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NUTRITIONAL STATUS AND HAEMATOLOGICAL HEALTH: INVESTIGATING THE LINK BETWEEN BMI AND ANAEMIA IN YOUNG NORTH INDIAN WOMEN.

Dr Nida Nowreen[1*], Dr Sheikh Imran Sayeed[2]

[1*]Assistant Professor, Department of Physiology, G.M.C. Srinagar, J&K, India
[2]Professor and Head, Department of Physiology, G.M.C. Srinagar, J&K, India

***Corresponding Author:** Dr Nida Nowreen
*Assistant Professor, Department of Physiology, G.M.C. Srinagar, J&K, India, 190010
Phone no: 9469780011, Email: nowreen.n3@gmail.com,
ORCID ID: https://orcid.org/0009-0000-4230-9493

Abstract

Background: Anaemia and obesity are emerging as dual public health challenges in low and middle-income countries, both contributing significantly to the global burden of disease. Evidence suggests that obesity-induced inflammation may impair iron metabolism, thereby increasing anaemia risk.

Aims and Objectives: To assess the relationship between body mass index (BMI) and anaemia among young women in North India.

Materials and Methods: A cross-sectional study was conducted among 162 female students aged 18–22 years at a tertiary medical college in Srinagar, India. Anthropometric measurements were recorded, BMI was calculated, and haematological parameters like haemoglobin and red blood cell count, were assessed. Statistical analysis was performed using Pearson's correlation.

Results: The prevalence of anaemia was 39.5% (22.8% mild, 15.4% moderate, 1.2% severe). Overweight and obesity were present in 41.3% of participants. Anaemia prevalence increased with BMI**:** 37.7% in normal weight, 42.9% in overweight, and 47.1% in obese participants. Obese women had higher rates of moderate-to-severe anaemia. Mean haemoglobin was lower in overweight/obese participants (11.04 ± 1.07 g/dl) compared to normal-weight (11.47 ± 1.74 g/dl), with a borderline non-significant difference ($p = 0.0599$). Correlations between BMI and haematological parameters were weak negative but statistically not significant.

Conclusion: Anaemia remains highly prevalent among young women in North India, with a trend toward increased prevalence and severity among overweight and obese individuals. These findings highlight the need for routine screening, nutritional counselling, and integrated interventions to address the dual burden of malnutrition which has critical implications for young women.

Keywords: Anaemia, Obesity, Overweight, Body Mass Index, Haematological Parameters, Young Women.

Introduction

Anaemia and obesity are pressing public health challenges, particularly in low and middle-income countries, where rapid lifestyle transitions have led to the coexistence of undernutrition and overnutrition.[1-4] Both conditions are major contributors to the global burden of disease, disproportionately affecting women of reproductive age.[1,3,5]

In South and Southeast Asia, the prevalence of overweight and obesity has risen sharply, from 18.9% in 2006 to 26.6% in 2016.[4] At the same time, anaemia remains a major health concern, with an estimated 571 million women aged 15–49 years affected worldwide in 2019.[1,2] Women are particularly vulnerable due to increased physiological demands, dietary deficiencies, and socio-cultural factors.[6]

Adolescence and early adulthood are critical stages of growth and development, requiring optimal nutritional support. However, young women's diets are increasingly characterised by high consumption of calorie-dense but micronutrient-poor foods, often resulting in obesity alongside micronutrient deficiencies.[7-10] At the molecular level, obesity-associated inflammation increases hepcidin levels, a key regulator of iron metabolism, leading to impaired intestinal absorption and iron sequestration.[11-13,25]

Previous studies on the BMI–anaemia association have produced mixed findings: some link anaemia to undernutrition and low BMI[22,24], while others suggest obesity may increase the risk.[19,20]

This study aimed to assess the relationship between body mass index (BMI) and anaemia among young women in North India, providing insights into the emerging dual burden of malnutrition affecting this vulnerable group.

Materials and Methods

Study design and setting

A cross-sectional study was conducted in the Department of Physiology, Government Medical College (G.M.C.) Srinagar, Jammu & Kashmir, India, from June to August 2025.

