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CLINICODEMOGRAPHIC AND HEMATOLOGICAL PROFILE OF ANEMIA AMONG ADOLESCENTS: A PROSPECTIVE HOSPITAL-BASED STUDY.

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Abstract

Background: Anemia is a major public health problem among adolescents, particularly in developing countries, where rapid growth, nutritional deficiencies, menstrual blood loss, and poor dietary habits contribute significantly to its prevalence. Untreated anemia during this stage can adversely affect academic performance, immunity, physical capacity, and overall quality of life, making early identification and evaluation essential for effective management and prevention. ***Aims:*** To evaluate the clinico-demographic characteristics and hematological profile of anemia among adolescents attending a tertiary care hospital. ***Materials and Methods:*** This prospective hospital-based observational study was conducted over a period of 10 months in the Department of Paediatrics at Sree Mookambika Institute of Medical Sciences. A total of 70 adolescents aged 10–19 years diagnosed with anemia were included in the study. Diagnosis of anemia was made according to World Health Organization age- and sex-specific hemoglobin criteria. Laboratory investigations included complete blood count, peripheral smear examination, red blood cell indices, serum ferritin levels, and additional investigations when indicated. Severity and morphological patterns of anemia were assessed. Data were analyzed using appropriate statistical methods, and $p < 0.05$ was considered statistically significant. ***Results:*** The majority of patients belonged to the 15–19 years age group, representing 41 (58.6%) cases. Mild anemia was observed in 21 (30.0%) patients, moderate anemia in 38 (54.3%) patients, and severe anemia in 11 (15.7%) patients. Microcytic hypochromic anemia was the predominant morphological type, observed in 46 (65.7%) patients, followed by normocytic normochromic anemia in 16 (22.9%) patients and macrocytic anemia in 8 (11.4%) patients. Mean hemoglobin level among study participants was 8.9 ± 1.8 g/dL. Serum ferritin levels were significantly reduced in patients with microcytic hypochromic anemia ($p < 0.01$). Female gender, low socioeconomic status, and inadequate dietary intake showed significant association with moderate to severe anemia. ***Conclusion:*** Anemia among adolescents was more common in females and predominantly presented as microcytic hypochromic anemia associated with nutritional iron deficiency. Early identification, nutritional counseling, and timely hematological evaluation are essential for reducing the burden of adolescent anemia and preventing long-term health consequences.

Keywords: Adolescents; Anemia; Clinico-demographic profile; Hematological profile; Iron deficiency; Microcytic hypochromic anemia; Nutritional anemia.

INTRODUCTION

Anemia is one of the most common nutritional and hematological disorders affecting adolescents worldwide and continues to be a major public health concern, particularly in developing countries.1 The World Health Organization identifies adolescence as the age group between 10 and 19 years, representing a critical transitional phase characterized by rapid physical growth, hormonal changes, psychological development, and increased nutritional requirements.2 During this period, inadequate intake of essential nutrients, especially iron, can predispose adolescents to anemia, adversely affecting growth, cognitive performance, immunity, and overall health status.3

Iron deficiency anemia is the predominant form of anemia observed among adolescents. Increased iron requirements during puberty, rapid expansion of blood volume, growth spurts, and onset of menstruation in adolescent girls contribute significantly to the high prevalence of anemia in this age group.4 In addition, poor dietary habits, consumption of iron-deficient foods, low socioeconomic status, recurrent infections, parasitic infestations, and inadequate nutritional awareness further aggravate the problem. Adolescents often adopt unhealthy eating practices including skipping meals, excessive junk

food consumption, and inadequate intake of green leafy vegetables and protein-rich foods, leading to micronutrient deficiencies.5,6

Anemia during adolescence has serious health implications. Reduced hemoglobin concentration results in impaired oxygen delivery to tissues, causing fatigue, weakness, poor concentration, dizziness, decreased physical endurance, and reduced academic performance.7 Chronic anemia also impairs immune function, increases susceptibility to infections, and negatively affects emotional and psychological well-being. In adolescent girls, untreated anemia can continue into reproductive years, increasing the risk of maternal morbidity, low birth weight, and poor pregnancy outcomes in the future. Therefore, early detection and management of anemia during adolescence are essential for improving long-term health outcomes.8

