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Nutritional Deficiencies in Anemia in Adolescents of Northern India

Yuthika Agrawal[1], Vipin Goyal[2], Abhishek Singh[3]
[1]Department of Biochemistry, SHKM GMC, Nalhar, Mewat
[2]Department of Chest and TB, SHKM GMC, Nalhar, Mewat
[3]Department of Community Medicine, SHKM GMC, Nalhar, Mewat

Original Research Article

***Corresponding author**
Abhishek Singh

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Abstract: Nutritional anemia constitutes the most important cause of anemia in adolescents. It is mainly due to deficiency of iron, vitamin B12 and folate. In comparison to the vast amount of studies done on pregnant mothers and young children, work done on adolescent having nutritional anemia is scarce. The present study was planned to study the types of nutritional anemia in adolescents (10-18.9yrs) attending the hospital and to correlate the severity of nutritional anemia with serum levels of ferritin, Vitamin B12 and folate. 200 adolescent of age between 10-19 yrs were taken and classified as anemic based on their haemoglobin levels. Complete blood count was done with peripheral smear examination. Serum ferritin, serum folate and serum vitamin B12 were estimated. Male:female ratio was 1.02:1. Maximum subjects were in early adolescence (69.5%) while least in late adolescence (5%). Mean haemoglobin level was 9.36 $\pm$ 2.45 gm/dl which falls in moderate category. Mean MCV was 85.27 $\pm$ 14.25 fl which suggests high prevalence of normocytosis. Mean serum B12 level was 230.17 $\pm$144.96 pg/ml, mean serum ferritin was 102.72 $\pm$ 9.61ng/ml and mean serum folate was 4.12 $\pm$ 2.19 ng/ml. s 5.5% of study subjects had isolated iron deficiency, 25.5% had isolated folate deficiency and 4% had isolated Vit B12 defeciency. Combined folate and Vit B12 deficiency was seen in 31.3%. Majority of the subjects of mild anemia (79%) had normocytic anemia while in severe anemia 31% had microcytic anemia and dimorphic anemia each while 27% had macrocytic anemia. Folate deficiency was the most common followed by vitamin B12 defeciency and then irons deficiency. Supplementation with not only iron and folic acid but also with vitamin B12 is required through national programmes.
Keywords: Nutrional anemia, adolescent, ferritin, iron, vitamin B12, folate.

INTRODUCTION

Adolescent has been defined by the world Health Organisation as the period of life spanning the ages between 10 to 19years [1]. Maximum physical, psychological and behavioural changes takes place in this formative period, but this period is also vulnerable to develop nutritional anemia, which has been constantly neglected by public health programs.

Anemia is a critical health concern as it affects growth and energy levels and has a negative effect on cognitive performance in adolescents. In pregnancy it is associated with premature births, low birth weight, and perinatal and maternal mortality.

The prevalence of anemia is disproportionately high in developing countries like India. It has mainly been ascribed to poverty, inadequate diet, certain diseases, pregnancy and lactation, and poor access to health services in developing countries [2]. Basu *et al* and Bulliyya have reported prevalence of anemia in adolescent Indians as 16.25% and 96.5% respectively [3, 4].

Nutritional anemia constitutes the most important cause of anemia in adolescents. It is mainly due to deficiency of iron, vitamin B12 and folate. Abha *et al* reported 2/3rd of the anemic adolescent are suffering from iron deficiency anemia [5]. Young people are particularly susceptible to develop anemia because of high iron requirements in their rapid growth. Girls loose considerable amount of blood during menstruation. Also adolescent's eating behaviour is guided by many factors such as personal self-esteem, body image, making them skip meals to reduce weight and peer pressure indulging them in unhealthy food habits making them prone to nutritional anemia. Megaloblastic anemia resulting from deficiency of folate and vitamin B12 also appears to be increasing over the last two dacades. Patra *et al*. reported

megaloblastic anemia (42.5%) to be the most common type of anemia in severely anemic adolescents admitted in a tertiary care hospital [6].

In comparison to the vast amount of studies done on pregnant mothers and young children, work done on iron, vitamin B12 and folate deficiency in adolescent having nutritional anemia is scarce. Though some studies are available correlating the severity of anemia and sociodemographic factors in Indian adolescents [7], there is insufficient data correlating the severity of anemia with the specific micronutrient deficiency. Availability of such data and information associated with nutritional anaemia in adolescents will help to plan interventions to combat anemia in adolescents, and help us plan health programs better. Therefore the present study was planned to study the types of nutritional anemia in adolescents (10-18yrs) attending the hospital.

