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Prevalence and symptomatology of anemia in young adults: A cross-sectional study

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ABSTRACT

OBJECTIVE: Anemia is a prevalent public health issue characterized by a reduction in hemoglobin concentration, often accompanied by nonspecific symptoms that overlap with various other medical conditions. Despite its high global and national prevalence, especially among women, the diagnostic value of clinical symptoms in identifying anemia remains uncertain. In this study, we aimed to determine the prevalence of anemia and evaluate the frequency and severity of anemia-related symptoms.

METHODS: This cross-sectional study was conducted among medical students aged 18–35 between February and May 2025. Participants completed a detailed symptom questionnaire encompassing 44 anemia-related symptoms and underwent capillary hemoglobin measurement. Statistical analyses included group comparisons and regression analyses to explore the association between symptoms and anemia status.

RESULTS: A total of 251 participants (150 women, 101 men; median age: 22 Years) were included. The overall prevalence of anemia was 28.3%, significantly higher in women (35.3%) than in men (17.8%, p=0.025). The most frequently reported symptoms among anemic participants included fatigue (87.3%), malaise (85.9%), and attention deficit (78.9%). No statistically significant differences were observed in the frequency or severity of symptoms between anemic (median: 18 Symptoms) and non-anemic participants (median: 19 Symptoms)(all p>0.05). Regression analyses did not identify any predictive model for anemia based on symptomatology.

CONCLUSION: Anemia was found to be prevalent even among young and otherwise healthy individuals. Anemia-related symptoms were common and similar across both anemic and non-anemic participants, suggesting that such nonspecific complaints may reflect underlying physiological processes or nutritional deficiencies rather than anemia alone.

Keywords: Anemia; capillary hemoglobin; nonspecific symptoms; symptoms.

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Anemia is a disorder characterized by a reduction in hemoglobin or hematocrit levels in the blood, resulting from various causes, which can lead to acute or chronic health issues. These disorders generally arise from blood loss, production defect, hemolysis, nutritional deficiencies, or inflammatory processes [1]. To standardize

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its diagnosis in clinical practice, anemia is mainly identified and classified through laboratory tests. According to the World Health Organization, anemia is defined as a hemoglobin level below 12 g/dL in women and below 13 g/dL in men [2]. Anemia constitutes a significant public health issue, negatively affecting individuals' quality of life and workforce productivity, while also elevating morbidity and mortality rates [3]. Approximately half of the adult population worldwide and a quarter of the adult population in Türkiye are affected by anemia [4].

Anemia is associated with a higher symptom burden and significantly reduced quality of life, particularly through symptoms such as fatigue, malaise, weakness, or easy fatigability. Fatigue stands out as the most common and disabling symptom, greatly affecting physical function and daily activities [5, 6]. However, the symptoms and symptom clusters seen in patients with anemia are not specific to the condition; anemia usually presents with non-specific symptoms that are also found in many other diseases alongside anemia [7]. These nonspecific symptoms often overlap with other conditions, making diagnosis more difficult and delaying treatment, highlighting the importance of increased clinical awareness when managing anemia [8]. A recent study identified the top ten symptoms as weakness, fatigue, easy fatigability, amnesia, feeling cold, alopecia, cold intolerance, sleep problems, nervousness, and cold feet [9].

Anemia should not be considered an isolated clinical diagnosis; rather, it should be recognized as a sign of an underlying disorder. The associated symptoms, such as fatigue, exertional dyspnea, and pallor, do not necessarily originate mainly from the decrease in hemoglobin [10]. This is exemplified in a recent study involving patients with iron deficiency (ID), which is the most common cause of anemia worldwide. The burden of symptoms in patients with non-anemic iron deficiency was found to be nearly the same as in those with iron deficiency anemia [9]. Given the high prevalence of anemia and its significant impact on quality of life, it is imperative to explore further the diagnostic challenges posed by its non-specific symptoms, which may be crucial in populations the symptomatology may be overlooked or misattributed in certain populations. Therefore, in this cross-sectional descriptive survey study, we aimed to determine the prevalence of anemia, as well as the frequency and severity of anemia-related symptoms among a young and healthy medical student population, to contribute to symptomatology education and to raise awareness of anemia among medical students.

