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A comprehensive study on abnormalities associated with red blood cells in Saudi adult patients

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ABSTRACT

Objectives: The present work aimed to study red blood cells (RBCs) parameters data of Saudi patients to cover hematological patterns and evaluate abnormality prevalence.

Methods: RBCs parameters data of adult Saudi patients who attended Prince Nasser bin Saad Al-Sudairy Hospital in Alghat province between January 1, 2019 and December 31 2019 were collected and studied.

Results: The study included 1663 patients; 814 (49%) males and 849 (51%) females. The proportion of patients with anemia as defined by low levels of hemoglobin (Hb) was similar in males (20%) and females (21%) with a clear drop in the percentage of anemia among females aged 51–65 years. Data from Alghat province showed bigger proportion of patients with macrocytic anemia (high mean cell volume [MCV] = 35% in males and 25% in females) compared with microcytic anemia (low MCV = 7% in males and 19% in females). Microcytic hypochromic anemia was found to be common in women (18%) compared with men (6%), with the highest prevalence being detected in females (31%) at age 46–50.

Conclusion: This is the first study to shed light on RBCs data from Alghat province, and provide insights into anemia in adults. Anemia was seen in 20–21% of the patients, with macrocytic anemia being the most prevalent type of anemia in the studied population.

Keywords: Anemia, complete blood count, Saudi Arabia

Introduction

Hematological parameters including red blood cell (RBC) count, hemoglobin (Hb) concentration, hematocrit (Hct), mean cell volume (MCV), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC) constitute a main part of complete blood count (CBC) that is routinely performed in medical diagnostic labs.[1] These parameters have a significant diagnostic value for many diseases, particularly anemia, polycythemia, and leukemia.[2] In the context of anemia, low values of Hb concentration, Hct, and RBCs count are generic indications of anemia. Further details from the RBCs indices, such as MCV and MCH, provide additional information on anemia.[3] For instance, normal MCV with decreased MCH is characteristic of normocytic hypochromic anemia, whereas reduced MCV with normal MCH is associated with microcytic normochromic anemia. Other patients show low MCV with low MCH featuring microcytic hypochromic anemia (MHA).

Anemia has been a global health issue; it has been estimated that 1.62 billion people from developing and developed countries (approximately, 25% of the world's population) suffer from anemia.[4] In the Kingdom of Saudi Arabia, it has been reported that the prevalence of anemia ranged from 30% to 56% in women during their reproductive age.[5] In Saudi adult males, the incidence of anemia was shown to be 38%.[6] In the UAE, anemia prevalence was shown to reach 26.7% [7] Similarly, anemia prevalence was reported to be 26% in Oman.[8] In Egypt, the anemia appeared to reach higher prevalence rate; a study that was conducted on 18,338 individuals showed that the proportion of subjects with anemia was 39%.[9] In the USA, the prevalence of anemia was reported to be 5.6%, which is much less that that seen in Saudi Arabia and other Arab countries.[10]

The prevalence of anemia increases in patients with poor dietary uptake, repeated pregnancies, hemorrhage, or gastric ulcers.[11] Chronic illnesses, such as chronic kidney disease, rheumatoid arthritis, inflammatory bowel disease, chronic heart failure and cancer, have also been shown to increase the risk of developing anemia.[12] Anemia has a significant effect on all stages of human life. For example, it reduces fetal physical and mental growth, causes slowness of cognitive growth and development in children, shortens the capacity of physical activity of adults, and adversely affects the quality of life of the elderly.

Studying RBCs parameters enables researches to identify abnormal patterns of hematological measurements and determine the prevalence of abnormal values. This kind of study is essential, especially in areas lacking such reports. Alghat is a province in Riyadh region, Saudi Arabia, where no research was reported on the laboratory findings of CBC, as proven by the search engines "PubMed" and "Google Scholar," using the keywords "Alghat anemia" or "Alghat CBC." The majority of the published studies that were based on CBC data from Saudi patients were specifically conducted on a particular sex (mostly females), age group (mostly children, adults aged 18–23 or childbearing age), or physical condition (e.g. pregnancy).[5,11,13-21] In contrast, the present study included CBC data from both sexes with a wider age range (from 15 to over 70) irrespective of physical condition. As a result, the present study aimed to report insight about the hematological patterns, and the prevalence of abnormality of CBC data from people living in Alghat province.

