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IMPACT OF ANEMIA ON COGNITIVE FUNCTION, IQ, ACADEMIC PERFORMANCE, ACHIEVEMENTS, AND STUDENTS ATTENDANCE AMONG MEDICAL STUDENTS: A CROSS-SECTIONAL STUDY.

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ABSTRACT

Background: Anemia is a common yet often under diagnosed condition among university students, particularly those in health sciences disciplines. It can adversely affect cognitive performance, academic achievement, and class attendance—critical components of student success. This study aimed to evaluate anemia risk and its potential effects on intellectual functioning and educational performance among undergraduate students in medical and health-related faculties.

Methods: A cross-sectional study was conducted among 199 students from five faculties (Medicine, Public Health, Pharmacy, Dentistry, and Biomedical Sciences) across all academic years. Data were collected through structured questionnaires and domain-based scoring tools assessing anemia risk factors, dietary habits, menstrual and medical history, cognitive symptoms, IQ estimation, academic achievement, and attendance. Anthropometric data (height, weight, BMI) were also recorded. Descriptive statistics, Pearson correlations and scoring interpretation models were used to categorize risk levels and impacts.

Results: The majority of participants were from the fourth academic year (44.7%) and the Public Health faculty (32.7%). The average BMI across all faculties was within the normal range (mean = 23 kg/m^2), though some variation was observed. Group-wise scoring indicated a moderate risk of anemia (mean = 13/40) and a moderate impact on cognitive performance and IQ (total score = 31–35/50 (P values < 0.05) across all groups. Symptom burden and poor dietary habits were the most frequently reported risk domains. Furthermore, cognitive and academic scores also associated with anemia risk, and some participants reported diminished attendance and performance (P< 0.05).

Conclusion: This study highlights a concerning link between anemia and diminished cognitive, IQ, academic, and attendance outcomes among university students. The findings underscore the need for early screening, nutritional intervention, and educational support to mitigate the academic consequences of anemia. Integration of anemia assessment into student health services could promote both well-being and academic success.

Keywords: Anemia, Cognitive Performance, University Students, Academic Achievement, IQ, Attendance, Medicals Student.

1 INTRODUCTION

Anemia, a condition characterized by reduced hemoglobin concentration or red blood cell count, remains a pervasive global public health issue with considerable implications for physical and mental health. Among vulnerable populations, students—particularly medical students—are uniquely susceptible to the adverse consequences of anemia due to their intense academic schedules, psychological stress, and often inadequate dietary habits (Kassebaum, 2016). The World Health Organization (WHO) estimates that anemia affects over 1.6 billion people worldwide, with the highest prevalence seen in low- and middle-income countries, including among young adults and students (WHO, 2021). While the physical symptoms of anemia, such as fatigue and weakness, are well recognized, the condition's impact on cognitive function, intelligence quotient (IQ), academic performance, and attendance remains under-explored, especially in high-demand educational environments such as medical schools.

Cognitive function refers to an individual's ability to perform tasks that require mental processes like memory, attention, problem-solving, and decision-making. Hemoglobin plays a vital role in oxygen delivery to the brain; consequently, anemia can result in cerebral hypoxia, impairing these essential cognitive processes (Beard & Connor, 2003). Several studies have demonstrated that iron-deficiency anemia, the most common form of the condition, is linked with impaired neurocognitive development, decreased concentration, and slower information processing speeds (Bryan et al., 2004). In academic settings, particularly among medical students who must manage voluminous material and rigorous examinations, even mild cognitive impairments can translate into measurable declines in academic outcomes.

IQ, a standardized measure of intelligence and problem-solving ability, is also potentially influenced by anemia. A body of evidence suggests that iron deficiency during adolescence and early adulthood may negatively affect IQ scores and learning potential (Halterman et al., 2001). While IQ is considered a relatively stable trait, transient physiological conditions such as anemia can suppress intellectual performance and test-taking ability. Furthermore, this condition can contribute to chronic tiredness and lack of motivation, affecting both classroom participation and academic engagement.

