

ORIGINAL ARTICLE

Emergency Room as a Window for Identifying Undiagnosed Anemia: a Clinical Evaluation

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ABSTRACT

Background: Anemia is a major global health concern with significant clinical consequences, particularly when undiagnosed. The emergency department (ED) provides an important opportunity for opportunistic screening; however, data on undiagnosed anemia in Saudi Arabia are limited. This study aimed to determine the prevalence and hematological characteristics of previously undiagnosed anemia among adult ED visitors in Makkah, Saudi Arabia.

Methods: A cross-sectional study was conducted at the Security Forces Hospital, Makkah, from October through December 2024. Adult patients (≥ 18 years) without a prior diagnosis of anemia were included, while pregnant women and those with trauma or active bleeding were excluded. Demographic and clinical data were retrieved from medical records. Hemoglobin (Hb) levels were analyzed according to World Health Organization (WHO) criteria. Red blood cell indices, including mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH), were used to classify anemia types. Statistical analysis was performed using SPSS; chi-squared and *t*-tests were applied, with $p < 0.05$ considered significant. A total of 135 adults were enrolled.

Results: The prevalence of previously undiagnosed anemia was 27.4% ($n = 37$). No significant differences were observed by gender ($p = 0.96$), age group ($p = 0.28$), or nationality ($p = 1.00$). Anemic patients had significantly lower Hb levels than non-anemic individuals ($p < 0.001$). Among anemic patients, 37.8% had microcytic anemia, 59.5% had normocytic anemia, and 2.7% had macrocytic anemia. A significant association between low MCV and anemia suggested iron deficiency anemia as the predominant cause. Over one-quarter of ED patients had undiagnosed anemia.

Conclusions: Routine screening in EDs could facilitate early detection and timely intervention to reduce complications.

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KEYWORDS

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INTRODUCTION

Anemia is a major global health problem with a broad range of clinical consequences, particularly when left undiagnosed and untreated. According to the World Health Organization (WHO), anemia affects over two billion individuals worldwide, with higher prevalence observed in women of reproductive age, and the elderly

[1]. It is defined by reduced hemoglobin levels and can present itself with symptoms such as fatigue, pallor, and shortness of breath [2]. However, in many cases, anemia is asymptomatic and remains undetected until it reaches a more severe stage or is discovered incidentally during medical evaluations [3].

The emergency room (ER) often serves as the first point of contact with the healthcare system for many individuals [4]. As such, it represents a key opportunity to identify conditions like undiagnosed anemia, which can significantly impact clinical outcomes. Studies have shown that anemia is frequently overlooked in acute care settings, particularly when symptoms are non-specific or attributed to other conditions. Early recognition in the ER can prompt further investigation and timely management.

In Saudi Arabia, limited studies have evaluated the burden of undiagnosed anemia among patients. However, existing data from other settings within the country highlight a notable prevalence. A study conducted in Riyadh reported that 18% of elderly male and female patients, over 60 years old, had moderate anemia based on their hematological indices, highlighting the need for routine screening in this population [5]. Another study conducted among hospitalized elderly patients in Taif, Saudi Arabia, found that all 66 participants included in the research were newly diagnosed with anemia despite having no prior diagnosis. Furthermore, 31.8% of them had microcytic hypochromic anemia, with significantly low serum iron levels, indicating potential iron deficiency. The study concluded that anemia in older adults is often missed due to overlapping symptoms with aging and comorbid conditions, emphasizing the need for routine screening [6,7].

Despite the recognized impact of anemia, limited data exist on the prevalence of undiagnosed anemia among patients visiting emergency departments in Saudi Arabia. This study aimed to fill that gap by assessing the frequency and characteristics of undiagnosed anemia in ER visitors, ultimately advocating for better screening and early intervention strategies in acute care settings.

MATERIALS AND METHODS

Study design

This study was designed as a cross-sectional observational study aimed at determining the prevalence of previously undiagnosed anemia among patients presenting to the emergency department.

Participants

The study included male and female adult patients aged 18 years and older who presented to the emergency department on selected days during the study period. Patients were eligible for inclusion if they had no prior diagnosis of anemia and were undergoing routine blood work as part of their ER evaluation. Patients were excluded from the study if they were pregnant and lactat-

ing women, younger than 18 years of age, or presented to the emergency department due to trauma, active bleeding, or accidents, as these conditions could directly influence hemoglobin levels and confound the assessment of undiagnosed anemia.

Data collection

Data collection was carried out at the Security Forces Hospital in Makkah over a three-month period, from October through December 2024. Blood samples were obtained from eligible patients as part of their routine clinical evaluation upon presentation to the emergency department. Patients who met the inclusion criteria and did not fulfill any of the exclusion conditions were enrolled consecutively. Demographic information, presenting complaints, and medical history were recorded from patient files and electronic health records. Hemoglobin levels and other relevant hematological parameters were obtained through laboratory analysis to identify cases of previously undiagnosed anemia.

