

Hematological indices and undiagnosed anemia among adult male patients in Makkah, Saudi Arabia

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ABSTRACT

Background: Hematological indices are essential tools for evaluating physiological and pathological conditions, particularly anemia, which may remain undiagnosed in adult males due to the absence of specific clinical symptoms. This study aimed to assess the distribution of hematological indices and identify undiagnosed anemia among adult male patients.

Methods: A cross-sectional study was conducted among 211 adult male participants attending outpatient services at Security Forces Hospital in Makkah, Saudi Arabia. Blood samples were analyzed using an automated hematology analyzer to measure complete blood count parameters. Anemia was defined as hemoglobin <13 g/dL. Descriptive statistics, chi-square test, and independent-samples t-test were applied.

Results: Anemia was identified in 30 participants (14.2%), predominantly among older age groups. The mean hemoglobin level was significantly lower among anemic participants compared to non-anemic participants (11.52 ± 1.38 g/dL vs 14.93 ± 1.23 g/dL, $p < 0.001$). Most participants were asymptomatic, although a substantial proportion of anemic participants also lacked clinical symptoms. Microcytic red blood cells were observed in 28.0% of participants, with 28.8% of them being anemic, while 8.6% of normocytic participants were anemic. Anemia severity was mainly mild to moderate.

Conclusions: Anemia and subclinical hematological abnormalities are common among adult males and often clinically silent, highlighting the importance of routine laboratory screening for early detection and prevention.

Keywords: anemia, hematological indices, MCH, MCV, RBC

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INTRODUCTION

Background and clinical importance

Hematological indices are among the most essential and commonly ordered laboratory blood tests that provide valuable insights into the physiological and pathological status of individuals [1,2]. These indices, including hemoglobin (Hb), red blood cell (RBC) count, hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), are routinely measured as part of the complete blood count (CBC) [3]. They play a central role in the diagnosis, classification, and monitoring of various disorders. Alterations in these parameters may reflect underlying nutritional deficiencies, chronic diseases, inflammatory states, or bone marrow dysfunction [4]. Anemia may remain undiagnosed in adult males, particularly in its mild or early stages, due to the absence of specific clinical symptoms [1,5]. In addition, hematological indices are widely

used as initial screening tools in both outpatient and inpatient settings due to their accessibility, cost-effectiveness, and rapid turnaround time. They also offer indirect insights into oxygen transport capacity, tissue oxygenation, and overall metabolic function, making them essential components of routine clinical assessment. However, hematological parameters can be influenced by many factors, including age, gender, environment, and ethnicity [6, 7].

Clinical and Public Health Significance

Understanding the distribution of hematological indices among adult male patients is crucial for several reasons. First, it facilitates the identification of subclinical abnormalities that may otherwise go unnoticed during routine clinical evaluation. Second, it supports early diagnosis and timely management of conditions such as anemia and other hematological disorders. Third, population-specific data can aid in establishing local reference ranges, which are important for accurate interpretation of laboratory results [8].

Gaps in current knowledge

Despite the clinical importance of hematological indices, there is limited data describing their distribution among adult male patients in hospital-based settings, especially in Saudi Arabia. Most available studies have focused on specific diseases or mixed populations without providing detailed characterization of hematological parameters in adult males alone. Additionally, variations in hematological indices across age groups and in relation to clinical and lifestyle factors remain underexplored [1, 9].

Aim of the study

Therefore, the present study aims to evaluate the distribution of key hematological indices among adult male patients. In addition, this study aims to identify previously undiagnosed anemia and examine its distribution across different age groups and red blood cell morphological patterns. By analyzing these parameters within a defined clinical setting, this study seeks to provide a comprehensive overview of hematological profiles in this population and to contribute to the existing body of knowledge. The findings may have implications for improving clinical assessment, guiding diagnostic approaches, and informing preventive healthcare strategies among adult males.