Academic performance, a multidimensional construct encompassing grades, test scores, clinical skills, and theoretical knowledge, is particularly important among medical students due to the high standards of competency required in medical practice. Research shows that anemia-related fatigue and cognitive deficits can lead to decreased academic productivity, reduced learning efficiency, and lower examination scores (Gibson et al., 2001). In clinical education settings, where attention to detail and mental acuity are vital, anemia may also compromise practical performance, which can have downstream implications for patient care and safety.

Additionally, anemia may negatively affect school attendance. Medical students often experience high physical and psychological demands, and the fatigue associated with anemia may increase absenteeism from lectures, clinical rotations, and examinations (Kharche et al., 2012). Missed attendance not only impacts academic achievement but may also delay academic progression and licensure. This is particularly relevant in competitive environments where consistent performance and presence are prerequisites for graduation and professional success.

Despite its importance, anemia among medical students is frequently underdiagnosed and underreported. The pressures of medical education may lead students to ignore signs of declining health, often attributing symptoms to academic burnout rather than a clinical condition. Moreover, medical curricula may not adequately emphasize student health monitoring, leading to a paradox where future healthcare providers themselves suffer from preventable or manageable conditions like anemia (Lee et al., 2006). This underscores the need for institutional policies that prioritize student health through regular screenings, nutritional interventions, and stress management strategies.

The context of this cross-sectional study is particularly relevant in light of the ongoing challenges facing healthcare education in many developing countries. Resource limitations, food insecurity, and lack of routine health checkups may predispose medical students to higher anemia risk compared to peers in other academic disciplines or regions (Gebreweld et al., 2019). Evaluating the impact of anemia on cognitive and academic outcomes in this specific population is crucial for guiding educational policy, curriculum design, and student support services.

Overall, anemia among medical students is an important but often overlooked issue that can significantly impair cognitive function, reduce IQ scores, diminish academic performance, hinder academic achievements, and contribute to poor attendance. Investigating this relationship through a cross-sectional study offers valuable insights into the extent of the problem and potential interventions. Ensuring the well-being of medical students is not only essential for their

personal success but also for the quality of healthcare delivery in the future, as they represent the upcoming generation of healthcare providers. This study aimed to assess the impact of anemia on cognitive function, IQ, academic performance, educational achievements, and class attendance among medical students in Benghazi university using a cross-sectional design.

2 METHODOLOGY

2.1 Study Design and Setting

This was a cross-sectional analytical study conducted among undergraduate students enrolled in various medical faculties branches at university of Benghazi from beginning of April to the end of June 2025. The study aimed to assess the anemia and risk of anemia and its association with cognitive function, IQ, academic achievement, and attendance.

2.2 Study Population

A total of 199 students from five faculties—Medicine, Public Health, Pharmacy, Dentistry, and Biomedical Sciences—participated in the study. Inclusion criteria included enrollment in the university during the study period, willingness to participate, and completion of all required questionnaires. Students with known chronic conditions affecting cognition (e.g., neurological disorders) were excluded.

2.3 Sampling Method

Participants were selected using stratified random sampling to ensure representation from each faculty and academic year. Informed consent was obtained from all participants prior to data collection.

2.4 Questionnaire Development

A comprehensive researcher-developed questionnaire was created to collect data on age, gender, faculty, height, weight, BMI, menstrual history, medical history, dietary practices, cognitive symptoms, IQ estimation, academic performance, and class attendance. Items were compiled based on literature review and clinical relevance (e.g., Al-Hakeem et al., 2018; Halterman et al., 2001; Gibson et al., 2008). The initial draft underwent content validation by an expert panel (nutritionists, hematologists, educational psychologists) and was pilot-tested on 20 medical students for clarity and reliability. Based on feedback, the instrument was refined and the final version is provided in Appendix. Total scoring procedures and categorical cutoff values were established according to standard scoring methods.

