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Prevalence of Anaemia among Adolescent Girls and its Correlation with Body Mass Index, Urogenital Symptoms, and Chronic Pelvic Pain: A Cross-sectional Study in a Tertiary Care Hospital in North India

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Abstract

Background: Anaemia remains a major public health concern among adolescent girls in India, with implications for growth, cognition, and future reproductive health. The present study aimed to determine the prevalence of anaemia and to evaluate its association with body mass index, urogenital symptoms, and chronic pelvic pain among adolescent girls.

Material and Methods: This cross-sectional study was conducted among 400 adolescent girls aged 12–18 years attending a tertiary care hospital in North India. Anthropometric measurements were recorded and body mass index was calculated. Haemoglobin levels were estimated using an automated analyser. Associations were analysed using the Chi-square test, and multivariable logistic regression analysis was performed to identify factors independently associated with anaemia.

Results: The prevalence of anaemia was 62.0% (248/400). Moderate anaemia was the most common form (48.0%), followed by mild (11.5%) and severe (2.5%). On multivariable analysis, underweight participants had higher odds of anaemia, whereas chronic pelvic pain and vaginal discharge were associated with lower odds.

Conclusion: Anaemia is highly prevalent among adolescent girls, with undernutrition emerging as an important associated factor. These findings highlight the need for targeted nutritional interventions and integrated health programmes.

Keywords: Body mass index, Chronic pelvic pain, Nutritional status, Urogenital symptoms, Vaginal discharge.

Introduction

Anaemia remains a significant public health problem among adolescents, particularly in low- and middle-income countries such as India. Adolescents constitute a substantial proportion of the population in India, representing a large and vulnerable demographic group. Adolescent girls are especially susceptible to anaemia due to increased iron requirements associated with rapid growth, onset of menarche, and suboptimal dietary intake. Recent national data indicate that more than half of adolescent girls in India are anaemic, reflecting a persistent and substantial disease burden despite ongoing nutritional interventions [1]. Globally, anaemia continues to affect a large proportion of the adolescent population, with important implications for individual and public health [2].

Anaemia during adolescence is associated with impaired physical growth, reduced cognitive performance, decreased work capacity, and compromised immune function [2, 3]. Furthermore, it

has long-term consequences for reproductive health, including increased risk of adverse maternal and neonatal outcomes in later life. Given these wide-ranging effects, early identification and management of anaemia in this population is of critical importance.

Nutritional status, as assessed by body mass index (BMI), plays a key role in determining haemoglobin levels. While undernutrition has traditionally been linked to anaemia, emerging evidence suggests that overweight and obesity may also contribute through mechanisms involving chronic low-grade inflammation and altered iron metabolism [4, 5]. However, data exploring the association between BMI and haematological parameters among adolescent girls in India remain limited and inconclusive.

In addition to nutritional factors, urogenital and gynaecological conditions may influence haemoglobin status. Urogenital symptoms such as dysuria, frequency of micturition, burning micturition, perineal itching, and vaginal discharge are frequently reported in adolescent girls and may indicate underlying infections or poor hygiene practices [6]. Chronic pelvic pain is another under-recognised condition in this age group and may be associated with chronic inflammatory or infective aetiologies [7]. These conditions may contribute to anaemia through mechanisms such as chronic inflammation, recurrent infections, or menstrual abnormalities.

Despite the recognised burden of anaemia and its multifactorial determinants, there is a paucity of studies examining the combined relationship between nutritional status, urogenital symptoms, and chronic pelvic pain among adolescent girls in the Indian setting. A better understanding of these associations is essential for developing comprehensive and targeted adolescent health strategies.

The present study was therefore undertaken to determine the prevalence of anaemia among adolescent girls attending a tertiary care hospital in North India and to evaluate its association with BMI, urogenital symptoms, and chronic pelvic pain.

Materials Abd Methods

Study design and setting: This cross-sectional study was conducted in the outpatient department of a tertiary care hospital in North India from August 2025 to March 2026. The study was approved by the Institutional Ethics Committee (Reference No. IEC/MLNMC/2025/No. OP-05).

Objectives: The primary objectives were to determine the prevalence of anaemia and to evaluate its association with BMI, urogenital symptoms, and chronic pelvic pain. The secondary objectives were to identify etiological factors associated with chronic pelvic pain and to determine factors independently associated with anaemia among adolescent girls.

Inclusion criteria: Adolescent girls aged 12–18 years attending the outpatient department during the study period and providing informed consent (or assent with parental/guardian consent, as applicable) were included.