Study variables

The primary variable assessed in this study was the presence of previously undiagnosed anemia, defined by hemoglobin levels below the World Health Organization (WHO) reference range: < 13 g/dL for males and < 12 g/dL for females [1]. Secondary variables included gender, nationality, age, and presenting complaints. Patients' hemoglobin concentration, red blood cell indices (including MCV and MCH), were analyzed to classify the type of anemia, where applicable (e.g., microcytic, normocytic, or macrocytic).

Statistical analysis

All collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS), version 26.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were used to summarize categorical variables as frequencies and percentages, and continuous variables as means and standard deviations. The prevalence of undiagnosed anemia was calculated as the proportion of anemic patients among the total number of participants included. Chi-squared tests were applied to assess the association between anemia status and categorical variables such as gender and age group, while independent *t*-tests were used to compare mean age between normal and anemic participants. A *p*-value of less than 0.05 was considered statistically significant.

Ethical approval

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Security Forces Hospital at Makkah. The approval number is 0776-301224. All data were handled confidentially, and no personal identifiers were used. Since the study was based on retrospective data collected during routine clinical care, the need for informed consent was waived by the ethics committee.

RESULTS

Demographic characteristics

A total of 135 adult patients were included in this study, recruited at the Emergency Department of the Security Forces Hospital in Makkah on randomly selected days during the period from October through December 2024. All participants were 18 years or older. Out of the total sample, 68 (50.4%) were female and 67 (49.6%) were male, indicating a nearly equal gender distribution. The majority of the patients were Saudi nationals (93.3%), while 9 patients (6.7%) were non-Saudi.

The age of participants ranged from 18 to 95 years, with a mean age of 47.2 ± 19.9 years. For analysis, patients were categorized into six age groups: 28 (20.7%) were 18 - 29 years, 35 (25.9%) were 30 - 39 years, 15 (11.1%) were 40 - 49 years, 19 (14.1%) were 50 - 59 years, 23 (17.0%) were 60 - 69 years, and 15 (11.1%) were 70 years or older (Table 1).

Clinical presentations

Patients presented to the emergency department with a wide variety of clinical complaints. The most commonly reported symptom was non-specific pain, reported in over 50 cases, involving the chest, abdomen, back, limbs, or generalized body pain. Abdominal pain was recorded in more than 20 patients, while chest pain was reported in over 10 patients. Additionally, fever and upper respiratory tract infections, including cough and sore throat, were present in approximately 25 cases. Other presentations included headache, low back pain, dizziness, asthma, shortness of breath, vomiting, dysuria, gastritis, stroke, dislocations, trauma-related injuries, constipation, and palpitations.

All participants were asked whether they had a known diagnosis of anemia, and all responded "no," confirming they were unaware of having the condition. Patients with a known history of anemia were excluded from the study.

Prevalence of undiagnosed anemia

Out of the 135 patients, 37 (27.4%) were found to have previously undiagnosed anemia. Among these, 18 were female and 19 were male, indicating a nearly equal gender distribution. Additionally, two patients with undiagnosed anemia were non-Saudi (one male and one female). A chi-squared (χ^2) test showed no statistically significant association between gender and previously undiagnosed anemia ($\chi^2 = 0.00$, $p = 0.96$), nor between nationality (Saudi vs. non-Saudi) and undiagnosed anemia ($\chi^2 = 0.00$, $p = 1.00$).

The mean age of participants with undiagnosed anemia (51.7 ± 24.0 years) was slightly higher than that of non-anemic individuals (45.6 ± 18.0 years). However, statistical comparison using an independent t -test ($t = 1.37$, $p = 0.17$) showed no significant difference between the two groups. Furthermore, a chi-squared (χ^2) test comparing age group distribution between normal and anemic patients showed no significant association ($\chi^2 =$

1.15 , $p = 0.28$).

Hematological parameters among normal and anemic participants

The hemoglobin (Hb) levels of male and female participants were analyzed according to the World Health Organization (WHO) reference range, which defines anemia as Hb levels below 13 g/dL in males and 12 g/dL in females. Among males, the mean Hb level in the normal group was 15.15 ± 1.10 g/dL, whereas males with previously undiagnosed anemia had a markedly lower mean Hb level of 11.03 ± 1.27 g/dL. This difference was found to be highly statistically significant ($t = 12.43$, $p < 0.001$) (Table 2).

Similarly, female participants with normal Hb levels had a mean of 13.09 ± 0.87 g/dL, while those with undiagnosed anemia had a significantly reduced mean Hb level of 10.16 ± 1.16 g/dL. The difference between these groups was also highly statistically significant ($t = 9.76$, $p < 0.001$) (Table 2). These findings confirm that both male and female participants with undiagnosed anemia had significantly lower Hb levels compared to their normal counterparts.

