

## Nutritional Anemia Status in Adolescent Girls in Rural Schools of Raipur, India

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### Abstract

**Introduction:** Nutritional deficiency, especially iron deficiency is the most common etiological factor for anemia, particularly in adolescent girls when the requirement for iron increases tremendously to physiological need.

**Aim:** This study not only would highlight the burden of nutritional anemia in them, but also it would aid in drawing recommendations and rendering suggestions to assess and maneuver the existing schemes. The aim was to estimate the prevalence of anemia among school going girls to associate anemia to their demographic profile and nutritional status.

**Materials and methods:** This was a community based cross sectional observational study. The demographic profile was collected followed by estimation of Iron profile and Vitamin B12 levels estimation among 382 adolescent girls aged 10 to 18 years, in schools at rural area of Raipur district, India.

**Results:** Iron and vitamin B12 deficiency was present in 11% and 58% respectively. Statistically significant association was observed between severity of anemia serum ferritin ( $p < 0.01$ ) but not with serum vitamin B12 levels.

**Conclusion:** Anemia in adolescent girls was found to be very common. Moreover, Vitamin B12 deficiency was more common than iron deficiency in adolescent girls. There is need to shift the focus from old paradigm of iron deficiency anemia to other forms of anemia basically vitamin B12 deficiency anemia, as observed from this study.

**Keywords:** Adolescent girls; Anemia; Iron deficiency; Vitamin B12 deficiency

### Introduction

Anemia is defined by World Health Organization (WHO) as low blood hemoglobin concentration,  $< 12$  gm/dl, and has been regarded as public health problem in both developed and developing countries [1]. In spite of successful implementation of National Nutritional Anemia Control Programme (NNACP) and Iron Folic acid supplementation (IFA) - National Nutritional Anemia Prophylaxis programme, the burden of anemia is surprisingly large enough in Indian children, particularly in adolescent girls [2]. As per the National Rural Health Mission (NRHM), Adolescent Division, Ministry of Health and Family Welfare (MoHFW), Government of India 2013 database, anemia in India is a severe grade public health problem with a high prevalence of about 74% with hemoglobin  $< 11$  gm/dl [3]. It is widely prevalent in all age groups, nearly 58% in pregnant women, 50% among non-pregnant non-lactating women, 56% among adolescent girls, 30% in adolescent boys and around 80% in children under two years of age. The burden of anemia is a major contributor for low birth weight, lowered resistance to infection, poor cognitive and motor development, weakness, fatigue, difficulty in concentrating and lower productivity [3]. Anemia is a multi-factorial disease and the magnitude of anemia has significant adverse health, social and economic consequences and demands strategic implementation of prevention and control programmes to treat and prevent anemia. The strategies and comprehensive actions should be community or population group oriented taking into consideration of specific etiologies and local conditions. Seeking for an aim to calculate the total prevalence and disability burden rates in 187 countries over 20 years period (1990-2010), Kassebaum et al. conducted the first comprehensive audit of global burden of anemia based on hemoglobin deficiency. The team enlisted 17 different causes of anemia and the top 5 causes with highest prevalence were iron deficiency anemia (IDA), hookworm, sickle cell disorders (SCD), thalassemias, schistosomiasis

and malaria [4]. In Indian scenario, nutritional deficiency, especially iron deficiency is the most common etiological factor for anemia, particularly in adolescent girls when the requirement for iron increases tremendously to physiological need. These adolescent girls who are the future mothers, will have low pre-pregnancy iron reserve to meet the requirement of growing fetus resulting in pre-term babies and/or low birth weight babies. The panel of eminent economists has estimated the benefit-to-cost ratio of iron interventions, cognitive improvement and physical productivity to be as high as 200:1 [3].