Highlight key points

- Anemia-related symptoms (fatigue, malaise, attention deficit) reduce quality of life, yet they are nonspecific and comparative studies on symptom burden between anemic and non-anemic individuals remain scarce.
- Symptom frequency and severity are largely similar in anemic and non-anemic young individuals, underscoring that symptomatology alone cannot reliably distinguish anemia.
- Anemia-related complaints are not primarily driven by hemoglobin levels but reflect broader mechanisms including nutritional deficiencies, comorbidities, and pathophysiological processes.
- The unexpectedly high symptom burden in both groups highlights the role of lifestyle, environmental, and psychosocial factors in shaping symptom reporting.

MATERIALS AND METHODS

Study Setting

This cross-sectional descriptive survey study was conducted with participants aged 18 to 35, studying at Marmara University Faculty of Medicine, between February 1, 2025, and May 31, 2025. Ethical approval for this study was obtained from Marmara University Medical School Research Ethics Committee (Decision number: 09.2024.1317, date:15.11.2024). Institutional authorization to conduct this study was secured from the Marmara University Medical School Deanery (Approval number: 957453, date: 22.01.2025). All patients provided written informed consent.

Study Design and Participants

This cross-sectional descriptive survey study aimed to determine the prevalence, frequency, and severity of anemia-related symptoms among a cohort of young and healthy medical students. The study population was selected from medical students, as their academic obligations overlapped with anemia-related symptoms, such as fatigue, impaired concentration, and cognitive impairment. This sample is relevant for assessing symptom perception and misattribution since training-related stress and sleep deprivation may disguise or normalize anemia-related symptoms. Self-reporting and symptom interpretation are also more consistent due to the similar educational background. The main inclusion criteria were medical students aged 18–35 at the specified institution who provided informed consent. The main exclusion criteria included participants diagnosed with anemia in the past year and/or currently undergo-

ing active treatment, those whose anemia has resolved but who are still receiving treatment for nutritional deficiencies, individuals experiencing an acute illness at the time, and those with advanced organ failure (such as stage 4 and 5 chronic kidney disease, Child-Pugh Class C cirrhosis, NYHA Class 3 and 4 chronic heart failure, respiratory failure requiring oxygen therapy, and similar conditions). The sample was selected using simple random sampling until the required sample size was reached, ensuring equal representation from each class. For students who were selected but did not give informed consent or agree to participate, the next student on the sampling list was selected. The sample size was calculated based on a 95% confidence level and 5% absolute precision, resulting in a sample size of 246 individuals. Anticipating potential data loss, the sample size was inflated by 10%, resulting in a planned total of 270 participants. Ultimately, 251 participants completed the study and were included in the final analysis.

Assessment Instruments

Participants were administered a questionnaire that included demographic and clinical information, as well as an anemia symptom questionnaire developed by the researchers, whose face validity was previously tested in a pilot group, and underwent capillary hemoglobin measurement using a capillary hemoglobin measurement device. Demographic and clinical data collected included age, sex, weight, height, known diseases, surgical history, current medications, presence of past anemia, and its cause if applicable. Additionally, results from complete blood count, biochemistry, and nutritional parameters—such as iron, iron-binding capacity, ferritin, folate, and vitamin B12 levels—performed within the past year were recorded from participants who provided this data through national health registry records.

