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Nutritional anaemia in children in post supplementation era: A cross sectional study

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ABSTRACT

Background: Nutritional anemia is still the primary cause of anemia despite of various nutritional programmes in developing countries. **Aims and Objective:** The present study was planned to asses Iron, Folate, and Vitamin B12 deficiency anaemia in developing countries. **Materials and Methods:** This cross-sectional study was conducted at a tertiary care centre in Agra in collaboration with Institute of Genomics and Integrative Biology, New Delhi. Admitted children of age 6 months to 14 years having signs and symptoms of anaemia were included in the study. Sample size calculated was 157. All the cases were subjected to CBC, GBP, serum iron, ferritin, folate and vitamin B12 level estimation. **Results:** Out of 672 children, 157 children with clinical feature of anaemia were enrolled in the study. Among these 157 children, 52.87% were male. Percent proportion of anaemia was highest among toddlers (27.39%) and lowest in adolescent (10.83%). The maximum cases were of urban area (65.6%) and middle socioeconomic status (47.13%). Most of the children were undernourished/underweight (60.4%). Mean iron level was significantly low in female children, children of rural areas, low socioeconomic status and malnutrition/underweight. Mixed iron, folate and B12 deficiency was found in 48.41%, 30.57% and 22.93% cases respectively. In 24.20% cases no deficiencies were found and were classified as anaemia due to some unspecified causes. **Conclusion**: Nutritional deficiency anaemia is contributing to a large proportion of anaemic patients. More intensified programmes are needed especially for female children, children of rural areas, low socioeconomic status and malnutrition/underweight.

Key words: Nutritional anaemia; Megaloblastic anaemia; Iron deficiency anaemia

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INTRODUCTION

According to World health organization (WHO), anaemia is a widespread public health problem with major consequences for human health as well as social and economic development.[1] Anaemia, is functionally defined as an insufficient RBC mass to adequately deliver oxygen to peripheral tissues. WHO published a data in 2015 on "global prevalence of Anaemia 2011", according to which anaemia affects 273.2 Million children of age 6 months to 59 months, which corresponds to 42.6 % of the total population of the children.[2] Nutritional deficiencies are the primary cause of anaemia. Anaemias of nutritional origin are acquired problems caused by diets that lack sufficient quantity of bioavailable essential hematopoietic nutrients to meet the need for hemoglobin and red blood cell synthesis.[3] Forty-two percent of the cases of anaemia in children are attributable *to* Iron deficiency. According to data from "Global Prevalence of Anaemia 2011" India has a mean haemoglobin concentration of 10.6g/dl in children of age 6 month to 59 months, which already comes under the category of mild anaemia.[2] Government

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of India is carrying out various health program to combat nutritional anaemia. WHO and UNICEF re-emphasize the urgent need to combat anaemia and stress the importance of recognizing its multifactorial aetiology for developing effective control programmes.[1] The aim of this study was to evaluate Iron, Vitamin B12 and Folate deficiency in children with anaemia.

MATERIALS AND METHODS

This cross-sectional study was conducted in Department of Pediatrics, S.N. Medical College, Agra in collaboration with Institute of Genomics and Integrative Biology, New Delhi.

Admitted children of age 6 months to 14 years having signs and symptoms of anaemia were included in the study. The sample size was calculated using the formula 4 X % PREVALENCE X (100 - % PREVALENCE) / (d^2). Prevalence was obtained from national family health survey-3 (NFHS 3) data of Uttar Pradesh between the age group of 6-59 months, in which the prevalence of anaemia was 73.9%. 'd' is the 'allowable error of prevalence' which was taken as 10%. Sample size calculated was 157 and the samples were collected from November 2014 to March 2015. This study was approved by ethical committee of the institute. Subjects were included in the study after taking informed consent from the parents/guardian.

In this study, we excluded the children who had received Iron, folate, vitamin B12 therapy, blood transfusion in immediate past, patients diagnosed with other pathological anaemia and seriously sick children.

