Student's Journal of Health Research Africa
e-ISSN: 2709-9997, p-ISSN: 3006-1059
Vol.7 No. 2 (2026): June 2026 Issue
https://doi.org/10.51168/354ga376
Original Article

Assessment of socioeconomic status and anemia profiles in adolescent girls in Nellore District and awareness of anemia complications: A cross-sectional study.

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Abstract

Background

Adolescence is a critical growth phase marked by heightened nutritional demands, making young girls highly vulnerable to anaemia. This study evaluated the prevalence of anaemia, assessed various biochemical blood parameters, and measured the level of awareness regarding anaemia complications among adolescent girls.

Methods

A cross-sectional study was conducted among 635 girls aged 12–18 years. Data were collected via socio-demographic questionnaires and anthropometric measurements. Multiple Blood Parameters (Hemoglobin, Serum Ferritin, Total Iron-Binding Capacity, and Complete Blood Counts) were evaluated. A validated tool was used to gauge awareness of anaemia complications.

Results

The overall prevalence of anaemia was 58.3%. A strong, statistically significant association was observed between anaemia severity and lower socioeconomic status. Furthermore, awareness regarding the long-term complications of anaemia was remarkably low, with only 31.2% of the participants demonstrating adequate knowledge.

Conclusion

Anaemia remains a severe public health crisis among adolescent girls in India, heavily driven by socioeconomic inequities and nutritional deficits. Targeted interventions, including nutritional education, iron-folic acid supplementation, and socioeconomic support, are urgently required to combat this burden.

Recommendations

There is a strong need for early intervention, particularly nutritional interventions in adolescent girls, which helps curtail future complications regarding health and pregnancy-related complications in the future.

Keywords: *Anemia, Adolescents, Awareness, Folic Acid Supplementation*
Submitted: *April 15, 2026* ***Accepted:*** *May 20, 2026* ***Published:*** *June 30, 2026*

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Introduction

The World Health Organization (WHO) defines adolescence as the period between 10 and 19 years of age. This phase is characterized by a rapid growth spurt and an increase in skeletal mass and blood volume, leading to an increased demand for micronutrients, particularly iron[1]. In developing nations, particularly India, adolescent girls face a disproportionately high risk of anaemia due to inadequate dietary diversity, widespread poverty, early onset of menarche, and high rates of worm infestation[2].

Anaemia during adolescence has severe, debilitating consequences. It compromises cognitive function, physical capacity, and overall academic performance. Furthermore, if left unaddressed, it tracks into adulthood, significantly increasing the risk of maternal and fetal complications during future pregnancies[3,16]. Despite these detrimental impacts, health literacy regarding anaemia and its complications remains critically low in marginalized communities[17].

This cross-sectional study was designed to bridge this knowledge gap by assessing the exact prevalence of anaemia, profiling multiple haematological parameters, and determining the extent of health awareness among 635 adolescent girls aged 12–18 years.

Materials and methods

Study design

A Cross-sectional, School- and Community-based study was conducted over 12 months. The study targeted adolescent girls aged 12 to 18 years residing in semi-urban and rural areas.

Study setting

The study was conducted in Nellore District of Andhra Pradesh, India, by faculty of ACSR Government Medical College. From 01 October 2024 to 30 September 2025 in urban and rural areas of Nellore District.

Sample size and sampling technique

Using a prevalence rate of 50% (to maximize statistical power), an allowable error of 5%, and a 95% confidence interval, the minimum required sample size was calculated. Anticipating a non-response or dropout rate of 5%, the final sample size was fixed at 635 participants. Participants were selected using a Multi-Stage Random Sampling Technique.

Inclusion criteria

- Adolescent Girls aged 12–18 years.
- Informed assent from the participant and written informed consent from a parent or legal guardian.
- Permanent residents of the designated study area.

Exclusion criteria

- Girls with known Chronic Systemic illnesses (e.g., sickle cell disease, thalassemia, tuberculosis).
- Girls who had received blood transfusions in the three months before the present study.
- Girls experiencing acute febrile illnesses at the time of the study.

Data collection and anthropometry

A pre-tested, semi-structured questionnaire was utilised to gather socio-demographic details (parental education, occupation, household income) and awareness levels regarding anaemia. Socioeconomic status (SES) was classified using the standardised Kuppuswamy socioeconomic scale. Anthropometric measurements (height and weight) were recorded using standardised calibrated equipment, and Body Mass Index (BMI) for age was calculated.

Bias

Adequate time and a well-trained team have been deployed to minimise the potential sources of bias.

Ethical consideration

This study underwent ethical approval. State the name of the ethics committee that approved the study, the date of approval, and the ethical clearance number if available. Provide the statement of informed consent.

