selenium, which have previously been shown to be linked to anemia. Despite these limitations, our study has successfully identified a comprehensive set of factors that are associated with nutritional anemia, in children from Uttar Pradesh, India.

CONCLUSION

In northern India, nutritional anemia still poses a significant problem not only among younger children but also among older ones. Despite the introduction of public health policies, iron deficiency continues to be the primary cause of this condition, however, B12 and folate deficiencies also have substantial contributions. Therefore, when formulating policies for the National Nutritional Anemia Control Program, it is crucial to consider addressing deficiencies in vitamin B12 and folate as well.

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