METHODS

Study design and participants

This cross-sectional study was conducted among adult male patients attending outpatient services at Security Forces Hospital in Makkah, Saudi Arabia. Participants were recruited during routine clinical visits and were not hospitalized at the time of the study. All participants underwent a clinical assessment performed by a physician, which included detailed medical history taking and physical examination. Individuals who reported a previous diagnosis of anemia were excluded in order to focus on participants without known anemia at baseline.

Data collection and clinical assessment

Sociodemographic and clinical information was obtained during the clinical evaluation. The assessment aimed to identify general health status and exclude individuals with previously diagnosed hematological disorders. All participants provided informed consent prior to inclusion in the study.

Laboratory investigations

Following the clinical assessment, laboratory investigations were conducted to evaluate the hematological profile of the participants. Venous blood samples were

collected from all participants by trained laboratory personnel under standard aseptic conditions. Blood samples were drawn into tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. Hematological parameters were analyzed in the hospital hematology laboratory using an automated hematology analyzer (Sysmex XN-2000, Japan). Complete blood count (CBC) measurements included hemoglobin concentration (Hb), red blood cell (RBC) count, mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH).

Assessment of hematological indices

The measured hematological indices were used to evaluate red blood cell characteristics and overall hematological status. Based on RBC indices, participants were categorized according to red blood cell morphology into microcytic hypochromic, normocytic normochromic, and macrocytic patterns. These classifications facilitated the identification of variations in hematological profiles among the study population.

Statistical analysis

Data were entered, coded, and analyzed using Microsoft Excel. Descriptive statistics, including frequencies, means, standard deviations, and percentages, were used to summarize participants' characteristics and hematological parameters. The distribution of hematological indices was examined to identify patterns and variations within the study population. The chi-square test of independence was used to assess associations between categorical variables, including age group and anemia status. An independent-samples t-test was performed to compare mean hemoglobin (Hb) levels between anemic and non-anemic participants, as well as mean corpuscular volume (MCV) between microcytic and normocytic groups. A p -value < 0.05 was considered statistically significant.

Ethical considerations

The study protocol was approved by the Ethics Committee of the College of Applied Medical Sciences at Taif University, with approval granted via official institutional email. In addition, ethical clearance was obtained from the Institutional Review Board (IRB) of the Security Forces Hospital Program in Makkah (IRB No. 0776-301224). Participation in the study was entirely voluntary. All participants were informed about the purpose of the study and their right to withdraw at any time without any consequences. Verbal informed consent was obtained from all participants prior to data collection, in accordance with the approved ethical procedures. To ensure confidentiality, all personal identifiers were removed from the data collection forms, and data confidentiality was strictly maintained throughout the study and after its completion.

RESULTS

Participant characteristics and age distribution

A total of 211 adult male participants aged ≥18 years were included in this study. All participants were Saudi nationals and were recruited from outpatient services at Security Forces Hospital in Makkah, Western region of Saudi Arabia. At the time of recruitment, participants had no prior documented diagnosis of anemia based on their medical history; therefore, any anemia identified in this study represents previously undiagnosed cases. The distribution of participants across different age groups is presented in Table 1.

Anemia prevalence and age distribution

Among the 211 participants, 30 cases of previously undiagnosed anemia were identified. The mean hemoglobin level was significantly lower among anemic participants (11.52 ± 1.38 g/dL) compared to non-anemic participants (14.93 ± 1.23 g/dL), with a highly statistically significant difference (t=-12.74, p<0.001). The distribution of anemia across age groups showed that the highest proportion was observed in participants aged 55–64 years (n=13, 43.3% of anemic cases), followed by those aged >65 years (n = 10, 33.3%). Smaller proportions were found in the 45–54-year group (n=4, 13.3%) and the 35–44-year group (n=3, 10.0%), while no anemia cases were detected among participants younger than 35 years (Table 1). A chi-square test of independence showed a statistically significant association between age group and anemia status (χ²(5, N=211)=14.17, p=0.015), indicating that anemia was more prevalent in older age groups.