Further analysis of the mean corpuscular volume (MCV) revealed that among the 37 anemic patients, 14 (37.8%) had low MCV values (< 81 fL), indicating microcytic anemia, 22 (59.5%) had normal MCV values (81 - 96 fL), consistent with normocytic anemia, and 1 patient (2.7%) had an MCV above the normal range, suggesting macrocytic anemia. Among the 98 patients without anemia, 10 (10.2%) had low MCV levels despite normal Hb, while the remaining 87 (88.8%) had normal MCV values (Table 2).

Analysis of the mean corpuscular hemoglobin (MCH) showed that all patients with low MCV values had reduced MCH levels (< 27 pg), consistent with microcytic hypochromic anemia, whereas patients with normal MCV values demonstrated MCH levels within the normal range (27 - 32 pg).

A chi-squared test demonstrated a highly significant association between low MCV levels and anemia status ($\chi^2 = 10.91$, $p = 0.001$), indicating that microcytosis was more frequent among anemic patients. Given that microcytic hypochromic anemia in adults is most commonly caused by iron deficiency anemia (IDA), these findings strongly suggest that IDA may represent the predominant underlying etiology of undiagnosed anemia in this population.

DISCUSSION

Demographic characteristics

This study investigated the prevalence and hematological characteristics of previously undiagnosed anemia in adult patients presenting to the emergency department (ED). The demographic profile revealed that 50.4% of participants were female and 49.6% were male, with no statistically significant difference in previously undiag-

Table 1. Age distribution of the study participants.

Age group (years)	Number of patients	Percentage (%)
18 - 29	28	20.70%
30 - 39	35	25.90%
40 - 49	15	11.10%
50 - 59	19	14.10%
60 - 69	23	17.00%
70 and above	15	11.10%

Table 2. Hematological parameters (Hb, MCV, and MCH) among normal and anemic participants.

Parameter	Normal participants (n = 98)	Anemic participants (n = 37)	p-value
Hb (g/dL), male (normal)	15.15 ± 1.10	-	< 0.001
Hb (g/dL), male (anemic)	-	11.03 ± 1.27	< 0.001
Hb (g/dL), female (normal)	13.09 ± 0.87	-	< 0.001
Hb (g/dL), female (anemic)	-	10.16 ± 1.16	< 0.001
MCV < 81 fL (low), n (%)	10 (10.2%)	14 (37.8%)	0.001
MCV 81 - 96 fL (normal), n (%)	87 (88.8%)	22 (59.5%)	0.001
MCV > 96 fL (high), n (%)	0 (0%)	1 (2.7%)	0.001
Low MCH (< 27 pg) among low MCV, n (%)	11 (100%)	14 (100%)	0.001
Normal MCH (27 - 32 pg) among normal MCV, n (%)	87 (100%)	22 (100%)	0.001

Data are presented as mean ± SD for continuous variables and n (%) for categorical variables. Anemia was defined as Hb < 13 g/dL in adult males and < 12 g/dL in adult females (WHO criteria).

nosed anemia prevalence between genders ($p = 0.96$). On the other hand, many studies attribute higher anemia prevalence to females due to menstrual losses and pregnancy-related iron demands [8-11]; the nearly equal distribution in our population suggests that chronic disease and dietary factors may play a greater role than reproductive status in this ED population.

The majority of participants (93.3%) were Saudi nationals, with only 6.7% being non-Saudi. This disproportion reflects the nature of the study setting, as it was conducted at the Security Forces Hospital, which primarily serves Saudi nationals and their relatives. No significant association was found between nationality and anemia status ($p = 1.00$), indicating that lifestyle and access to healthcare may be similar across these groups.

The mean age of all participants was 47.2 ± 19.9 years, and although the mean age of anemic patients (51.7 ± 24.0 years) was slightly higher than that of non-anemic patients (45.6 ± 18.0 years), this difference was statistically nonsignificant ($p = 0.17$). Furthermore, age group analysis revealed no significant association with anemia status ($p = 0.28$). These findings differ from global studies, which often show increased anemia prevalence with

advancing age, particularly after 60 years, due to chronic diseases and nutritional deficiencies [12,13]. The absence of an age-related pattern in our study may be explained by the heterogeneous ED population, where acute illnesses rather than age-related chronic conditions predominate.

Clinical presentations

The clinical presentations of patients in this study were diverse, with non-specific pain being the most common complaint, followed by abdominal pain, chest pain, fever, and respiratory symptoms. These findings are typical of ED populations, where patients frequently present with acute, non-specific complaints. Interestingly, none of the patients were aware of having anemia, consistent with the notion that anemia often develops insidiously and remains asymptomatic until it becomes severe or is discovered incidentally [14,15].