After taking detailed history and clinical examination, 5 ml of blood sample was collected through venepuncture and the samples was divided into two parts, E.D.T.A sample were subjected to complete blood count and general blood picture, and the serum samples were stored at -200 degree Celsius in cryovials for the estimation of serum iron, ferritin, folate and vitamin B12 and were later sent to the Institute of Genomics and Integrative Biology by maintaining the cold chain. Iron estimation was done using colorimetric method with ferrozine without deproteinization. Ferritin estimation was done by particle enhanced immunoturbidimetric assay. Vitamin B12 estimation was based on competitive test principle using intrinsic factor specific for vitamin B12. Folate assay based on a competitive test principle using natural folate binding protein (FBP) specific for folate. Cut of value for serum Iron, Ferritin, Folate and Vitamin B12 are 30 microgram/dl, 15 ng/ml, 5.0 ng/ml and 200 pg/ml respectively.[4-6] Cases, who did not qualified above mentioned criteria were classified as anaemia due to unspecified causes. We implied the Student unpaired t test and analysis of variance (ANOVA) for quantitative data and student chi square test for qualitative data analysis.

RESULTS

A total of 672 children of age group 6 months to 14 years were admitted in our department from November 2014 to March 2015. Out of these, 157 children with clinical feature suggestive of anaemia were included in the study. Socio-demographic profiles of these patients have been shown in Table 1. Among these 157 children, 52.87% were male. The percent proportion of anaemia was highest among toddlers (27.39%) and lowest among adolescent (10.83%). The cases belonging to urban areas were 65.6%. Maximum cases belonged to middle (47.13%) and lower (35.67%) socioeconomic status (as per Kuppuswamy's grading). We found maximum cases belonged to severe (31.84%) followed by moderate (28.66%) and mild (19.05%) grade of under nutrition/ underweight as per W.H.O classification of malnutrition/ underweight. Out of all anaemic cases, 57.96% cases were of moderate grade of anaemia, 38.21% were of severe and 3.82% were of mild grade of anaemia. On general blood picture (GBP) examination maximum number of cases had microcytic hypochromic (31.85%) followed by macrocytic hypochromic (24.20%), dimorphic (23.57%) and normocytic normochromic (20.83%) blood picture (Table: 1).

Iron deficiency was present in 90% of the cases having microcytic and 83.7% cases of dimorphic general blood picture. Folate deficiency was observed in 47.37% cases of macrocytic general blood picture and 40.54% cases of dimorphic general blood picture. Vitamin B12 deficiency was found in cases with dimorphic GBP (48.65%) followed by macrocytic (36.84%), normocytic (25%) and microcytic (16%) general blood picture cases.

Mean micronutrient levels in all the three types of anaemia patients have been shown in Table 2. Iron and ferritin were significantly low in females as compared to males. Folate and vitamin B12 were also low in females but values were not statistically significant. The mean micronutrient levels (iron, ferritin, Folate and vitamin B12) were low in rural population when compared to urban. Iron levels were significantly low in the patient of low socioeconomic class. Mean micronutrient levels for iron were significantly low in various grades of malnutrition/ underweight (Table-2).

Table 1: Demographic and pathological profile of the subjects

Demographical Factors	N=157(%)	Iron deficiency N=76	Folate Deficiency N=48	Vitamin B12 deficiency N=36
Age Group				
Infant	18 (11.47%)	6 (7.89%)	4 (8.33%)	6 (16.67%)
Toddler	43 (27.39%)	23 (30.26%)	14 (29.17%)	8 (22.22%)
Pre-School	38 (24.20%)	19 (25%)	12 (25%)	10 (27.78%)
School-Going	41 (26.11%)	20 (26.32%)	10 (20.83%)	9 (25%)
Adolescent	17 (10.83%)	8 (10.53%)	8 (16.67%)	3 (8.33%)
Sex				
Male	83 (52.87%)	43 (56.58%)	24 (50%)	21 (58.33%)
Female	74 (47.13%)	33 (43.42%)	24 (50%)	15 (41.67%)
Residency				
Urban	103 (65.6%)	33 (43.42%)	18 (37.50%)	10 (27.78%)
Rural	54 (34.4%)	43 (56.58%)	30((62.50%)	26 (72.22%)
Socioeconomic Status				
Upper	27 (17.20%)	3 (3.95%)	5 (10.42%)	5 (13.89%)
Middle	74 (47.13%)	33 (43.42%)	16 (33.33%)	18 (50%)
Lower	56 (35.67%)	40 (52.63%)	27 (56.25%)	13 (36.11%)
Underweight/Undernutrition				
Mild	31 (19.75%)	1519.74	5 (10.42%)	6 (16.67%)
Moderate	45 (28.66%)	2228.95	18 (37.5%)	14 (38.89%)
Severe	50 (31.84%)	3444.74	19 (39.58%)	11 (30.55%)
Normal	31 (19.75%)	56.58	6 (12.5%)	5 (13.89%)
Grades Ofanemia				
Mild	6 (3.82%)	3 (50%)	2 (33.33%)	1 (16.67%)
Moderate	91 (57.96%)	47 (51.65%)	28 (30.77%)	23 (25.27%)
Severe	60 (38.21%)	26 (43.33%)	18 (30%)	12 (20%)
General Blood Picture				
Microcytic Hypochromic	50 (31.85%)	45 (90%)	0	8 (16%)
Macrocytic Hypochromic	38 (24.20%)	0	18 (47.37%)	14 (36.84%)
Dimorphic	37 (23.57%)	31 (83.78%)	15 (40.54%)	18 (48.65%)
Normocytic Normochromic	32 (20.83%)	0	3 (9.38%)	8 (25%)