Methods

Study design and data collection

The present work is a cross-sectional study that aimed to analyze the data of RBCs parameters of Saudi patients who attended Prince Nasser bin Saad Al-Sudairy Hospital in Alghat province between January 1, 2019, and December 31, 2019. Three ml of whole blood was drawn from each patient into EDTA tube, and CBC test was conducted on all samples using automated hematology analyzer XN-1000 Sysmex (Sysmex, Kobe, Japan). RBCs related parameters; such as RBC count, Hct, Hb concentration, MCV, MCH and mean cell hemoglobin concentration (MCHC) were recorded by a laboratorian in the hospital registry. Next, the data of RBCs related parameters of the patients were collected from the hospital registry and were transferred to an excel file for the analysis. The data were collected for 1663 patients (814 male patients and 849 female patients), the age range of the patients was from 15 years to 91 years. The study was conducted in accordance with the granted ethical approval from Prince Nasser bin Saad Al-Sudairy Hospital (approval number: GH/01 Aug 2020).

Inclusion and exclusion criteria

A number of criteria were applied to the study for the collection of RBCs-related data. The exclusion criteria are: (1) RBCs data from patients who are younger than 15 years old, (2) RBCs data from non-Saudi patients, (3) RBCs data with missing information of one or more of the following parameters (RBC count, Hb concentration, percentage of Hct, MCV, MCH and MCHC). The inclusion criteria are: (1) Saudi patients aged 15 years or older, (2) RBC data with complete information of the following parameters (RBC count, Hb concentration, percentage of Hct, MCV, MCH, and MCHC).

Statistical analysis

Prism graph pad software (version 5.04) and Excel software (version 14.4.0) were used to perform the statistical analysis and construct the graphs. The statistical significance was calculated using the student-unpaired *t*-test (significance findings must show $P \leq 0.05$).

Results

The CBC data from Saudi patients aged 15 years or older who attended Prince Nasser bin Saad Al-Sudairy Hospital in Alghat province between January 1, 2019, and December 31, 2019, were studied. The CBC data included six parameters as follows: count of RBCs, concentration of Hb, percentage of Hct, MCV, MCH, and MCHC. Figure 1 shows the values of these parameters from 814 male patients and 849 female patients. The normal value of RBCs count, Hb concentration and percentage of Hct have been known to vary in males compared with females.[1] Therefore, to make a proper comparison between the CBC values from the two genders, the values were standardized using z-score (i.e., deviation of the value from the median of normal value). Then, the z-score of the CBC values that were higher or lower than the normal values were compared in male patients and female patients [Table 1]. The analysis showed that while the number of patients with a low RBCs count was similar in males and females (164; 20% vs. 150; 18%), the z-score of the low values of RBCs count was significantly lower in males (–2.14) compared with females (–1.77; $P = 2.58 \times 10^{-9}$). This indicated that the RBCs count in relation to the normal value was lower in male patients than in female patients. Likewise, the number of patients who had Hb concentration above the normal value was similar in males compared with females (55; 7% vs. 48; 6%). Nevertheless, the z-score of the upper Hb concentration values was significantly greater in females compared with males (1.62 vs. 1.23; $P = 2.35 \times 10^{-7}$). The number of patients exhibiting Hct percentage above the normal value was almost double in males as opposed to females (123; 15% vs. 67; 8%), but women showed bigger z-score of the upper Hct values than men did (1.63; vs. 1.36; $P = 0.006$). Importantly, the number of patients with reduced MCV values was almost 3 times higher in females than in males (165; 19% vs. 61; 7%) with the z-score of the low MCV values being smaller in men compared with women (z score = –1.87 vs. –1.35; $P = 0.001$). Similarly, low MCH values were more predominant in females compared with males (203; 23% vs. 80; 10%). Males showed lower z-score of the reduced values of MCH than females did (–161 vs. –1.39; $P = 0.012$).