The anemia symptom questionnaire was developed to include symptoms of anemia as described in the existing literature, as well as symptoms associated with anemia caused by nutritional deficiencies, which are the most common causes of anemia worldwide. The questionnaire includes a total of 44 symptoms grouped into six clusters: 12 Non-specific (malaise, frequent sickness, fatigue, hot flashes, easy fatigability, weight loss, diaphoresis, pica, paresthesia in hands and feet, loss of appetite, geosminophilia, weakness), eleven neuropsychiatric (amnesia, sleep disturbances, nervousness, attention deficit, headache, cold intolerance, unhappiness, cold hands and feet, restless leg, dizziness, tinnitus), eight dermatological (hair loss, onycholysis, xerosis, oral ulcers, pruritus, pallor, koilonychia, jaundice), three cardiopulmonary (palpitations, angina, dyspnea), five musculoskeletal (arthralgia, myalgia, muscle cramps, lower limb edema, bone pain), and five gastrointestinal symptoms (constipation, nausea, abdominal pain, dysphagia, diarrhea). Initially, the presence of these symptoms was evaluated as absent or present. Later, participants were asked to rate the severity or degree of discomfort caused by these symptoms on a scale of 1 to 10.

Capillary blood samples were collected from the fingertips of participants using a lancet for hemoglobin measurement. The hemoglobin testing device was the BeneCheck Uni Hemoglobin Monitoring System (General Life Biotechnology Co. Ltd., New Taipei City, Taiwan), along with BeneCheck Hb Hemoglobin Test Strips (General Life Biotechnology Co. Ltd., New Taipei City, Taiwan, LOT: H24003030). Previous validation studies have demonstrated a high degree of agreement between capillary blood samples analyzed using the BeneCheck hemoglobin monitoring system and venous blood samples analyzed using standard laboratory analyzers. In comparisons with automated systems such as Sysmex KX-21N, strong linear correlations ($R^2 \approx 0.95–0.98$) were reported, with more than 95% of measurements within ±15% bias, supporting its suitability for anemia screening and prevalence studies [11]. Measurements were performed according to the manufacturer's instructions, without the use of additional external calibration or laboratory-based quality-control procedures. Participants were classified as anemic or non-anemic based on World Health Organization criteria [2].

Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software, version 26.0 (SPSS Inc., Chicago, IL, USA). Categorical variables are presented as frequencies and percentages (%). The normality of continuous variables was evaluated with the Kolmogorov–Smirnov and Shapiro–Wilk tests. Parametric continuous variables, which are normally distributed, are expressed as mean and standard deviation (SD), while non-parametric variables are shown as median and interquartile range (IQR). Pearson's Chi-square test and Fisher's Exact test were used to analyze and compare categorical variables. Student's t-test was employed to compare parametric continuous variables between

Table 1. Distribution of demographic and clinical data of participants with and without anemia

	Anemic (n=71)	Non-anemic (n=180)	p
Age	22 (21–24)	21 (20–23)	0.15
Female gender (%)	74.6	53.8	0.02
Body mass index (kg/m^2)	21.9 (19.9–24.6)	23 (20.4–25.2)	0.11
Presence of comorbid disease (%)	19.7	17.7	0.72
Previous history of anemia	21 (of 48, 43.8)	34 (of 109, 31.2)	0.12
Previous history of iron deficiency	29 (of 40, 72.5)	52 (of 86, 60.5)	0.18
Previous history of B12 deficiency	6 (of 36, 16.7)	22 (of 76, 28.9)	0.16
Previous history of folate deficiency	3 (of 26, 11.5)	7 (of 63, 11.1)	0.95

Data are presented as n (%) or median (interquartile range). Chi-square tests and Mann-Whitney U tests were used for statistical analysis.

two independent groups, whereas the Mann–Whitney U test was used for non-parametric variables. Logistic regression and exploratory machine learning methods were used to explore multivariable associations between anemia status and symptom patterns. These analyses were intended to identify potential discriminatory trends rather than to develop a formal predictive model. Statistical significance was defined as $p<0.05$.

