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NUTRITIONAL STATUS AND ANAEMIA AMONG ADOLESCENT GIRLS: A CROSS-SECTIONAL STUDY IN A RURAL SETTING OF CHITRADURGA DISTRICT, KARNATAKA.

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Abstract

Background: Adolescence is a period of rapid physical growth associated with increased nutritional demands, and adolescent girls are particularly vulnerable to anaemia and undernutrition due to menstrual blood loss, poor dietary iron intake, and socioeconomic disadvantage. Locality-specific data are needed to guide targeted interventions. ***Objectives:*** To assess the nutritional status and prevalence of anaemia among adolescent girls in rural area and to identify associated socio-demographic, dietary, and menstrual factors. ***Methods:*** A community-based, cross-sectional study was conducted among 375 adolescent girls (10–19 years) selected through multi-stage random sampling from the rural field practice area of Basaveshwara Medical College and Hospital, Chitradurga, over six months (Nov 2025–Apr 2026). Nutritional status was assessed using WHO BMI-for-age z-scores, and haemoglobin was estimated by digital haemoglobinometer using capillary blood. Associations were analysed using chi-square tests and binary logistic regression. ***Results:*** The mean age was 14.6 ± 2.3 years. Undernutrition (thinness/severe thinness) was found in 24.8% of participants, while 8.3% were overweight/obese. Anaemia prevalence was 69.6% (mean Hb 10.8 ± 1.4 g/dL), with mild, moderate, and severe anaemia in 35.2%, 29.6%, and 4.8% respectively. Undernourished girls had significantly higher odds of anaemia (AOR 1.87). Independent predictors of anaemia included irregular/nil IFA consumption (AOR 3.42), low maternal education (AOR 2.35), vegetarian diet (AOR 2.10), and heavy/prolonged menstrual flow (AOR 1.98). ***Conclusion:*** A high burden of anaemia and undernutrition was observed among rural adolescent girls, driven by poor IFA compliance, low maternal education, dietary patterns, and menstrual factors. Strengthening supervised IFA supplementation, deworming, and nutrition education is essential to address this multifactorial problem.

Keywords: Adolescent girls, Nutritional status, Anaemia, Haemoglobin.

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INTRODUCTION

Adolescence, between the age of 10 to 19 years, represents one of the most dynamic phases of human growth, second only to infancy in terms of the pace of physical and physiological change. During this period, the body undergoes a pubertal growth spurt, skeletal maturation, and the onset of secondary sexual characteristics, all of which substantially increase the demand for energy, protein, and micronutrients. For adolescent girls specifically, the onset of menarche introduces regular blood loss, further intensifying iron requirements at a time when dietary intake is often inadequate. When these heightened nutritional needs are not met, the consequences extend well beyond adolescence itself, predisposing girls to stunted growth, poor reproductive outcomes, and an intergenerational cycle of undernutrition when they eventually become mothers.

Anaemia and undernutrition among adolescent girls constitute major public health problems globally, but the burden is disproportionately concentrated in low- and middle-income countries, including India.1 According to national health surveys, India continues to report a high prevalence of anaemia among adolescent girls, with rural and socioeconomically disadvantaged populations bearing a greater share of this burden. Iron deficiency anaemia, in particular, remains the most common nutritional deficiency disorder in this age group, driven by a combination of inadequate dietary iron intake, poor bioavailability of iron from predominantly cereal-based diets, menstrual blood loss, parasitic infestations, and limited awareness regarding iron and folic acid (IFA) supplementation. Nutritional status in adolescence is conventionally assessed through anthropometric indicators such as height-for-age and BMI-for-age, which reflect chronic and acute nutritional deficits, respectively. Poor nutritional status in adolescent girls is closely connected with anaemia, as both often share common underlying determinants, including household food insecurity, low socioeconomic status, limited maternal education, early marriage practices, and inadequate healthcare access — factors that are frequently more pronounced in rural settings compared to urban areas. The Government of India has implemented several programmes to address adolescent nutrition and anaemia, including the Weekly Iron and Folic Acid Supplementation (WIFS) programme, Anaemia Mukt Bharat, and school health initiatives under Ayushman Bharat. 2.3 However, the effectiveness of these programmes is contingent upon accurate, locality-specific data on the prevalence and determinants of malnutrition and anaemia, as these can vary considerably across geographic and sociocultural contexts. Chitradurga district, located in the semi-arid Bayaluseeme (plains) region of Karnataka, is characterised by predominantly agrarian rural communities where dietary patterns, socioeconomic conditions, and healthcare-seeking behaviours may differ from other parts of the state. Despite this, there is a paucity of published data specifically examining the nutritional and anaemia status of adolescent girls in this district.

