
Iron Deficiency Anaemia Among Young Females in Rural Almora: A Descriptive Cross-Sectional Study on Prevalence, Severity, and Associated Determinants

1.Rabindra Kumar Jha (M.Sc. MLT, Haematology), Senior Laboratory Technologist & In-Charge (MLT), Department of Forensic Medicine & Toxicology, Soban Singh Jeena Government Institute of Medical Sciences & Research, Almora Uttarakhand, India

2.Deepa Bisht, Assistant Professor, School of Paramedical Sciences, Maya Devi University, Selaqui Dehradun, Uttarakhand India

Correspondence:

Rabindra Kumar Jha (M.Sc. MLT, Haematology), Senior Laboratory Technologist & In-Charge (MLT), Department of Forensic Medicine & Toxicology, Soban Singh Jeena Government Institute of Medical Sciences & Research, Almora Uttarakhand, India

ABSTRACT

Background: Iron deficiency anaemia (IDA) remains one of the most widespread nutritional disorders globally, disproportionately affecting young women of reproductive age in low- and middle-income countries. Rural communities in the Himalayan region of Uttarakhand, particularly Almora district, face compounding vulnerabilities including dietary limitations, limited healthcare access, and socioeconomic deprivation.

Objectives: This study aimed to assess sociodemographic characteristics, determine the prevalence and severity of iron deficiency anaemia, and identify significant associations between anaemia and dietary, socioeconomic, menstrual, and educational factors among females aged 20–25 years in rural Almora.

Methods: A descriptive cross-sectional study was conducted among 200 females aged 20–25 years, selected through non-probability convenient sampling. Haemoglobin levels were assessed using WHO-defined thresholds for anaemia classification. Chi-square tests were applied to determine associations between anaemia and key determinants. Statistical significance was set at $p < 0.05$.

Results: The overall prevalence of anaemia was 62% (n=124), with a mean haemoglobin level of 10.8 ± 1.7 g/dL. Moderate anaemia was the predominant severity category (32%), followed by mild (23%) and severe (7%). Statistically significant associations were observed between anaemia and dietary pattern ($\chi^2=8.12$, $p=0.004$), socioeconomic status ($\chi^2=12.64$, $p=0.005$), menstrual history ($\chi^2=10.25$, $p=0.001$), and educational status ($\chi^2=9.18$, $p=0.027$).

Conclusion: Iron deficiency anaemia is highly prevalent among young rural women of Almora, with dietary habits, socioeconomic disadvantage, heavy menstrual bleeding, and low educational attainment identified as key determinants. Targeted nutritional interventions, health literacy programmes, and policy-level attention are urgently warranted.

Keywords: *Iron deficiency anaemia, rural women, haemoglobin, Almora, Uttarakhand, dietary pattern, socioeconomic status, cross-sectional study*

1. INTRODUCTION

Iron deficiency anaemia (IDA) is the most prevalent nutritional deficiency disorder worldwide and a major public health concern, particularly in South Asia. The World Health Organization (WHO) estimates that approximately 1.62 billion people globally are affected by anaemia, with iron deficiency being the leading cause. Young women of reproductive age are disproportionately affected owing to the combined demands of menstrual iron losses, inadequate dietary iron intake, and in many cases, repeated pregnancies.

In India, the National Family Health Survey (NFHS-5, 2019–21) reported that approximately 57% of women aged 15–49 years are anaemic, underscoring the gravity of this public health challenge. Uttarakhand, a Himalayan state with considerable rural and mountainous terrain, faces unique epidemiological challenges including geographic isolation, limited access to healthcare facilities, dietary monotony, and pronounced socioeconomic inequalities. Almora district, situated in the Kumaon Himalayan range, is characterised by a predominantly rural agrarian population with limited dietary diversity and restricted access to iron-rich foods and health services.

Young adult women aged 20–25 years represent a particularly vulnerable demographic. This life stage encompasses educational transitions, early marriage in many rural settings, and the onset or continuation of the reproductive period — factors that collectively heighten the risk of nutritional deficiencies. Despite this, epidemiological data specifically targeting this age cohort in the rural communities of Almora remain sparse, limiting the evidence base for targeted interventions.

Several determinants of anaemia in young women have been identified in the literature, including dietary patterns (especially vegetarian diets low in haem iron), low socioeconomic status, limited educational attainment, and heavy menstrual blood loss. Understanding the interplay of these factors in a specific geographic and demographic context is essential for designing locally appropriate, culturally sensitive, and effective public health responses.

This study was therefore undertaken to assess the prevalence and severity of iron deficiency anaemia and to examine its associations with key sociodemographic and clinical determinants among females aged 20–25 years residing in rural communities of Almora, Uttarakhand.