RESULTS

A total of 251 participants were included in the study, consisting of 150 women and 101 men. The median age was 22 (20–23) years, and the median BMI was 22.4 (20.3–25.1) kg/m^2. Comorbid diseases were identified in 46 participants (18.3%). In the anemic group, the most common comorbidities were respiratory disorders (n=5, 7.0%), endocrine disorders (n=5, 7.0%), central nervous system disorders (n=2, 2.8%), rheumatologic disorders (n=1, 1.4%), and hematologic disorders (n=1, 1.4%). In the non-anemic group, comorbidities included respiratory (n=13, 7.2%), endocrine (n=4, 2.2%), cardiovascular (n=2, 1.1%), central nervous system (n=2, 1.1%), rheumatologic (n=2, 1.1%), hematologic (n=2, 1.1%), gastrointestinal (n=2, 1.1%), and renal (n=1, 0.6%) disorders. Prior history of anemia or nutritional deficiencies older than one year was retained in the analysis, as the exclusion criteria applied only to diagnoses within the past year or to those under active treatment. As such, 35% (n=55) of the 157 participants with previous complete blood counts had a history of anemia. Among participants with available nutritional parameters, 64.3% (n=81) of the 126 with iron studies had a history of iron deficiency, 25.0% (n=28) of the 112 with vitamin B12 levels had a deficiency, and 11.2% (n=10) of the 89 with folate levels had a folate deficiency. A comparison of anemic and non-anemic participants regarding demographic and clinical data is presented in Table 1. The overall prevalence of anemia was 28.3% (95% CI: 22.7%–33.9%), with a significantly higher rate among women (35.3% vs. 17.8%, p=0.002, chi-square test). No significant differences were observed in demographic or clinical variables between the two groups.

Symptomatic Burden in Anemic Participants

Overall, the anemic participants had a median of 18 (12–24) symptoms, whereas the non-anemic participants had a median of 19 (11–24) symptoms. The ten most frequently observed symptoms among anemic participants were: Fatigue (87.3%), malaise (85.9%), headache (78.9%), attention deficit (78.9%), easy fatigability (71.8%), sleep disturbances (70.4%), unhappiness (70.4%), nervousness (70.4%), cold hands and feet (66.2%), and xerosis (66.2%). The ten findings with the highest median scores among anemic participants were: Fatigue 5 (3–7), malaise 4 (3–6), attention deficit 4 (2–6), sleep disturbances 4 (0–7), cold hands and feet 4 (0–7), headache 3 (1–6), easy fatigability 3 (0–6), cold intolerance 3 (0–6), xerosis 3 (0–6), and nervousness 3 (0–5.5).

A Comparison of Symptoms of Anemic and Non-Anemic Participants

The comparison of 44 symptoms between anemic and non-anemic participants is presented in Figures 1 and 2. When symptom clusters were evaluated, the most fre-