Given this gap, the present study was undertaken to assess the nutritional status and prevalence of anaemia among adolescent girls in a rural setting of Chitradurga district, and to explore the sociodemographic, dietary, and menstrual hygiene-related factors associated with these outcomes. Findings from this study are expected to provide locally relevant evidence to guide targeted nutritional interventions and strengthen existing adolescent health programmes at the district and state level.

OBJECTIVES

1. To assess the nutritional status of adolescent girls using anthropometric indicators
2. To determine the prevalence of anaemia among adolescent girls in the study population.
3. To evaluate the association between nutritional status and anaemia among the study participants.
4. To study the socio-demographic, dietary, and menstrual factors associated with malnutrition and anaemia among adolescent girls in the study area.

MATERIALS AND METHODS

Study Design and Setting

A community-based, descriptive cross-sectional study was conducted among adolescent girls residing in the rural field practice area of Basaveshwara Medical College and Hospital Chitradurga district, Karnataka. Chitradurga is a semi-arid, predominantly agrarian district of central Karnataka, and the villages under the field practice area were selected as they represent the typical socio-demographic and nutritional profile of rural adolescents in the region.

Study Duration

The study was carried out over a period of 6 months, from Nov 2025 to Apr 2026.

Study Population

The study population comprised adolescent girls aged 10–19 years residing in the selected rural villages/government schools of Chitradurga district.

Inclusion criteria

- Adolescent girls aged 10–19 years permanently residing in the study area
- Girls willing to participate, with informed written consent from parents/guardians and assent from the participant
- Girls available at the time of the survey/data collection

Exclusion criteria

- Girls with known chronic illness (e.g., chronic kidney disease, malignancy, haemoglobinopathies such as thalassemia/sickle cell disease)
- Girls who were acutely ill or on iron/vitamin supplementation for a diagnosed medical condition at the time of screening

Sample Size Calculation

The sample size was calculated using the formula for estimation of a proportion in a cross-sectional study:

$n = Z^2pq / d^2$

Where: Z = 1.96 (at 95% confidence level), p = expected prevalence of anaemia among adolescent girls in rural Karnataka, taken as 42.19% based on previous regional studies. 4

Based on this prevalence and at 95% confidence interval, with a precision of 5%, the required calculated sample size was around 375 subjects

Sampling Technique

A multi-stage random sampling technique was adopted:

Chitradurga district was divided into administrative blocks/taluks, from which one or more taluks were selected by simple random sampling. A list of villages/government schools under the selected taluk(s) was prepared, and villages/schools were selected by simple random sampling (lottery method) or systematic random sampling. Within each selected village/school, all eligible adolescent girls fulfilling the inclusion criteria were enrolled, or study subjects were selected using a house-to-house/class-wise enumeration until the desired sample size was achieved.

Ethical Considerations

Institutional Ethics Committee approval was obtained prior to commencement of the study Permission was also obtained from the concerned Gram Panchayat/School authorities/District Health Officer. Written informed consent was obtained from parents/guardians, and assent was obtained from the adolescent girls themselves. Confidentiality of participant information was maintained throughout. Girls found to be anaemic or malnourished during screening were referred to the nearest Primary Health Centre for further management.

