Clin. Lab. 2025;71:XXX-XXX
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ORIGINAL ARTICLE

Prevalence and Classification of Anemia among Renal Failure Patients of Al Majmaah and Al Zulfi Hospitals, Riyadh, Saudi Arabia

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SUMMARY

Background: **Anemia is a grave problem of renal failure and has important adversative consequences. When unhealthy renal system drops its capability to make the erythropoietin critical to the formation of hemoglobin, anemia is developed. Anemia with renal failure is well-defined as a condition in which the level of hemoglobin (Hb) in the blood is under the normal range.**

Methods: **A retrospective study was done to evaluate the prevalence of anemia in individuals diagnosed with renal failure at the hospitals of Al Majma'ah and Al Zulfi in Saudi Arabia. The patients' data were collected from June 2020 through June 2024, and 152 participants diagnosed with renal failure and undergoing hemodialysis have been included in the study.**

Results: **The study included 63% males and 37% females, and 77% in Majmaah and 59% in Zulfi were anemic. The average age of participants in Majmaah was 55.1 years, while in Zulfi, the average age was 53.4 years. Hb level in Majmaah was 10.1 g/dL, matching the 10.8 g/dL in Zulfi. The averages of the mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were higher in patients from Majmaah compared to Zulfi, with values of 92.325 fL vs. 88.78 fL and 29.671 pg vs. 28.82 pg, respectively, and with minimal variations in mean corpuscular hemoglobin concentration (MCHC; 32.2 g/dL vs. 32.5 g/dL). The mean glycated hemoglobin (HbA1c) levels were 6.2% and 6.5% at Majmaah and Zulfi, respectively. Ferritin levels were substantially higher in Majmaah than in Zulfi (569.6 ng/mL vs. 487.3 ng/mL). The mean urea and creatinine concentrations were higher in Majmaah than in Zulfi (22.5 md/dL vs. 10.9 mg/dL and 746.7 µmol/L vs. 476.2 µmol/L). Significant differences in Hb levels were observed between patients with and without anemia. HbA1c levels approached significance in Majmaah but not in Zulfi. Hb exhibited a significant negative correlation with ferritin ($r = -0.349$, $p < 0.05$). MCV showed a strong positive correlation with MCH ($r = 0.730$, $p < 0.05$) and a positive correlation with urea ($r = 0.225$). Additionally, MCH was significantly and positively correlated with MCHC ($r = 0.394$, $p < 0.05$) and urea ($r = 0.241$, $p < 0.05$).**

Conclusions: **The prevalence of anemia was generally high among renal failure patients treated at Majmaah and Zulfi hospitals. Normocytic normochromic anemia is the most prevalent type in patients with renal failure. Preventive measures and targeted interventions are necessary to reduce anemia prevalence in patients of renal failure in Saudi Arabia.**

(Clin. Lab. 2025;71:xx-xx. DOI: 10.7754/Clin.Lab.2024.241046)

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Manuscript accepted November 4, 2024