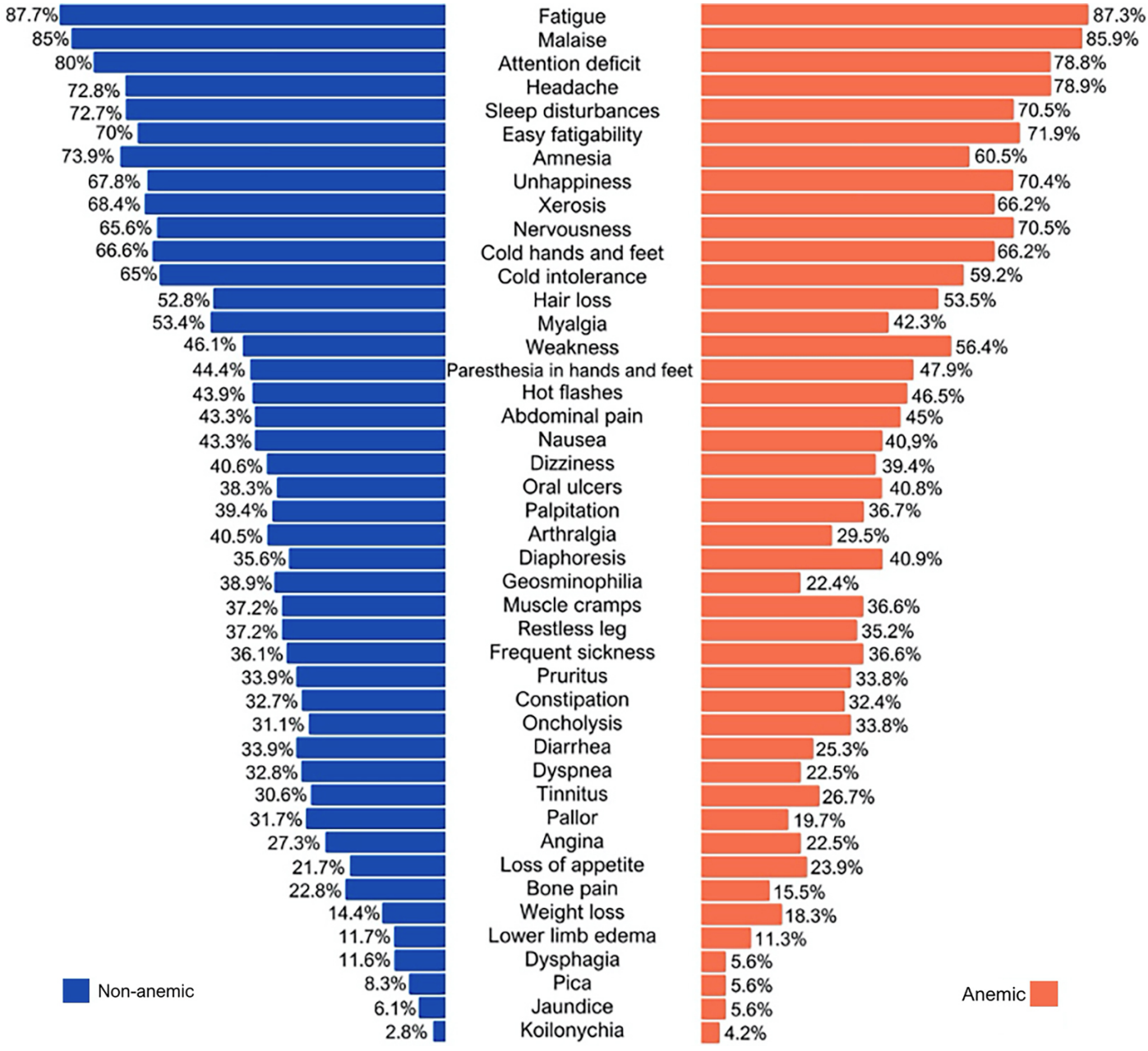


FIGURE 1. Symptom frequencies in anemic and non-anemic participants.

The figure illustrates the proportion (%) of participants reporting each symptom in the anemic and non-anemic groups. Symptoms are ranked by overall frequency and displayed symmetrically to facilitate direct comparison. Blue bars denote non-anemic participants, whereas red bars denote anemic participants. The figure demonstrates a substantial and overlapping symptom burden across groups, particularly for neuropsychiatric and non-specific complaints.

quently observed symptoms were non-specific, followed by neuropsychiatric and dermatological symptoms. The frequencies of symptom clusters in anemic and non-anemic groups are provided in Table 2. No significant differences were observed in the symptoms between anemic and non-anemic participants, either across clusters or in individual symptom-based comparisons. In the evaluation of symptom scores, the majority of symptoms did not show significant differences between groups. neither cluster assessments nor scoring comparisons revealed any clinically or statistically significant differences between anemic and non-anemic participants. Neither logistic regression analyses nor exploratory modeling approaches demonstrated meaningful discriminatory ability between participants with and without anemia based on symptom presence or symptom scores.

