



ORIGINAL ARTICLE

Prevalence and Determinants of Anaemia in Undergraduate Medical Students: Cross-Sectional Study

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Abstract

Background: Anemia is a common public health issue, especially among young people, including medical students, who may disregard their health because of irregular food intake and academic stress. To encourage early intervention and preventative measures, it is crucial to determine the prevalence of anemia in this group and the risk factors that are linked to it.

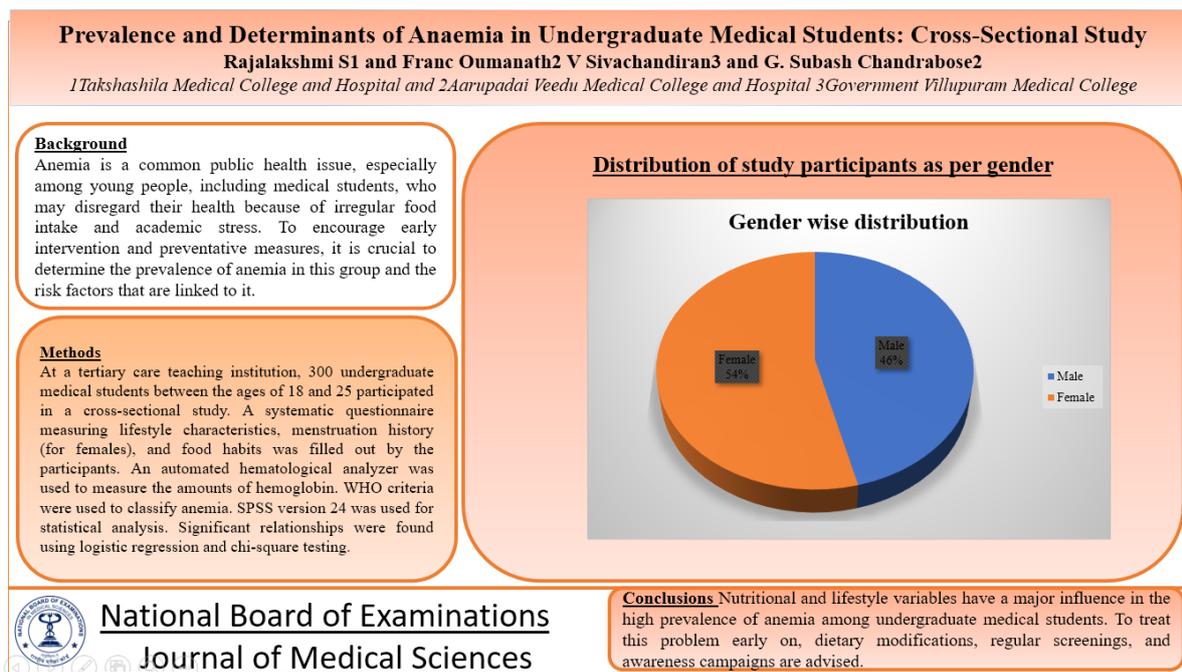
Materials and Methods: At a tertiary care teaching institution, 300 undergraduate medical students between the ages of 18 and 25 participated in a cross-sectional study. A systematic questionnaire measuring lifestyle characteristics, menstruation history (for females), and food habits was filled out by the participants. An automated hematological analyzer was used to measure the amounts of hemoglobin. WHO criteria were used to classify anemia. SPSS version 24 was used for statistical analysis. Significant relationships were found using logistic regression and chi-square testing. **Results:** Out of 300 undergraduate medical students, 43.3% were found to be anemic. Mild anemia was most prevalent (62.31%), followed by moderate (26.15%) and severe anemia (11.54%). Anemia showed a significant association with inadequate iron intake, irregular meal patterns, and heavy menstrual bleeding. High academic stress demonstrated a borderline association with anemia status.

Conclusion: Nutritional and lifestyle variables have a major influence in the high prevalence of anemia among undergraduate medical students. To treat this problem early on, dietary modifications, regular screenings, and awareness campaigns are advised.