Furthermore, investigations were conducted to study the CBC data of the two genders in relation to age. The patients were divided into 12 age groups and the percentage of patients with values above or below the normal CBC values were determined. Figure 2 shows the abnormalities of CBC parameters in each age group of the two sexes. Although the proportion of patients

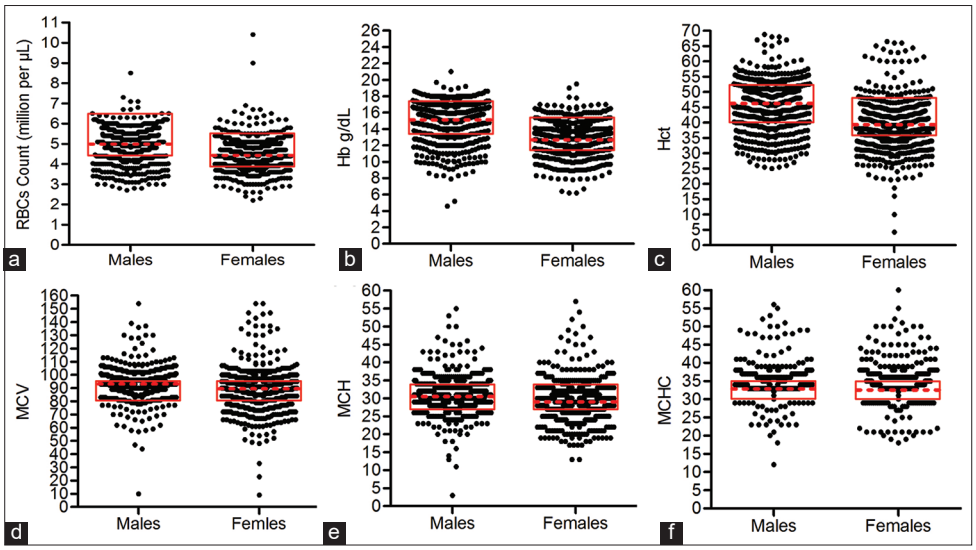

Figure 1: Values of hematological parameters from 814 male patients and 849 female patients. (a) red blood cells count; (b) hemoglobin (Hb) concentration; (c) hematocrit (Hct) percentage; mean cell volume given in femtoliter; mean cell hemoglobin (MCH) given in picogram; (f) mean cell hemoglobin concentration given in gram per deciliter. The red box shows the borders of normal values; and the dotted line represent the mean value

Table 1: Abnormality in the values of RBCs parameters in men and women

Parameter	Values above normal (z-score)			Values below normal (z-score)		
	Male	Female	*P*-value	Male	Female	*P*-value
Count of RBCs	1.55–3.87 (2.16) *n*=7 (0.9%)	1.31–7.82 (2.29) *n*=28 (3%)	0.81	–3.61–−1.42 (−2.14) *n*=164 (20%)	−3.53–−1.31 (−1.77) *n*=150 (18%)	2.58×10^{-9}
Concentration of Hb	0.96–2.53 (1.23) *n*=55 (7%)	1.16–3.31 (1.62) *n*=48 (6%)	2.35×10^{-7}	–5.02–−0.97 (−1.81) n=150 (20%)	–4.03–−1.16 (–1.82) *n*=177 (21%)	0.84
Percentage of Hct	0.96–3.12 (1.36) *n*=123 (15%)	0.77–3.50 (1.63) *n*=67 (8%)	0.006	−2.88–−0.96 (−1.67) *n*=125 (15%)	−5.39–−1.00 (−1.59) *n*=203 (24%)	0.24
MCV	0.811–6.70 (1.41) *n*=294 (36%)	0.59–4.90 (1.18) *n*=214 (25%)	0.001	−7.82 to -0.80 (−1.87) *n*=61 (7%)	–5.79–−0.63 (–1.33) *n*=165 (19%)	0.001
MCH	1.03–5.52 (1.85) *n*=86 (11%)	0.81–5.28 (1.69) *n*=72 (9%)	0.34	−6.29–−0.92 (−1.61) *n*=80 (10%)	−3.58–−0.81 (−1.39) *n*=203 (24%)	0.012
MCHC	0.76–5.76 (1.78) *n* = 107 (13%)	0.79–6.85 (1.84) *n* = 120 (14%)	0.72	–5.16–−0.76 (−1.72) *n* = 34 (4%)	−3.55–−0.74 (−1.59) *n* = 56 (7%)	0.56