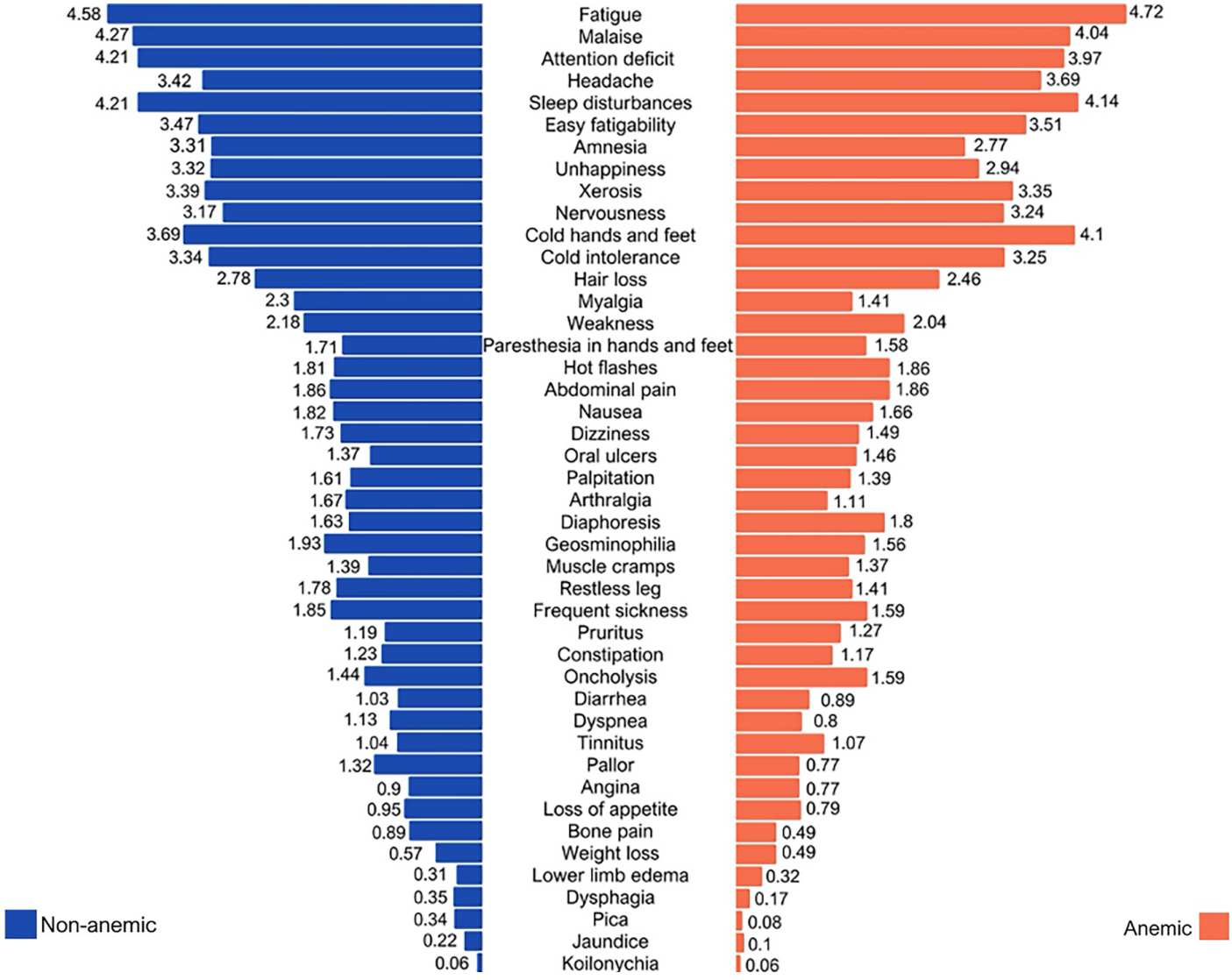


Figure 2. Distribution of median symptom scores in anemic and non-anemic participants.