Keywords: Iron deficiency, prevalence, anemia, medical students, risk factors, cross-sectional study

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Graphical Abstract



Introduction

The World Health Organization (WHO) defines anemia as a hemoglobin concentration of less than 13 g/dL in males and less than 12 g/dL in non-pregnant women. Anemia is still a major worldwide public health concern that mostly affects young people in low- and middle-income nations [1]. Menstrual blood loss, persistent infections, and dietary deficits are frequent causes of this multifactorial illness in teens and young adults [2]. Academic stress, irregular eating habits, and sedentary lifestyles may all increase the incidence of anemia in medical students [3].

Nearly half of all instances of anemia globally are iron deficiency anemia, which is the most common type [4]. Studies have shown that even those with access to healthcare and education, such as medical students, are not exempt from the burden of anemia, despite the fact that it is frequently linked to disadvantaged

groups [5,6]. Students' dietary intake and general health may be jeopardized by the demanding requirements of medical school, which include excessive study sessions and inadequate sleep hygiene [7].

According to earlier studies, the prevalence of anemia among medical students varies from 20% to 60%, with female students experiencing a much greater incidence because of iron loss associated with menstruation [8,9]. Medical students are a vulnerable but neglected population because they may disregard their own health despite their understanding of disease pathophysiology and prevention (10). To provide focused treatments and encourage health-conscious behavior among aspiring healthcare professionals, it is crucial to determine the prevalence and related risk factors in this age group.

The purpose of this study is to determine the incidence of anemia among medical students enrolled in undergraduate

programs and to examine risk factors for the condition, such as food habits, lifestyle choices, and female menstruation history.

Materials & Methods

At a tertiary medical college and hospital in Puducherry, India, three-month cross-sectional observational research was carried out. The study's objectives were to determine the prevalence of anemia and evaluate risk factors related to it in medical undergraduates.

Examine the Population and Sampling Undergraduate medical students enrolled in MBBS programs (first to final year) between the ages of 18 and 25 were deemed qualified for inclusion. Students who had recently received blood transfusions, had chronic diseases, had known hematological problems, or were using iron supplements were not allowed to participate. Stratified random selection was used to determine a sample size of 300

participants, guaranteeing proportionate representation from each academic year. All participants provided written, informed consent.

A standardized, pre-validated questionnaire covering sociodemographic information, eating habits, menstruation history (for women), academic stress, physical activity, and sleep patterns was given to the participants. To determine BMI, anthropometric measures (weight and height) were noted.

An automated hematological analyzer was used to determine the hemoglobin content of venous blood samples (2–3 mL) that were obtained under aseptic conditions. According to WHO recommendations, anemia was characterized and categorized as mild (11.0–12.9 g/dL for males & 11.0–11.9 g/dL for females), moderate (8.0–10.9 g/dL), and severe (<8.0 g/dL).

Results:

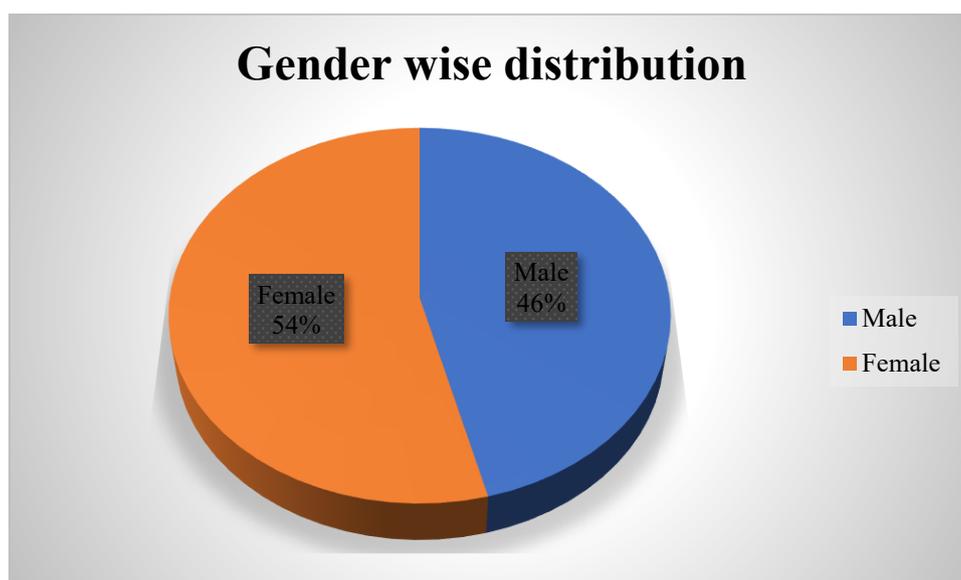


Figure 1. Distribution of study participants as per gender

Figure 1 depicts the gender-wise distribution of the study participants. The figure demonstrates that both male and female students were adequately represented in the study, ensuring a balanced sample for assessing anemia prevalence and its associated factors. The inclusion of participants from both genders strengthens the external validity of the study findings and allows for meaningful interpretation of gender-related physiological and behavioral determinants of anemia.

The observed gender distribution is particularly relevant in anemia research, as biological factors such as menstruation, hormonal differences, and varying nutritional requirements can influence hemoglobin levels. A substantial

representation of female participants is crucial, given that adolescent and young adult females are traditionally considered a high-risk group for anemia due to menstrual blood loss and increased iron requirements. At the same time, the inclusion of male participants allows for the identification of lifestyle and dietary factors contributing to anemia beyond gender-specific physiological causes.

Overall, Figure 1 confirms that the study population was sufficiently diverse in terms of gender, thereby enabling a comprehensive assessment of anemia and reducing the risk of gender-related sampling bias. This distribution provides a strong foundation for interpreting the subsequent findings related to anemia severity and associated risk factors.

Table 1. Distribution of Anemia Severity among Anemic Students

Severity of Anemia	Number of Students	Percentage (%)
Mild	81	62.31
Moderate	34	26.15
Severe	15	11.54
Total	130	100.00

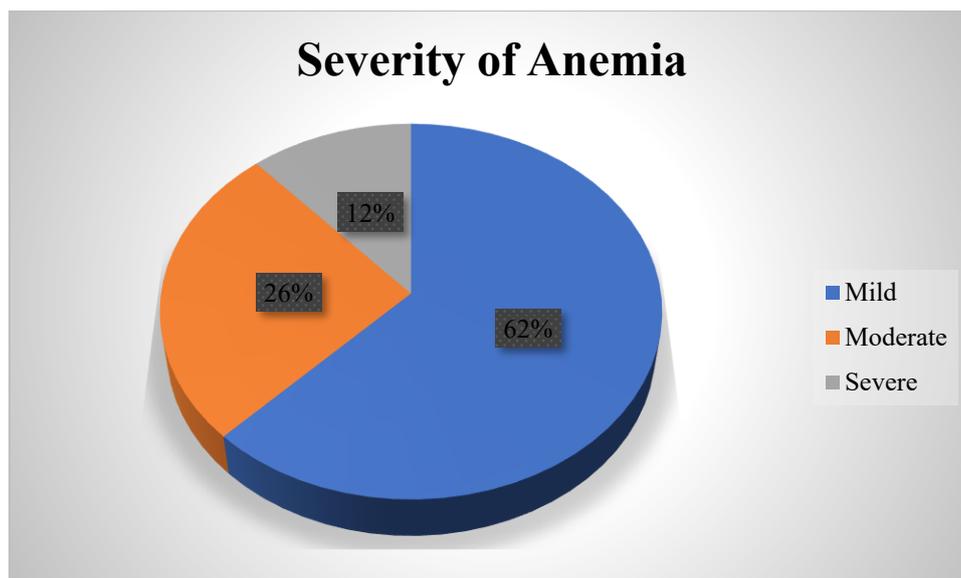


Figure 2. Distribution of Anemia Severity among Anemic Students.

Table 1 illustrates the distribution of anemia severity among the anemic students ($n = 130$). The results indicate that **mild anemia** was the most common form, affecting **62.31%** of the anemic participants. This was followed by **moderate anemia** in **26.15%** and **severe anemia** in **11.54%** of students.