2.5 Data Collection Tools

Data were collected using a structured, pre-validated questionnaire divided into three main sections:

1. Demographic and Anthropometric Data
    - Age, sex, academic year, and faculty
    - Height and weight measurements were self-reported and used to calculate Body **Mass Index (BMI)** using the standard formula: BMI = weight (kg) / height^2 (m^2)
2. Anemia Risk and Lifestyle Assessment
    - Domains included dietary habits, menstrual history (for females), family and medical history, symptoms, and use of medications or substances.
    - Each domain was scored based on the presence or absence of risk factors, with higher scores indicating greater anemia risk.
3. Cognitive, IQ, and Academic Impact Assessment
    - Cognitive symptoms (e.g., fatigue, concentration difficulties)
    - Self-assessed academic performance and class attendance
    - IQ assessment was based on simplified logical reasoning and short-term memory tasks adapted from standard cognitive testing models.

2.6 Scoring and Interpretation

Scores were totaled for each domain. Risk levels and performance impact were categorized as follows:

- Low, Moderate, or High Anemia Risk (based on total domain scores)
- Cognitive performance and IQ were rated on a scale of 0–20 and categorized as low, moderate, or average
- Academic impact was based on self-reported attendance and grade satisfaction

2.7 Statistical Analysis

Data were entered and analyzed using SPSS version 25.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize demographic and clinical data. Group comparisons were performed using Pearson's correlation and ANOVA, where appropriate. A P-value of <0.05 was considered statistically significant.

2.8 Ethical Considerations

The study protocol was approved by the Institutional Research Ethics Committee from Benghazi University. Participants were assured of confidentiality, and data were anonymized prior to analysis. Participation was voluntary, and students had the right to withdraw at any time without academic consequence.

3 RESULTS

The data collected on 199 students shown that the group aged 20–23 years comprises the highest percentage of respondents (39.20%, n=78), followed by those aged 24–25 years (34.17%, n=68). Participants above 25 years constitute 16.58% (n=33), while the smallest proportion belongs to the 17–19 age group, accounting for only 10.05% (n=20). Each bar is labeled with both the frequency and the corresponding percentage, highlighting the relative distribution across age categories (Figure 1). The participants in this study predominantly female (Figure 2).