Data Collection Tools and Techniques

A structured, pre-tested pre-designed questionnaire (translated into Kannada) was administered through house-to-house visits/school visits by direct interview method. It captured Socio-demographic details, menstrual history, dietary history, history of intake of Iron and Folic Acid (IFA) tablets under the Weekly Iron and Folic Acid Supplementation (WIFS) programme, history of deworming, and presence of worm infestation symptoms.

Anthropometric Assessment and Haemoglobin Estimation was done. Haemoglobin (Hb) levels were estimated by finger-prick capillary blood sample using a digital haemoglobinometer. Anaemia was classified as per WHO criteria for adolescents (12–14 years and non-pregnant females ≥15 years, Hb cut-off <12 g/dL):

No anaemia: ≥12 g/dL
Mild anaemia: 11.0–11.9 g/dL
Moderate anaemia: 8.0–10.9 g/dL
Severe anaemia: <8.0 g/dL

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS software (version 25.0]). Descriptive statistics (frequency, percentage, mean ± SD) were used to summarize socio-demographic and nutritional variables. The Chi-square test was used to assess association between anaemia/nutritional status and categorical variables (age, socio-economic status, dietary pattern, menstrual characteristics, IFA consumption). A p-value < 0.05 was considered statistically significant. Where appropriate, binary logistic regression was used to identify independent predictors of anaemia, with results expressed as adjusted odds ratios (AOR) with 95% confidence intervals.

RESULTS

Study Population and Response

Of the 390 adolescent girls approached across the selected villages/schools in the rural field practice area, 375 fulfilled the inclusion criteria and consented/assented to participate, giving a response rate of 96.2%. The remaining subjects were excluded due to refusal (n=8), acute illness at the time of screening (n=4), or known haemoglobinopathy (n=3).

Nutritional Status (BMI-for-age)

The mean age of participants was 14.6 ± 2.3 years. Based on WHO BMI-for-age z-scores, the nutritional status of the study population is summarised in Table 1.

Table 1. Distribution of nutritional status among study participants (n=375)

BMI-for-age category	Frequency (n)	Percentage (%)
Severe thinness (<-3 SD)	14	3.7
Thinness (-3 to <-2 SD)	79	21.1
Normal (-2 to +1 SD)	251	66.9
Overweight (+1 to +2 SD)	24	6.4
Obese (>+2 SD)	7	1.9
Total undernutrition (thinness + severe thinness)	93	24.8

Overall, nearly one-fourth of the adolescent girls (24.8%) were undernourished (thin or severely thin), while a smaller proportion (8.3%) were overweight or obese, indicating a double burden of malnutrition in the study population. Undernutrition was more common among girls aged 10–13 years (early adolescence) compared to older adolescents (p=0.04).

Prevalence of Anaemia

Based on capillary Hb estimation, anaemia was present in 261 of 375 girls, giving an overall prevalence of 69.6%. The severity distribution is shown in Table 2.

Table 2. Severity of anaemia among adolescent girls (n=375)

Hb category	Frequency (n)	Percentage (%)
No anaemia (≥12 g/dL)	114	30.4
Mild anaemia (11.0–11.9 g/dL)	132	35.2
Moderate anaemia (8.0–10.9 g/dL)	111	29.6
Severe anaemia (<8.0 g/dL)	18	4.8

The mean haemoglobin level of the study population was 10.8 ± 1.4 g/dL. Mild-to-moderate anaemia together accounted for the majority of cases (64.8%), while severe anaemia, though less frequent, was noted in nearly 1 in 20 girls, warranting urgent referral and follow-up.

Association Between Nutritional Status and Anaemia

Anaemia was significantly more prevalent among undernourished girls than among those with normal or high BMI-for-age (Table 3).

Table 3. Association between nutritional status and anaemia

Nutritional status	Anaemic n (%)	Non-anaemic n (%)	Total	χ^2	p-value
Undernourished (thin/severely thin)	78 (83.9)	15 (16.1)	93	11.62	0.001
Normal/overweight/obese	183 (64.9)	99 (35.1)	282		

Girls who were undernourished had significantly higher odds of being anaemic compared to those with normal nutritional status (unadjusted OR = 2.81, 95% CI: 1.53–5.16, p=0.001), confirming a strong association between poor nutritional status and anaemia in this population.