Clinical findings based on physical examination

The findings of the physical examination revealed that 137 out of 211 participants (64.9%) were asymptomatic and showed no clinical signs suggestive of anemia. Among symptomatic participants, fatigue was the most commonly reported isolated complaint, affecting 21 participants (10.0%), including 18 non-anemic and 3 anemic individuals. Dizziness was reported in 10 participants (4.7%), including 8 non-anemic and 2 anemic individuals, while shortness of breath was observed in 7 participants (3.3%), including 6 non-anemic and 1 anemic individual.

In addition, 36 participants (17.1%) presented with multiple concurrent symptoms, including 22 non-anemic and 14 anemic individuals. Among the anemic participants, 10 out of 30 individuals (33.3%) were asymptomatic despite having low hemoglobin levels. A chi-square test demonstrated a statistically significant association between symptom status and anemia status (χ²(4, N=211)=23.62, p<0.001), indicating that the distribution of clinical findings differed significantly between anemic and non-anemic participants. Asymptomatic status was considerably more common among non-anemic individuals, whereas multiple concurrent symptoms were more frequently observed among anemic participants (Table 2).

To further evaluate the clinical relevance of symptoms, symptom distribution was examined according to anemia status. Although a substantial proportion of anemic participants remained asymptomatic, similar symptoms were also observed among non-anemic individuals. These findings suggest that clinical manifestations are non-specific and cannot reliably differentiate anemic from non-anemic participants, emphasizing the importance of laboratory investigations for accurate diagnosis.

Hemoglobin and RBC count in relation to common types of anemia

Among the study population, 59 out of 211 participants (28.0%) were identified as having microcytic red blood cells (MCV<80 fL) with corresponding low MCH, consistent with a microcytic hypochromic pattern. Within this subgroup, 17 participants (28.8%) exhibited low hemoglobin (Hb) levels and reduced RBC counts, indicating anemia (Table 3). According to the World Health Organization (WHO), anemia in adult males is defined as a hemoglobin concentration below 13 g/dL [10]. In contrast, the majority of individuals in this group, i.e., 42 participants (71.2%), had normal Hb levels and RBC

Table 1. Age distribution and anemia prevalence

Age (years)	N (%)	Anemia (N, %)
18–24	11 (5.2%)	0 (0.0%)
25–34	17 (8.1%)	0 (0.0%)
35–44	47 (22.3%)	3 (6.4%)
45–54	36 (17.1%)	4 (11.1%)
55–64	62 (29.4%)	13 (21.0%)
>65	38 (18.0%)	10 (26.3%)
All ages	211 (100.0%)	30 (14.2%)

Table 2. Clinical findings according to anemia status

Clinical finding	Anemic (n, %)	Non-anemic (n, %)	Total (n, %)	Chi-squared test
Asymptomatic	10 (33.3%)	127 (70.2%)	137 (64.9%)	N=211 df=4 χ²=23.62 p<0.001.
Fatigue	3 (10.0%)	18 (9.9%)	21 (10.0%)	
Dizziness	2 (6.7%)	8 (4.4%)	10 (4.7%)	
Shortness of breath	1 (3.3%)	6 (3.3%)	7 (3.3%)	
Multiple symptoms	14 (46.7%)	22 (12.2%)	36 (17.1%)	
Total	30 (100%)	181 (100%)	211 (100%)	

counts despite the presence of microcytic hypochromic indices, suggesting possible early-stage of hematological alterations; however, iron deficiency cannot be confirmed in the absence of biochemical investigations.

Comparison of mean MCV values between groups demonstrated a marked and statistically significant difference. The mean MCV was significantly lower in the microcytic group (72.9 fL) compared to the normocytic group (87.4 fL), with an independent-samples t-test confirming a highly significant difference ($t=-13.62$, $p<0.001$). These findings indicate that microcytosis is present in a considerable proportion of participants, including individuals without obvious anemia, highlighting the clinical value of RBC indices in the early detection of underlying hematological abnormalities.