KEYWORDS

anemia, renal failure, Riyadh region, Saudi Arabia

INTRODUCTION

Anemia is a grave impediment of renal failure and has major adverse consequences. When an unhealthy kidney mislays its capability to synthesize the erythropoietin necessary to the synthesis of Hb, anemia occurs [1]. Anemia with renal failure is described as a condition in which the level of Hb in the blood is under the normal Hb range. Based on the Kidney Disease Improving Global Outcomes (KDIGO) Anemia Work Group, anemia in renal failure happens when the Hb range is less than 13 g/dL for males and less than twelve gram/dL for females. An expected glomerular filtration rate (eGFR) of less than 60 mL/minute/1.73 m^2 is a good gauge for the analysis of anemia in renal failure cases [2]. Big variances have been stated on the extent of anemia in cases of renal failure across studies. Some studies displayed anemia prevalence of 48% in America, 39.36% in Bharat [3], 97.8% in Brazil [4], 51.5% in China [5], 79% in Cameroon, 43.18% in South Africa [6], and 64.5% in Ethiopia [7]. Furthermore, people from the USA had a three-time bigger possibility of anemia, paralleled with whites. Though the main reason of anemia in cases with renal failure is the insufficient synthesis of erythropoietin from the kidneys to back erythropoiesis, there is also the outcome of a multifaceted relationship among patient-specific characteristics, including diabetes with or deprived of nephropathy, progressive renal failure periods, nutritious deficiency, diabetes mellitus, blood diseases, not enchanting iron increments, lung diseases, and BMI less than 18.5 kg/m^2. The impending contrary clinical consequences of anemia in renal failure cases comprise cognitive damage, heart pain, heart-kidney anemia syndrome, upper medical charges and condensed value of life, bigger hospital admittance frequency, deteriorating renal failure, faster development of heart disease, and greater death rate [8]. Though, some researches have revealed that early documentation and quick management of anemia through near stabilization of Hb and iron levels in renal failure cases is linked with abridged renal disease advancement, as well as improved energy, work capability, value of life, brain function, and heart function. Moreover, improving the Hb or hematocrit value before starting dialysis may decrease death rate. Similarly, researches reveal that positive associations between rises in Hb levels and value of life methods were testified [8]. Though, discrepancy was witnessed among these researches. A research study done by Al Quaiz found a significant frequency of anemia among females from Riyadh, with an estimated 37 percent of females suffering from the condition. Many studies have been undertaken in various population groups such as school children, teenagers, university students, and females in the reproductive age group in Saudi Arabia, and the findings have revealed a high incidence of anemia in these categories in the country [9,10]. Renal disease is the fifth most common disease causing death in Saudi Arabia; the rate is 32.09% according to Saudi Arabia's top 50 causes of death. A study was conducted by Athar Mohamed Khalifa et al. in Al Jouf Province of Saudi Arabia on renal failure patients, in which the majority of the study population was found to be anemic (moderate anemia) 63.7% at age ≤ 85. The relationship between gender and the anemic state was assessed, and it was found that males represent about 53.3% and females 46.7%. They assessed the relationship between chronic diseases and anemic states, such as IHD, bronchial asthma, diabetes, hypertension, and Down syndrome. Hypertension was found to be the highest prevalent primary etiology among patients who developed CKD compared with other primary causes. Yet, this study provides the much-needed data regarding the degree of anemia in the CKD population in Saudi Arabia, which has not been done before so far. Comprehension study is required in a large population for the estimation of the prevalence of anemia in CKD in the Saudi population. Studies on the different tertiary level hospitals of different parts of Saudi Arabia involving a large population size will be more representative of the entire country [11].

MATERIALS AND METHODS

This is a retrospective study that was done to evaluate the prevalence of anemia in individuals diagnosed with renal failure. This study has been conducted at the hospitals of Al Majma'ah and Al Zulfi in Saudi Arabia. The patients' data was collected from June 2020 through June 2024. A total of 152 participants diagnosed with renal failure and undergoing hemodialysis have been included in the study.

Inclusion criteria

1) Adults aged 18 years or older
2) Both genders (female and male)
3) Comprehensive medical records of individuals who were officially diagnosed with renal failure

Exclusion criteria

1) Individuals younger than 18 years
2) Individuals diagnosed with blood diseases or other comorbidities that have a major impact on their hemoglobin levels
3) Patients who are either reluctant or unable to grant in-formed consent

Data was taken from pre-established data collection sheets, including gender, age, complete blood counts, serum ferritin level, renal function (urea and creatinine), and HbA1c. Data were recorded in excel sheets, from patients' files. Then, it was transferred to SPSS (Statistical Package for Social Sciences), version 22, (IBM Corp., USA) for analysis purposes. Frequencies, per-

Table 1. Demographic and laboratory characteristics of the participants in both hospitals.

Demographic and laboratory characteristics	Majmaah hospital		Zulfi hospital	
Gender, n (%) (f, m)	m = 38 (63)	f = 22 (37)	m = 58 (63)	f = 34 (37)
Anemia status, n (%) (a, wa)	a = 46 (77)	wa = 13 (22)	a = 54 (59)	wa = 38 (41)
	mean ± SD	range	mean ± SD	range
Age	55.1 ± 15.2	22 - 84	53.4 ± 16	24 - 85
Hb	10.1 ± 2	5.7 - 15.8	10.8 ± 1.9	4.9 - 14.6
MCV	92.325 ± 6.302	81.5 - 108.70	88.78 ± 6.269	72 - 102
MCH	29.671 ± 2.130	25.40 - 33.50	28.82 ± 2.333	22 - 36
MCHC	32.2 ± 1.1	28.7 - 34.5	32.5 ± 1.5	28.7 - 35.8
HbA1c	6.2 ± 1.6	4.6 - 11.8	6.5 ± 2	2.1 - 13.7
Ferritin	569.6 ± 305.1	50.6 - 1,578	487.3 ± 372.1	8 - 1,739.5
Urea	22.5 ± 9.3	3.1 - 54.2	10.9 ± 8.3	1.4 - 34.8
Creatinine	746.7 ± 335.1	123 - 1,772	476.2 ± 310.9	84.5 - 1,458

Table 2. Comparison of laboratory characteristics between participants with anemia and without anemia in both hospitals.