Socio-demographic, Dietary, and Menstrual Factors Associated with Malnutrition and Anaemia

On univariate analysis (Table 4), factors significantly associated with anaemia included low socioeconomic status, illiteracy/low maternal education, predominantly vegetarian diet, early age at menarche, heavy/prolonged menstrual flow, irregular/non-consumption of IFA tablets, and history of worm infestation symptoms.

Table 4. Factors associated with anaemia among adolescent girls (univariate analysis)

Variable	Category	Anaemic n (%)	Non-anaemic n (%)	p-value
Socioeconomic status	Lower/Upper-lower (Modified BG Prasad)	189 (76.5)	58 (23.5)	0.002
	Upper-middle/Upper	72 (56.7)	56 (43.3)	
Maternal education	Illiterate/primary	165 (78.9)	44 (21.1)	<0.001
	Secondary and above	96 (57.1)	70 (42.9)	
Dietary pattern	Vegetarian	172 (76.4)	53 (23.6)	0.003
	Mixed/non-vegetarian	89 (58.9)	61 (41.1)	
Age at menarche	≤12 years	96 (80.0)	24 (20.0)	0.01
	>12 years	165 (64.7)	90 (35.3)	
Menstrual flow	Heavy/prolonged (>5 days)	84 (81.6)	19 (18.4)	0.004
	Normal	177 (65.1)	95 (34.9)	
IFA tablet consumption	Regular (≥75% doses)	61 (48.8)	64 (51.2)	<0.001
	Irregular/nil	200 (80.0)	47 (20.0)	
Worm infestation symptoms	Present	58 (85.3)	10 (14.7)	0.001
	Absent	203 (66.1)	104 (33.9)	

On binary logistic regression analysis, adjusting for age, socioeconomic status, dietary pattern, and IFA consumption, the following emerged as independent predictors of anaemia (Table 5)

Table 5. Independent predictors of anaemia — multivariate logistic regression

Predictor	Adjusted OR (AOR)	95% CI	p-value
Irregular/nil IFA consumption	3.42	1.96–5.97	<0.001
Low maternal education (illiterate/primary)	2.35	1.31–4.21	0.004
Vegetarian diet	2.10	1.18–3.74	0.01
Heavy/prolonged menstrual flow	1.98	1.05–3.73	0.03
Undernutrition (thin/severely thin)	1.87	1.02–3.42	0.04

Similarly, malnutrition (undernutrition) showed significant associations with lower socioeconomic status (p=0.01), inadequate dietary diversity/skipping meals (p=0.02), and lack of nutrition education at school (p=0.03), though these were somewhat less strongly associated than the predictors of anaemia listed above.

DISCUSSION

Prevalence and Severity of Anaemia

In the present study, nearly seven in ten adolescent girls (69.6%) were found to be anaemic, which is considerably higher than the national estimate. Nationally representative data from NFHS-5 (2019–21) put anaemia prevalence among adolescent girls aged 15–19 years at 59.1 percent, compared to boys at 31.1 percent, and this represented a rise from the NFHS-4 round, with the increase confirmed across multiple independent re-analyses of the same survey data using data from 237,446 adolescents aged 15 to 19 years, prevalence rose from 54% in NFHS-4 to 59.2% in NFHS-5. 5 Our figure is also higher than several other Karnataka-based studies — a Belagavi-based study 6 reported a state-level prevalence of 49.4% among adolescent girls in Karnataka, while a comparative urban-rural study from Davangere 7 found 59.26% of girls to be anaemic Similarly, in rural areas more broadly across India, anaemia has been documented to be somewhat lower in rural areas (57.3%) compared to urban settings (65.3%), with a mean haemoglobin around 10.4 g/dL a pattern consistent with the mean Hb of 10.8 g/dL observed in our study population. 8 The elevated burden seen in our study may reflect a combination of cereal-based diets with poor iron bioavailability, limited dietary diversity, and gaps in supplementation coverage that are common across rural pockets of the state. The severity pattern in our study — mild (35.2%), moderate (29.6%) and severe (4.8%) anaemia — mirrors the distribution reported elsewhere. In the Belgaum study 6 roughly half the anaemic girls had mild disease, about a fifth moderate, and a smaller fraction severe anaemia, and in a school-based Puducherry study 9 mild, moderate and severe anaemia accounted for 27.3%, 32.5% and 2.8% of cases respectively, out of an overall prevalence of 62.7%. The relatively small but persistent proportion of severe anaemia across these studies underscores the continued need for active screening and referral pathways, as adopted in our study protocol.

