



Original Article

Clinical and Epidemiological Profile of Anemia Among Adolescents: A Hospital Based Cross-Sectional Study

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ABSTRACT

Background: Globally, anemia prevalence remains high among adolescents, with developing countries bearing the greatest burden due to nutritional deficiencies, infections and limited access to health services which result in impaired physical growth, reduced cognitive performance, diminished school achievement, and decreased work capacity, potentially affecting long-term health and socioeconomic outcomes.

Objective: To study the clinical and epidemiological profile of anemia among adolescents and to identify factors associated with its occurrence.

Method: After taking ethical permission, a hospital based cross-sectional study was planned during February to May 2026 at a Medical College. Adolescent attending Outpatients department were included in study. Data were collected using a predesigned, pretested structured questionnaire that included information on sociodemographic variables, dietary habits and nutritional intake, menstrual history and clinical symptoms of anemia. Clinical examination was followed by laboratory investigations for assessment of anemia.

Results: Out of the 400 participants, 180 adolescents were anemic, yielding an overall prevalence of 45%. Anemia was graded as mild (10%), moderate (18%), and severe (17%). The study demonstrated significantly higher anemia prevalence among female (50%), rural adolescents (52.1%), vegetarians (54.5%), low socioeconomic class (56%). The mean hemoglobin and hematocrit levels were significantly lower among anemic adolescents compared to non-anemic participants.

Conclusion: The present study highlights that anemia affects nearly half of adolescents (45%), with significantly higher prevalence among females, rural residents, vegetarians, and individuals from low socioeconomic backgrounds.

Keywords: Anemia, Adolescent, Cross-sectional study.

INTRODUCTION

Anemia is a major global public health concern characterized by low hemoglobin concentration, leading to reduced oxygen-carrying capacity of blood and impaired physiological function. Adolescents, defined as individuals aged 10–19 years, represent a vulnerable population due to rapid growth, increased nutritional requirements, and, for girls, the onset of menstruation that further elevates iron demand. These physiological changes make adolescents particularly susceptible to anemia, especially iron deficiency anemia, the most common form observed worldwide.¹⁻⁴

Globally, anemia prevalence remains high among adolescents, with developing countries bearing the greatest burden due to nutritional deficiencies, infections and limited access to health services.⁵ Globally, it is estimated that 40% of all children aged 6–59 months, 37% of pregnant women and 30% of women 15–49 years of age are affected by anemia. Anemia caused 50 million years of healthy life lost due to disability in 2019. The largest causes were dietary iron deficiency, thalassaemia, sickle cell trait, and malaria.^{6,7}

Anemia during adolescence can have significant consequences, including impaired physical growth, reduced cognitive performance, diminished school achievement and decreased work capacity, potentially affecting long-term health and socioeconomic outcomes.⁵ In India, with one of the largest adolescent populations in the world, national and community-based studies have reported substantial anemia prevalence. Data from the Comprehensive National Nutrition Survey indicated that approximately 28.5% of Indian adolescents were anemic, with markedly higher rates among girls compared to boys.⁸ Moreover, trends from the National Family Health Survey reveal that anemia prevalence among older adolescents increased between survey periods, highlighting persistent challenges in addressing this condition.⁹

The etiology of anemia in adolescents is multifactorial. Nutritional factors such as inadequate intake of iron and other micronutrients (e.g., vitamin A, zinc) are primary contributors, while menstrual blood loss further increases risk among females.^{8,10} Sociodemographic determinants including low socioeconomic status, dietary diversity and poor sanitation also influence anemia risk and distribution.¹⁰ Given the high prevalence and diverse determinants of anemia in adolescents, understanding its clinical and epidemiological profile is critical for designing effective public health strategies, including nutritional supplementation, anemia control programs and targeted education interventions.

OBJECTIVE

To study the clinical and epidemiological profile of anemia among adolescents and to identify factors associated with its occurrence.