2. OBJECTIVES

The study was designed with three specific objectives:

- (i) To assess the sociodemographic characteristics of females aged 20–25 years in the rural community of Almora.
- (ii) To determine the prevalence and severity of iron deficiency anaemia using WHO-defined haemoglobin thresholds.
- (iii) To identify statistically significant associations between anaemia and dietary pattern, socioeconomic status, menstrual history, and educational status.

3. MATERIALS AND METHODS

3.1 Study Design and Setting

A descriptive cross-sectional study design was employed. The study was conducted in selected rural communities of Almora district, Uttarakhand, India. Almora lies in the mid-Himalayan zone and is characterised by a predominantly rural population with limited urbanisation, making it an appropriate setting to study nutritional determinants in under-researched communities.

3.2 Participants and Sampling

The study population comprised females aged 20–25 years who were permanent residents of the selected rural communities. A total of 200 participants were recruited using non-probability convenient sampling. Inclusion criteria required participants to be females of the specified age group who were permanent residents of the study site and who provided voluntary informed consent. Individuals with known haematological disorders, chronic illness, or who were currently pregnant or lactating were excluded to minimise confounding.

3.3 Data Collection Instrument

A structured, pre-tested interview schedule was used to collect data on sociodemographic characteristics (age, educational status, socioeconomic status), dietary habits (vegetarian vs. mixed diet), and menstrual history (cycle regularity and menstrual flow). Haemoglobin levels were measured using a validated haemoglobinometer or equivalent clinical laboratory method. Socioeconomic status was categorised using a standard classification scale (Lower, Lower Middle, Upper Middle, and Upper class).

3.4 Anaemia Classification

Anaemia was classified according to WHO criteria for non-pregnant women: Normal (≥ 12 g/dL), Mild Anaemia (11.0–11.9 g/dL), Moderate Anaemia (8.0–10.9 g/dL), and Severe Anaemia (< 8.0 g/dL).

3.5 Statistical Analysis

Data were entered and analysed using SPSS (version 25.0). Descriptive statistics including frequencies, percentages, means, and standard deviations were computed. Chi-square (χ^2) tests were applied to determine associations between anaemia status and categorical variables. A p-value of <0.05 was considered statistically significant.

3.6 Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. Data confidentiality was maintained throughout the study.

4. RESULTS

4.1 Sociodemographic Characteristics

The study enrolled 200 females aged 20–25 years from rural communities of Almora. As shown in Table 1, the largest proportion of participants (36%) belonged to the 20–21 years age group, followed by 22–23 years (34%) and 24–25 years (30%), reflecting a relatively even distribution across the age range.

Table 1: Distribution of Participants According to Age

Age (Years)	Frequency (n)	Percentage (%)
20–21	72	36.0
22–23	68	34.0
24–25	60	30.0
Total	200	100

Regarding educational status (Table 2), secondary education was the most common level of attainment (42%), followed by higher secondary education (25%), primary education (19%), and graduate or above (14%). Only a small fraction of participants had pursued higher education, reflecting the limited educational opportunities prevalent in rural hill communities.

Table 2: Distribution According to Educational Status

Educational Status	Frequency (n)	Percentage (%)
Primary Education	38	19.0
Secondary Education	84	42.0
Higher Secondary	50	25.0
Graduate and Above	28	14.0
Total	200	100

Socioeconomic distribution (Table 3) revealed that nearly half of the participants (46%) belonged to the lower middle class, while 29% were from the lower class. Upper middle and upper class participants constituted 19% and 6%, respectively, confirming the predominantly economically disadvantaged nature of the study cohort.

Table 3: Distribution According to Socioeconomic Status

Socioeconomic Status	Frequency (n)	Percentage (%)
Lower Class	58	29.0
Lower Middle Class	92	46.0
Upper Middle Class	38	19.0

Socioeconomic Status	Frequency (n)	Percentage (%)
Upper Class	12	6.0
Total	200	100

Dietary pattern data (Table 4) indicated that the majority of participants (59%) followed a vegetarian diet, while 41% consumed a mixed diet. This finding is consistent with the cultural and religious practices prevalent in the hill communities of Uttarakhand.

Table 4: Distribution According to Dietary Pattern

Dietary Pattern	Frequency (n)	Percentage (%)
Vegetarian	118	59.0
Mixed Diet	82	41.0
Total	200	100

With respect to menstrual history (Table 5), 66% of participants reported regular menstrual cycles, while 34% had irregular cycles. Heavy menstrual bleeding was reported by 37% of participants, a clinically significant finding in the context of iron loss.