Values were given as follows: range, an average, number of patients (n) and percentage. Statistical significance was determined using student-unpaired *t*-test. z-score was calculated as follows: (CBC value minus median of normal value) divided by standard deviation. MCV: Mean cell volume, MCH: Mean cell hemoglobin, MCHC: Mean cell hemoglobin concentration

with reduced RBCs count was similar in males and females (20% vs. 18%), the age group 56–60 had almost a 4 times larger percentage of patients with low RBCs count in females compared with males (41% vs. 11%). Both sexes exhibited a similar proportion of patients with low Hb concentration (20% for males vs. 21% for females). Nevertheless, the male age groups of 51–56, 56–60 and 61–65 showed at least a two-fold increase in the percentage of patients with a reduced level of Hb compared with that of women. In contrast, decreased levels of Hb dominated females aged 21–25, 41–45 and 66–77. Females aged 51–65 exhibited the lowest percentage of cases with low Hb. Interestingly, more than 40% of male and female patients aged 70 or older had low levels of Hb. Low Hct values were more common in females than in males (24% vs. 16%). On the contrary, low values of Hct in the age groups 56–60, 61–65 and >70 were more prevalent in men compared with women.

While the proportion of patients with small values of MCV was bigger in females than in males (19% vs. 7%), reduced MCV was found only in men (39%) for the age group 66–70, but not in women. High MCV values were more common in males compared with females; the predominance of high MCV values in men was over-pronounced in the age group >70 (60% form men vs. 26 for women). Small MCH values were more prevalent in females compared with males across nearly all age groups. In contrast, big MCH values were more common in males compared with females in all age groups. Although reduced MCHC values were found more frequently in females compared with males (7% vs. 4%), low MCHC values were more predominant in men ages 51–55 and 61–65.

Moreover, an analysis was performed to identify patients with MHA, as evident by low measurements of MCV and MCH.