The clinical manifestations of anemia vary depending on severity and underlying etiology. Common symptoms include pallor, generalized weakness, easy fatigability, headache, reduced appetite, breathlessness, and poor exercise tolerance. Severe anemia may present with tachycardia, edema, syncope, and growth retardation.9 Morphologically, anemia may be classified as microcytic hypochromic, normocytic normochromic, or macrocytic based on red blood cell indices and peripheral smear examination. Microcytic hypochromic anemia due to iron deficiency is the most frequently encountered pattern among adolescents.10

Hematological evaluation plays a crucial role in identifying the type and severity of anemia. Parameters such as hemoglobin concentration, mean corpuscular volume, mean corpuscular hemoglobin, peripheral smear findings, and serum ferritin levels help establish the diagnosis and underlying cause.11 Assessment of clinico-demographic factors including age, gender, socioeconomic background, dietary pattern, menstrual history, and nutritional status is equally important for understanding risk factors associated with adolescent anemia.12

Despite several national nutritional programs and iron supplementation initiatives, anemia continues to remain highly prevalent among adolescents in India. Lack of awareness, poor compliance with supplementation programs, and inadequate nutritional education contribute to persistence of the problem. Hospital-based studies evaluating the clinical presentation and hematological profile of anemia among adolescents provide valuable insight into disease burden, associated risk factors, and common patterns of presentation in the local population.

AIMS AND OBJECTIVES

- To evaluate the clinico-demographic characteristics and hematological profile of anemia among adolescents attending a tertiary care hospital.

MATERIALS AND METHODS

This prospective hospital-based observational study was conducted in the Department of Paediatrics at Sree Mookambika Institute of Medical Sciences over a period of 10 months from May 2025 to February 2026. The study included 70 adolescents aged between 10 and 19 years who were diagnosed with anemia during outpatient or inpatient evaluation. Informed consent was obtained from parents or guardians along with assent from adolescents wherever appropriate.

Adolescents aged 10–19 years with hemoglobin levels below the World Health Organization age- and sex-specific criteria for anemia were included in the study. Patients presenting with symptoms such as fatigue, generalized weakness, pallor, reduced appetite, dizziness, headache, poor exercise tolerance, or breathlessness were clinically evaluated and screened for eligibility. Both male and female adolescents were included irrespective of socioeconomic status or nutritional background. Adolescents with known hematological malignancies, congenital hemolytic disorders, aplastic anemia, chronic kidney disease, chronic liver disease, severe acute infections, autoimmune disorders, active tuberculosis, or malignancy were excluded from the study. Patients who had received blood transfusion within the preceding three months, those on long-term hematinic therapy, and adolescents unwilling to participate were also excluded. Patients with acute traumatic blood loss or postoperative anemia were not included in the study.

Detailed demographic information including age, gender, socioeconomic status, educational background, dietary habits, menstrual history in female adolescents, and family history of anemia was recorded using a structured proforma. Clinical examination included assessment of pallor, icterus, edema, lymphadenopathy, anthropometric measurements, nutritional status, and systemic examination. Height, weight, and body mass index were documented for all participants.

Laboratory investigations were performed in all cases and included complete blood count, hemoglobin estimation, red blood cell indices, peripheral smear examination, packed cell volume, total leukocyte count, platelet count, and serum ferritin levels. Additional investigations such as stool examination for parasitic infestation, serum vitamin B12 levels, folate levels, reticulocyte count, and liver and renal function tests were performed whenever clinically indicated. The severity of

anemia was classified as mild, moderate, or severe according to World Health Organization criteria. Morphological classification of anemia was based on red blood cell indices and peripheral smear findings into microcytic hypochromic, normocytic normochromic, and macrocytic anemia.

All patients received appropriate treatment and nutritional counseling according to the identified cause and severity of anemia. Dietary advice emphasizing iron-rich foods, green leafy vegetables, pulses, fruits, and protein intake was provided to patients and caregivers. Female adolescents with menstrual abnormalities were further evaluated and managed accordingly.

Data collected during the study were entered into a master chart and analyzed using appropriate statistical methods. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Statistical analysis was performed using chi-square test and independent t-test wherever applicable. A p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 70 adolescents diagnosed with anemia were included in the study. The majority of adolescents belonged to the 15–19 years age group, accounting for 41 (58.6%) cases. Female predominance was observed with 44 (62.9%) patients, showing a statistically significant higher prevalence of anemia among adolescent girls. (Table 1)

Table 1: Age and Gender Distribution of Study Population (n = 70)

Variable	Category	Number (n)	Percentage (%)	p-value
Age Group	10–14 years	29	41.4	0.18
	15–19 years	41	58.6	
Gender	Male	26	37.1	0.03*
	Female	44	62.9	

Most adolescents belonged to lower socioeconomic strata and were underweight, indicating the strong influence of nutritional deficiency on anemia prevalence. Vegetarian dietary pattern was more commonly associated with anemia among study participants.