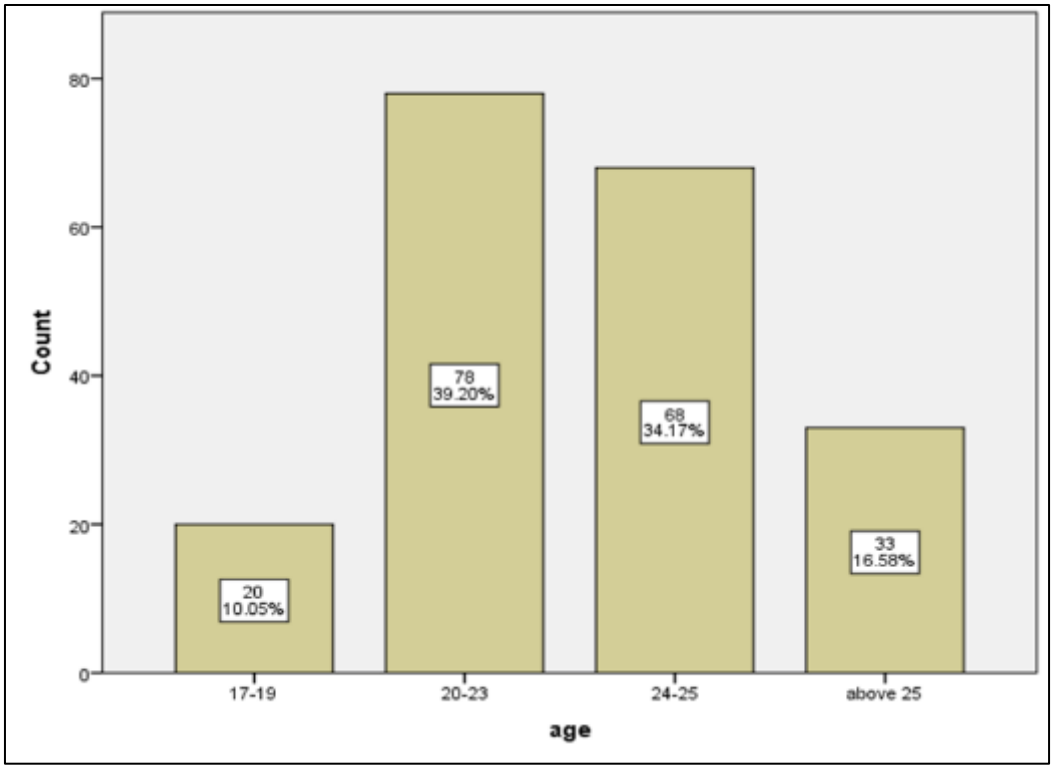

Figure 1: Ages distribution of students

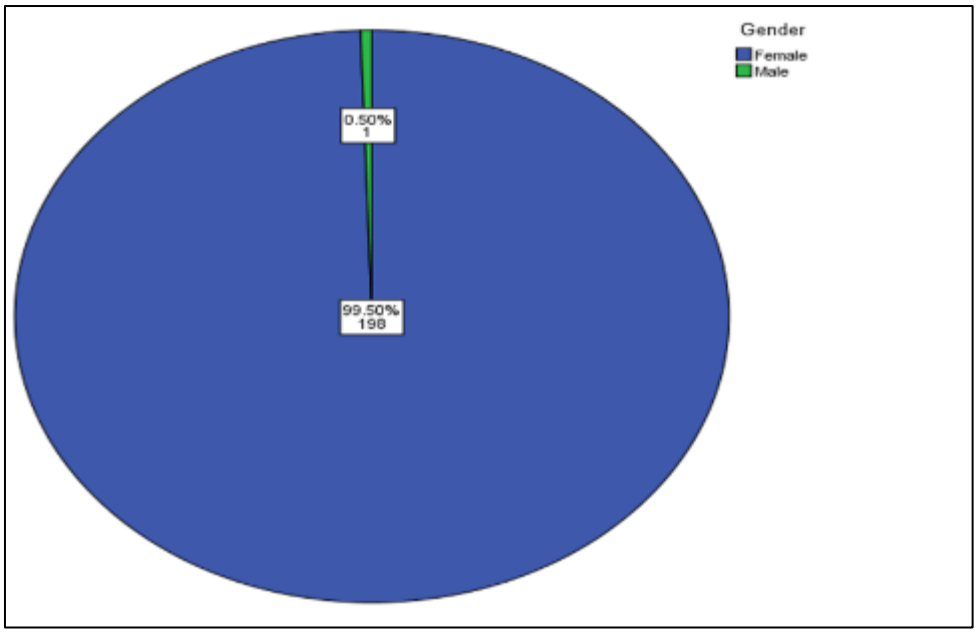

Figure 2: Gender distribution

Table 1 presented the distribution of 199 university students according to their academic year and faculty. The majority of the participants were in the fourth year (44.7%), followed by first-year students (25.1%), second-year students (15.6%), and third-year students (10.1%), while fifth-year students constituted the smallest group (4.5%).

Regarding faculty distribution, the Faculty of Public Health had the largest representation (32.7%), followed by the Faculty of Medicine (29.1%). The remaining students were from the Faculty of Pharmacy (13.6%), Biomedical Sciences (13.1%), and Dental Faculty (11.6%). This stratification offers a diverse student population sample across both academic levels and disciplines, allowing a comprehensive analysis of anemia and its effects within the medical faculties branches.

Table 1: Academic years and faculties branches

		N	N %
Study year	fifth	9	4.5%
	First	50	25.1%
	Fourth	89	44.7%
	Second	31	15.6%
	Third	20	10.1%
	Total	199	100.0%
Faculty	Biomedical sciences	26	13.1%
	Dental	23	11.6%
	Medicine	58	29.1%
	Pharmacy	27	13.6%
	Public health	65	32.7%
	Total	199	100.0%

The anthropometric data of the 199 students included in the study shown in table 2. The mean height was 161 cm, with a standard deviation of 7 cm, indicating slight variability in stature across the group. The average body weight was 61 kg (SD = 13 kg), and the calculated mean Body Mass Index (BMI) was 23 kg/m^2, with a standard deviation of 5 kg/m^2. This data provides a general overview of the participants' physical health status and allows for classification of nutritional categories based on BMI values, such as underweight, normal weight, overweight, or obese.