Of the Institutional Ethical Committee of ACSR Government Medical College, Nellore, with approval No EC/NEW/INST/2020/1057; Dated 02 July 2024.

Blood sample collection and analysis

Under strict aseptic conditions, 3–5 mL of venous blood was drawn from each participant. The blood samples were analyzed for multiple parameters:

Hemoglobin (Hb): Measured using the cyanmethhemoglobin method. Anaemia was graded according to WHO criteria (mild, moderate, and severe).

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Red Blood Cell (RBC) Indices: Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCH).
Serum Ferritin: Measured using Enzyme-Linked Immunosorbent Assay (ELISA) to determine iron stores.
Total Iron-Binding Capacity (TIBC): Measured to assess iron transport capability in the blood.

Assessment of awareness

A scoring system was developed to evaluate awareness. Participants were asked about the causes, symptoms (fatigue, pallor), and complications of anaemia (impaired growth, susceptibility to infections, poor cognitive performance). A score of < 50% was categorized as "low awareness," while scores >50% were categorized as "adequate awareness."

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS (Statistical Package for the Social Sciences). Categorical variables were presented as frequencies and percentages. Continuous variables were presented as Means and Standard Deviations. Chi-square tests were used to determine associations between categorical variables (e.g., anaemia prevalence and SES). A p-value of < 0.05 was considered statistically significant.

Results

Socio-Demographic profile of participants

The study included 635 adolescent girls with a mean age of 15.2 ± 1.4 years. A vast majority of the participants belonged to lower-middle and upper-lower socioeconomic classes. A significant proportion of the mothers (42.5%) had no formal education, while 35.8% had only primary education. A total of 991 Adolescent Girls were approached, and among them, 260 girls or their parents didn't consent to participate in the study. 96 Girls dropped from the study after initial consent.

Prevalence and severity of anaemia

Out of the 635 girls, 370 were found to be anaemic, yielding an overall prevalence of 58.3%. According to the WHO classification of anaemia, the distribution was as follows:
Mild Anaemia: 25.2% (Hb 10.0–11.9 g/dL)
Moderate Anaemia: 28.7% (Hb 7.0–9.9 g/dL)
Severe Anaemia: 4.4% (Hb <7.0 g/dL)

Biochemical blood parameters

The haematological and biochemical profiles of the participants are detailed in Table 1.

Table 1: Biochemical Blood Parameters of Study Participants (n=635)

Blood Parameter	Mean Value ± SD	Reference Range
Hemoglobin (g/dL)	10.8 ±1.5	> 12.0
Serum Ferritin (ng/mL)	18.4 ±7.5	15 – 150
MCV (fL)	76.5± 8.2	80 – 100
MCH (pg)	25.2 ± 3.6	27 – 31
TIBC (mug/dL)	410.2 ±45.6	250 – 450

Awareness regarding anaemia and its complications

Only 31.2 % of the participants had adequate awareness regarding the complications associated with anaemia. While the majority of girls associated feeling "weak" with lack of blood, fewer than 20% were aware of the long-term cognitive and reproductive consequences of the condition. A statistically significant correlation was found between awareness levels and maternal education.

Association between anaemia and socio-demographic factors

There was a strong and statistically significant association between the prevalence of anaemia and the socioeconomic status of the participants' families ($p < 0.001$). Girls from lower-income households were disproportionately affected, highlighting the role of dietary diversity and access to nutritious foods.

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Table 2: Distribution of Anaemia by Socioeconomic Status

Socioeconomic Status (SES)	Non-Anaemic (n=265)	Anaemic (n=370)	Total (n=635)	Chi-square Value	p-value
Lower	42 (15.8%)	154 (41.6%)	196 (30.8%)		
Middle	112 (42.3%)	158 (42.7%)	270 (42.5%)		
Upper	111 (41.9%)	58 (15.7%)	169 (26.7%)	22.45	<0.001

As depicted in Table 2, a greater burden of anaemia is borne by girls in the lower SES categories.

Distribution of anaemia by age and BMI

The prevalence of anaemia showed a slight variation across the age groups. Older adolescents (16–18 years) exhibited a higher prevalence of anaemia compared to younger adolescents, which can be attributed to the cumulative effect of menstrual iron losses.

Table 3: Prevalence of Anaemia by Age Group

Age Group (Years)	Total Participants	Anaemic Participants	Percentage
12-14	215	115	53.5%
15-16	230	138	60.0%
17-18	190	117	61.6&

Furthermore, the prevalence was higher among girls who were classified as underweight (BMI-for-age<5th percentile) compared to their normal-weight peers.