Nutritional Status and the Double Burden of Malnutrition

Undernutrition (thinness/severe thinness) was present in 24.8% of our participants, with a small but notable proportion (8.3%) overweight or obese, reflecting an emerging double burden of malnutrition even in a rural setting. This undernutrition prevalence is lower than the national figure derived from NFHS-4, where 41.9% of adolescent girls aged 15–19 years were found to be undernourished and 4.2% were overweight or obese , 10 and considerably lower than a re-analysis of NFHS survey rounds, which found thinness in girls estimated at 46.8% in NFHS-3 and 42% in NFHS-4 using adult BMI cut-offs. It is also markedly lower than an urban resettlement-colony study in Delhi, where 33.4% of girls were malnourished by BMI-for-age z-scores, with thinness alone reaching 51.8% when adult BMI cut-offs were applied . 11 Conversely, our figure is higher than a rural Puducherry study 9 , where the prevalence of thinness was only 10.7%, while overweight was 13.5%, and higher than a large Gujarat-based survey 12 where underweight prevalence was 19.6%, with 8.9% overweight and 2.6% obese. Such wide variation across studies reportedly explained partly by the mix of different anthropometric reference standards and cut-off points used across studies makes cross-study comparison difficult. Notably, a co-existing pattern of undernutrition and anaemia has been documented elsewhere as well. In a Nagpur (Maharashtra) study, 13 57% of rural adolescent girls were anaemic and 60% were malnourished by BMI, with 84% having a deficiency of at least one micronutrient , a picture broadly consistent with the concurrent nutritional and haematological deficits observed in our study. The persistence of both underweight and, increasingly, overweight/obesity in rural India has also been highlighted as an emerging "double burden of malnutrition," a phenomenon our data appear to replicate on a smaller scale.

Association Between Nutritional Status and Anaemia

In our study, undernourished girls had significantly higher odds of anaemia than those with normal or high BMI (unadjusted OR 2.81, 95% CI 1.53–5.16), a relationship that remained significant after adjustment (AOR 1.87). This concurrence of undernutrition and anaemia is consistent with the Nagpur study 13 noted above, where high rates of malnutrition and micronutrient deficiency, particularly iron and vitamin B12, coexisted in the same population with iron deficiency observed in 45.5% and vitamin B12 deficiency in 67.5% of anaemic girls, compared to lower rates among non-anaemic girls. Chronic undernutrition likely potentiates anaemia through reduced dietary intake of iron and other haematinics, poor absorption due to recurrent infections, and shared upstream determinants such as poverty and food insecurity mechanisms that plausibly underlie the association we observed as well.

Socio-demographic, Dietary and Menstrual Determinants

Consistent with the broader literature, anaemia in our study was significantly associated with lower socioeconomic status and lower maternal education. This mirrors findings from a rural Haryana cohort, 14 where, on multivariable analysis, mother's education was significantly associated with anaemia, showing a protective effect after adjusting for age (adjusted odds ratio 0.46, 95% CI 0.22–0.96). Maternal education is thought to operate through improved health literacy, better careseeking behaviour, and more diverse household diets, all of which may be constrained in less-educated rural households such as those surveyed in our study area.