MATERIALS AND METHODS

The study was as a cross-sectional observational study. Two hundred (200) adolescent with the following inclusion criteria were included in the study after informed consent duely signed by patient's guardian:

- Age between 10-20 yrs
- Hemoglobin below the following cut-off values:
  Girls 10-18 yrs→ <12 gm/dl
  Boys 10-14 yrs→ <12 gm/dl
  Boys 15-18 yrs→ <13gm/dl

Exclusion criteria was

- Those received haematinics in past 4 weeks
- Those who received blood transfusions in past 4 weeks
- Those with known haematological or any othersystemic disorder (thalassemia etc.)
- Those with evidence of apparent chronic infections (tuberculosis, malaria etc)

Complete blood count (CBC) was done with peripheral smear examination. Serum ferritin was done with direct sandwich ELISA method. Serum folate and serum vitamin B12 were estimated by chemiluminescent immunoassay. Cut-offs used for mean corpuscular volume (MCV), severity of anemia and micronutrient levels are shown in table 1,2 and 3.

Table-1: MCV cut-offs for adolescents [8]

AGE GROUP	MICROCYTIC	NORMOCYTIC	MACROCYTIC
MALES	<78	78-98	>98
FEMALES	<78	78-102	>102

Table-2: Grading of severity of anemia based on Hb concentrations [9, 10]

AGE	SEVERE	MODERATE	MILD	NO ANEMIA
Females 10-18yrs Males 10-14 yrs	<7	7-9.9	10-11.9	≥12
Males ≥ 15 yrs	<7	7-9.9	10-12.9	≥13

Table-3: Micronutrioent level to define defeciency

VIAMIN B12	FOLATE	FERRITIN
<200 pg/ml	<5.0 ng/ml	<12ng/ml (119)

STATISTICAL ANALYSIS

Analysis was done using appropriate statistics using SPSS. p value ≤ 0.05 was considered significant.

RESULTS

Of the 200 adolescent enrolled in the study, 120 were outpatient while 80 were inpatient cases. Male female ratio was 1:1.02. Maximum subjects were in early adolescent. Most subjects were non vegetarians and belonged to families having upper lower socioeconomic status according to modified Kuppuswamy's scale and per capita income <1500. Demographic characteristic of the cases are shown in table 4.

Table-4: Demographic parameters of the cases

Parameter	Number (%)
Mean Age	13.0 ± 4.5yrs
Male : femlale	1:1.02
Stage of adolescence (yrs.) Early (10-13.9) Mid (14-16.9) Late (17-18.9)	 139 (69.5%) 51 (25.5%) 10 (5.0%)
Socioeconomic status Lower Upper lower Lower middle Upper middle Upper	 0 (0) 137 (68.5%) 56 (28%) 7 (3.5%) 0 (0)
Food habit Vegetarian Non-vegetarian	 39 (19.5%) 161 (80.5%)
Nutritional status (BMI) Very underweight (< -3SD) Underweight (-2 to -3 SD) Normal (+1 to +2SD) Overweight (+1 to +2SD)	 55 (27.5%) 35 (17.5%) 108 (54%) 2 (1%)
Females premenarche: postmenarche	40:61

Mean haemoglobin level was 9.36 ± 2.45 gm/dl which falls in moderate category. Mean MCV was 85.27 ± 14.25 fl which suggests high prevalence of normocytosis. Mean serum B12 level was 230.17 ±144.96 pg/ml, mean serum ferritin was 102.72 ± 9.61ng/ml and mean serum folate was 4.12 ± 2.19 ng/ml. These parameters are shown in table 5.

Table-5: Parameters in the study group

FACTORS	Mean ± SD
Hb (gm/dl)	9.36 ± 2.45
MCV (fl.)	85.27 ± 14.25
Serum B12 (pg/ml)	230.17 ±144.96
Serum Folate (ng/ml)	4.12 ± 2.19
Serum ferritin (ng/ml)	102.72 ± 9.61

Table-6: Gender distribution of study subjects according to stage of adolescence

Stage of adolescence (yrs)	Male	Female	Total
Early (10-13.9)	11 (77.8%)	62 (61.4%)	139 (69.5%)
Mid (14-16.9)	18 (18.1%)	33 (32.7%)	51 (25.5%)
Late (17-18.9)	4 (4.1%)	6 (5.9%)	10 (5%)
Total	99 (100%)	101 (100%)	200 (100%)

Adolescent were grouped into 3 stages: Early adolescence (10-13.9 yrs), mid adolescence (14-16.9 yrs) and late adolescence (17-18.9 yrs). 99 males and 101 females were enrolled for the study with male:female ratio of 1.02:1. Maximum subjects were in early adolescence (69.5%) while least in late adolescence (5%) (Table 6).

Table-7: Gender distribution in relation to severity of anemia

Severity of anemia	Males	Females	Total
Mild (11-11.9 g/dl)	56 (56.5%)	45 (44.6%)	101 (50.5%)
Moderate (8-10.9 g/dl)	27 (27.3%)	31 (30.7%)	58 (29%)
Severe (<8 g/dl)	16 (16.2%)	25 (24.7%)	41 (20.5%)
Total	99 (100%)	101 (100%)	200 (100%)

In males 56.6% had mild anemia, 27.3% had moderate anemia and 16.2% had severe anemia, while among females 44.6% had mild, 30.7% had moderate and 24.7% had severe anemia (table 7).