In contrast, 152 participants (72.0%) exhibited normocytic normochromic red blood cell indices, characterized by normal MCV and MCH values. Among these, 13 participants (8.6%) were identified as anemic, presenting with low Hb levels and reduced RBC counts despite normal red blood cell indices. The remaining 139 participants (91.4%) demonstrated normal Hb levels and RBC counts, indicating an overall normal hematological profile (Table 3). Importantly, no cases of macrocytic red blood cells ($MCV>100$ fL) were detected among the study participants.

The findings of this study indicate that anemia can occur despite normal red blood cell size and hemoglobin content, potentially reflecting underlying conditions such as chronic disease, early-stage anemia, or non-iron-deficiency etiologies. These results highlight the importance of assessing hemoglobin levels and RBC counts in conjunction with red blood cell indices to ensure accurate detection and classification of anemia.

Severity of anemia: microcytic vs normocytic

Among the 17 participants identified with microcytic hypochromic anemia, the majority were classified as having mild anemia. Specifically, 13 individuals (76.5%) had hemoglobin levels within the range of 11.0–12.9 g/dL, while 4 participants (23.5%) were categorized as having

moderate anemia (8.0–10.9 g/dL). No cases of severe anemia ($Hb<8.0$ g/dL) were observed in this subgroup, indicating that most microcytic hypochromic cases were of mild severity. A similar pattern was observed among normocytic normochromic participants with anemia ($n=13$), where mild anemia was also the most common presentation, affecting 8 individuals (61.5%), while 5 participants (38.5%) had moderate anemia. Likewise, no cases of severe anemia were detected in this group (Table 4).

Overall, anemia severity in both morphological categories was predominantly mild to moderate. However, moderate anemia was relatively more frequent among normocytic participants compared to the microcytic group. These findings suggest that, despite differences in red blood cell morphology, the severity of anemia in this study population remains generally mild, with no evidence of advanced or severe disease.

DISCUSSION

The present study evaluated the distribution of hematological indices among adult male patients attending outpatient services at a tertiary hospital in Makkah, Saudi Arabia, and provided insights into red blood cell (RBC) morphology, anemia status, and severity patterns. The findings demonstrated that a considerable proportion of participants exhibited abnormal hematological indices despite being clinically asymptomatic or unaware of anemia, highlighting the silent nature of early hematological alterations.

The present study demonstrated a significant difference in mean hemoglobin levels between anemic and non-anemic participants, with markedly lower values observed among anemic individuals. This finding supports the accuracy of anemia classification based on WHO criteria and highlights hemoglobin as a sensitive and reliable parameter for detecting anemia [10]. The clear distinction between groups further emphasizes the importance of routine laboratory assessment, as clinical symptoms alone may not adequately reflect underlying hematological abnormalities. The result of this

Table 3. Association between RBC morphology, hemoglobin levels, and RBC count

RBC morphology	Anemic* (n, %)	Non-anemic* (n, %)	Total (n, %)
Microcytic hypochromic	17 (28.8%)	42 (71.2%)	59 (28.0%)
Normocytic normochromic	13 (8.6%)	139 (91.4%)	152 (72.0%)
All samples	30 (14.2%)	181 (85.8%)	211 (100.0%)

Table 4. Comparison of anemia severity between common types of anemia (based on WHO classification)

Severity of anemia	Hemoglobin (g/dL)	Microcytic hypochromic (n, %)	Normocytic normochromic (n, %)
Mild anemia	11.0–12.9	13 (76.5%)	8 (61.5%)
Moderate anemia	8.0–10.9	4 (23.5%)	5 (38.5%)
Severe anemia	< 8.0	0 (0.0%)	0 (0.0%)
Total	—	17 (100%)	13 (100%)