Exclusion criteria: Participants with known haemoglobinopathies (such as thalassaemia and sickle cell disease) or chronic systemic illnesses (including chronic renal disease, hepatic disease, or autoimmune disorders) were excluded. Participants with a history of blood transfusion within the preceding three months or those receiving iron supplementation for more than three months prior to recruitment were also excluded. Participants who did not provide consent or whose parents/guardians did not consent were excluded.

Sample size: The sample size was calculated using the formula for estimating a single proportion ($n = Z^2pq/d^2$). Assuming a prevalence of anaemia of 54.0% among adolescent girls based on National Family Health Survey-5 (NFHS-5) data [2], with a 95.0% confidence interval (CI) and an absolute precision of 5.0%, the minimum required sample size was estimated to be 382. Considering potential non-response and incomplete data, a total of 400 participants were included.

Data collection and variables: Written informed consent was obtained from participants aged 18 years, and assent along with parental/guardian consent was obtained for those below 18 years. Participants were enrolled using a consecutive sampling technique, whereby all eligible individuals presenting during the study period were recruited until the desired sample size was achieved.

Data were collected using a predesigned and pretested structured proforma. Information regarding demographic characteristics, menstrual history, and dietary habits was recorded. Urogenital symptoms (dysuria, frequency of micturition, burning

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micturition, perineal itching, and vaginal discharge) were assessed based on self-reported history at enrolment. Chronic pelvic pain defined as non-cyclic pelvic pain persisting for six months or more, was assessed. Pelvic ultrasonography was performed in participants with such symptom to evaluate possible etiological factors.

For anthropometric assessment, height was measured using a stadiometer and weight was recorded using a digital weighing machine. BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m^2). Participants were categorised according to the Asia-Pacific BMI classification as underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23–24.9 kg/m^2), obese class I (25–29.9 kg/m^2), and obese class II (≥30 kg/m^2).

Venous blood samples were collected under aseptic conditions in ethylenediaminetetraacetic acid anticoagulant tubes and analysed using an automated haematology analyser (MEDONIC M32) following standard laboratory protocols. Anaemia was defined according to World Health Organization criteria as haemoglobin <12 g/dL in adolescent girls and classified as mild (11.0–11.9 g/dL), moderate (8.0–10.9 g/dL), and severe (<8.0 g/dL).

Statistical analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 25. Continuous variables were expressed as mean ± standard deviation (S.D.) and categorical variables as frequencies and percentages. The prevalence of anaemia was calculated with 95% CI. Associations between categorical variables were analysed using the Chi-square test. Differences in continuous variables between groups were assessed using Student's t-test.

Univariable analysis was performed initially. Variables with a p-value<0.20 in univariable analysis were included in the multivariable logistic regression model. BMI was analysed as a binary variable (underweight versus non-underweight) in the regression model. Adjusted odds ratios (aOR) with 95% CI were reported. A two-sided p-value<0.05 was considered statistically significant.

Artificial intelligence (AI) tools were used solely for language editing and improvement of manuscript clarity. No AI tools were used for data analysis, data interpretation, or generation of results. The authors take full responsibility for the accuracy and integrity of the content.

Results

A total of 400 participants were included in this study.

Baseline characteristics: The mean age was 15.30 ± 1.96 years, and the mean haemoglobin level was 10.90 ± 1.62 g/dL. With respect to nutritional status, 186 (46.5%) participants had normal BMI, while 104 (26.0%) were underweight. Overweight, obesity class I and obesity class II were observed in 61 (15.3%), 19 (4.8%) and 30 (7.5%) participants, respectively (Table 1).

Among clinical variables, 214 (53.5%) reported perineal itching, 138 (34.5%) had chronic pelvic pain, and 120 (30.0%) had vaginal discharge. Burning micturition, frequency of micturition and dysuria were reported by 115 (28.8%), 91 (22.8%) and 85 (21.3%) participants, respectively (Table 1).

Prevalence of anaemia: The overall prevalence of anaemia was 248 (62.0%), while 152 (38.0%) participants were non-anaemic. Among those with anaemia, moderate anaemia (192, 48.0%) was the most common, followed by mild (46, 11.5%) and severe anaemia (10, 2.5%), illustrated in Figure 1.

Association of anaemia with clinical variables: A statistically significant association was observed between BMI and anaemia (p-value<0.001). The proportion of anaemia was highest among underweight participants (75, 72.1%), followed by overweight (40, 65.6%) and normal BMI (107, 57.5%) categories.