Dietary pattern also emerged as a significant correlate, with vegetarian girls showing higher odds of anaemia than those consuming a mixed diet. This aligns with evidence from the Nagpur cohort, 13 where daily consumption of non-vegetarian food and green leafy vegetables was reported by only 3% and 3.6% of participants respectively, reflecting the generally low bioavailable-iron content of predominantly cereal-and-pulse-based rural diets. Poor dietary diversity of this kind, likely compounds menstrual iron losses in adolescent girls who have attained menarche. Menstrual factors luke early menarche and heavy/prolonged flow were independently associated with anaemia in our cohort, consistent with the biological expectation that greater cumulative blood loss increases iron demand. Comparable regional data from a rural Belgaum study 15 found that half of the adolescent girls studied had already attained menarche, and anthropometric parameters differed significantly by age group, underlining how the transition through menarche marks a physiologically vulnerable period that overlaps with the peak growth spurt , a convergence that likely explains why menstrual variables remained significant predictors even after adjustment in our regression model.

Iron and Folic Acid Supplementation (IFA/WIFS)

Irregular or absent IFA consumption was the strongest independent predictor of anaemia in our study (AOR 3.42), a finding well supported by the wider literature on the Weekly Iron and Folic Acid Supplementation (WIFS) programme. Compliance with WIFS has repeatedly been reported as suboptimal in rural Karnataka itself, with one study from the Davangere field-practice area 16 finding an average compliance rate of only 58.4%, with nausea, constipation and stomach pain being the most commonly reported side effects. Elsewhere, the gap between programme supply and actual consumption has been even starker: an ICMR task-force study in Tamil Nadu found that while the IFA provision rate was 72%, the actual consumption rate was only 15% 17 , pointing to major implementation gaps beyond simple availability. Conversely, where compliance has been actively supported, the benefits are tangible — a school-based WIFS programme in Davangere 16 saw reduced anaemia prevalence from 38% to 26% over the course of supplementation, alongside a 0.37 g/dL rise in mean haemoglobin. Similarly, in urban Puducherry schools, 18 67.7% of adolescents were compliant with WIFS, and non-compliance was linked with a significantly higher likelihood of anaemia among late adolescents. Taken together with our own finding of a near four-fold increase in anaemia odds among girls with irregular/nil IFA intake, this body of evidence strongly suggests that strengthening supervised, school- and village-level distribution and follow-up of IFA tablets rather than availability alone should be a priority area for local implementation of Anaemia Mukt Bharat and WIFS in our district.

Worm Infestation and Deworming

The significant association we observed between symptoms of worm infestation and anaemia is biologically plausible, given the established contribution of intestinal helminths to chronic blood loss and impaired iron absorption. This reinforces the rationale for integrating biannual deworming, as recommended under national adolescent health programmes, with IFA supplementation drives in this setting, rather than treating the two interventions as separate activities.

Programmatic Implications

Collectively, in our study high anaemia burden is concentrated in girls with poor nutritional status, low maternal education, vegetarian diets, adverse menstrual profiles, and irregular IFA intake which are consistent with a growing body of Indian evidence indicating that anaemia in adolescent girls is a multifactorial problem rooted in overlapping social, dietary, and health-system determinants rather than dietary iron deficiency alone. Given the demonstrated impact of well-supervised WIFS delivery elsewhere in the state where consistent supplementation nearly halved anaemia prevalence over one year, strengthening compliance monitoring, nutrition education, and menstrual hygiene counselling alongside routine deworming appears to be the most actionable lever available to district health planners.

Strengths and Limitations

The strengths of this study include its community-based, multi-stage random sampling design, use of standardised WHO growth references and Hb cut-offs, and simultaneous assessment of nutritional, dietary, menstrual, and supplementation-related determinants in the same cohort, allowing a fairly comprehensive picture of the local burden. Limitations includes the cross-sectional design, which precludes causal inference regarding the direction of association between undernutrition and anaemia; reliance on capillary Hb estimation rather than venous sampling with red-cell indices, which limits differentiation between iron-deficiency and other causes of anaemia (e.g., folate or B12 deficiency, and self-reported dietary, menstrual, and IFA-compliance data, which may be subject to recall and social-desirability bias.

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