Study population

A total of 162 female students aged 18–22 years (medical, dental, paramedical) were included. Written informed consent was obtained from each participant.

Inclusion criteria: Female students willing to participate.

Exclusion criteria: Male students; those on iron supplementation; with chronic illnesses (e.g., tuberculosis); acute infections at the time of study; or recent weight-loss interventions.

Data collection

Standardised methods were used to measure weight (nearest 0.1 kg) and height (nearest 0.5 cm). BMI was calculated as weight (kg)/height (m^2) and classified per WHO[21]: normal weight (18.5–24.9), overweight (25.0–29.9), obese (≥30.0). Haemoglobin was estimated using the digital Haemoglobinometer. RBC count was performed using a hemacytometer. Anaemia was classified as per WHO[1]: mild (11–11.9 g/dl), moderate (8–10.9 g/dl), severe (<8 g/dl).

The study protocol was approved by the Institutional Review Board of G.M.C. Srinagar.

Statistical analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics (version 25.0). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Pearson's correlation coefficient was used to assess the association between BMI and haematological parameters. Independent t-tests were applied to compare mean haemoglobin levels across BMI categories. A p-value <0.05 was considered statistically significant.

Results

A total of 162 young women aged 18–22 years were included in the analysis, with a mean age of 19.17 ± 1.00 years. The mean height and weight of participants were 150.0 ± 4.0 cm and 56.60 ± 9.06 kg, respectively, corresponding to a mean BMI of 24.45 ± 3.59 kg/m^2. The mean haemoglobin concentration was 11.38 ± 1.74 g/dl, with other haematological indices shown in Table 1.

Table 1. General characteristics and haematological parameters of participants (n = 162)

Variable	Mean ± SD
Age (years)	19.17 ± 1.00
Height (cm)	150.0 ± 4.0
Weight (kg)	56.60 ± 9.06
BMI (kg/m²)	24.45 ± 3.59
Haemoglobin (g/dl)	11.38 ± 1.74

BMI: body mass index; RBC: red blood cell.

Prevalence of anaemia

The overall prevalence of anaemia was 39.5%, with 22.8% of participants having mild anaemia, 15.4% moderate anaemia, and 1.2% severe anaemia. The remaining 72.2% of participants were classified as non-anaemic (Table 2).

Table 2. Prevalence and severity of anaemia among participants

Severity of anaemia (Hb, g/dl)	Frequency (%)
Normal (>12.0)	117 (72.2)
Mild (11.0–11.9)	37 (22.8)
Moderate (8.0–10.9)	25 (15.4)
Severe (<8.0)	2 (1.2)

BMI distribution and relationship with anaemia

Overweight and obesity were present in 41.3% of participants (34.4% overweight and 6.0% obese). Anaemia prevalence increased across BMI categories:

- 37.7% in normal-weight participants
- 42.9% in overweight participants
- 47.1% in obese participants

Although the prevalence of anaemia was higher in overweight and obese groups compared with normal-weight individuals, the differences were not statistically significant (Table 3).

Table 3. Distribution of anaemia across BMI categories

BMI category	Anaemic (%)	Non-anaemic (%)	Total (%)
Normal weight	44 (37.7)	73 (74.5)	117 (72.2)
Overweight	12 (42.9)	16 (16.3)	28 (17.3)
Obese	8 (47.1)	9 (9.2)	17 (10.5)
Total	64 (39.5)	98 (60.5)	162 (100)

BMI classification according to WHO (1995).

Mean haemoglobin across BMI categories

The mean haemoglobin concentration was slightly lower in overweight/obese participants (11.04 ± 1.07 g/dl) compared to those with normal BMI (11.47 ± 1.74 g/dl). However, this difference was not statistically significant (p = 0.059) (Table 4).

Table 4. Comparison of mean haemoglobin levels across BMI categories

BMI category	Mean Hb (g/dl) ± SD
Normal weight	11.47 ± 1.74
Overweight/obese	11.04 ± 1.07

Statistical test: p = 0.0599 (two-tailed; not significant).

