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ORIGINAL RESEARCH

A Prospective Analytical Study On Anemia among Adolescents attending the Pediatric department of a Tertiary care hospital

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ABSTRACT

Introduction: Adolescent growth spurt results in 15% increase in iron requirements and girls being the most vulnerable. Nutritional anemia may be defined as a low hemoglobin concentration due to deficiencies in hemopoietic nutrients such as iron, folate, and vitamin B12.

Aims and Objectives: To study the etiology, clinicohematological profile and epidemiological features and spectrum of adolescents with anemia. and the objective is (i) to determine the epidemiological features of study subjects (ii) to evaluate the clinical signs and symptoms in anemic adolescents (iii) to find the etiology of anemia in these cases.

Material and Methods: A prospective analytical study on 200 children below 18 years of age come to Department of Pediatrics JLN Medical College & Hospital, Ajmer, from03.11.2023 to July 2024. All adolescents visited in OPD or admitted to pediatric ward with anemia were included. Patients not giving consent for the study and critically ill patients admitted in PICU where samples were not possible to get collected were excluded.

Results: The percentage distribution of anemia was maximum (46%) in 13-15 years age. The mean age was 14.29+2.13 years. Female adolescents predominated, constituting76%. Mild anemia predominated in upper to lower-middle socioeconomic classes (I-III), while moderate anemia in upper-lower and lower classes (IV-V). Severe anemia remained relatively uncommon across all socioeconomic classes (7.5-11.25%). Mild (44.6%), moderate (45.95%), and severe (9.4%) anemia prevalence showed minimal gender differences. Microcytic anemia predominates in 10-12 (48.1%) year-olds, while macrocytic anemia in 13-15 year-olds (41.3%). The main etiologies were nutritional deficiencies (Vitamin B12/folate: 47.5%, iron deficiency: 46.5%) and mixed/dimorphic anemia (13%), with chronic disease, hemorrhage and infections contributing to normocytic anemia.

Conclusion: Anemia prevalence was higher in adolescents from low socioeconomic backgrounds, particularly females, due to dietary deficiencies and menstrual blood loss. Supplementing iron, folic acid, and vitamin B12, along with dietary diversification, is recommended to reduce anemia prevalence.

Keywords: Adolescent Anemia, Nutritional Deficiencies, Pediatric Healthcare

INTRODUCTION

World Health Organization (WHO) defines adolescents as children aged 10- 19 years of age[1]. Adolescent growth spurt results in 15% increase in iron requirements and girls being the most vulnerable[2]. The diagnosis of anemia is based on clinical features like fatigability, lethargy and pallor. During the adolescence period, requirement for iron doubles in girls as they lose iron during menstruation[3].

Anemia defined by WHO as "condition in which hemoglobin content of blood is lower than normal as a result of a deficiency of one or more essential nutrients, regardless of the cause of such deficiency". Anemia is established if the hemoglobin is below the cut-off points recommended by WHO as shown[4]: The prevalence of anemia is 31.1% in adolescent boys and 59.1% in adolescent girls as per NFHS 5[5]

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Age	6m-5 yrs	5-11yrs.	12-14yrs	15-19yrs.
Hb (gm/dl)	<11	<11.5	<12	Girls:<12 Boys:<13

There are nutritional and non nutritional causes of anemia: micronutrient deficiencies and genetic blood disorders, including haemoglobinopathies, inflammation, infectious diseases and other physiological conditions such as menstruation and pregnancy[6,7]. In India, an analysis characterized types of anemia among children and adolescents aged 1–19 years. Among anaemic adolescents, 21.3% had iron deficiency only (iron deficiency anemia), 25.6% had folate or vitamin B12 deficiency without iron deficiency (folate or vitamin B12 deficiency anemia), 18.2% had iron deficiency plus folate or vitamin B12 deficiency (dimorphic anemia), 31.4% had no iron or folate or vitamin B12 deficiency (anemia of other causes) and 3.4% had anemia of inflammation[8]. Anemia is also associated with several individual and household-level characteristics such as education, age at marriage and wealth[9]. To develop solutions for addressing anemia in India, a country with large subnational variations in diets and living conditions, it is important to understand if factors associated with anemia vary across geographies.