Table 2: Body weight and BMI assessment

	Mean± SD
Height (cm)	161±7
Weight (Kg)	61±13
BMI (kg/m2)	23±5

Table 3 presented a comparison of anthropometric measurements—height, weight, and Body Mass Index (BMI)—across students from five different faculties: Biomedical Sciences, Dentistry, Medicine, Pharmacy, and Public Health. The mean height ranged narrowly between 160–162 cm across all faculties, with slight variations in standard deviation. The average body weight showed more variability: students in the Faculty of Public Health had the highest mean weight (63 kg, SD = 15), while Pharmacy students had the lowest (57 kg, SD = 9). BMI values ranged from 22 to 25 kg/m^2, with Public Health students recording the highest mean BMI (25 kg/m^2, SD = 6), and Pharmacy students showing the lowest (22 kg/m^2, SD = 4).

Table 3: Relation between boy weight and faculties branches

	Faculties									
	Biomedical sciences		Dental		Medicine		Pharmacy		Public health	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height	160	5	162	6	162	9	160	5	161	6
weight	59	13	61	12	61	12	57	9	63	15
BMI	23	4	23	4	23	4	22	4	25	6

In the next anemia was investigated by different domain. Table 4 summarizes the results of Group I's assessment across six domains related to anemia risk factors:

- Medical history domain: mean score of 2
- Dietary intake domain: mean score of 4
- Symptoms domain: mean score of 5
- Menstrual and reproductive history domain: mean score of 2
- Medications and substance use domain: mean score of 0
- Family history domain: mean score of 1

The total average score for Group I was 13 out of 40. According to the interpretation guide, this score places the group in the category of moderate anemia risk, where lifestyle and dietary factors are likely contributors. There were significant low or medium association between anemia and certain domain such as medical history, diet intake, symptoms, medical and substances used (Table 4)

Table 4: Scores and Correlation group I domain assessment

	Mean± SD	**R**	**P values**
Subtotal medical history domain	2±0.4	0.165	0.02
Subtotal diet intake domain	4±0.5	0.56	0.021
Subtotal symptoms domain	5±0.7	0.29	0.003
Subtotal Menstrual & Reproductive History domain	2±0.1	0.40	0.54
subtotal_Medications and Substance Use domain	0	0.91	0.007
Subtotal family history domain	1±0.1	0.12	0.76
Total score/40	13±2.6		

3.1 Interpretation Guide

- **0–10:** Low risk of anemia or minimal contributing factors
- **11–20:** Moderate risk; lifestyle/dietary factors likely involved
- **21–30:** High risk; consider lab tests and clinical evaluation
- **31–40:** Very high risk; multiple causes likely (chronic disease, deficiency, genetic, etc.)

Table 5 presents the mean scores of Group II domain assessment of the participants across three primary domains related to anemia, IQ and cognitive performance:

- Anemia risk domain: mean score of 9
- Cognitive and academic performance domain: mean score of 7
- IQ assessment domain: mean score of 15

The total score was 31 out of 50, which, according to the study's interpretive guide, suggests a moderate impact of anemia on cognitive performance. This range indicates that while anemia may not be severely impairing, it is likely contributing to some level of reduced mental efficiency and academic output. In addition, there were positive correlation in group II domain assessment (Table 5)

Table 5: Scores and Correlation group II domain assessment

	Mean± SD	**R**	**P values**
Subtotal Anemia risk	9±1.4	0.448	0.000
Subtotal Cognitive and Academic Performance	7±1.1	0.32	0.01
IQ score	15±2.1	0.78	0.033
Total score /50	31±4.7		

Total Score	**Impact of Anemia on IQ (Suggested)**
0–15	No significant cognitive impact from anemia
16–30	Mild impact on cognitive performance
31–40	Moderate impact – further intervention needed
41-50	Severe impact – clinical and academic support advised

Table 6 outlines the average scores of Group III participants across five key domains assessing the effect of anemia on academic performance and daily functioning: Anemia risk domain: mean score of 9. Cognitive and academic performance domain: mean score of 7. IQ assessment domain: mean score of 15, attendance domain: mean score of 2 and academic achievement domain: mean score of 2. The cumulative total score for the group was 35 out of 50, placing them in the moderate to significant impact category, based on the interpretation scale. This suggests that anemia is not only affecting cognitive function but also influencing academic success and class attendance. The correlation have been found between component of domains and anemia (Table 6).