MATERIALS AND METHODS

Study design: A hospital based cross-sectional analytical study.

Study setting: The study was conducted at outpatient department (OPD) of Jhalawar Medical College, Jhalawar over a period of 4 months from February to May 2026.

Study population: Adolescents aged 10–19 years attending OPD at selected study setting during the study period.

Inclusion criteria:

- Adolescents aged 10–19 years, attending OPD during study period.
- Willing to participate in the study and consent was given by parents/guardians or participants.

Exclusion criteria

- Known hematological disorders (e.g., thalassemia, sickle cell disease),
- Chronic systemic illness.
- History of blood transfusion in the last 3 months.
- Currently receiving iron supplementation.

Sample size: The sample size was calculated using the formula for estimating prevalence in cross-sectional studies $4pq/l^2$. Where prevalence was considered 28.5%, $Z=1.96$ at 95% confidence level, and allowable error=5%.⁸ Apart from formula 10% sample was added for correction of sample size. Based on prevalence estimates and considering feasibility, the calculated minimum sample size was approximately 354. After rounding off, accounting a total of 400 adolescents were included in the study.

Sampling technique: Participants were selected using random allocation technique from OPD.

Method of Data collection: Data were collected using a predesigned, pretested structured questionnaire that included information on sociodemographic variables, dietary habits and nutritional intake, menstrual history (for female participants), history of deworming and infections and clinical symptoms of anemia.

Clinical assessment: A thorough clinical examination was conducted to assess pallor, vital signs and other signs of anemia. Anthropometric measurements including height and weight were recorded, and Body Mass Index (BMI) was calculated to assess nutritional status.

Laboratory investigations: Approximately 2–3 mL of venous blood was collected under aseptic precautions. Hemoglobin estimation was performed using automated hematology analyzer. Anemia was classified according to WHO criteria for male and female.¹¹

Data analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 23.0. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Chi-square test and student t test was used to assess associations between dependent and independent variables and p-value < 0.05 was considered statistically significant.

Ethical considerations: Ethical clearance was obtained from the Institutional Ethics Committee via letter number - 28 dated 18.02.2026. Written informed consent from parents/guardians and consent from participants were obtained. Confidentiality and privacy were maintained throughout the study.

RESULTS

A total of 400 adolescents participated in the study. Among them, 184 (46%) were males and 216 (54%) were females, with a male-to-female ratio of 1:1.17. Out of the 400 participants, 180 adolescents were anemic, yielding an overall prevalence of 45%, while 220 (55%) had normal hemoglobin levels.

According to WHO hemoglobin classification, anemia was graded as mild (40, 10%), moderate (72, 18%), and severe (68, 17%). Severe anemia constituted a considerable proportion of the total cases. Moderate anemia was the most common category. Anemia was more prevalent among females than males (p=0.029). As out of 216 females, 108 (50%) were anemic, while among 184 males, 72 (39.1%) were anemic.

The mean hemoglobin level among anemic adolescents was 9.2 ± 1.8 g/dL, which was significantly lower compared to 13.1 ± 1.2 g/dL among non-anemic adolescents. The difference was found to be highly statistically significant (p < 0.001). The mean hemoglobin, hematocrit, RBC count, and red cell indices were significantly lower among anemic adolescents compared to non-anemic participants (p < 0.001). RBC indices revealed a microcytic hypochromic pattern, suggesting iron deficiency as the predominant etiology. Platelet counts were mildly elevated among anemic individuals, whereas total leukocyte counts showed no statistically significant difference.