India's Adolescent Anemia Control Programme was initiated as a pilot programme in 2000 in five states with three interventions targeting girls aged 10–19 years: weekly iron folic acid (IFA) supplementation, monthly nutrition and health education and biannual deworming prophylaxis (UNICEF, 2018[10]). After a decade of evidence generation and phased implementation scale-up, the Government of India universalized the programme and included boys as beneficiaries. In 2018, the programme added a „test and treat" strategy with revised coating and dosage for the IFA supplements (aligned to WHO standards) and other selected interventions to tackle non nutritional causes, rebranded as the Anemia-Free India Programme. Given the data gaps on prevalence and factors associated with adolescent anemia, the Government of India conducted the ComprehensiveNationalNutritionSurvey(CNNS)2016 –2018(MoHFWetal.,2019[11]).

This is the first nationally representative survey in India to provide information on genetic, nutritional and non nutritional factors implicated in the aetiology of anemia for individuals below 20 years of age.

Classification of Anemia as per WHO[4] on the basis of severity – Mild Anemia - Hb 10gm/dl-to lower limit of normal, **Moderate Anemia**- Hb 7 gm/dl- 9.9 gm/dl and **Severe Anemia** - Hb<7gm/dl.

Nutritional anemia may be defined as a low hemoglobin concentration due to deficiencies in hemopoietic nutrients such as iron, folate, and vitamin B12[12].Deficiencies in hematinic nutrients are not only the most common causes of anemia but also are the easiest to treat once the specific deficient nutrient is determined[13]. Inadequate consumption of hemopoietic nutrients such as iron, vitamin B12 and folate is a major cause of low hemoglobin concentration in the blood.[12] Low bioavailability of iron and other hematinic nutrients could be a contributory factor to anemia[13]. Unfortunately, anemia can be caused by other factors, which are not associated with dietary intake. These causes include worm infestation, malaria, chronic blood loss, gastrointestinal bleeding, cancers, vascular lesions, and ulcers[12].

Anemia has a negative effect on the overall growth, cognitive development and academic performance of adolescents. Anaemic adolescents who get pregnant also have an increased risk of morbidity, mortality, and poor birth outcomes such as low birth weight, premature birth, and still birth[14]. Anemia can also result in fatigue and low productivity, which have a negative impact on the economy.

There are certain strategies for reducing anemia in adolescents under Rashtriya Kishor Swasthya Karyakram (RKSK)[15] which includes: (i) Weekly Iron Folic Acid Supplementation Programme (WIFS) (ii) Screening of target groups for moderate/severe anemia and referring these cases to an appropriate health facility. (iii) Biannual de- worming 6 months apart, for control of worm infestation. (iv) Information andcounsellingforimprovingdietaryintakeandfortakingactionsforpreventionofintestinal worm infestation.

Clinical findings generally do not become apparent until the hemoglobin level falls to <7 to 8 gm/dl. Clinical features can include pallor, sleepiness, irritability, and decreased exercise tolerance. Pallor can involve the tongue, nail beds, conjunctiva, palms or palmar creases. A flow murmur is often present. Ultimately, weakness, tachypnea, shortness of breath on exertion, tachycardia, cardiac dilation, and high output cardiac failure results from increasingly severe anemia, regardless of its cause.[14]

AIM AND OBJECTIVES

The aim of the study is to study the etiology, clinicohematological profile and epidemiological features and spectrum of adolescents with anemia and the objective is (i) to determine the epidemiological features of study subjects (ii) to evaluate the clinical signs and symptoms in anemic adolescents (iii) to find the etiology of anemia in these cases.

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MATERIALSANDMETHODS

A prospective analytical study on 200 children below 18 years of age come to the OPD and IPD of the Department of Pediatrics JLN Hospital, a tertiary care medical centre attached to JLN Medical College Ajmer, Rajasthan from 03.11.2023 to July 2024. All adolescents visited in OPD or admitted to pediatric ward with anemia were included. Patients not givingconsentforthestudyandcriticallyillpatientsadmittedinPICUwhere samples were not possible to get collected were excluded.