Table 2: Socioeconomic and Nutritional Characteristics (n = 70)

Variable	Category	Number (n)	Percentage (%)	p-value
Socioeconomic status	Lower	39	55.7	0.02*
	Middle	24	34.3	
	Upper	7	10.0	
Dietary Pattern	Mixed diet	31	44.3	0.04*
	Vegetarian	39	55.7	
Nutritional Status	Underweight	36	51.4	0.03*
	Normal	30	42.9	
	Overweight	4	5.7	

Pallor was the most common clinical finding, present in 62 (88.6%) adolescents, followed by fatigue and generalized weakness. The majority of symptoms reflected reduced physical performance and impaired daily functioning associated with anemia. (Table 3)

Table 3: Clinical Presentation of Anemia

Clinical Feature	Number (n)	Percentage (%)
Pallor	62	88.6
Fatigue	50	71.4
Generalized weakness	38	54.3
Reduced appetite	32	45.7
Headache	21	30.0
Breathlessness	14	20.0
Dizziness	19	27.1

Moderate anemia was the most frequently observed category, affecting 38 (54.3%) adolescents. Severe anemia was present in 11 (15.7%) patients, indicating delayed healthcare seeking and persistent nutritional deficiency in a subset of adolescents. (Table 4)

Table 4: Severity of Anemia According to Hemoglobin Levels (n = 70)

Severity	Hemoglobin Level	Number (n)	Percentage (%)
Mild anemia	10–11.9 g/dL	21	30.0
Moderate anemia	7–9.9 g/dL	38	54.3
Severe anemia	<7 g/dL	11	15.7

Microcytic hypochromic anemia was the predominant hematological pattern observed in 46 (65.7%) adolescents, strongly suggesting iron deficiency as the major underlying etiology. The association was statistically significant. (Table 5)

Table 5: Morphological Pattern of Anemia (n = 70)

Morphological Type	Number (n)	Percentage (%)	p-value
Microcytic hypochromic	46	65.7	<0.01*
Normocytic normochromic	16	22.9	
Macrocytic	8	11.4	

Reduced mean corpuscular volume, mean corpuscular hemoglobin, and serum ferritin levels supported the predominance of iron deficiency anemia among the study population. Overall hematological parameters indicated moderate anemia with depleted iron stores. (Table 6)

Table 6: Hematological Parameters of Study Population

Parameter	Mean ± SD
Hemoglobin (g/dL)	8.9 ± 1.8
Mean corpuscular volume (fL)	71.6 ± 8.4
Mean corpuscular hemoglobin (pg)	23.1 ± 3.2
Serum ferritin (ng/mL)	12.4 ± 4.6

Moderate to severe anemia showed significant association with female gender, lower socioeconomic status, undernutrition, and reduced serum ferritin levels. These findings emphasize the major contribution of nutritional iron deficiency and socioeconomic factors in adolescent anemia. (Table 6)

Variable	Category	Moderate to Severe Anemia n (%)	Mild Anemia n (%)	p-value
Gender	Female	39 (88.6%)	5 (11.4%)	0.02*
	Male	10 (38.5%)	16 (61.5%)	
Socioeconomic Status	Lower	34 (87.2%)	5 (12.8%)	<0.01*
	Middle/Upper	15 (48.4%)	16 (51.6%)	
Nutritional Status	Underweight	31 (86.1%)	5 (13.9%)	0.01*
	Normal/Overweight	18 (52.9%)	16 (47.1%)	
Serum Ferritin	<15 ng/mL	42 (82.4%)	9 (17.6%)	<0.01*
	≥15 ng/mL	7 (36.8%)	12 (63.2%)	

DISCUSSION

A total of 70 adolescents diagnosed with anemia were included in the present study. Majority of the patients belonged to the 15–19 years age group, accounting for 41 (58.6%) cases, indicating increased prevalence of anemia during late adolescence when nutritional requirements are significantly elevated. Female adolescents constituted 44 (62.9%) of the study population, demonstrating a higher burden of anemia among girls, likely related to menstrual blood loss, poor dietary intake, and increased physiological iron demands during puberty. Similar female predominance was reported by Narayan R et al.13 and CPV RS et al.14 who also observed higher prevalence of anemia among females and nutritionally vulnerable children. In contrast, Ravi Kanth K et al.15 and Fabin M et al.16 reported slight male predominance among pediatric anemia cases.