study showed that anemia was predominantly observed in older age groups, with the highest proportion among participants aged 55–64 years, followed by those older than 65 years, while no cases were detected in individuals younger than 35 years. This age-related increase in anemia prevalence is consistent with previous studies, which have shown that anemia becomes more common with advancing age due to factors such as chronic diseases, nutritional deficiencies, and age-related physiological changes. Guralnik et al. reported a significantly higher prevalence of anemia among older adults in the United States, particularly in individuals aged ≥ 65 years, highlighting aging as a key determinant of anemia risk [11]. Similarly, a study conducted in Saudi Arabia by Zaini et al. reported a higher prevalence of anemia among older hospitalized patients, supporting the role of age-related factors in anemia occurrence [12]. The predominance of anemia in older participants in the current study may therefore reflect the cumulative effect of comorbidities and reduced nutritional status commonly observed in this age group. International studies have demonstrated considerable variation in anemia prevalence among adult males depending on demographic characteristics, nutritional status, healthcare access, and underlying chronic diseases. Population-based studies from Europe and Asia have similarly reported increased anemia prevalence among older adults, emphasizing the global impact of aging on hematological health and the importance of early laboratory-based screening strategies [2, 11, 13].

This study showed that most participants were asymptomatic, including a substantial proportion of anemic individuals, with nearly two-thirds exhibiting no clinical signs. These findings indicate that anemia, particularly in its mild or early stages, may often be clinically silent and remain undiagnosed without laboratory screening. When symptoms were present, fatigue was the most commonly reported complaint, followed by dizziness and shortness of breath. Notably, some participants experienced multiple concurrent symptoms, suggesting more pronounced clinical involvement. A study conducted in northern Germany similarly reported that symptoms commonly attributed to anemia are non-specific and frequently occur in both anemic and non-anemic individuals, suggesting that anemia may remain clinically unrecognized and that other underlying conditions may better explain these symptoms [13]. In addition, a study conducted in Makkah reported that 36% of patients presenting to the emergency department with symptoms such as shortness of breath, abdominal pain, chest pain, and drowsiness were newly diagnosed with anemia and were previously unaware of their condition [5]. Importantly, when symptoms were analyzed according to anemia status, a substantial proportion of anemic participants remained asymptomatic,

while similar symptoms were also observed among non-anemic individuals. This finding reinforces previous reports that symptoms commonly attributed to anemia are non-specific and may not reliably distinguish anemic from non-anemic patients, highlighting the risk of under-recognition in clinical practice [14].

A key finding of this study was the relatively high prevalence of microcytic hypochromic red blood cells (28.0%), with the majority of these individuals (71.2%) having normal hemoglobin and RBC counts. This may suggest early-stage hematological alterations, including possible iron deficiency or other underlying conditions. Similar observations were reported by Cappellini and Motta, who demonstrated that variations in hematological indices, particularly MCV and MCH, can occur even among apparently healthy adult males [15]. In contrast, studies from Saudi Arabia have primarily focused on anemia prevalence and risk factors rather than detailed RBC morphology. For example, Alquaiz et al. reported variability of important factors like overweight and low socio-economic status and their association with anaemia among Saudi males, but did not specifically address subclinical microcytosis, which may explain the under-recognition of early hematological abnormalities in this population [16]. Similar findings have been reported internationally, where microcytosis may precede overt anemia and remain clinically undetected for prolonged periods. Studies from both developed and developing countries have emphasized the value of routine CBC parameters, particularly MCV and MCH, in the early identification of subclinical iron deficiency and other hematological abnormalities. In many healthcare settings, especially where advanced biochemical testing is not routinely available, hematological indices remain essential low-cost screening tools for identifying individuals who may benefit from further diagnostic evaluation and early intervention [17–18].

Another important finding was that anemia was detected in both microcytic and normocytic groups, supporting the concept that anemia cannot be solely classified based on RBC size. In the present study, 28.8% of microcytic participants and 8.6% of normocytic participants were anemic. This aligns with existing literature indicating that normocytic anemia is often associated with chronic disease or inflammatory conditions, whereas microcytic anemia is more commonly linked to iron deficiency [15]. The absence of macrocytic red blood cells in this study is noteworthy and may reflect the relatively younger population structure and lower prevalence of vitamin B12 or folate deficiencies in this cohort. This finding is consistent with regional data suggesting that macrocytic anemia is less common in Saudi Arabia compared to other regions, where alcohol-related disorders contribute more significantly to macrocytosis [19].