Vaginal discharge was inversely associated with anaemia (p-value=0.020), with a lower proportion of anaemia among those reporting vaginal discharge (64, 53.3%) compared to those without vaginal discharge (184, 65.7%).

Chronic pelvic pain was inversely associated with anaemia (p-value=0.013), with a lower prevalence among those reporting pain (68, 49.3%) compared to those without (180, 68.7%). Among participants with chronic pelvic pain, ultrasonographic findings were available for a subset; most scans were normal, while polycystic ovarian morphology and haemorrhagic ovarian cysts were observed in a small proportion.

No statistically significant associations were observed with dysuria (p-value=0.170), perineal itching (p-

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value=0.054), frequency of micturition (p-value=0.910) and burning micturition (p-value=0.950) (Table 2).

Multivariable logistic regression analysis: On multivariable logistic regression analysis, underweight participants had significantly higher odds of anaemia compared to non-underweight participants (aOR: 2.18; 95% CI: 1.45–3.26; p-value<0.001). Chronic pelvic pain (aOR: 0.58; 95% CI: 0.40–0.83; p-value=0.004) and vaginal discharge (aOR: 0.72; 95% CI: 0.52–0.99; p-value=0.043) were associated with lower odds (Table 3).

Discussion

The present study demonstrates a high burden of anaemia among adolescent girls, with nearly two-thirds of participants affected. Undernutrition, as reflected by low BMI, emerged as a significant factor associated with anaemia. In the study by Aghadiati F et al (2025) [8], the overall anemia prevalence was 40%. Anemia prevalence varied significantly across categories: underweight (75.0%) showed the highest rate, followed by normal (33.3%), and overweight (25.0%). Statistical analysis revealed a significant association between BMI-for-age and anemia (p = 0.041). On the contrary, in the study by Alomari DZ et al (2026) [9], distribution of anemia across BMI categories revealed that 60.7% of anemic girls had a normal BMI, 22.3% were overweight, 14.2% obese, and only 1.4% severely thin. No significant association was found between BMI categories and anemia ($p = 0.796$). The study underscores that the anemia–BMI relationship is not universal but rather shaped by the broader nutritional transition and socioeconomic context. These findings highlight the multifactorial nature of anaemia among adolescents, involving both nutritional and clinical determinants.

The high prevalence of anaemia observed in this study is consistent with national estimates from NFHS-5 and recent Indian studies, which continue to report a substantial burden among adolescent girls despite ongoing public health efforts [1, 10]. The significant association between underweight status and anaemia is in agreement with previous research highlighting the role of inadequate dietary intake and poor iron stores in adolescents [11]. These findings are also supported by national-level data demonstrating a coexistence of undernutrition and anaemia [1]. This finding reinforces the importance of nutritional status as a key determinant of haemoglobin levels in this age group.

In contrast, higher BMI categories were not associated with increased odds of anaemia in this study. While previous evidence suggests that overweight and obesity may influence iron metabolism through inflammatory pathways [5], the present findings did not demonstrate a significant association. This may be related to differences in dietary patterns, socioeconomic factors, or the relatively smaller number of participants in higher BMI categories.

Chronic pelvic pain and vaginal discharge showed inverse associations on multivariable analysis.This should be interpreted with caution. These findings may reflect residual confounding, differences in healthcare-seeking behaviour, or earlier clinical attention among symptomatic individuals rather than a true protective relationship. Adolescents with chronic symptoms may have increased contact with healthcare services, leading to earlier detection and management of anaemia. Previous studies have reported inconsistent associations between reproductive health symptoms and anaemia, suggesting that contextual and behavioural factors may influence these relationships [12,13]. In the study by Gete DG et al (2024) [14], women with endometriosis had a significantly higher risk of iron deficiency than those without endometriosis after adjusting for sociodemographic, lifestyle, reproductive, and nutrition factors (adjusted odds ratio [aOR] = 1.46; 95% confidence interval [CI] [1.29, 1.66]; $p < .0001$).

In the study by Goldberg HR et al (2024) [15], the prevalence of iron deficiency in our endometriosis cohort was 53.4% This study highlights the high prevalence of iron deficiency, which remains undiagnosed in over half of patients with endometriosis presenting to a gynecologist.