Lab results	Majmaah hospital			Zulfi hospital		
	anemic (A)	without anemia (WA)	p-value	anemic (A)	without anemia (WA)	p-value
Hb	9.39 ± 1.58	12.61 ± 1.44	0.001 *	9.6 ± 1.3	12.5 ± 0.9	0.001 *
MCV	92.58 ± 6.41	89.48 ± 4.323	0.296	89.2 ± 6.37	87.56 ± 5.933	0.230
MCH	29.79 ± 2.155	28.42 ± 1.445	0.172	28.96 ± 2.4	28.49 ± 2.205	0.381
MCHC	32.16 ± 1.15	32.23 ± 0.87	0.83	32.4 ± 1.7	32.5 ± 1.4	0.817
HbA1c	6.6 ± 1.72	5.25 ± 0.7	0.059	6.7 ± 2	6.3 ± 2.1	0.433
Ferritin	584.19 ± 307.21	487.55 ± 287.15	0.314	487.2 ± 333.4	487.3 ± 425.7	0.999
Urea	22.62 ± 9.78	22.23 ± 8.42	0.898	10.4 ± 7.5	11.7 ± 9.3	0.449
Creatinine	748.67 ± 361.53	720.15 ± 236.22	0.79	446.2 ± 307.1	518.9 ± 315.4	0.272

*** - Statistically significant at $p < 0.05$.**

Table 3. Comparison of laboratory characteristics between the hospitals, among the participants with anemia.

Lab results	Anemia (A)		
	Majmaah hospital	Zulfi hospital	p-value
Hb	9.39 ± 1.58	9.6 ± 1.32	0.468
MCV	89.48 ± 4.323	87.56 ± 5.933	0.498
MCH	28.42 ± 1.445	28.49 ± 2.205	0.946
MCHC	32.16 ± 1.15	32.45 ± 1.66	0.32
HbA1c	6.6 ± 1.72	6.69 ± 1.96	0.868
Ferritin	584.19 ± 307.21	487.2 ± 333.41	0.136
Urea	22.62 ± 9.78	10.39 ± 7.49	0.001 *
Creatinine	748.67 ± 361.53	446.19 ± 307.07	0.001 *

*** - Statistically significant at $p < 0.05$.**

Table 4. Gender-wise comparison of lab characteristics in both hospitals among the participants with anemia.

Lab results	Anemia (A)		
	men	women	p-value
Hb	9.6 ± 1.5	9.3 ± 1.33	0.334
MCV	88.16 ± 6.05	86.57 ± 3.837	0.547
MCH	28.40 ± 2.243	28.84 ± 1.268	0.646
MCHC	32.44 ± 1.39	32.04 ± 1.56	0.21
HbA1c	6.73 ± 1.92	6.48 ± 1.77	0.657
Ferritin	491.12 ± 290.48	622.38 ± 377.1	0.06 *
Urea	16.73 ± 10.89	14.42 ± 9.67	0.313
Creatinine	632.09 ± 388.78	481.26 ± 282.07	0.055

*** - Statistically significant at $p < 0.05$.**

Table 5. Correlation matrix of laboratory characteristics among the participants with anemia.

Lab results	Correlation matrix among renal failure patients (A)							
	Hb	MCV	MCH	MCHC	HbA1c	Ferritin	Urea	Creatinine
Hb	1	0.004	0.024	0.076	-0.233	-0.349 *	-0.091	0.047
MCV		1	0.730 *	-0.074	-0.187	0.151	0.225 *	0.175
MCH			1	0.394 **	-0.255	0.104	0.241 *	0.172
MCHC				1	-0.038	-0.049	0.065	0.087
HbA1c					1	0.048	0.107	0.049
Ferritin						1	0.163	0.065
Urea							1	0.841 *
Creatinine								1

*** - Showing statistically significant correlation at $p < 0.05$.**

centages, mean, and standard deviations were calculated where appropriate as descriptive statistics. Shapiro-Wilk test suggested that the data was non-normally distributed, which is why the non-parametric Mann-Whitney test for differences was applied. p-values less than or equal to 0.05 were considered statistically significant.