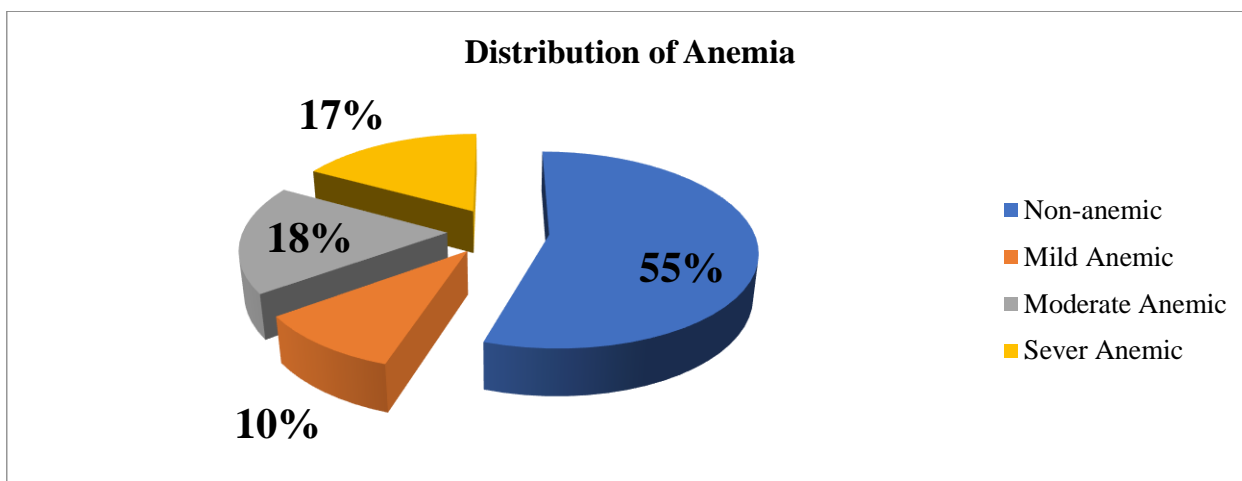


Figure 1: Distribution of Anemia among study participants.

Table 1: Association of anemia with socio-demographic variables.

Variables	Anemic (180)	Non-anemic (240)	Total (400)	X2 , p value
Gender				4.75, 0.029
Male	72 (39.1%)	112 (60.9%)	184	
Female	108 (50%)	108 (50%)	216	
Residence				12.01, < 0.001
Rural	125 (52.1)	115(47.9)	240	
Urban	55 (34.4)	105 (65.6)	160	
Socioeconomic status				32.45, 0.001
Low	140 (56.0)	110 (44.0)	250	
High	40 (26.7)	110 (73.3)	150	
Diet				8.02, < 0.001
Vegetarian	120 (54.5)	100 (45.5)	220	
Mixed	60 (33.3)	120 (66.7)	180	

Table 2: Hematological value among study participants.

Parameters	Anemic (180)	Non-anemic (240)	T value	P value
Hemoglobin (g/dL)	9.2 ± 1.8	13.1 ± 1.2	26.8	<0.001
Hematocrit (%)	30.8 ± 3.4	40.9 ± 2.8	32.6	<0.001
RBC count (million/mm ³)	3.6 ± 0.5	4.7 ± 0.4	24.5	
MCV	72.4 ± 6.8	86.9 ± 5.2	25.7	<0.001
MCH (pg)	22.3 ± 3.1	29.4 ± 2.3	28.1	<0.001

MCHC (g/dL)	29.8 ± 2.6	33.5 ± 1.8	19.6	<0.001
RDW (%)	16.8 ± 2.4	13.2 ± 1.5	18.9	<0.001
Total leukocyte count (/mm ³)	7,200 ± 1,600	7,450 ± 1,400	1.70	0.08
Platelet count (lakh/mm ³)	3.6 ± 0.9	3.2 ± 0.8	4.81	0.001

Clinical profile of anemic adolescents: The most common clinical features observed among anemic participants were pallor (150, 83.3%), easy fatigability (128, 71.1%), dizziness (92, 51.1%), breathlessness on exertion (60, 33.3%). A higher prevalence of anemia was observed among underweight adolescents compared to those with normal BMI. This association was statistically significant ($p < 0.05$).