Discussion

The present study investigated the haematological profiles, prevalence, and awareness of anaemia among 635 adolescent girls in India. With an overall anaemia prevalence of 58.3 %, our findings highlight a major public health concern. This high prevalence is consistent with national data reported by the National Family Health Survey, which consistently indicates that anaemia remains a formidable challenge among adolescents in India[4].

The biochemical analysis in our study provides valuable insights into the etiology of this condition. The mean serum ferritin level was 18.4 ± 7.5 ng/mL, and the mean MCV was 76.5± 8.2 fL, both of which point heavily toward iron deficiency anaemia[5]. Adolescence is a period of rapid growth and development; the demand for iron increases significantly to support the expansion of blood volume and muscle mass. In female adolescents, this physiological requirement is exacerbated by menstrual blood loss. Without a compensatory increase in dietary iron intake, these factors rapidly deplete iron stores, culminating in anaemia[6].

Furthermore, our results show a statistically significant association between anaemia and socioeconomic status. Participants from lower-income households were the most affected. This disparity is primarily due to a lack of dietary diversity. Diets in lower-socioeconomic households are often plant-based and lack highly bioavailable heme iron, leading to poor iron absorption. Additionally, poverty limits access to healthcare, sanitation (which impacts worm infestations), and health education[7].

A critical and alarming finding of this study is the low level of awareness regarding anaemia and its long-term complications. Only 31.2% of the participants had adequate knowledge. Many girls were unaware of how the condition impacts their cognitive function, physical development, and long-term reproductive health. The lack of awareness was strongly correlated with lower maternal education. This suggests that intergenerational cycles of malnutrition and illiteracy play a significant role in perpetuating the anaemia burden. Education empowers individuals to make better dietary choices and seek appropriate medical care[8].

While the Government of India has implemented various programs, such as the Weekly Iron-Folic Acid Supplementation (WIFs) program, our study's findings suggest that supplementation alone is insufficient[9]. Compliance and efficacy are frequently hampered by a lack of understanding of why the supplements are necessary. Therefore, there is a distinct need for a holistic approach that

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integrates nutritional supplementation with comprehensive health education in schools and communities[10].
This study has included the majority of the rural population, as the majority of adolescent girls hail from small villages; this study reflects the true magnitude of the problem faced by many.

Conclusion

Anaemia is highly prevalent among adolescent girls in the studied population, affecting more than half of the cohort[11,15]. The condition is primarily driven by iron deficiency, low dietary diversity, and socioeconomic disadvantages. Furthermore, awareness regarding the complications of anaemia remains critically low[12].
To effectively combat this public health challenge, purely biomedical interventions are inadequate. There is a pressing need for multi-sectoral strategies that improve the socioeconomic conditions of vulnerable families, promote female literacy, and enhance dietary diversity. Furthermore, school-based health education must be bolstered to improve awareness about anaemia complications and ensure adherence to iron and folic acid supplementation[13]. By addressing these root causes, we can safeguard the health and well-being of the next generation[19,20].

Limitations

- The study was done only in Nellore District, which is a coastal district of Andhra Pradesh, so generalizability is difficult.
- Peripheral smear study has not been done
- As the current study is a cross-sectional study, follow-up is missing for adolescent girls

Recommendations

There is a strong need to take up the same study in a large population of diverse areas to emphasize the urgent need for precautionary measures.

Acknowledgement

Faculty of Pathology and Biochemistry departments of ACSR Government Medical College, Nellore

List of abbreviations

WHO: World Health Organisation
MCV: Mean Corpuscular Volume
MCH: Mean Corpuscular Hemoglobin
MCHC: Mean Corpuscular Hemoglobin Concentration
BMI: Body Mass Index

Source of funding

The study did not receive any funding.

Conflict of interest

The authors declare no conflict of interest.

Data availability

Data can be accessed from the Department of Biochemistry & Pathology at ACSR Government Medical College, Nellore.

Author contribution

Dr M . Keerthi Tej, first author, has contributed to initiating the project and has presented to Ethical committee for approval. He has contributed to data collection and biochemical analysis of Blood Parameters.
Dr. K. Divya Teja, Second Author, contributed to hematological analysis of blood investigations & Statistics.
Dr. P.V.Susheel Kumar, Third Author, was instrumental at the root level in the collection of Primary individual data and coordinating with all specialties.

Author biography

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https://doi.org/10.51168/354ga376
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PUBLISHER DETAILS

Student's Journal of Health Research (SJHR)
(ISSN 2709-9997) Online
(ISSN 3006-1059) Print
Category: Non-Governmental & Non-profit Organization
Email: studentsjournal2020@gmail.com
WhatsApp: +256 775 434 261
Location: Scholar's Summit Nakigalala, P. O. Box 701432, Entebbe Uganda, East Africa