The predominance of mild anemia suggests that a majority of affected students are in the early stage of the condition, where clinical manifestations may be subtle or nonspecific. Although mild anemia may not present with overt symptoms, it can still negatively impact concentration, academic performance, and physical stamina. Importantly, this stage represents a critical window for preventive intervention, as appropriate dietary modification, iron supplementation, and health education can effectively reverse the condition and prevent progression.

However, the presence of moderate and severe anemia in nearly **38%** of

anemic students is a cause for concern. Moderate anemia is often associated with fatigue, reduced cognitive efficiency, and decreased immunity, which can adversely affect students' academic and daily functioning. Severe anemia, though less prevalent, represents a serious health condition that may require immediate medical evaluation and intervention. Students with severe anemia are at increased risk of cardiovascular strain, frequent infections, and poor quality of life.

The distribution pattern observed in Table 1 underscores that anemia among students is not merely a mild nutritional issue but includes clinically significant forms that can have long-term consequences if left unaddressed. These findings highlight the need for routine screening programs in educational institutions and reinforce the importance of early detection to prevent progression to more severe stages.

Table 2. Association between Selected Determinant Factors and Anemia Status (n=300)

Risk Factor	Anemic		Non-Anemic		p-value
Inadequate Iron Intake	53	44.17	43	25.29	0.034
Irregular Meal Pattern	86	71.67	62	36.47	0.001
Heavy Menstrual Bleeding	51	42.50	23	13.53	0.009
High Academic Stress	73	60.83	51	30.00	0.054

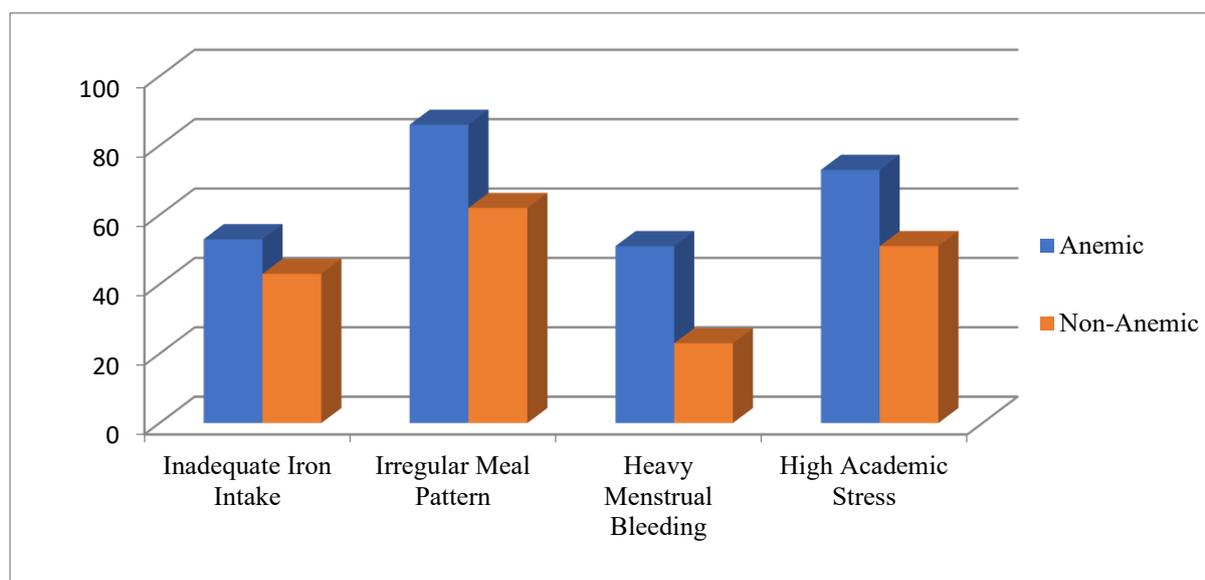


Figure 3. Association between Selected Determinant Factors and Anemia Status (n=300)

Table 2 illustrates the association between selected determinant factors and anemia status among the study participants (n = 300), comparing anemic and non-anemic students.