DISCUSSION

The present hospital-based cross-sectional study evaluated the clinical and epidemiological profile of anemia among 400 adolescents and demonstrated an overall anemia prevalence of 45%. This finding indicates that anemia continues to be a significant public health problem among adolescents. The observed prevalence in the current study is comparable with national and regional data. The NFHS-5 reported anemia prevalence of approximately 40–59% among adolescents, highlighting the persistent burden of nutritional anemia in this age group.¹² Similar findings were reported by Kaur et al.¹³, who documented a prevalence of 46.5% among school-going adolescents, closely matching our results. Likewise, Choudhary et al.¹⁴ observed a prevalence of 43.8% in a hospital-based adolescent population.

Gender differences: In the present study, anemia was significantly higher among females (50%) compared to males (39.1%) ($p = 0.029$). This gender disparity may be attributed to menstrual blood loss, increased iron requirements during growth spurts, poor dietary intake, and sociocultural practices favoring males in food distribution. Comparable findings were reported by Patel et al.¹⁵, who observed anemia prevalence of 52% among girls compared to 38% among boys. Similarly, Verma and Rawal documented significantly higher anemia among adolescent females.¹⁶ These consistent observations suggest that adolescent girls constitute a high-risk group requiring targeted interventions.

Severity pattern: Regarding severity, moderate anemia (40%) was the most common type, followed by severe (37.8%) and mild anemia (22.2%). The predominance of moderate anemia has also been documented in studies by Gupta et al.¹⁷ indicating delayed detection and inadequate early treatment.

Sociodemographic factors: The study demonstrated significantly higher anemia prevalence among rural adolescents (52.1%), vegetarians (54.5%), low socioeconomic class (56%). These associations were statistically significant ($p < 0.001$). Rural residence and low socioeconomic status are often linked with poor access to healthcare, lower dietary diversity, parasitic infestations, and inadequate sanitation. Similar findings were reported by Kotecha et al.¹⁸ and Pasricha et al.¹⁹, who highlighted poverty and dietary insufficiency as key determinants of adolescent anemia. Vegetarian adolescents showed higher anemia prevalence, possibly due to lower bioavailability of non-heme iron. This observation is supported by Thankachan et al., who demonstrated poorer iron absorption in vegetarian diets.

Hematological profile: The mean hemoglobin and hematocrit levels were significantly lower among anemic adolescents (Hb: 9.2 ± 1.8 g/dL; Hct: 30.8 ± 3.4%) compared to non-anemic participants (Hb: 13.1 ± 1.2 g/dL; Hct: 40.9 ± 2.8%). RBC indices showed reduced MCV, MCH, and MCHC with elevated RDW, suggestive of microcytic hypochromic anemia, which is typically indicative of iron deficiency. These findings are consistent with reports by WHO and studies by Benoist et al.²⁰, confirming iron deficiency as the most common etiology of anemia in adolescents.

CONCLUSION

The present study highlights that anemia affects nearly half of adolescents (45%), with significantly higher prevalence among females, rural residents, vegetarians and individuals from low socioeconomic backgrounds. Moderate anemia was the most common severity grade. Hematological indices predominantly indicated microcytic hypochromic anemia, suggestive of iron deficiency. Anemia remains a major public health concern among adolescents and warrants early identification and intervention.

Recommendations

- Periodic school and community-based anemia screening programs.
- Iron–folic acid supplementation for adolescents, especially girls.
- Nutrition education promoting iron-rich and fortified diets.
- Deworming and infection control measures.
- Special focus on rural and low socioeconomic populations.
- Implementation and strengthening of national adolescent health programs.

Limitations

- Hospital-based design limits generalizability to the community.
- Cross-sectional nature prevents causal inference.
- Dietary intake assessment was not quantified.
- Biochemical iron studies (serum ferritin, transferrin saturation) were not performed to confirm iron deficiency.
- Sociodemographic data relied on self-reporting, introducing possible recall bias.

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