In the present study, ultrasonographic evaluation of participants with chronic pelvic pain mostly had normal findings, followed by polycystic ovarian morphology and occasional haemorrhagic ovarian cysts. These findings suggest that identifiable structural abnormalities may not be present in a substantial proportion of adolescents with chronic pelvic pain, consistent with the multifactorial and often functional nature of this condition [7]. However, as imaging was not available for all participants, these observations should be interpreted with caution.

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Perineal itching showed a borderline association with anaemia on univariable analysis; however, this association was not retained after adjustment in the multivariable model, suggesting a possible confounding effect. In the study by Verstraelen H et al (2005) [16] , no statistically significant correlation between vaginal microflora status and routinely assessed iron parameters. The study by Tchernodrinski et al (2025) [17], demonstrates a strong association between anemia and bacterial vaginosis recurrence. No significant associations were observed between anaemia and other urogenital symptoms such as dysuria, frequency of micturition, and burning micturition, indicating that these factors may not have a consistent or independent relationship with haemoglobin status in this population.

The study has important strengths, including a relatively large sample size, systematic data collection using a structured proforma and the use of objective haemoglobin estimation. In addition, the inclusion of both anthropometric and clinical variables in the analysis allowed adjustment for potential confounding factors. However, certain limitations should be acknowledged. The cross-sectional design limits causal inference and the hospital-based setting may introduce selection bias, thereby limiting generalisability to the broader adolescent population. Ultrasonographic evaluation was available for a subset of participants with chronic pelvic pain, providing additional insights into underlying aetiologies, although findings should be interpreted in the context of partial data availability. Furthermore, inclusion of biochemical markers such as serum ferritin and inflammatory markers could further enhance understanding of the underlying aetiology of anaemia

The findings of this study have implications for adolescent health programmes. Screening strategies should prioritise underweight adolescents, who appear to be at higher risk of anaemia. Integration of nutritional assessment into routine adolescent health services may facilitate early detection. The observed associations with certain gynaecological symptoms highlight the need for a more comprehensive approach to adolescent health; although these findings require further validation in community-based and longitudinal studies.

Conclusion

Anaemia continues to be a significant public health concern among adolescent girls, with a high prevalence observed in the present study. Undernutrition, particularly underweight status, was identified as an important determinant of anaemia. The study highlights the importance of routine nutritional assessment and targeted screening in this population. Strengthening adolescent health programmes with an emphasis on nutrition and early detection may help reduce the burden of anaemia.

Tables Abd Figures

Table 1 : Baseline Characteristics Of Study Participants (N=400)

Variable	Category	n (%)
Age (years)		15.30 ± 1.96*
Haemoglobin (g/dL)		10.90 ± 1.62*
BMI† (kg/m²)	Underweight	104 (26.0)
	Normal	186 (46.5)
	Overweight	61 (15.3)
	Obese class I	19 (4.8)
	Obese class II	30 (7.5)
Perineal itching	Present	214 (53.5)
Chronic pelvic pain	Present	138 (34.5)

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Vaginal discharge	Present	120 (30.0)
Burning micturition	Present	115 (28.8)
Frequency of micturition	Present	91 (22.8)
Dysuria	Present	85 (21.3)

†BMI: body mass index

*Values are expressed as mean ± standard deviation (S.D.)

Table 2 : Association of anaemia with clinical variables (n=400)

Variable	Category	Anaemic n (%)	Non-anaemic n (%)	p-value
BMI†	Underweight	75 (72.1)	29 (27.9)	<0.001*
	Normal	107 (57.5)	79 (42.5)	
	Overweight	40 (65.6)	21 (34.4)	
	Obese Class I	10 (52.6)	9 (47.4)	
	Obese Class II	16 (53.3)	14 (46.7)	
Vaginal discharge	Present	64 (53.3)	56 (46.7)	0.020*
	Absent	184 (65.7)	96 (34.3)	
Dysuria	Present	57 (67.1)	28 (32.9)	0.170
	Absent	191 (60.6)	124 (39.4)	
Perineal itching	Present	142 (66.4)	72 (33.6)	0.054
	Absent	106 (57.0)	80 (43.0)	
Frequency of micturition	Present	59 (64.8)	32 (35.2)	0.910
	Absent	189 (61.2)	120 (38.8)	
Burning micturition	Present	71 (61.7)	44 (38.3)	0.950
	Absent	177 (62.1)	108 (37.9)	
Chronic pelvic pain	Present	68 (49.3)	70 (50.7)	0.013*
	Absent	180 (68.7)	82 (31.3)	

†BMI: Body mass index

*Chi-square test applied. p-value<0.05 considered statistically significant. Values are expressed as n (%).