Table: 2 Mean Micronutrient levels and Demographic profile of anaemia

Demographical Factors	Iron Deficiency Anemia				Folate Deficiency Anemia		Vitamin B12 Deficiency Anemia	
	Iron Mean±SD (mg/L)	p value	Ferritin Mean±SD (mcg/dl)	p value	Folate Mean±SD (mcg/L)	p value	B12 Mean±SD (pg/ml)	p value
Age group								
Infant	0.19±0.1	0.333	19.79±32.56	0.682	3.41±1.72	0.088	54.84±23.50	0.284
Toddler	0.15±0.08		7.29±4.68		3.91±2.83		55.08±24.34	
Pre- school	0.32±0.51		33.30±120.18		3.64±1.57		44.69±21.34	
School-going	0.19±0.09		10.43±10.51		3.75±1.16		52.17±26.63	
Adolescent	0.18±0.10		8.38±5.11		4.02±2.44		48.11±16.78	
Sex								
Male	0.25±0.16	0.0094	21.18±81.74	0.0001	4.22±2.44	0.1253	51.59±20.32	0.8861
Female	0.18±0.17		9.28±8.66		3.31±1.46		50.43±25.87	
Residency								
Urban	0.19±0.10	0.0415	10.33±22.3	0.4916	3.03±1.66	0.0674	58.44±62.44	0.6776
Rural	0.25±0.14		13.32±12.33		4.07±2.15		67.85±51.34	
Socio								
Economic status								
Upper	0.27±0.05	0.031	20.84±4.05	0.956	4.04±1.52	0.079	48.41±18.18	0.976
Middle	0.23±0.08		10.35±15.44		3.86±0.94		46.36±22.10	
Lower	0.19±0.07		9.87±83.03		2.53±2.52		45.80±25.03	
Nutrition status								
Under-weight or under- nutrition								
Mild	0.18±0.09	0.006	12.90±22.37	0.486	3.48±1.39	0.603	62.40±28.37	0.516
Moderate	0.17±0.18		10.38±111.93		3.45±1.56		52.64±20.20	
Severe	0.12±0.08		7.93±4.65		3.23±2.76		49.52±25.16	
Normal	0.32±0.08		14.33±3.82		4.55±0.72		64.20±8.35	

Table 3: Etiological profile of anaemia

Type of Anaemia	Number of children {N=157(%)}
Pure Iron deficiency	50 (31.85%)
Pure Folate deficiency	19 (12.10%)
Pure Vitamin B12 deficiency	17 (10.83%)
Iron plus Folate deficiency	14 (8.92%)
Folate plus Vitamin B12 deficiency	7 (4.46%)
Iron plus B12 Deficiency	4 (2.55%)
Iron plus Folate plus Vitamin B12 deficiency	8 (5.10%)
Non nutritional causes	38 (24.20%)
Total	157 (100%)

Out of 157 anaemic cases, 50(31.85%) had pure iron deficiency, 19(12.10%) had pure folate deficiency and 17(10.83%) had pure vitamin B12 deficiency. In mixed form of anaemia, iron plus folate, folate plus Vitamin B12 and iron plus B12 contributed to 14(8.92%), 7(4.46%) and 4(2.55%) cases respectively. In 8(5.10%) cases there was combined deficiency of all three micronutrient (Iron, folate and Vitamin B12). In 38 (24.20%) cases no deficiency was found and such cases were classified as anaemia due to non-nutritional causes. Causes of non-nutritional anaemia include malaria, worm infestation, hemoglobinopathies, chronic disease, haemolytic disorders, thyroid disorders, liver disorders and renal disorders. Aetiologies of anaemia in 157 children are depicted in Table 3.