Correlation analysis

Pearson's correlation showed a weak negative association between BMI and haematological parameters including haemoglobin (r = –0.051), RBC count (r = –0.001). None of these correlations reached statistical significance (p > 0.05) (Table 5).

Table 5. Correlation between BMI and haematological parameters

Parameter	Correlation coefficient (r)	p-value
Haemoglobin (g/dl)	–0.051	0.515
RBC count	–0.001	0.988

p < 0.05 considered statistically significant.

Discussion

Anaemia and obesity are among the most prevalent nutrition-related health challenges worldwide, with both conditions increasingly coexisting as the dual burden of malnutrition. The present study tries to evaluate the relationship between body mass index (BMI) and haematological parameters among young North Indian women—a population particularly vulnerable due to the combined pressures of dietary transitions, academic stress, and evolving lifestyle behaviours.

The prevalence of anaemia in this study was 39.5%, aligning with earlier investigations among Indian medical and paramedical students, which have reported anaemia rates between 35–45%.[16-18]These findings underscore the persistent burden of anaemia even in relatively educated populations with access to healthcare.

Although not statistically significant, our data showed a progressive increase in anaemia prevalence with higher BMI: 37.7% in normal-weight, 42.9% in overweight, and 47.1% in obese participants. Importantly, obese participants also demonstrated a greater proportion of moderate-to-severe anaemia. These trends mirror findings from studies in India[19] and Saudi Arabia[20], which reported a positive association between higher BMI and anaemia risk. The observed trend can be explained by obesity-associated low-grade chronic inflammation, which increases the expression of hepcidin, a key regulator of iron metabolism. Elevated hepcidin reduces intestinal iron absorption and promotes sequestration of iron in macrophages, lowering circulating iron levels[11,12,25]. Furthermore, diets typical of overweight/obese individuals—rich in energy but poor in micronutrients—may exacerbate deficiencies.[8,23,26]

Our correlation analysis found a weak, non-significant negative relationship between BMI and haematological parameters, which agrees with some prior studies but contrasts with others that associate anaemia more strongly with undernutrition and low BMI.[22,24] These discrepancies highlight the multifactorial nature of anaemia, influenced by dietary intake, menstrual health, genetics, infections, and socioeconomic status in addition to BMI.

In addition, dietary patterns typical of overweight and obese populations—characterised by high intakes of energy-dense but micronutrient-poor foods—further exacerbate iron deficiency risk.[8,23,27]

Some studies, however, have associated anaemia more strongly with undernutrition and low BMI.[22,24]This inconsistency may reflect population differences, dietary habits, menstrual health, or methodological variations across studies. It highlights the multifactorial nature of anaemia, influenced by genetic predisposition, infections, socioeconomic determinants, and dietary diversity in addition to BMI[7,27]

The coexistence of obesity and anaemia has critical implications for young women. Anaemia impairs cognition, immunity, and reproductive health[14,15], while obesity predisposes to long-term metabolic and cardiovascular diseases.[4,5] Together, they create compounded risks that require integrated interventions, including routine haematological screening, targeted nutritional counselling, and lifestyle modification programs.

This study had certain limitations that should be acknowledged. First, a detailed nutritional assessment was not conducted. Secondly, the sample size was relatively small and restricted to medical and paramedical students from a single institution, which may limit the generalizability of findings. Finally, the cross-sectional design precludes establishing causality, and a lack of follow-up prevents assessment of longitudinal changes in nutritional and haematological status. Future research with larger, more diverse populations and inclusion of biochemical markers is warranted to build on these findings.

Conclusion

The present study demonstrated a high prevalence of anaemia (39.5%) among young North Indian women and suggested a trend toward higher anaemia prevalence among overweight and obese participants compared to those with normal BMI. Although the association between BMI and haematological parameters was weak and not statistically significant, the findings align with emerging evidence that obesity may contribute to iron deficiency through inflammation-mediated mechanisms.[13,25]

Given the challenge posed by obesity and anaemia, routine haematological screening, dietary counselling, and lifestyle interventions are essential for this vulnerable group. Integrating obesity management strategies with micronutrient deficiency prevention could improve both immediate wellbeing and long-term health outcomes.

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