Table 6: Scores and Correlation group III domain assessment

	Mean±	**R**	**P values**
Subtotal Anemia risk domain	9±2.6	0.44	0.000
Subtotal Cognitive and Academic Performance	7±1.8	0.32	0.01
IQ assessment domain	15±2.7	0.75	0.03
Subtotal attendance domain	2±0.2	0.43	0.000
Academic Achievement domain	2±0.1	0.234	0.001
Total scores/ 50	35±3.2		

Category	Score
A: Anemia Risk	____ /15
B: Cognitive/Academic Performance	____ /10
C: IQ Assessment	____ /15
D: Academic Achievement	____ /5
E: Attendance & Engagement	____ /5
Total Score	____ /50

3.2 Interpretation of Total Score

Total Score	Effect of Anemia on IQ, Academic Achievement, and Attendance
0–15	No significant impact on IQ, academic performance, or attendance
16–25	Mild to moderate impact; anemia may be affecting academic performance and attendance
26–35	Moderate to significant impact; further evaluation and intervention recommended
36–45	Severe impact; likely affecting IQ, academic achievement, and attendance. Immediate clinical and academic support needed
46–50	Critical impact; immediate intervention required for anemia and academic support

4 DISCUSSION

The present study demonstrated a well-distributed representation of students from various health-related faculties, particularly the Faculty of Public Health and the Faculty of Medicine. The higher participation from these faculties may reflect either larger student populations or greater engagement in health-related research activities. The age distribution revealed that most participants were between 20 and 25 years, representing late adolescence and early adulthood—a critical developmental stage characterized by significant physical, psychological, and behavioral changes that influence health behaviors and academic performance (Sawyer et al., 2018). The predominance of students aged 20–23 years, followed by those aged 24–25 years, suggests that the findings are particularly relevant to university-aged populations.

In contrast, lower participation among younger (17–19 years) and older (>25 years) individuals may limit the generalizability of the findings, especially if age acts as a confounding factor (Patton et al., 2016). Age is a key determinant in epidemiological studies, influencing knowledge, attitudes, and practices (KAP), as well as health-related behaviors. Younger individuals may lack sufficient exposure or awareness, whereas older individuals may exhibit more established lifestyle patterns or chronic conditions (Galea & Tracy, 2007). Therefore, age-adjusted analyses are important to minimize potential bias.

The predominance of fourth-year students suggests that advanced students may be more accessible or more engaged in academic research. Their level of academic maturity may also enhance the accuracy of self-reported data, particularly in areas related to health status and cognitive performance. The inclusion of students from multiple faculties strengthens the generalizability of the findings and allows comparison across disciplines. Previous studies indicate that academic workload, stress, and dietary habits differ between disciplines, thereby influencing both physical and cognitive health outcomes (El-Masry et al., 2013; Al-Sharbatti et al., 2011).

Anthropometric findings revealed that the mean body mass index (BMI) of participants fell within the normal range according to World Health Organization standards. However, the relatively high standard deviation indicates variability, suggesting the presence of both underweight and overweight individuals. BMI remains a useful indicator of nutritional status, but it does not fully capture micronutrient deficiencies. For example, individuals with normal BMI may still experience "hidden hunger," particularly iron deficiency, which is common among university students (Beard, 2001).

Low BMI has been associated with iron-deficiency anemia, particularly among female students due to factors such as dietary restrictions and menstrual blood loss (Kaur et al., 2006; Al Hassan, 2015). Conversely, higher BMI may contribute to inflammation-related disruptions in iron metabolism, leading to anemia of chronic disease (Cepeda-Lopez et al., 2011). These findings emphasize the importance of combining anthropometric data with dietary and biochemical assessments for accurate anemia risk evaluation.