DISCUSSION

Anaemia is a significant public health problem with major consequences for human health and socio-economic development. Anaemia is an indicator of poor nutrition and poor health. Developing countries carry the most significant burden of the reported cases of anaemia whose aetiology is often multifactorial.[7]

In our study maximum cases belonged to toddler, school going and preschool age children. The numbers of cases in these different age groups were nearly same. There was decrease in prevalence of anaemia as age increases and these findings were similar to the study done by Rajaratnam. J et al.[8] The reason of higher prevalence of anaemia in early age group children could be dependency for their nutrition on care providers. In present study, anaemia was more common in males and this observation was similar to another study.[9]

In this study almost two third of cases belonged to urban area. Health care facilities are easily accessible in urban areas and this can be attributed to the increase in the number of urban patients. This is in accordance with several studies done in the past.[10-13] Iron and ferritin levels were significantly low in females; it might be due to poor attitude towards female child health and nutrition in our society. Iron levels were statistically low in rural population as compared to urban. In our study anaemia was more prevalent among cases of middle and low socioeconomic status. Several studies done in south East Asia also showed similar results.[14-17]

Mean iron level was significantly low in low socioeconomic status, though the mean micronutrient level of ferritin, folate and B12 were also low in the low socioeconomic status but were not statistically significant. This is supported by the study on adolescent girls in Korea, where there was a relationship between household income and ferritin levels for iron deficiency anaemia.[18]

In our study 80.25% anaemic cases had some grade of malnutrition/ underweight and only 19.75% of cases had normal nutrition. This was in accordance with study done in Northern Himalayan state of India and Bihar where anaemic cases had different grades of malnutrition/underweight.[15,19,20] Mean micronutrient levels were studied in different grades of malnutrition/ underweight and it was found that mean micronutrient level of iron was significantly low in different grades of malnutrition/underweight. The levels of ferritin, folate and Vitamin B12 were also low in different grades of malnutrition/underweight but the results were not statistically significant.

Among 157 anaemic cases studied, prevalence of moderate anaemia was highest followed by severe and mild. Similar results were found in other studies.[21,22] In present study maximum percentage of cases were of microcytic hypochromic general blood picture (31.85%) followed by macrocytic (24.20%), dimorphic (23.57%) and normocytic normochromic blood picture (20.38%). The study was similar to other studies done in past in which they found that in maximum cases general blood picture was of microcytic hypochromic type.[21,22]

In the present study pure or mixed iron deficiency had the highest prevalence (48.41%). Prevalence of iron deficiency was commonest in studies done in past.[9,23-25] Pure or mixed folate deficiency was around 30.57% and contributed to the second most common cause of nutritional deficiency anaemia and this was in accordance with Mamabolo et al.[26] In present study vitamin B12 or cobalamine (22.93%) deficiency was least common cause of nutritional deficiency anaemia. The study was similar to other studies in which they found vitamin B12 deficiency was the least common cause of anaemia.[26-28] Variation in the causes of anaemia and micronutrient levels in different studies may be due

to either selection of age group or demographical and geographical reasons.

CONCLUSION

Nutritional deficiency anaemia is still contributing a large proportion of the anaemic patients. In spite of large-scale supplementation with iron and folate, the deficiency of these micronutrient, are still prevalent, so the strengthening of same is required. Vitamin B12 deficiency is also common in paediatric age group. Large proportion of the paediatric population is still vegetarian so supplementation and fortification of vitamin B12 is also required to reduce the prevalence of anaemia.

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DISCLOSURE

These are present affiliations of author no 1,2,4 and 7. All the authors were working in SN Medical college Agra at the time of study.

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RK, PK- Concept and design of study, final draft of manuscript; **MS, SP**- Supervised data collection and literature review; **VS, SP**- Data collection, analysis and first draft of manuscript; **RA, PK-**Statistical analysis, interpretation of results; **CH**- Literature review and interpretation of lab results.

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