As per National Family Health Survey-3 (NFHS-3), nutritional deficiency, in form of malnourishment, anemia, micronutrient deficiency (folate vitamins B12, A, Riboflavin, Thiamin), is highly prevalent in Chhattisgarh state, more so seen in rural community, people with low socioeconomic status, illiterate women and those with low body weight [5,6]. Four out of the top 5 causes depicted above by Kassebaum and team, are quite prevalent in our state. Those are IDA (57.5%), SCD (3.2 - 22.5%), Beta Thalassemia trait (0.5 - 8.5%) and malaria (8.16%) [4,5,7]. Besides, vitamin B12 (cobalamin) deficiencies are also extremely common in Indian population, owing to vegetarian diet consumed by major population. In most health centers in rural areas, mean corpuscular volume (MCV) is evaluated for macrocytosis and thus used as a screening parameter for macrocytic anemia instead

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of serum vitamin B12 estimation which is an expensive parameter to be used for diagnosing cobalamin deficiency. As a result vitamin B12 deficiency is actually under-diagnosed as MCV alone is an unreliable screening parameter for the same [8]. Raina et al. depicted suboptimal levels of vitamin B12 in 53.6% of enrolled subjects [9]. Refsum et al. in their study estimated cobalamin deficiency in 75% of subjects [10]. Present nutritional prophylaxis programme does not include vitamin B12 supplementation which is also a vital micronutrient because it can lead to 'folate trap' and eventually produce megaloblastic anemia. Further reduction in vitamin B12 level leads to hyperhomocysteinemia, which is considered as a risk factor for atherosclerosis. Besides these, early diagnosis and treatment of chronic depletion of cobalamin is crucial failing which it may result in irreversible neurological damage [9].

Compared to vast majority of articles published on prevalence of anemia, mostly IDA, relatively few published data from India are available reflecting vitamin B12 status and its association with anemia in adolescent girls. This study not only would highlight the burden of nutritional anemia in them, but also it would aid in drawing recommendations and rendering suggestions to assess and maneuver the existing schemes.

### Aim and Objectives

1. To estimate the prevalence of anemia among school girls aged 10-18 years.
2. To associate the severity of anemia with serum levels of ferritin and vitamin B12.
3. To study the association of anemia with age, socio-economic status and BMI.

### Materials and Methods

It was a cross-sectional study that included 382 school going girls of age group 10 -18 years at rural areas of Raipur district, India. All school going adolescent girls of age group 10-18 years whose parents/ LAR signed consent form were included in the study. Those who were not willing to sign, or those with known cases of hemolytic anemia and those beyond the specified age group were not included in the study.

Semi-structured, pre-designed and pre-tested, self-administered questionnaire was used to fill up all required demographic profiles. Blood was collected under all aseptic conditions for evaluating complete hemogram, peripheral smear and sickling test, serum iron, total iron binding capacity (TIBC) and vitamin B12 levels. Serum B12 and Ferritin measured in Electrochemiluminescence method in Cobas e-400 immunoassay autoanalyzer from Roche Diagnostics and serum Iron and TIBC measured by Iron-Ferrozine method in Biosystem B 400 fully automated clinical autoanalyzer from Biosystem reagent and Instruments in the clinical biochemistry laboratory.

Severity of anemia was categorized as given below:

Severity of anemia	Cut-off (WHO criteria) [11]
Mild	10-11.9 gm/dl
Moderate	7-9.9 gm/dl
Severe	<7 gm/dl
Vitamin B12	<200 pg/ml
Ferritin	<15 ng/ml

### Results

The results revealed that 36.4% were found to be anemic in the study group (Table 1). The percentage of mild, moderate and severe

anemia in the anemic population was respectively 84.9%, 12.9% and 2.1% (Table 1). The age group of the study population was sub-classified into 10-14 years and 15-18 years taking into consideration that the starting age of menarche is usually 14 years. No significant association of hemoglobin levels could be established with either age or menarche attainment (Table 2 and Figure 1).

The Chi-square test in Tables 3-5 illustrated that hemoglobin concentration was significantly ( $p < 0.001$ ) associated respectively with the different socioeconomic class, body mass index and diet pattern of the study subjects. Nearly 58% of adolescent girls had vitamin B12 deficiency. Prevalence of iron deficiency and combined iron and vitamin B12 deficiency was observed to be respectively 11% and 16.5% (Figure 2). Serum ferritin levels accorded significant ( $p < 0.05$ ), between non-anemic and moderately anemic subjects whereas significant

Hb (gm/dl)	No. Of cases (n=382)	Percentage	
Normal	243	63.6	36.4%
Mild	118	30.9	
Moderate	18	4.7	
Severe	3	0.8	
Total	382	100	

Table 1: Haemoglobin wise distribution of cases in study group.

Age group	No. Of cases	Percentage	Anemic	Non-Anemic
10-14 yrs	184	48.2	62 (33.6%)	122 (66.3%)
15-18 yrs	198	51.8	74 (37.3%)	124(62.6%)
Total	382	100	139	243

Table 2: Age wise distribution of cases in study group.