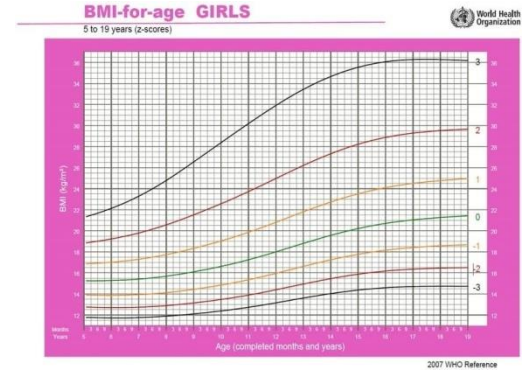
Adolescents who look pale clinically or have a CBC report with Hb in anemic range as defined below:

10-11yearsoldhavingHb<11.5gm/dl, 12-14years old having Hb <12gm/dl,

15-19years old-girls having Hb<12gm/dl, boys having Hb<13gm/dl; were further evaluated.

Prior approval for the study was taken from the institutional ethical committee. Written informed consent was taken from the parents of the patients.

During childhood and adolescence the ratio between weight and height varies with sex and age, so the cut-off values that determine the nutritional status of those aged 0–19 years are gender- and age-specific. The cut-off points of the 2006 BMI-for-age reference for children aged 0–5 years for the diagnosis of overweight and obesity will be set as the 97th and the 99th percentile, respectively. For those aged 5–19 years, overweight is defined as a BMI-for-age value over +1 SD and obesity as a BMI-for-age value over +2 SD.



Following investigations were carried out: (i)1st tier investigations- CBC, PBF, RC+RI. (ii) 2nd tier investigations- S. LDH, Iron studies, Vitamin B12, S. Folate, LFT. (iii) 3rd tier investigations-Bone marrow, Anti-Ttg, MP, RFT, SE, CBNAAT, USGw/a, DCT, ICT, TFT, HPLC. Any other relevant investigation: Chest X Ray, 2D Echo, Stool for occult blood / ova/ cyst, Urine c/m/copper.

Others-(a)Anti-TTG Levels (b) Bone Marrow Aspiration & Biopsy(c)TFT

Statistical Analysis:

Data entry and Statistical Analysis was performed with the help of Microsoft Excel and SPSS version 25 (IMB Statistics Inv. Chicago, Illinois, USA) Categorical variables were expressed as proportions and quantitative variables as mean and SD. Chi Square test was used for categorical variables, comparison and level of significance was determined based on p value.

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RESULTS

A total of 200 cases of 'anemia in adolescents' were the subjects of the present study. These adolescents visited in OPD or casualty, some of these were admitted in pediatric wards and PICU of Jawaharlal Nehru Hospital, Ajmer

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TABLE 1 :

Age Range(years)	Number	Percent
10-12	52	26
13-15	92	46
16-19	56	28
Total	**200**	**100**
Sex		
Male Child	48	24
Female Child	152	76
Total	**200**	**100**
Residential Status		
Rural	117	58.5
Urban	83	41.5
Total	**200**	**100**

The percentage distribution of anemia was maximum (46%) in 13-15 years age group followed by 28% in 16-19 years age group, and least common i.e. 26% in 10-12 years age group. The mean age was 14.29$\pm$2.13 years. Female adolescents predominated, constituting 76% in whole of the series. While comparing both the groups, the Chi Square was 54.08 and p value $P < 0.0001$ (Highly Significant). 58.5% of the cases belong to rural background and 41.5% of the cases belong to urban background.

TABLE 2: SOCIOECONOMIC CLASS

Socio Economic Class	Mild		Moderate		Severe		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Upper (I) (n=10)	7	70	2	20	1	10	10	100
Upper middle (II) (n=20)	13	65	5	25	2	10	20	100
Lower middle (III) (n=40)	27	67.5	10	25	3	7.5	40	100
Upper Lower (IV)(n=50)			26	52	5			
Lower (V) (n=80)	21	26.25	50	62.5	9	11.25	80	100
Total	**87**	**43.5**	**93**	**46.5**	**20**	**10**	**200**	**100**

Table 2 shows that in I (Upper) class maximum number of cases (70%) were of mild anemia followed by moderate (20%) anemia and less common (10%) of severe anemia. In II (Upper middle) class also maximum number of cases (65%) were of mild anemia followed by moderate (25%) anemia and less common (10%) of severe anemia. In III (Lower middle) class also maximum number of cases (67.5%) were of mild anemia followed by moderate (25%) anemia and less common (7.5%) of severe anemia. In IV (Upper lower) class maximum number of cases (52%) were of moderate anemia followed by mild (38%) anemia and less common (10%) of severe anemia. In V (Lower) class maximum number of cases (62.5%) were of moderate anemia followed by mild (26.25%) anemia and less common (11.25%) of severe anemia.