Table 3 : Multivariable logistic regression analysis of factors independently associated with anaemia

Variable	Category	aOR (95% CI)†	p-value
Body mass index	Underweight (vs non-underweight)	2.18 (1.45–3.26)	<0.001*
Vaginal discharge	Present vs absent	0.72 (0.52–0.99)	0.043*
Chronic pelvic pain	Present vs absent	0.58 (0.40–0.83)	0.004*

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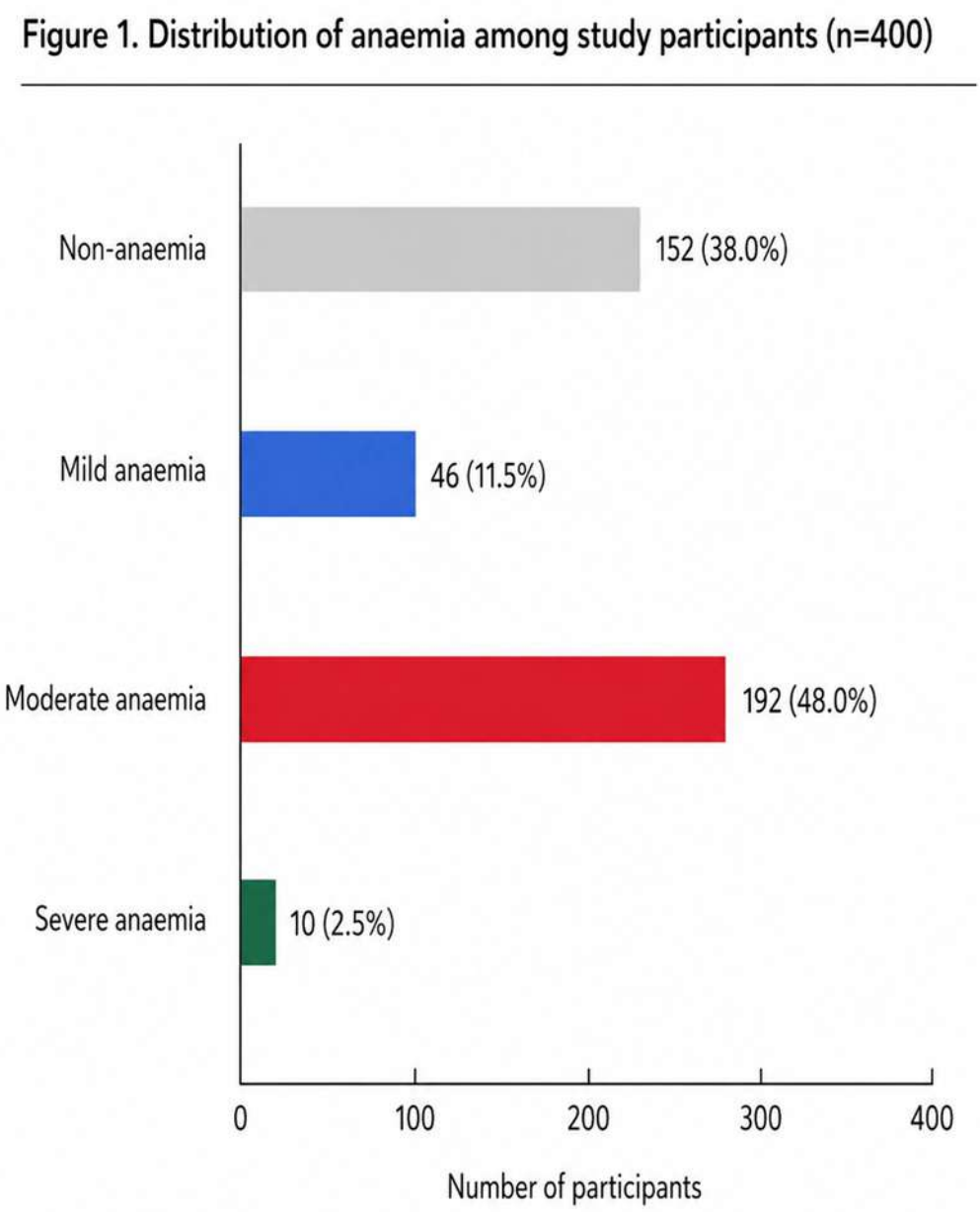
†aOR: adjusted odds ratios; CI: confidence interval.

*p-value<0.05 considered statistically significant

Figure 1 : Distribution of anaemia among study participants (n=400)



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