The wide range of presenting symptoms highlights the ED as a valuable opportunity for opportunistic screening. Many patients who do not seek regular primary healthcare may still present to emergency facilities for acute issues, creating a unique setting for identifying

undiagnosed chronic conditions such as anemia. Studies in similar settings have demonstrated that opportunistic screening in EDs can significantly improve early diagnosis rates for anemia and other chronic diseases [15].

Prevalence of undiagnosed anemia

In this study, 27.4% of adults were found to have previously undiagnosed anemia, which represents a relatively high prevalence for an emergency department population. This rate aligns with other research conducted in Saudi Arabia. For example, a cross-sectional study in Riyadh identified anemia in 24.2% of adults undergoing routine health assessments [8], while a study from Taif documented 66 cases of undetected anemia among hospitalized elderly males and females [6]. Moreover, Zaini (2020) reported that 36% of Saudi diabetic patients admitted to the emergency room during the study period had previously undiagnosed anemia [16].

The findings reinforce the importance of incorporating anemia screening into emergency care protocols. Identifying and treating anemia early can reduce the risk of complications such as cardiovascular strain, delayed wound healing, and impaired quality of life [5,6].

Hematological parameters among normal and anemic participants

The evaluation of hematological parameters confirmed significant differences between normal and anemic patients. Male patients with anemia had a significantly lower mean Hb level (11.03 ± 1.27 g/dL) compared to normal males (15.15 ± 1.10 g/dL, $t = 12.43$, $p < 0.001$). Similarly, anemic females had a mean Hb of 10.16 ± 1.16 g/dL compared to 13.09 ± 0.87 g/dL in non-anemic females ($t = 9.76$, $p < 0.001$). These findings confirm that anemia was clinically relevant and not merely a mild laboratory finding.

Further analysis of red blood cell indices provided insight into the likely etiology. Among anemic patients, 14 (37.8%) had low MCV values (< 81 fL), indicating microcytic anemia, while 22 (59.5%) had normocytic anemia and 1 (2.7%) had macrocytic anemia. All patients with low MCV also had low MCH values (< 27 pg), consistent with microcytic hypochromic anemia. A chi-squared test showed a highly significant association between low MCV and anemia status ($\chi^2 = 10.91$, $p = 0.001$), confirming that microcytosis was more common among anemic patients. These findings strongly suggest that iron deficiency anemia (IDA) was the predominant cause, which is consistent with previous reports in Saudi and Middle Eastern populations [17].

Interestingly, 10 (10.2%) of the non-anemic patients had low MCV and MCH values despite normal Hb, suggesting subclinical iron deficiency. Early identification and treatment in such cases may prevent progression to overt anemia. This supports recommendations for routine evaluation of MCV and MCH, even in patients with normal Hb levels, to detect early iron deficiency [18]. Normocytic anemia (59.5%) was the most common type among anemic patients, which may reflect anemia of

chronic disease or early stages of iron deficiency before significant microcytosis develops. Macrocytic anemia was rare (2.7%), consistent with the low prevalence of folate or vitamin B12 deficiency in this population.

Clinical implications and recommendations

The findings of this study have important clinical and public health implications. The high prevalence of undiagnosed anemia supports the inclusion of routine Hb testing in ED evaluations, especially for patients presenting with nonspecific symptoms such as fatigue, dizziness, or generalized pain. Early identification can guide timely intervention, preventing severe anemia and its complications.

Given that microcytic hypochromic anemia was the most common type, targeted screening for IDA, including serum ferritin and iron studies, should be considered in ED protocols. Moreover, the presence of microcytosis in non-anemic individuals highlights the need for follow-up to prevent progression to anemia.

From a public health perspective, these findings underscore the importance of nutritional education and early detection strategies for IDA, particularly in high-risk groups. Collaboration between ED physicians and primary healthcare providers is essential to ensure appropriate follow-up and management.

Strengths and limitations

A major strength of this study is its focus on the ED population, which is underrepresented in anemia research. The use of both Hb and red blood cell indices allowed for better characterization of anemia types. However, there are limitations. The cross-sectional design limits the ability to establish causality, and iron studies or ferritin levels were not performed, preventing definitive confirmation of IDA. Additionally, the study was conducted at a single center, which may limit generalizability.

CONCLUSION

This study demonstrates that the ED provides valuable opportunity for identifying undiagnosed anemia. More than a quarter of adult patients were anemic, with microcytic hypochromic anemia most likely IDA being the predominant type. Routine screening in ED settings, coupled with follow-up investigations, could significantly improve early detection and management of anemia, ultimately reducing its associated morbidity.

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Declaration of Interest:

The authors declare that they have no conflicts of interest.

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