TABLE 3: SEX DISTRIBUTION ACCORDINGTO SEVERITY OFANEMIA

Type of Anemia	Male		Female	
	Number	Percent	Number	Percent
Mild(n=88)	22	45.83	66	43.42
Moderate(n=92)	22	45.83	70	46.05
Severe(n=20)	4	8.33	16	10.53
Total	**48**	**100.00**	**152**	**100.00**

43.4% of females and 45.8% of males fall into the mild anemia category, 46.1%of females and 45.8% of males in the moderate anemia category; 10.5% of females and 8.3% of males in the severe anemia category.

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TABLE 4: Mean values of hematological indices

MEAN	Iron Deficiency Anemia (IDA)	Dimorphic Anemia (DA)	Megaloblastic Anemia (MA)
Hb	8.35 ±2.07	7.55 ±2.05	8.66 ±2.10
MCV	66.49±12.99	82.55±9.52	104.5±12.15
MCH	26.13±5.90	28.14±5.46	32.15±3.6
MCHC	27.89±3.01	28.80±3.9	31.75±2.67
RDW-CV	19.13±5.76	20.83±7.53	19.3 ±6.15
S.Iron	22.03±5.21	21.63±7.1	-
TIBC	430.03±39.36	435±28.74	-
S. Ferritin	8.45 ±0.97	8.67 ±0.56	-
Vit.B12	-	157±49.4	165.54±45.6
Folate	-	3.03 ±1.31	3.93 ±1.81

TABLE 5: Type of anemia on the basis of age group

Type of Anemia	10-12years		13-15years		16-19years	
	N	Percent	N	Percent	N	Percent
Normocytic (n=26)	9	17.3	8	8.7	9	16.1
Microcytic (n=78)	25	48.1	30	32.6	23	41.1
Macrocytic (n=70)	12	23.1	38	41.3	20	35.7
Mixed (n=26)	6	11.5	16	17.4	4	7.1
Total	**52**	**100**	**92**	**100**	**56**	**100**

Table 5 shows that in 10-12 years age group, microcytic anemia is the most prevalent type constituting 48.1% of the cases, followed by macrocytic anemia (23.1%), normocytic anemia (17.3%) and mixed anemia (11.5%). In 13-15 years age group, macrocytic anemia is the most prevalent type constituting 41.3% of the cases, followed by microcytic anemia (32.6%), mixed anemia (17.4%) and normocytic anemia (8.7%). In 16-19 years age group, microcytic anemia is the most prevalent type constituting 41.1%of the cases, followed by microcytic anemia (35.7%), normocytic anemia (16.1%) and mixed anemia (7.1%).

TABLE 6: Etiology of anemia

Etiology	No. of cases	Percent
Iron Deficiency Anemia	93	46.5
VitaminB12/Folate Deficiency Anemia	95	47.5
Mixed (IronDeficiency+VitB12/Folate Deficiency Anemia)	26	13
Anemia of Chronic Disease	15	7.5
Infections	7	3.5
Hemolytic Anemia	12	6
Hemorrhagic Anemia	5	2.5
Malaria	1	0.5
Leukemias & Lymphomas	2	1
Fanconi Anemia	1	0.5
Chronic renal failure	5	2.5
Hypothyroidism	3	1.5
Celiac Disease	10	5
Thalassemia	10	5

Table 6 shows the distribution of cases on the basis of etiology in which 95 cases (47.5%) were found to have vitamin B12 / folate deficiency followed by iron deficiency anemia which constituted93 cases (46.5% cases) and the mixed i.e. dimorphic anemia had 26 cases in it i.e. 13% of the total cases. Normocytic group had Anemia of chronic disease (15 cases), hemorrhagic anemia (5 cases), and infections (7 cases except malaria which belonged to microcytic group).

DISCUSSION

A total of 200 cases of 'anemia in adolescents' were the subjects of the present study. These adolescents visited in Pediatirc Department either OPD or casualty, some of these were admitted in pediatric wards or PICU of Jawaharlal Nehru Hospital, Ajmer. Data of study were collected, arranged and analysed.