The figure presents the median severity scores of self-reported symptoms, assessed using a 10-point Likert scale (0=not present, 10=very severe). Symptoms are ranked by overall frequency and displayed symmetrically to allow visual comparison between groups. Blue bars represent non-anemic participants, and red bars represent anemic participants. The figure highlights the considerable overlap in symptom severity across groups, particularly neuropsychiatric and non-specific symptoms showing the highest median scores.

DISCUSSION

In this cross-sectional descriptive survey study, we aimed to determine the prevalence of anemia in a relatively young and healthy population. Additionally, we evaluated the frequency and severity of symptoms associated with anemia. We found that 28.3% of the participants were affected by anemia. The prevalence in our population was similar to previously reported rates, with anemia affecting approximately 25.8% of adults in Türkiye and 23.1% of the global population [12, 13]. Gender was a significant factor in anemia prevalence; 35.3% of women and 17.8% of men were anemic in our cohort, which aligns with a large-scale analysis of population-based hemoglobin data from 204 countries reporting anemia prevalence of 30–35% in women and 12–15% in men [14]. Beyond gender, no significant associations were found between anemia and other demographic or clinical parameters in our study. This outcome may be attributed to the relatively homogeneous nature of our sample in these aspects, as well as the limited sample size and the predominantly young population, with a median age of 22 years. In contrast, findings from a large population-based study involving 7,607 individuals aged 10

Table 2. Distribution of symptom clusters by frequency in anemic and non-anemic groups

	Anemic (n=71) %	Non-anemic (n=180) %	p
Non-specific	95.8	96.1	0.9
Neuropsychiatric	94.4	98.9	0.055
Dermatological	87.3	88.9	0.72
Cardiopulmonary	47.9	52.2	0.53
Musculoskeletal	62	64.4	0.71
Gastrointestinal	60.6	62.8	0.74

Data are presented as n (%). Chi-square tests were used in statistical analysis.

to 90 years indicated a marked increase in anemia prevalence with advancing age, especially among men [15]. The absence of such patterns in our study seems to be a result of the restricted population characteristics rather than a true lack of association, highlighting the importance of broader and more diverse samples in future research.

The symptoms of anemia can adversely affect individuals' daily lives and workforce productivity; moreover, the long-term effects of anemia may impair overall health, leading to increased morbidity and mortality [16, 17]. However, research specifically addressing the symptomatology of anemia is limited. In this context, recognizing anemic symptoms and implementing appropriate treatment strategies are crucial for improving quality of life and minimizing workforce loss. Symptoms associated with anemia range from mild, nonspecific clinical manifestations to significant symptoms that can significantly affect daily activities. Although the data are limited, a recent study identified weakness, fatigue, easy fatigability, amnesia, feeling cold, alopecia, cold intolerance, sleep problems, nervousness, and cold feet as the most common symptoms among patients with iron deficiency anemia [9]. Similarly, among the 44 symptoms evaluated in our study, the most frequent symptoms were headache, malaise, easy fatigability, attention deficit, and fatigue in individuals with anemia, falling into nonspecific and neuropsychiatric symptom clusters.

The secondary aim of this study was to predict the presence of anemia based on symptoms in this cohort. However, as previous data show, the symptoms and symptom clusters observed in anemic patients are not specific, and considerably variable and heterogeneous. Our study found no significant variation in diversity, severity, or combinations of symptoms, whether assessed by presence or severity. Two major previous studies aiming to define anemia-related symptoms reported similar results. In a cross-sectional analysis from a population-based cohort, Weckmann et al. [18] found that four common anemia symptoms (fatigue, lack of energy, lack of concentration, and dyspnea) had limited specificity, with an 8% positive predictive value for diagnosing anemia. Only the lack of energy showed a significant association with anemia in a multivariate model. Factors such as polypharmacy, depression and/or anxiety, insomnia, female gender, and comorbidities further increased symptom burden. In their study comparing symptomatic differences between patients with iron deficiency anemia (IDA) and those with non-anemic iron deficiency (NAID), Özbilen et al. [9] found that many nonspecific symptoms observed in IDA were also reported at similar rates in individuals with NAID, hypothesizing that the presence of anemia itself is not required for such symptoms to occur [9]. Considered alongside previous literature, these findings support the hypothesis that the symptomatology of anemia may be driven by the underlying pathophysiological processes or associated comorbidities rather than by anemia itself. Despite the absence of iron status markers other than hemoglobin in this study, NAID might help explain the significant and overlapping symptom burden among groups. Although our study included a younger cohort of participants with a lower comorbidity burden, the results aligned with those of earlier studies. Multiple underlying factors in a patient's pathophysiology often overlap with anemia symptoms, which may reflect not only the disorder itself but also signs of underlying causes, such as nutritional deficiencies that lead to anemia.