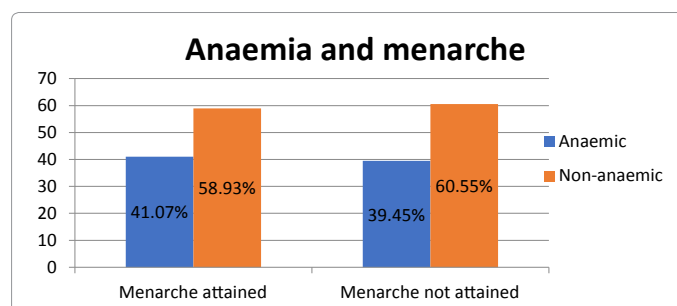


Figure 1: Percentage distribution of attainment of menarche in study population.

SE class	Haemoglobin (gm %)				Total
	Mild	Moderate	Severe	Normal	
II	5	0	1	12	18
III	46	8	0	86	140
IV	66	10	2	144	222
V	1	0	0	1	2
Total	118	18	3	243	382

Chi square test  $p < 0.001$  highly significant

Table 3: Association between SES and Hb in study group.

BMI	Haemoglobin (gm %)				Total
	Mild	Moderate	Severe	Normal	
Below 18.5	91	14	2	194	301
18.5 -25	25	4	1	48	78
25.1-29	2	0	0	1	3
Total	118	18	3	243	382

Chi square test  $p < 0.001$  highly significant

Table 4: Association between BMI and Hb in study group.

Diet pattern	Haemoglobin (gm %)				Total
	Severe	Mild	Moderate	Normal	
Vegetarian	1	39	3	85	128
Mixed	2	79	15	158	254
Total	3	118	18	243	382

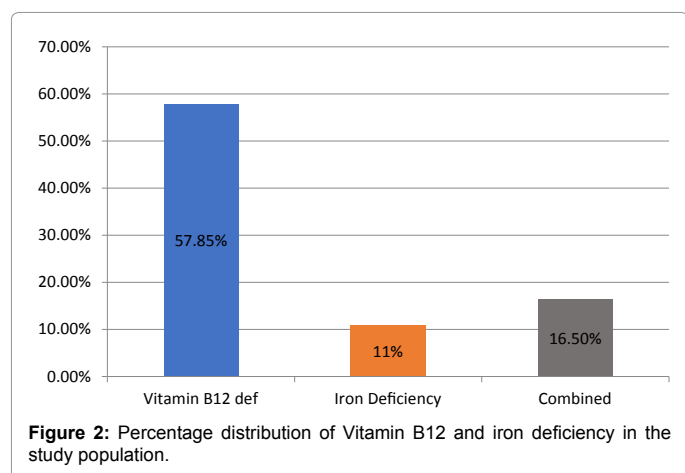
Chi square test  $p < 0.001$  highly significant

**Table 5:** Association between diet pattern and Hb in study group.

Group	Serum ferritin (ng/ml) (mean $\pm$ SD)	Serum B12 (pg/ml) (mean $\pm$ SD)
Normal <sup>a</sup>	48.53 $\pm$ 35.71 <sup>**c</sup>	237.28 $\pm$ 247.56 <sup>**c</sup>
Mild Anemia <sup>b</sup>	40.66 $\pm$ 37.19	219.15 $\pm$ 146.22 <sup>**c,d</sup>
Moderate Anemia <sup>c</sup>	18.33 $\pm$ 22.21	208.28 $\pm$ 133.23 <sup>**a,d</sup>
Severe Anemia <sup>d</sup>	13.00 $\pm$ 8.88	737.33 $\pm$ 193.53 <sup>**a,c</sup>

\* $p < 0.05$  and \*\* $p < 0.001$ , when compared to other groups as superscripted

**Table 6:** Comparison of serum ferritin and B12 levels in different groups of anemia.



**Figure 2:** Percentage distribution of Vitamin B12 and iron deficiency in the study population.

differences between the groups were observed for serum vitamin B12 values ( $p < 0.001$ ) (Table 6).

Hemoglobin concentration correlated positively with serum ferritin ( $p < 0.001$ ) whereas illustrated no significant correlation with vitamin B12 ( $p = 0.338$ ), as represented in Table 7. Logistic regression as delineated in Table 8 revealed that anemia was significantly associated with serum ferritin level ( $p < 0.01$ ) whereas not associated with vegetarian diet, SES and low serum B12 levels. Low serum ferritin ( $< 15$  ng/ml) attributes to anemia development by 1.93 times.