RESULTS

Table 1 summarizes the demographic and laboratory characteristics of the participants from Majmaah and Zulfi hospitals. The proportion of men and women included from both hospitals were similar (63% men and 37% women), and anemia was diagnosed in 46 (77%) and 54 (59%) participants in Majmaah and Zulfi, respectively. The average age of the participants in Majmaah and Zulfi was 55.1 (SD = 15.2, range: 22 - 84 years) and 53.4 years (SD = 16, range: 24 - 85 years), respectively. Mean hemoglobin (Hb) levels in patients from Majmaah and Zulfi were 10.1 g/dL (SD = 2) and 10.8 g/dL (SD = 1.9), respectively. The averages of the mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were higher in patients from Majmaah compared to patients from Zulfi, with values of 92.325 fL vs. 88.78 fL; SD 6.302 vs. 6.269 and 29.671 pg vs. 28.82 pg; SD 2.130 vs. 2.333, respectively, and with minimal variations in mean corpuscular hemoglobin concentration (MCHC; 32.2 g/dL vs. 32.5 g/dL; SD 1.1 vs. 1.5). The mean glycated hemoglobin (HbA1c) levels were 6.2% (SD = 1.6) and 6.5% (SD = 1.5) in patients from Majmaah and Zulfi, respectively. Ferritin levels were substantially higher among patients from Majmaah than among patients from Zulfi (569.6 ng/mL vs. 487.3 ng/mL; SD 305.1 vs. 372.1). The mean urea and creatinine concentrations were higher in Majmaah than in Zulfi (22.5 mg/dL [SD = 9.3] vs. 10.9 mg/dL [SD = 8.3] and 746.7 µmol/L [SD = 335.1] vs. 476.2 µmol/L [SD = 310.9]).

Table 2 presents the comparison of laboratory charac-

teristics between patients with and without anemia from both hospitals. Significant differences in Hb levels were observed in patients from both Majmaah and Zulfi hospitals (9.39 ± 1.58 vs. 12.61 ± 1.44) and (9.6 ± 1.3 vs. 12.5 ± 0.9), respectively (p = 0.001 for both). MCV, MCH, and MCHC were not significantly different between patients with or without anemia. HbA1c levels approached significance in Majmaah (p = 0.059) but not in Zulfi. The ferritin, urea, and creatinine levels were not significantly different between the groups at either hospital.

Patients with anemia showed no significant differences in Hb, MCV, MCH, MCHC, HbA1c, and ferritin levels between the two hospitals. Notably, urea (22.62 ± 9.78 vs. 10.39 ± 7.49) and creatinine levels (748.67 ± 361.53 vs. 446.19 ± 307.07) were significantly higher in Majmaah (p = 0.001 for both) (Table 3).

Sex-wise comparison of patients with anemia revealed no significant differences in Hb, MCV, MCH, MCHC, HbA1c, and urea levels. Ferritin levels were higher in women than in men (622.38 ± 377.1 vs. 491.12 ± 290.48), approaching significance (p = 0.06). Creatinine levels were higher in men than in women (632.09 ± 388.78 vs. 481.26 ± 282.07), near significance (p = 0.055) (Table 4).

The correlation matrix for patients with anemia revealed several significant correlations between laboratory characteristics. Hb levels were significantly negatively correlated with ferritin levels ($r = -0.349$, $p < 0.05$). MCV demonstrated a strong positive correlation with MCH ($r = 0.730$, $p < 0.05$) and a positive correlation with urea ($r = 0.225$). Additionally, MCH demonstrated significant positive correlations with MCHC ($r = 0.394$, $p < 0.05$) and urea ($r = 0.241$, $p < 0.05$). Finally, urea levels demonstrated a strong positive correlation with creatinine levels ($r = 0.841$, $p < 0.05$).