Inadequate Iron Intake

Inadequate iron intake was reported by **44.17%** of anemic students compared to **25.29%** of non-anemic students, with a statistically significant association ($p = 0.034$). This finding confirms the pivotal role of dietary iron deficiency in the development of anemia. Students consuming diets low in iron-rich foods, such as green leafy vegetables, legumes,

and animal sources, are more likely to develop anemia. The significant association emphasizes the need for nutritional awareness and dietary interventions tailored to student populations.

Irregular Meal Pattern

Irregular meal patterns were observed in **71.67%** of anemic students, significantly higher than **36.47%** among non-anemic students, with a highly significant p -value of **0.001**. This strong association suggests that inconsistent eating habits contribute substantially to anemia. Skipping meals or eating at

irregular intervals may lead to inadequate overall nutrient intake and poor iron absorption. Academic workload, time constraints, and stress may further exacerbate unhealthy eating behaviors among students.

Heavy Menstrual Bleeding

Heavy menstrual bleeding was reported by **42.50%** of anemic students compared to **13.53%** of non-anemic students, showing a statistically significant association ($p = 0.009$). This finding highlights excessive menstrual blood loss as an important physiological determinant of anemia, particularly among female students. Without adequate iron replenishment, recurrent menstrual blood loss can rapidly deplete iron stores, leading to anemia. This underscores the importance of menstrual health assessment and counseling as part of anemia prevention strategies.

High Academic Stress

High academic stress was reported by **60.83%** of anemic students and **30.00%** of non-anemic students, with a borderline statistical association ($p = 0.054$). Although this association did not reach conventional levels of statistical significance, the observed trend suggests that academic stress may indirectly contribute to anemia. Stress can influence dietary intake, sleep patterns, and hormonal balance, potentially affecting nutrient metabolism and hemoglobin synthesis.

Figure 2 demonstrates that anemia constitutes a significant public health concern among the studied students. A substantial proportion of participants were identified as anemic, indicating that anemia remains prevalent even in an

apparently healthy, academically active population. This finding highlights the persistent burden of nutritional and physiological deficiencies among young individuals, particularly in settings where dietary practices, lifestyle habits, and academic pressures may adversely influence health status. The proportion of non-anemic students, though comparatively higher, does not diminish the importance of the anemic group, as the observed prevalence exceeds what would be expected in a nutritionally secure population. The presence of anemia in this age group is particularly concerning because it can negatively affect physical endurance, cognitive performance, attention span, and overall academic productivity. Figure 3 suggests that anemia is not confined to marginalized or clinically ill populations but extends to students who may otherwise appear healthy.

Furthermore, the visual representation underscores the need for early screening and preventive strategies within educational institutions. The relatively high prevalence depicted in Figure 1 supports the necessity for targeted nutritional interventions, regular hemoglobin assessment, and health education programs focusing on balanced diets and micronutrient adequacy. Overall, Figure 1 sets the foundation for understanding the magnitude of anemia in the study population and justifies further exploration of its severity and associated risk factors, as presented in Tables 1 and 2.

Discussion

The present study included an adequate representation of both male and female students, allowing meaningful interpretation of gender-related

determinants of anemia. The balanced gender distribution strengthens the external validity of the findings and enables comparison with existing literature. The observed prevalence of anemia among students, despite being an academically active and seemingly healthy population, indicates that anemia continues to be a significant public health issue among young adults. Similar findings have been reported in recent studies. A cross-sectional study by Kaur et al. [11]. reported a high prevalence of anemia among college students, particularly among females, attributing this to increased iron requirements and menstrual blood loss. Likewise, Abioye et al. [12] observed that anemia remains prevalent among young adults even in urban and educated populations, emphasizing the role of dietary inadequacy and lifestyle factors. In contrast, a study by Suryanarayana et al. [13] reported a comparatively lower prevalence of anemia among male students, suggesting better dietary intake and lower physiological iron loss. Another study conducted in South Korea by Kim et al. [14] found minimal gender differences in anemia prevalence, possibly due to better nutritional awareness and fortified food consumption. These contrasts may reflect regional differences in dietary practices, health awareness, and public health interventions.