Regarding anemia severity and following the WHO recommendations, anemia in men was categorized as moderate when hemoglobin levels were 8.0–10.9 g/dL and severe when hemoglobin levels were below 8.0 g/dL [20]. In this study, the majority of cases in both microcytic and normocytic groups were classified as mild, with no cases of severe anemia observed. This pattern is consistent with a previous study conducted in Saudi Arabia, where mild anemia was the most frequently reported category among adult populations in Makkah [21]. The predominance of mild anemia may suggest earlier detection or less advanced disease, particularly in outpatient settings. Similarly, Beghé and colleagues reported that mild anemia is often the most common presentation in community-based populations, reinforcing the need for routine screening and early intervention [22]. The finding that a considerable proportion of participants were asymptomatic despite having abnormal hematological indices further underscores the limited sensitivity of clinical symptoms in detecting early anemia. Fatigue and dizziness were the most commonly reported symptoms; however, these manifestations were present in only a minority of participants. This observation is consistent with previous research indicating that clinical symptoms of anemia are often non-specific and may not correlate well with laboratory findings, particularly in cases of mild anemia [13,22–25].

Overall, the results of this study emphasize the importance of comprehensive hematological evaluation, including RBC indices, hemoglobin levels, and RBC count, rather than relying solely on clinical presentation. The detection of microcytosis in non-anemic individuals highlights an opportunity for early intervention and prevention of progression to overt anemia. Furthermore, the findings support the need for increased awareness of subclinical hematological abnormalities in adult males in Saudi Arabia.

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish causal relationships between hematological indices and associated factors. Second, the study was conducted in a single hospital setting and included only adult male participants, which may limit the generalizability of the results to other populations, including females and community-based samples. Third, biochemical investigations such as serum ferritin, vitamin B12, and folate levels were not assessed; therefore, the underlying causes of anemia, particularly iron deficiency, could not be confirmed. Although participants' medical history was obtained from clinical records, some potential confounding factors, such as detailed dietary intake, socioeconomic status, and comorbid conditions, were not comprehensively evaluated, which may influence hematological parameters. Finally, regression-based analyses to identify inde-

pendent predictors of anemia were not performed because the study was primarily designed as a descriptive investigation, and the limited number of anemia cases may restrict the stability of multivariable models. Future studies with larger sample sizes are recommended to explore predictive and regression-based approaches.

CONCLUSIONS

This study demonstrated that anemia and abnormal hematological indices are relatively common among adult male patients attending outpatient services, with a notable proportion of cases remaining previously undiagnosed. Anemia was more prevalent in older age groups and was predominantly mild in severity. Importantly, a considerable number of participants exhibited microcytosis despite normal hemoglobin levels, suggesting early or subclinical hematological alterations. The findings also highlight that anemia may occur in both microcytic and normocytic patterns, indicating that reliance on red blood cell indices alone may be insufficient for accurate detection. Furthermore, a substantial proportion of anemic participants were asymptomatic, while similar symptoms were also observed among non-anemic individuals, indicating that clinical manifestations are non-specific and have limited value in identifying anemia. These results underscore the importance of routine laboratory screening and comprehensive evaluation of hematological parameters for early detection and appropriate management. Future studies incorporating biochemical investigations are recommended to better characterize the underlying causes of anemia and guide targeted interventions.

ABBREVIATIONS

EDTA – Ethylenediaminetetraacetic acid

Hb – Hemoglobin

MCH – Mean corpuscular hemoglobin

MCHC – Mean corpuscular hemoglobin concentration

MCV – Mean corpuscular volume

RBC – Red blood cell

RDW – Red cell distribution width

WHO – World Health Organization

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AUTHORS' CONTRIBUTION

RGZ – conceptualization, methodology, investigation, formal analysis, writing (original draft), writing (review & editing).

The author has read and approved the final version of the manuscript.

CONFLICT OF INTEREST

None to declare.

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