Table-8: Hematopoetic micronutrient deficiency

Defeciencies	No of subjects	%
Iron def *	11	5.5%
Folate deficiency	51	25.5%
Vit B12 def	8	4%
Iron + folate def	21	10.5%
Folate + Vit B12 def	63	31.5%
Iron +Vit B12 def	5	2.5%
Triple def	24	12%
No def.	17	8.5%

*= serum ferritin<12ng/ml, others determined by serum level of folate, vit B12

Among the study subjects 5.5% had isolated iron deficiency, 25.5% had isolated folate deficiency and 4% had isolated Vit B12 defeciency. Combined folate and Vit B12 deficiency was seen in 31.3%. Subjects having deficiency of all three micronutrients were 12%, while 8.5% subjects had no micronutrient deficiency (table 8).

Table-9: Severity of anemia in relation to type of anemia as assessed by MCV and examination of peripheral smear

Blood picture	Anemia				
	Mild	Moderate	Severe	Total	P value
Microcytic	15 (14.8%)	27 (46.6%)	13 (31.7%)	55 (27.5%)	<.001
Normocytic	80 (79.3%)	26 (44.8%)	4 (9.7%)	110 (55%)	
Macrocytic	4 (3.9%)	2 (3.4%)	11 (26.9%)	17 (8.5%)	
Dimorphic	2 (2%)	3 (5.2%)	13 (31.7%)	18 (9%)	
Total	101 (100%)	58 (100%)	41 (100%)	200 (100%)	

Majority of the subjects of mild anemia (79%) had normocytic anemia while in severe anemia 31% had microcytic anemia and dimorphic anemia each while 27% had macrocytic anemia (table 9).

DISCUSSION

Prevalence of anemia is very high in India particularly pregnant and lactating women and preschool children[11,8]. Limited data is available on nutritional anemia in adolescents. Present study was undertaken to find out etiology of nutritional anemia in adolescents[3,12,13]. The study was a hospital based study on 200 adolescent attending a tertiary care centre hospital with almost 1:1 male female ratio, which is in corroboration with study by Sinha *et al*.[14] Inspite of high prevalence of anemia in females in community, an equal number in reporting to a tertiary care hospital reflects the preferential male child caring society in India.

Our study showed that of 200 anemic adolescents 69.5% belonged to early adolescence (10-13.9yrs), 25.5% were in mid adolescence (14-16.9 yrs) and which finally decreased to 5% in late adolescence (17-18.9 yrs). This is same as shown by Jayasree *et al*,[12] who showed a decrease in prevalence of anemia from 55% in early adolescent (10-13 yrs) to 14% in late adolescence (17-19yrs). But this is in contrast to study by Biradar *et al*.[15] who showed an increase in prevalence with increasing age in anemic adolescents. This variation can be due to not adequate representation of late adolescents in our hospital.

Among the study subjects 50.5% had mild anemia, 29% had moderate anemia and 20.5% had severe anemia. Many studies have revealed high proportion of mild anemia followed by moderate anemia [4,5,12,15]. Our study shows a high proportion of severely anemic cases which can be attributed to hospital based nature of study which is in accordance with a study done by Sandeep Ray[16].

There is insufficient data available on etiological profile of nutritional anemia in adolescents from India. In our study Vitamin B12 deficiency was found in 50% of anemic adolescents and 79.5% of anemic adolescents had folate deficiency and iron deficiency was seen in 30.5% of subjects. Folate deficiency and vit B12 defeciency shown in our study is much higher to those reported by Ahmed *at al.* [17] (folate 25%) and Sandeep Ray[16] (folate 14%, vit B12 43%). Ahmed *et al.* [17]. observed Vit B12 defeciency of 7% in anemic adolescent girls of Bangladesh. But if a more stringent cut- off of <3ng/ml would have used to detect folate deficiency, 29% of subjects will only have folate deficiency, which is similar to other results. Iron

deficiency found in our study is comparable with studies by Ahmed *et al*. [18] (32%) and Kurniawan *et al.*[19] (29%). Low dietary intake of these nutrients can be the main cause of these anemic adolescent children.

In our study dimorphic picture based on MCV and on peripheral smear examination (9%) and macrocytic picture (8.5%) (combined 17.5%) was more as compared to studies done by Shilpa T [20] on adolescent girls (2.1%) and Dhage *et al*.[21]. (13%) but this is in concordance to the high prevalence of viamin B12 and folate deficiency in our study group.

CONCLUSION

Folate deficiency was the most common followed by vitamin B12 defeciency and then iron deficiency. Low intake of these nutrients can be a significant determinant towards causing nutritional anemia. Supplementation with not only iron and folic acid but also with vitamin B12 is required through national programmes.

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