Faculty-wise differences in BMI and weight suggest variability in lifestyle and dietary habits across disciplines. Students from the Faculty of Public Health demonstrated higher BMI values, which may reflect sedentary behavior or irregular dietary patterns. In contrast, Pharmacy students showed lower BMI, possibly due to better nutritional awareness or different academic routines. Such variations highlight the influence of academic environment on health behaviors. Previous studies have shown that academic stress, meal timing, and physical activity significantly affect nutritional status and anemia risk (El-Ansari et al., 2011).

The assessment of anemia risk factors among Group I participants revealed a moderate overall risk score, indicating the presence of multiple contributing factors despite the absence of overt clinical anemia. The highest scores were observed in the symptom domain, suggesting that many students experience early manifestations of anemia such as fatigue, dizziness, and headaches. These symptoms, although nonspecific, are commonly associated with iron deficiency and may negatively impact daily functioning and academic performance (Beard, 2001).

Dietary factors also contributed significantly to anemia risk, reflecting inadequate intake of iron-rich foods and the consumption of dietary inhibitors such as tea and coffee, which reduce iron absorption (Hurrell & Egli, 2010). These findings are consistent with previous research indicating that university students often adopt poor dietary habits due to academic pressures and lifestyle constraints (Al-Hashem, 2020).

Menstrual and reproductive factors showed a moderate contribution, highlighting the role of menstrual blood loss in iron deficiency among female students (Gonzalez et al., 2012). In contrast, medication use and substance-related factors showed minimal impact, although this may reflect underreporting. Medical and family history contributed minimally, suggesting that lifestyle factors are the primary drivers of anemia risk in this population.

The findings from Group II demonstrated a clear association between anemia and cognitive performance. The moderate anemia risk score, combined with reduced cognitive and academic performance, suggests that anemia-related factors are negatively affecting students' mental functioning. Iron deficiency is known to impair oxygen delivery to the brain and disrupt neurotransmitter synthesis, leading to reduced concentration, memory, and learning capacity (Beard, 2001; Bryan et al., 2004).

The observed IQ scores further support this relationship, indicating that anemia may contribute to reduced cognitive efficiency. Previous studies have consistently shown that iron deficiency is associated with lower IQ scores and impaired academic achievement, particularly during periods of high cognitive demand (Grantham-McGregor & Ani, 2001). These findings underscore the importance of early detection and intervention to prevent long-term cognitive consequences.

Similarly, Group III findings demonstrated a moderate to significant impact of anemia on academic and functional outcomes. Although cognitive scores remained relatively high, reduced attendance and academic achievement scores suggest that anemia-related fatigue and reduced concentration may impair students' ability to fully engage in academic activities. This is consistent with previous research showing that even mild anemia can lead to decreased attendance and academic performance (Al-Hakeem et al., 2018; Kassebaum et al., 2014).

Overall, the findings highlight the multifactorial nature of anemia among university students, involving dietary, physiological, and lifestyle factors. The observed impact on cognitive performance, academic achievement, and attendance emphasizes the need for comprehensive intervention strategies. Universities should consider implementing routine anemia screening, nutritional education programs, and targeted support for at-risk students. Such interventions could improve both health outcomes and academic success, particularly in high-demand academic environments.

5 CONCLUSION

This study provides clear evidence of a moderate prevalence of anemia among undergraduate students in health-related disciplines, with significant implications for their cognitive function, academic achievement, and class attendance. The domain-based assessments revealed that anemia risk was most influenced by poor dietary habits, clinical symptoms, and menstrual history. Additionally, cognitive performance and IQ scores were noticeably lower in students with higher anemia risk scores, suggesting a negative correlation between anemia and intellectual capacity.

Although most students maintained a normal BMI, this did not fully protect against anemia, emphasizing the role of micronutrient deficiencies rather than general malnutrition. Furthermore, the study highlights a functional impact—students with moderate anemia risk also reported reduced attendance and lower academic performance, which may be overlooked in routine academic evaluations.

In conclusion, the findings underline the urgent need for early identification and intervention strategies targeting anemia in university settings. Addressing this issue is critical not only for improving student health but also for enhancing academic success and long-term professional development in the health sciences field.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

There is no potential conflict of interest.

Statement of Ethical approval

The study protocol was approved by the Institutional Research Ethics Committee from Benghazi University

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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