In the present study, 200 cases of anemic adolescents were studied, 92 (46%) of which belonged to 13-15 years of age group, 56 (28%) lied in 16-19 years of

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age group and 52 (26%) lied in 10-12 years of age group. The mean age of the subjects was 14.29±2.13 years. Abilash Sasidharannair Chandra-Kumari et al. in a similar study which was conducted in Tamil Nadu on 255 adolescent girls observed a similar prevalence[16]. Female:Male ratio was 3:1. In females, the higher proportion of anemia observed reflects the adverse effect of possibly lower dietary iron in take with menstrual blood loss, which impose sex trade mand for iron. Similar sex ratio with female predominance was observed by Samuel Scott et al (2021) at national and regional levels.[17]

Also, the present study showed that anemia was found to be more prevalent in adolescents who belonged to low socioeconomic status as compared to those who belonged to high socio-economic status. 40% of the subjects belonged to lower class (V), 25% of the subjects belonged to upper lower class (IV), 20% to lower middle class (III), 10% to upper middle class (II) and least i.e. 5% to upper class (I). Similar study done at Baghdad, Iraq by Shatha S.Al-Sharbatti et al, supported the view that anemia was found to be more prevalent in adolescents living in low socio economic area compared with those living in high socio economic area.[18] Abilash Sasidharannair Chandrakumari et al., in a similar study which was conducted in Tamil Nadu on 255 adolescent girls observed that majority of the adolescent girls belonged to socio economic class IV and V[16].

In the present study prevalence of mild, moderate and severe anemia was 43.5%, 46.5% and 10% respectively. A study conducted in Delhi by Bhushan D. Kamble and published in 2021 showed that the prevalence of mild, moderate and severe anemia was 48%, 45% and 7% respectively[19] which was similar to one reported by Chandrakumari AS et al.[16] and Habib N et al.[20] in Pakistan. DLHS-4[21] report of Haryana revealed that prevalence of mild and moderate anemia was 57.9% and severe anemia was 6.3% among adolescent girls. Another study conducted among anemic adolescent girls in Orissa showed that 45.2% had mild anemia, 46.9% and 4.4% had moderate and severe anemia, respectively.[22]

Macrocytic group in this study comprises 35% (70) of the cases however, based on etiology megaloblastic anemia (vitaminB12/folate deficiency) remains the single most common (47.5% of the cases) cause of anemia in our study. This was comparable with the study done by Patra et al (2011) in which megaloblastic anemia was the commonest one (42.5%).[23] Mussarrat et al. (2009) in their study showed in megaloblastic anemia peripheral blood morphology showed macrocytosis 68.5%, anisopoiki-locytosis 65.5%, hypersegmentation 51.5%, leuco erythroblastosis 25.2%[24]. Khanduri et al (2007)[25]in his study showed similar peripheral blood picture results.

26 out of 200 cases (13%) were diagnosed with mixed (dimorphic) picture and normocytic picture in each group.

Normocytic normochromic group comprised of the following cases- Anemia of chronic disease (7.5%) which had Tuberculosis (2%), Hypo-thyroidism (1.5%), Hepatitis B (1%), Chronic Renal failure (2.5%) in it. Hemorrhagic anemia comprised 2.5% of the cases in the present series. Of these 3 cases had dengue shock syndrome and 2 adolescent girls presented with menorrhagia. Also in our study 1 case of Fanconi Anemia was found and 2 cases of leukemias were found.

CONCLUSION

Anemia was found to be more prevalent in adolescents who belonged to low socioeconomic status compared with those who belonged to high socio-economic status. A notable relationship between anemia and socio-economic status is strong recommendation for need of developing and implementing policies which improve and eliminate socioeconomic disparities.

In females, the higher prevalence of anemia observed reflect the adverse effect possibly of lower dietary iron intake with menstrual blood loss, which imposes extra demand for iron.

Supplementation of iron, folic acid and dietary diversification can reduce magnitude of anemia substantially**.**

Based on our findings, we propose that the government consider supplementing the current iron and folic acid regimen for adolescents with vitamin B12. This intervention is anticipated to significantly decrease the burden of megaloblastic anemia which is the single most common cause of anemia in our study.

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