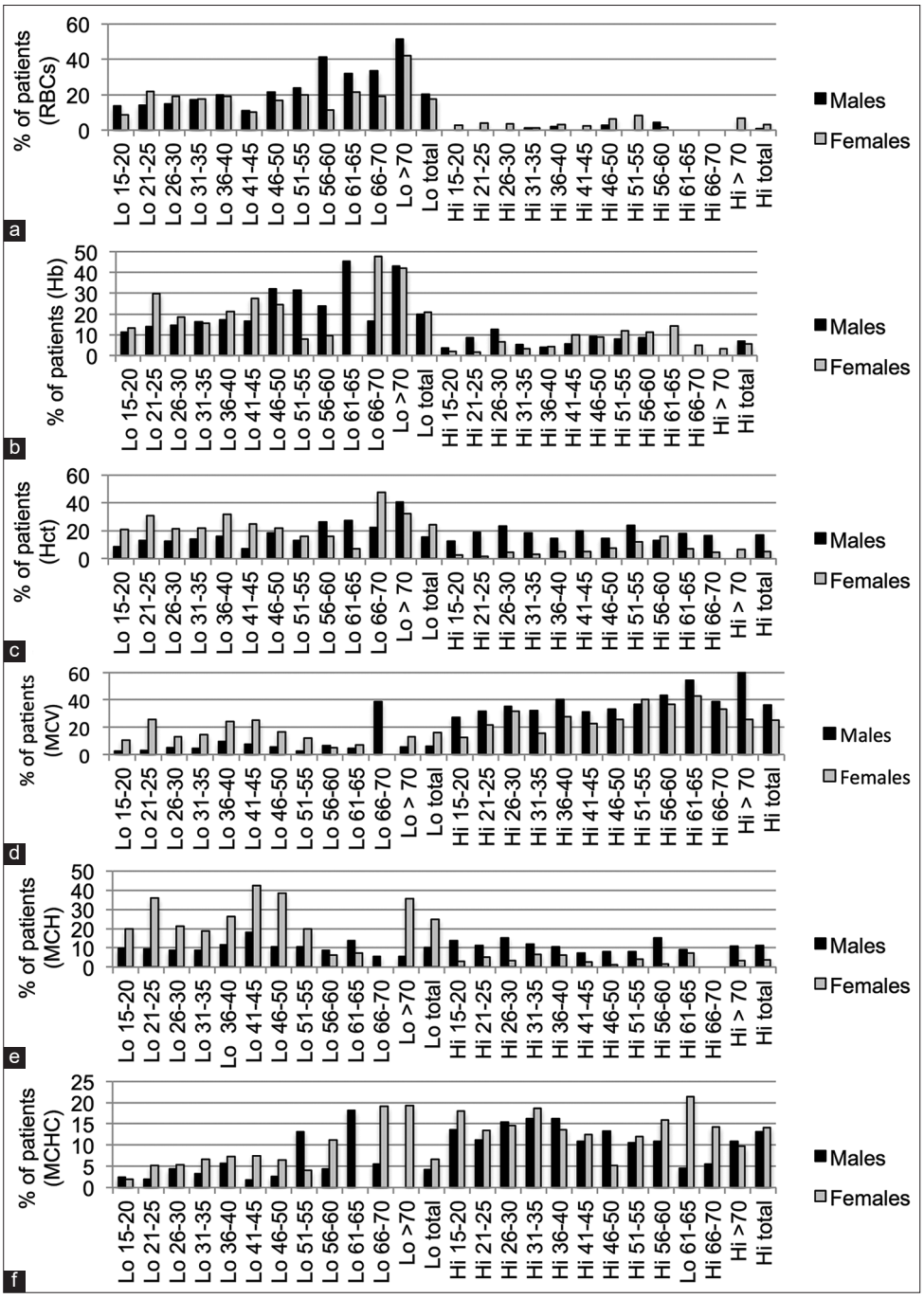

Figure 2: Percentage of patients (males and females) with abnormal values of hematological parameters. Patients were divided into 12 age groups and the percentage of abnormal values was calculated. (a) red blood cells count; (b) hemoglobin (Hb) concentration; (c) hematocrit (Hct) percentage; mean cell volume; mean cell hemoglobin (MCH); (f) mean cell hemoglobin concentration; Lo is for patients with values bellow the normal; Hi denotes patients exhibiting values greater than the normal

The analysis found that 153 female patients (18%) and 52 male patients (6%) with small values of MCV and MCH [Figure 3a]. The distribution of the low values of MCV and MCH in the 12 age groups of the sexes is shown in Figure 3b. Reduced MCV and MCH were most commonly found in females aged 46–50 (31%). In contrast, the age groups 56–60, 61–65 and 66–70 showed the smallest percentage (≤5%) of females with reduced MCV and MCH. For men, the largest proportion of patients (10%) with low MCV and MCH was found in the age group 36–40.