This study found unexpectedly high symptom loads among both anemic and non-anemic subjects. Surprisingly, both groups exhibited similar and a high symptom burden for a young, healthy population. Several factors may account for this finding. The comprehensive symptom questionnaire may have led to greater symptom reporting by identifying subclinical or transient complaints. Second, self-reported surveys are vulnerable to recall bias and symptom overreporting. In addition, medical students often experience high academic stress, sleep abnormalities, and mental strain, all of which may contribute to non-specific symptoms and symptom misattribution. These contextual influences may have obscured anemia-specific symptom patterns and represent critical environmental considerations [19, 20]. The high prevalence of nonspecific and neurocognitive symptoms in our group

reflects patterns observed in previous population-based studies, where these symptoms exhibited low specificity for anemia diagnosis despite their substantial incidence [18]. Further studies should seek to validate symptom-based questionnaires across various age demographics and populations, while also integrating iron status indicators beyond hemoglobin levels. Expanding this methodology to include a broader cohort of young people and non-medical students may elucidate the associations among iron deficiency, anemia, and symptomatology.

The findings of this study should be viewed in light of some limitations. First, instead of a laboratory-based confirmatory approach, a capillary hemoglobin device was used. However, the device was clinically validated and approved, ensuring acceptable reliability. A further limitation is that concurrent iron status and nutritional markers (such as ferritin, transferrin saturation, vitamin B12, and folate) were not systematically measured at the time of hemoglobin testing. This may have limited the ability to differentiate anemia-related symptoms from those attributable to NAID or other nutritional deficiencies. Another limitation is that the study was conducted on a young and relatively healthy sample, which may limit the applicability of the findings to more diverse populations. Nevertheless, this was mitigated by the use of randomized sampling, enhancing representativeness. The study population consisted of medical students, which may limit generalizability. Higher health literacy and academic stress may influence symptom perception and reporting, possibly leading to symptom misattribution. Moreover, the high baseline prevalence of stress-related symptoms, sleep irregularities, and lifestyle factors in this group may have reduced observable differences in symptom frequency between groups. Additionally, although data collection was thorough, the study benefited from a systematic approach and detailed assessments, encompassing demographics, clinical history, a comprehensive symptom questionnaire, and hematologic measurements. The absence of additional calibration or external quality control procedures may represent a potential source of measurement variability. Finally, the observed prevalence of anemia closely aligned with national and global statistics, further supporting the external validity of the findings.

Conclusion

In this cross-sectional survey of a relatively young and healthy population, anemia was found to affect more than one-quarter of participants, with prevalence patterns consistent with both national and global estimates. Gender emerged as a significant determinant, with women disproportionately affected, while other demographic and clinical factors showed no clear associations—likely reflecting the homogeneity and age distribution of the cohort. Although anemia-related symptoms were frequently reported, they were largely nonspecific and heterogeneous, limiting their diagnostic value. These findings reinforce the notion that anemia symptomatology may be influenced by underlying pathophysiological mechanisms and comorbidities rather than anemia alone.

Ethics Committee Approval: The Marmara University Medical School Research Ethics Committee granted approval for this study (date: 15.11.2024, number: 09.2024.1317).

Informed Consent: All patients provided written informed consent.

Conflict of Interest: The authors declare no conflicts of interest.

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