DISCUSSION

The proportions of men and women included from both hospitals were similar (63% men and 37% women), which is closer with the findings of a study by Khalifa et al. [11]. Among the included patients, 46 (77%) and 54 (59%) participants from Majmaah and Zulfi had anemia, aligning with the results of a study conducted in Al Jouf, Saudi Arabia [11], and those of Lau et al. and Ponte et al. [12,13]. The incidence was higher than that reported in Korea (44.9%), Tanzania (33%), the United States (15%), and the United Kingdom (6.76%) [14-17]. However, it was lower than that reported by other studies (77.5%, 67%, and 64.5% in Nigeria, Kenya, and the University of Gondor, Ethiopia, respectively) [18,19]. The average age of participants from Majmaah and Zulfi was 55.1 and 53.4 years, respectively, which was consistent with the results of Khalifa et al. [11]. Mean hemoglobin (Hb) levels in patients from Majmaah and Zulfi were 10.1 g/dL and 10.8 g/dL, respectively. The averages of the mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were higher in patients from Majmaah compared to patients from Zulfi, with values of 92.325 fL vs. 88.78 fL and 29.671 pg vs. 28.82 pg, respectively, and with minimal variations in mean corpuscular hemoglobin concentration (MCHC; 32.2 g/dL vs. 32.5 g/dL). These findings are consistent with those of a study conducted in Malaysia [20]. In contrast, HbA1c levels were 6.2%, and 6.5% in patients from Majmaah and Zulfi, respectively. Ferritin levels were substantially higher in patients from Majmaah than in patients from Zulfi (569.6 ng/mL vs. 487.3 ng/mL), which were consistent with those reported by a study conducted in Korea [21]. The mean urea concentrations were higher in patients from Majmaah than those in Zulfi (22.5 md/dL vs. 10.9 mg/dL). Finally, mean creatinine levels were substantially higher in patients from Majmaah than those in Zulfi (746.7 µmol/L vs. 476.2 µmol/L). These high urea and creatinine levels were consistent with those of a study conducted in Malaysia [20].

Significant differences in Hb levels were observed in patients with and without anemia from both Majmaah and Zulfi hospitals (both p = 0.001). No significant differences in MCV, MCH, and MCHC were observed between patients with or without anemia. HbA1c levels approached significance in Majmaah (p = 0.059) but not in Zulfi. The levels of ferritin, urea, and creatinine were not significantly different between the groups at either hospital.

No significant differences in Hb, MCV, MCH, MCHC, HbA1c, and ferritin levels were observed among patients with anemia from Majmaah and Zulfi hospitals. Notably, urea (22.62 ± 9.78 vs. 10.39 ± 7.49) and creatinine levels (748.67 ± 361.53 vs. 446.19 ± 307.07) were significantly higher in patients from Majmaah hospital (p = 0.001 for both).

Sex-wise comparison of patients with anemia revealed no significant differences in Hb, MCV, MCH, MCHC, HbA1c, and urea levels. Ferritin levels were higher in women than in men (622.38 ± 377.1 vs. 491.12 ± 290.48), approaching significance (p = 0.06). Creatinine levels were higher in men than in women (632.09 ± 388.78 vs. 481.26 ± 282.07), near significance (p = 0.055) (Table 4).

The correlation matrix for patients with anemia revealed several significant correlations between laboratory characteristics. Hb levels were significantly negatively correlated with ferritin levels ($r = -0.349$, $p < 0.05$). MCV demonstrated a strong positive correlation with MCH ($r = 0.730$, $p < 0.05$) and a positive correlation with urea ($r = 0.225$). Additionally, MCH demonstrated significant positive correlations with MCHC ($r = 0.394$, $p < 0.05$) and urea ($r = 0.241$, $p < 0.05$). These findings are consistent with those of Yu et al. [22].

CONCLUSION

The prevalence of anemia was generally high among renal failure patients treated at Majmaah and Zulfi hospitals. Normocytic normochromic anemia is the most prevalent type in patients with renal failure. Anemia of mild and moderate severity was predominant in both sexes. There was no significant difference in HbA1c levels between patients with or without anemia, suggesting that diabetes is not a risk factor for development of anemia in renal failure. Our findings indicated higher levels of biochemical parameters like ferritin, urea, and creatinine in the patients of renal failure. Preventive measures and targeted interventions are necessary to reduce anemia prevalence in patients with renal failure in Saudi Arabia.

Acknowledgment:
This research was supported by the Majmaah University and hospitals of Al Majma'ah and Al Zulfi, Riyadh region, Saudi Arabia.

Ethical Consideration:
The confidentiality of the patients has been maintained according to the rules and regulations of the hospital.

Ethical Approval:
The research was approved by the Institutional Review Board of King Fahad Medical City Riyadh/Riyadh Second Health Cluster (IRB log number: 24-310C).

Declaration of Interest:
There are no conflicts of interest for all researchers.

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