Discussion

Studying RBCs-related data from 849 Saudi females and 814 Saudi males from Alghat province provided insightful clues about the hematological patterns and the prevalence

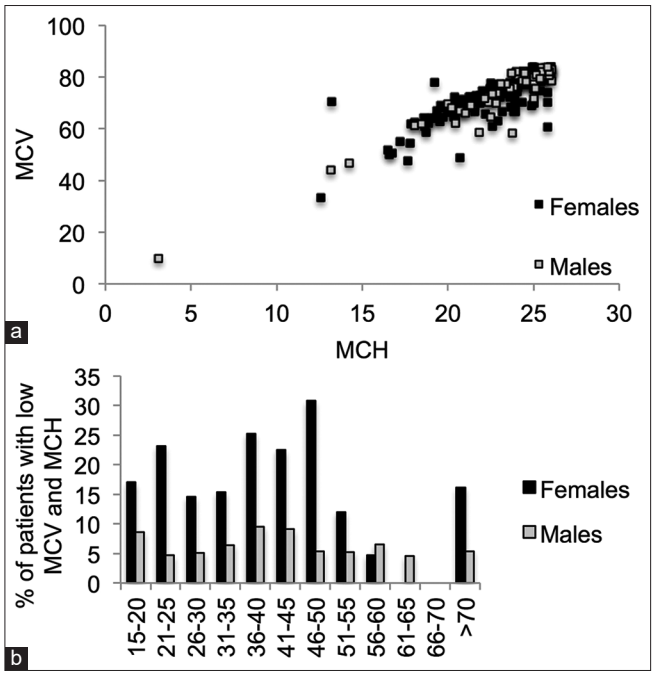

Figure 3: Comparison of female and male patients with microcytic hypochromic anemia. (a) Scattered blot of patients with values of mean cell volume (MCV) and mean cell hemoglobin (MCH) smaller than the normal. Patients were divided into 12 age groups and the percentage of abnormal values was calculated. (b) Percentage of patients with decreased MCV and MCH in each age group (12 age groups)

of abnormality of RBCs data. The incidence rate of anemia, as defined by a reduced level of Hb, was shown previously to be higher in females as opposed to males.[22] However, the present study showed a similar percentage of anemic cases (low Hb) in women and men (20% in males and 21% in females). Noticeably, there was an increase in the percentage of females with a low level of Hb in the age groups 21–25, 26–30, 36–40 and 41–45, compared with age groups 51–55, 56–60 and 61–65. These findings support the concept that anemia prevalence increases in women during their reproductive years.[22] The prevalence of anemia in Alghat province appeared to be comparable with other published data from Saudi Arabia. For example, Al Sayes *et al*. reported that 23.9% of females aged 18–23 from Jeddah city suffer from anemia.[23] Similarly, the present study found that 30% of females aged 20–25 were anemic. The World Health Organization (WHO) reported that 32% of Saudi females at reproductive age were anemic.[24] Likewise, the prevalence of anemia ranged from 21% to 32% in females aged 20–45. Furthermore, the anemia data in Alghat province are also similar to that reported from other countries. For example, anemia prevalence was shown to reach 26.7% in the UAE.[7] Similarly, anemia prevalence was reported to be 26% in Oman.[8] In Egypt the anemia appeared to reach higher prevalence rate; a study that was conducted on 18,338 individuals showed that the proportion of subjects with anemia was 39%.[9] In the USA, the prevalence of anemia was reported to be 5.6%, which is much less that that seen in Saudi Arabia and other Arab countries.[10]

In the context of anemia among elders, a study conducted on CBC data of Saudi patients (age ≥60) from Riyadh city reported that 5.6% of males and 18% of females had anemia.[25] These findings were much less than that found in Alghat province, where the proportion of anemic patients were as follows: age group 61–65 (females = 0%; males = 45%), age group 66–70 (females = 48%; males = 17%) and age group ≥70 (females = 42%; males = 43%). In consistence with these data, patients ≥70 years exhibited reduced count of RBCs (51% of males and 42% of females) and decreased levels of Hct (41% of men and 32% of women). The increased prevalence of anemia in elderly people was previously attributed to the less adequate hemopoiesis, as evidenced by the resistance of hemopoietic stem cells to erythropoietin, which has been frequently reported in elderly patients.[26]