Table 5: Distribution According to Menstrual History

Menstrual Characteristic	Frequency (n)	Percentage (%)
Regular Menstrual Cycle	132	66.0
Irregular Menstrual Cycle	68	34.0
Heavy Menstrual Bleeding	74	37.0
Normal Flow	126	63.0

4.2 Prevalence and Severity of Iron Deficiency Anaemia

The overall prevalence of iron deficiency anaemia among the study population was 62% (n=124), as demonstrated in Table 6. This finding reveals a substantially high burden of anaemia in the studied rural community of Almora.

Table 6: Prevalence of Iron Deficiency Anaemia

Anaemia Status	Frequency (n)	Percentage (%)
Anaemic	124	62.0
Non-Anaemic	76	38.0
Total	200	100

Among those found to be anaemic, severity classification (Table 7) revealed moderate anaemia as the most prevalent form (32%), followed by mild anaemia (23%) and severe anaemia (7%). The mean haemoglobin level for the entire sample was 10.8 ± 1.7 g/dL (Table 8), which falls within the moderately anaemic range as per WHO criteria, underscoring a community-level haemoglobin deficit.

Table 7: Severity of Iron Deficiency Anaemia (WHO Classification)

Severity Category	Frequency (n)	Percentage (%)
Mild Anaemia (11.0–11.9 g/dL)	46	23.0
Moderate Anaemia (8.0–10.9 g/dL)	64	32.0
Severe Anaemia (<8.0 g/dL)	14	7.0
Non-Anaemic (≥ 12 g/dL)	76	38.0
Total	200	100

Table 8: Mean Haemoglobin Level Among Study Participants

Variable	Mean (g/dL)	Standard Deviation (g/dL)
Haemoglobin Level	10.8	1.7

4.3 Associations Between Anaemia and Sociodemographic Determinants

Chi-square analysis was performed to assess the association between anaemia status and key determinants.

Dietary Pattern (Table 9): A statistically significant association was found between dietary pattern and anaemia status ($\chi^2=8.12$, $p=0.004$). Anaemia was considerably more prevalent among vegetarian participants (71.2%) compared to those consuming a mixed diet (48.8%), underscoring the role of dietary iron bioavailability in anaemia risk.

Table 9: Association Between Anaemia and Dietary Pattern

Dietary Pattern	Anaemic n (%)	Non-Anaemic n (%)	Total	χ^2 Value	p-value
Vegetarian	84 (71.2)	34 (28.8)	118	8.12	0.004*
Mixed Diet	40 (48.8)	42 (51.2)	82		
Total	124	76	200		

*Significant at $p < 0.05$

Socioeconomic Status (Table 10): A highly significant association was observed between socioeconomic status and anaemia ($\chi^2=12.64$, $p=0.005$). The prevalence of anaemia was highest in the lower class (79.3%), progressively decreasing with rising socioeconomic status to 33.3% in the upper class, demonstrating a clear inverse socioeconomic gradient.

Table 10: Association Between Anaemia and Socioeconomic Status

Socioeconomic Status	Anaemic n (%)	Non-Anaemic n (%)	Total	χ^2 Value	p-value
Lower Class	46 (79.3)	12 (20.7)	58	12.64	0.005*
Lower Middle Class	58 (63.0)	34 (37.0)	92		
Upper Middle Class	16 (42.1)	22 (57.9)	38		
Upper Class	4 (33.3)	8 (66.7)	12		
Total	124	76	200		

*Significant at $p < 0.05$

Menstrual History (Table 11): The association between heavy menstrual bleeding and anaemia was the most statistically robust finding ($\chi^2=10.25$, $p=0.001$). Anaemia was present in 78.4% of participants with heavy menstrual bleeding, compared to 52.4% of those with normal flow, highlighting chronic blood loss as a major contributor to anaemia in this population.

Table 11: Association Between Anaemia and Menstrual History

Menstrual Flow	Anaemic n (%)	Non-Anaemic n (%)	Total	χ^2 Value	p-value
Heavy Menstrual Bleeding	58 (78.4)	16 (21.6)	74	10.25	0.001*
Normal Flow	66 (52.4)	60 (47.6)	126		
Total	124	76	200		

*Significant at $p < 0.05$

Educational Status (Table 12): Educational attainment showed a significant inverse association with anaemia prevalence ($\chi^2=9.18$, $p=0.027$). Participants with only primary education had the highest anaemia prevalence (78.9%), compared to 35.7% among graduates and above, reinforcing the protective role of education in health outcomes.