Severity of anemia among students in the present study, mild anemia constituted the majority (62.31%) of anemia cases, followed by moderate (26.15%) and severe anemia (11.54%). This pattern suggests that while most students are in the early stages of anemia, a considerable proportion have clinically significant forms that may adversely affect health and academic performance.

Comparable severity distributions have been reported in recent literature. Petry et al. observed that mild anemia was predominant among young adults, but emphasized that even mild anemia can impair cognitive function and physical endurance. Similarly, Pasricha et al. [15] highlighted that moderate and severe anemia among adolescents often reflects long-standing nutritional deficiencies and poor dietary diversity.

Conversely, a study by Verma et al. [16] reported a lower proportion of severe anemia among college students, attributing this to early detection and iron supplementation programs. Another contrasting report by Alquaiz et al. [17] found predominantly mild anemia with very few severe cases, suggesting effective preventive health services. The higher proportion of moderate and severe anemia in the present study may indicate gaps in screening and intervention strategies.

Dietary Factors and Anemia The study demonstrated a significant association between inadequate iron intake and anemia ($p = 0.034$). This finding reinforces the established role of dietary iron deficiency as a major contributor to anemia, particularly among students who may consume calorie-dense but nutrient-poor diets. Supporting evidence comes from Gibson et al. [18], who reported that insufficient intake of bioavailable iron is a leading cause of anemia among young adults. Similarly, Neumann et al. [19] emphasized that plant-based diets without adequate iron enhancers increase anemia risk. In contrast, Tiwari et al. [20] found no significant association between iron intake and anemia, suggesting that factors such as absorption inhibitors and chronic inflammation may play a larger role. Another study by Park et al. [21] reported

adequate iron intake among students but persistent anemia, highlighting the role of non-dietary causes.

Irregular Meal Patterns and Anemia
Irregular meal patterns showed a strong and highly significant association with anemia ($p = 0.001$). This suggests that meal skipping and inconsistent eating habits adversely affect overall nutrient intake and iron absorption. This finding aligns with Mistry et al. [22], who reported that students with irregular meals had significantly lower hemoglobin levels. Similarly, Alam et al. demonstrated that meal skipping was strongly associated with anemia among university students. However, Lee et al. [23] found no significant association between meal regularity and anemia, attributing this to widespread food fortification.

Menstrual Factors and Anemia
Heavy menstrual bleeding was significantly associated with anemia ($p = 0.009$), underscoring its importance as a physiological determinant among female students. This is consistent with findings by Munro et al. [24], who identified heavy menstrual bleeding as a major risk factor for iron deficiency. In contrast, study by Wang et al. [25] found no significant association, possibly due to widespread iron supplementation [26].

Academic Stress and Anemia
Although high academic stress showed only a borderline association with anemia ($p = 0.054$), the trend suggests a potential indirect relationship. Supporting studies by Mikkelsen et al. [27] indicate that chronic stress affects dietary intake and micronutrient metabolism. Conversely, Benton et al. [28] found no direct association between stress and anemia, suggesting resilience factors among students.

Conclusion

According to the current study, 43.3% of participants had anemia, mostly in the moderate category, indicating a significant incidence among undergraduate medical students. Students who had irregular eating schedules or insufficient iron intake were more vulnerable than female students, especially those who experienced significant menstrual bleeding. Lifestyle and dietary variables revealed as major influencers, despite a borderline connection with high academic stress. These results demonstrate that even a population with medical awareness is susceptible to avoidable anemia. Regular hemoglobin test, nutritional advice, and health education are crucial for early detection. Anemia prevalence can be successfully decreased by promoting a balanced diet, attending to menstruation health, and supporting regular eating habits. All things considered, the study emphasizes the necessity of institutional measures to protect students' academic performance and health.

Recommendation

To facilitate early identification, medical students should undergo routine screening for anemia. Programs for nutrition education that support balanced meals and diets high in iron are crucial. Female students should get counseling on managing severe monthly bleeding and menstrual health. Stress reduction and good lifestyle practices, such as getting enough sleep and exercising, ought to be promoted.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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