## Discussion

The study was conducted in the rural schools of Raipur district. The prevalence of anemia in the study group was found to be 36.4% (Table 1) which corroborated with 2010 global anemia prevalence of 32.9% as reported by Kassebaum et al. [4]. Approximately 15% of anemic population represented with moderate to severe degree anemia (Table 1). WHO estimated the prevalence of moderate and severe anemia to be 10% to 20% [12]. Main cause for anemia is dietary iron deficiency and many studies have also supported it [13-15]. However, our results decoded for vitamin B12 deficiency being the major concern in adolescent girls. 58% of the study population represented for vitamin B12 deficiency whereas 11% had iron deficiency and 16.5% had combined form (Figure 2). Bhardwaj et al. in their study on adolescent males and females at Kangra, Himachal Pradesh (India), showed anemia in 90% of the adolescent population enrolled for study

Correlation of Hb with	R value	P value
Ferritin	0.215	$< 0.001^{**}$
Vitamin B12	-0.49	0.338

Pearsons correlation \*\* $p < 0.001$  highly significant

**Table 7:** Correlation of Hb with ferritin and Vitamin B12.

Variables	Odds Ratio	95% CI	P value
Vegetarian diet	0.833	(0.533-1.30s)	0.421
Upper and lower SES	1.06	(0.69-1.62)	0.791
Serum ferritin $< 15$ ng/ml	1.93	(1.21-3.08)	0.005*
Serum vitamin B12 $< 200$ pg/ml	1.032	(0.67-1.57)	0.885

\* $p < 0.05$  significant

**Table 8:** Association of sociodemographic parameters with severity of anemia.

and strikingly all adolescent were deficient vitamin B12 levels [16]. The results were also in support with Raina et al. who deciphered vitamin B12 deficiency (sub-optimal or very low) in 78% adult subjects in the same area [9]. Age and attainment of menarche did not record any significant association in our study that corroborated with the study on adolescent girls in Iran by Ramzi et al. [17]. This could be due to the successful implementation of iron folic acid supplementation to the school going adolescent girls (Table 2; Figure 1). In contrary, few studies had depicted that high prevalence of anemia is associated with attainment of menarche [18,19].

Low hemoglobin concentration recorded significant association with SES, BMI and dietary pattern (Table 3-5) that was found similar to various published studies [20-22]. It causes to be ascribed to cooking practices like overcooking of food, vegetarian diet or even if non-vegetarian, it contained more of animal milk rather than meat. Hemoglobin level documented significantly positive correlation with serum ferritin ( $p < 0.001$ ) reflects lowering of hemoglobin would result in more release of iron from ferritin, that acts as a reservoir of iron, thus reducing their levels. Low ferritin reservoir ( $< 15$  ng/ml) increase the risk for developing anemia by 1.93 times (Table 8). However, hemoglobin was found to possess negative correlation, though not significant, with serum vitamin B12. This could be due to the fact that vitamin B12 is not directly related to red blood cell maturation as that of folic acid. Hence folic acid levels could have directed to a more confirmatory cause for anemia. Basically vitamin B12 have a distinctive role in folate coenzyme synthesis [22]. In this era of folic acid fortification, masking effect of folic acid on vitamin B12 deficiency has become a real concern. Folic acid supplementation to adolescent girls would somehow correct mean corpuscular volume (MCV) and correct anemia but without restoring vitamin B12 level. Uncorrected and delayed diagnosis of vitamin B12 deficiency could effect in irreversible neuropathy [23,24].

## Conclusion

Anemia is considered as a pandemic public health problem. Implementation of supplementation programme is not just enough to treat the endemic due to marked disparities in socioeconomic status, dietary pattern, cultural practices, non-compliance for supplementation and primary health care services. There is need to shift the focus from old paradigm of iron deficiency anemia to other forms of anemia basically vitamin B12 deficiency anemia, as observed from this study. The major limitation of the study is that couldn't evaluate the folic acid status of the adolescent girls due to financial constrain, which could have thrown a confirmatory result regarding anemia status.

## Recommendations

Supplementation with not only iron but also vitamin B12 besides deworming and folic acid is required through national programme.

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