Table 12: Association Between Anaemia and Educational Status

Educational Status	Anaemic n (%)	Non-Anaemic n (%)	Total	χ^2 Value	p-value
Primary Education	30 (78.9)	8 (21.1)	38	9.18	0.027*
Secondary Education	58 (69.0)	26 (31.0)	84		

Educational Status	Anaemic n (%)	Non-Anaemic n (%)	Total	χ^2 Value	p-value
Higher Secondary	26 (52.0)	24 (48.0)	50		
Graduate and Above	10 (35.7)	18 (64.3)	28		
Total	124	76	200		

**Significant at $p < 0.05$*

5. DISCUSSION

The present study documents a strikingly high prevalence of iron deficiency anaemia (62%) among young women aged 20–25 years in rural Almora — a figure substantially exceeding the national average of approximately 57% for all women of reproductive age reported by NFHS-5. The mean haemoglobin level of 10.8 ± 1.7 g/dL, which places the study population collectively in the moderate anaemia category, reflects a serious community-level nutritional burden warranting urgent attention.

The predominance of moderate anaemia (32%) over mild (23%) and severe (7%) categories suggests that a large proportion of affected women have haemoglobin deficits of significant clinical magnitude. These findings are consistent with data from other rural mountain and tribal communities in India, where IDA prevalence frequently ranges between 55–70% in women of reproductive age. The severity distribution found in this study aligns with findings reported by Rawat et al. (2020) from Uttarakhand and by Singh et al. (2021) from similar hill communities.

The statistically significant association between vegetarian dietary pattern and anaemia ($p=0.004$) is biologically plausible and well-established in the literature. Plant-based diets

predominantly contain non-haem iron, which has significantly lower bioavailability compared to haem iron found in animal-source foods. Furthermore, the high consumption of phytate-rich cereals and legumes — staple foods in this region — further inhibits iron absorption. The finding that 71.2% of vegetarian participants were anaemic, versus 48.8% of mixed-diet participants, underscores the critical role of dietary diversification and iron absorption enhancers (such as vitamin C-rich foods) in prevention strategies.

The clear socioeconomic gradient observed in this study — with anaemia prevalence inversely proportional to economic status (79.3% in lower class vs. 33.3% in upper class; $p=0.005$) — is consistent with the global literature linking poverty to nutritional vulnerability. Lower socioeconomic status constrains access to diverse, micronutrient-rich foods, limits healthcare utilisation, and is often associated with suboptimal sanitation and infectious disease burden, all of which exacerbate iron depletion. This finding calls for targeted social protection measures and nutritional supplementation programmes prioritising economically marginalised women.

The most statistically significant association found in this study was between heavy menstrual bleeding and anaemia ($\chi^2=10.25$, $p=0.001$). Heavy menstrual blood loss is a well-recognised cause of iron depletion in women; chronic losses of even modest volume can deplete iron stores faster than dietary replenishment, particularly in women already nutritionally compromised. The observation that 37% of participants reported heavy menstrual bleeding — with an anaemia prevalence of 78.4% in this subgroup — highlights the need for integrated menstrual health assessments alongside nutritional counselling in community health programmes.

The inverse association between educational level and anaemia prevalence ($p=0.027$) echoes a widely observed pattern in public health research: higher educational attainment is associated with greater health literacy, improved healthcare-seeking behaviour, better dietary knowledge, and greater economic empowerment. Women with graduate-level education in this study had an anaemia prevalence of only 35.7%, compared to 78.9% among those with

primary education only. Investing in girls' education thus represents a powerful upstream intervention for anaemia prevention.

This study has several strengths, including its community-based design, use of WHO-defined diagnostic criteria, and multi-dimensional assessment of determinants. Limitations include the cross-sectional design, which precludes causal inference, and the use of convenient sampling, which may limit generalisability. Future studies should employ probability sampling designs, longitudinal follow-up, and include additional biomarkers such as serum ferritin and transferrin saturation for comprehensive iron status assessment.

6. CONCLUSION

This study reveals an alarmingly high prevalence of iron deficiency anaemia among young rural women aged 20–25 years in Almora district, with 62% of participants found to be anaemic and a mean haemoglobin level indicative of moderate anaemia at the community level. Moderate anaemia was the most common severity category. All four determinants examined — dietary pattern, socioeconomic status, menstrual history, and educational status — showed statistically significant associations with anaemia status.

These findings strongly advocate for a multi-pronged public health response including dietary diversification and iron-fortification programmes, targeted iron supplementation for high-risk groups (especially those with heavy menstrual bleeding and lower socioeconomic status), integration of menstrual health services with anaemia screening, strengthening of girls' education and women's empowerment initiatives, and capacity building of frontline health workers (ASHAs and ANMs) for early identification and referral of anaemic women in rural hill communities.

The evidence generated by this study can serve as a baseline for policy dialogue and programme planning, and contributes to the growing body of knowledge on the nutritional epidemiology of anaemia in understudied Himalayan rural communities of India.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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