The proportion of patients with large sized RBCs (high MCV = 25% in females and 36% in males) was almost double that of patients with small sized RBCs (low MCV = 19% in females and 7% in males). Macrocytic anemia can be caused by a variety of factors, including deficiency of vitamin B12 and/or folate.[27] The data from Alghat province did not agree with the data from other parts of Saudi Arabia; studies based on people living in Riyadh city, Madinah city, and Aseer city showed that the prevalence of microcytic anemia was much higher than that of macrocytic anemia (0.7% high MCV vs. 24% low MCV in Riyadh city; 0.4% high MCV vs. 52% low MCV in Madinah city; 0% high MCV vs. 45% low MCV in Aseer city).[14,28,29] This may call for screening of Vitamin 12 and/or folate levels in Alghat's patients with big value of MCV to determine whether the large RBCs were associated with a low concentration of vitamin B12 and/or folate.

The present study showed that MHA was more common among women (18%) compared with men (6%). MHA is mostly caused by reduced levels of body storage of iron.[27] Therefore, small RBCs with low content of Hb are characteristics of iron deficiency anemia (IDA).[30] In comparison with males, females of Saudi Arabia were commonly diagnosed with MHA.[31] In Riyadh city, 40% of women at childbearing age were reported with MHA.[11] In the present study, 15–31% of females aged 21–50 had MHA. In Jeddah city, 23.9% of Saudi females aged 18–23 were diagnosed with MHA.[23] The data from Alghat showed that from 17% to 23% of girls aged 15–25 had MHA. As mentioned earlier, a reduced level of iron is a key factor in developing MHA. Iron deficiency was shown to be associated with poor dietary systems and increased body demand, such as pregnancy. In Saudi Arabia, iron intake was shown to be lower than the recommended dose in women compared with men.[32]

The data available for study from Alghat province did not allow the search for driving factors of anemia in the studied cohort. However, different factors have been shown to contribute to anemia. For example, frequent pregnancy is common cause of

anemia in females at their reproductive age.[22] Furthermore, low iron intake, which was shown to be more common in females compared with males in Saudi Arabia, was reported to contribute to IDA.[32] Low intake of vitamin B12 and/or folate is known to lead to macrocytic anemia.[27] Therefore, the high rate of macrocytic anemia in Alghat province calls for screening of vitamin B12 and/or folate to determine their levels in the patients. This would help to identify the driving cause of macrocytic anemia and direct therapy.

While the present study provided important information about anemia in Alghat province, there were some limitations of the study. For example, comorbidity data were not available for the study to search for possible association of anemia with other diseases. Social information was also not available limiting the possibility to link anemia with particular habit and daily practice. Other laboratory tests, such as serum iron, ferritin, vitamin B12 and folate, were not provided preventing further investigation of the underlying cause of anemia in the studied cohort.

Collectively, the finding reported here are of benefit as they fill a knowledge gap of anemia in Alghat province, and provide information that has been needed to construct knowledge necessary to tackle this disease.

Conclusion

Overall, the present study is the first to report clinical findings based on CBC data from patients living in Alghat province. The analysis indicated similar proportions of anemic cases among women and men, with an increased percentage of anemic females younger than 46 years old. Notably, more than 40% of patients (>70 years) had anemia, calling for additional healthcare to be applied to this age group. Macrocytic anemia was found to be significantly more prevalent in Alghat province compared to other parts of Saudi Arabia, urging for an effort to identify the cause of such a finding. MHA was also found to be more common in women compared with men. Taken together, this study provided insightful clues about hematological findings in patients from Alghat province. Future work will be conducted by acquiring additional clinical and laboratory data to search for the driving cause of anemia seen in Alghat province to tackle the disease.

Authors' Declaration Statements

Ethics approval and consent to participate

The study was conducted in accordance with the granted ethical approval from Prince Nasser bin Saad Al-Sudairy hospital (approval number: GH/01 Aug 2020).

Availability of data and material

The data are available from the laboratory registry of Prince Nasser bin Saad Al-Sudairy hospital.

Competing interests

The author declared no conflict of interest.

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Authors' Contributions

This work was singly authored by S.A.A.

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