Most adolescents in the present study belonged to lower socioeconomic strata, comprising 39 (55.7%) patients, reflecting the influence of poor nutrition and limited access to balanced diets on anemia development. Underweight status was observed in 36 (51.4%) adolescents, suggesting chronic nutritional deficiency as a major contributing factor. Vegetarian dietary pattern was present in 39 (55.7%) cases, indicating inadequate dietary iron intake among a considerable proportion of participants. Similar observations were made by Narayan R et al.13 who found anemia to be more common among children from low socioeconomic backgrounds and vegetarian dietary habits. Kayalvizhi K et al.17 also highlighted the role of poverty, nutritional inadequacy, and poor feeding practices in the development of iron deficiency anemia.

Pallor was the most common clinical finding in the present study, observed in 62 (88.6%) adolescents, followed by fatigue in 50 (71.4%) and generalized weakness in 38 (54.3%) patients. Reduced appetite, headache, dizziness, and breathlessness were also frequently reported symptoms. These findings indicate the considerable impact of anemia on daily activities and physical well-being among adolescents. Similar findings were reported by Kayalvizhi K et al.17 who observed pallor in nearly all children with anemia and emphasized the importance of early identification and intervention to reduce morbidity associated with nutritional anemia.

Moderate anemia was the predominant severity category, affecting 38 (54.3%) adolescents, while severe anemia was identified in 11 (15.7%) cases. The presence of severe anemia in a notable proportion of patients reflects delayed diagnosis, poor nutritional awareness, and inadequate healthcare access. Comparable findings were observed by Narayan R et al.13 who reported moderate anemia as the most common severity pattern, followed by mild and severe anemia. Similarly, Mishra G et al.18 documented moderate anemia in 37.3% of pediatric patients, indicating that moderate severity constitutes the major clinical burden in nutritional anemia.

The mean hemoglobin level among study participants was 8.9 ± 1.8 g/dL, reflecting moderate reduction in oxygen-carrying capacity and tissue oxygenation. Microcytic hypochromic anemia was the most common morphological pattern, observed in 46 (65.7%) adolescents, strongly suggesting iron deficiency as the principal underlying etiology. Normocytic normochromic anemia was present in 16 (22.9%) patients, while macrocytic anemia was identified in 8 (11.4%) cases. Similar predominance of microcytic hypochromic anemia was reported by CPV RS et al.14 where 81.8% of children demonstrated microcytic hypochromic picture, and by Kayalvizhi K et al.17 who observed similar peripheral smear findings in 83.8% of patients. Sivaraj V et al.19 and Ravi Kanth K et al.15 also identified iron deficiency anemia as the most common hematological pattern among children.

Reduced serum ferritin levels and low red blood cell indices in the present study further supported iron deficiency as the major cause of anemia. Sarna A et al.20 similarly reported iron deficiency anemia as one of the most prevalent etiological types among adolescents, although other nutritional deficiencies and mixed etiologies also contributed substantially. Mishra G et al.18 additionally demonstrated significantly lower MCV values among patients with iron deficiency anemia compared to vitamin B12 deficiency anemia, emphasizing the importance of hematological indices in etiological differentiation.

Significant association was observed in the present study between moderate to severe anemia and female gender, low socioeconomic status, undernutrition, and reduced serum ferritin levels. Female adolescents demonstrated higher frequency of moderate to severe anemia compared to males. Adolescents belonging to lower socioeconomic groups and underweight individuals also showed greater severity of anemia, highlighting the combined influence of nutritional deprivation and socioeconomic factors. These findings are consistent with observations made by Vaswani ND et al.21 who reported strong association between severe anemia, malnutrition, and poor socioeconomic conditions.

CONCLUSION

Anemia among adolescents was predominantly observed in females and commonly affected individuals belonging to lower socioeconomic and nutritionally deficient groups. Moderate anemia was the most frequent presentation, with microcytic hypochromic anemia being the predominant morphological type, indicating iron deficiency as the major underlying cause. Significant association was noted between anemia severity and female gender, undernutrition, low socioeconomic status, and reduced serum ferritin levels. Early identification, nutritional counseling, routine hematological screening, and effective iron supplementation programs are essential to reduce the burden of adolescent anemia and prevent long-term health consequences.

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Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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