



## Burden of Anemia in Chronic Kidney Disease: A Cross-Sectional Study from the Nephrology Division, Khyber Teaching Hospital, Peshawar

Samra Suhail<sup>1</sup>, Ali Raza<sup>1</sup>, Annum Riaz Ahmed<sup>1</sup>, Rabia Khan Khalil<sup>1</sup>, Wisha Mushtaq<sup>2</sup>

<sup>1</sup>Nephrology Division, Khyber Teaching Hospital, Peshawar, KP, Pakistan.

<sup>2</sup>Khyber Medical College, Peshawar, KP, Pakistan.

### ARTICLE INFO

**Keywords** Chronic Kidney Disease, Anemia, Disease Burden, Khyber Teaching Hospital, Prevalence,

**Correspondence to:** Ali Raza,  
Resident Nephrologist, Khyber Teaching  
Hospital, Peshawar, KP, Pakistan.  
**Email:** [meetdoctorali@gmail.com](mailto:meetdoctorali@gmail.com)

### Declaration

#### Authors' Contribution

All authors equally contributed to the study and approved the final manuscript

**Conflict of Interest:** No conflict of interest.

**Funding:** No funding received by the authors.

### Article History

Received: 12-04-2025 Revised: 16-06-2025  
Accepted: 24-06-2025 Published: 30-06-2025

### ABSTRACT

**Background:** Chronic kidney disease (CKD) is a progressive condition commonly associated with anemia, especially in patients undergoing maintenance hemodialysis. Anemia contributes significantly to morbidity and mortality in CKD and is influenced by multiple demographic, clinical, and behavioral factors. **Objective:** To determine the prevalence of anemia among dialysis-dependent CKD patients at a tertiary care hospital in Pakistan and to identify key variables associated with its occurrence. **Methods:** A prospective, descriptive cross-sectional study was conducted from November 2024 to March 2025 at the Nephrology Unit of Khyber Teaching Hospital, Peshawar. A total of 284 adult hemodialysis-dependent CKD patients were enrolled using consecutive sampling. Data were collected via structured questionnaires and medical records. Anemia was defined as hemoglobin <12 g/dL in males and <11 g/dL in females. **Results:** The overall prevalence of anemia was 73.0%. Anemia was more common in females (85.6%), elderly patients (>75 years: 90%), those with diabetes (83.1%), hypertension (79.0%), lower educational levels, and longer CKD duration (>3 years: 89.8%). **Conclusion:** Anemia is highly prevalent among dialysis-dependent CKD patients, with specific subgroups at greater risk. Early identification and targeted management of these risk factors are crucial for improving patient outcomes.

### INTRODUCTION

Chronic kidney disease (CKD) is characterized by either kidney damage or a sustained reduction in glomerular filtration rate (GFR) below 60 mL/min/1.73 m<sup>2</sup> for a duration of three months or more, regardless of the underlying cause. Its global prevalence is rising at an alarming rate.(1) The kidneys play a vital role in regulating blood pressure, maintaining electrolyte balance, synthesizing the active form of vitamin D, and producing erythropoietin—a hormone that stimulates the production of red blood cells. Chronic Kidney Disease (CKD) has far-reaching consequences, adversely affecting almost all major organ systems and contributing to significant morbidity and mortality.(2) In Chronic Kidney Disease (CKD), kidney function gradually declines, often without noticeable symptoms until the disease reaches advanced stages. At that point, it is frequently associated with a high burden of complications, including cardiovascular and vascular disorders, anemia, pulmonary issues, sleep disturbances, fatigue, depression(3) bleeding(4), viral hepatitis B & C infection, and uremic pruritus(5).

Anemia associated with chronic renal insufficiency (CRI) holds considerable clinical and public health significance. It is a common complication of Chronic

Kidney Disease (CKD) and contributes substantially to global morbidity.(6,7) The overall prevalence of anemia was 7.3%, with a gender-wise distribution of 3.5% in men and 10.7% in women.(8) Iron deficiency anemia is commonly observed in patients, often as a result of increased iron demand driven by accelerated erythropoiesis following the administration of erythropoiesis-stimulating agents (ESAs).(9) Anemia is an early manifestation of chronic renal failure, with its consequences primarily affecting the cardiovascular system. Cardiovascular morbidity and mortality are strongly correlated with the severity of anemia.(10) Anemia is a common and well-recognized complication of Chronic Kidney Disease (CKD), with iron deficiency being highly prevalent among affected patients.(11) Patients with Chronic Kidney Disease (CKD) may lose up to 3 grams of iron annually due to ongoing blood losses, including those from frequent laboratory testing, gastrointestinal bleeding, and hemodialysis-related losses.(12) The National Health and Nutrition Examination Survey (NHANES) III demonstrated a clear association between declining estimated glomerular filtration rate (eGFR) and increasing prevalence of anemia. Data from 2007–2010 revealed that anemia was nearly twice as prevalent among individuals with Chronic Kidney Disease (15.4%) compared to the general population (7.6%). Furthermore,

the prevalence of anemia rose progressively with advancing CKD stage, ranging from 8.4% in Stage 1 to 53.4% in Stage 5.(13) In another study, the prevalence of anemia showed a similar trend, increasing from 1% to 33% among men and from 1% to 67% among women as CKD progressed.(14) Anemia is common in chronic kidney disease at all stages but it is universal among patients with stage-V CKD, besides this other possible causes include iron, B12 or folic acid deficiency or blood loss.(8)

Pakistan, being a developing country, faces a high burden of Chronic Kidney Disease (CKD), which is frequently associated with anemia. The rising prevalence of anemia in this population is further exacerbated by common comorbid conditions such as hypertension, diabetes mellitus, and malnutrition. In light of this, the present cross-sectional study was designed to determine the prevalence of anemia among CKD patients admitted to the Nephrology Unit at Khyber Teaching Hospital, Peshawar. Additionally, the study aims to identify key variables contributing to anemia and highlight preventive strategies to mitigate its complications in patients with CKD.

## METHODOLOGY

**Study Design:** Prospective, observational, descriptive cross-sectional study.

**Study Setting:** Nephrology Unit, Khyber Teaching Hospital (KTH), Peshawar.

**Study Duration:** 15<sup>th</sup> November 2024 to 15<sup>th</sup> March 2025.

**Sample Size:** 284 patients.

**Sampling Technique:** Non-probability consecutive sampling.

**Inclusion Criteria:** All hemodialysis dependent patients aged above 16 years who presented to the Nephrology Outpatient Department (OPD), or visited the emergency department for nephrology-related issues, or were admitted to the Nephrology ward at Khyber Teaching Hospital, Peshawar, during the seven-month study period were considered eligible for inclusion. Both acute on chronic and chronic kidney disease cases were included, provided that the patients gave informed consent to participate in the study.

**Exclusion Criteria:** Patients who were younger than 16 years of age, not dependent on hemodialysis, or did not provide informed consent were excluded from the study.

**Data Collection Tools:** Structured questionnaire and patient medical records.

**Definition of Anemia:** Hemoglobin <12 g/dL in males and <11 g/dL in females.

**Ethical Considerations:** Written informed consent was obtained from all participants or their attendants. Data was kept confidential and used exclusively for research purposes.

**Table 3**

*Distribution of Anemia by Demographic, Clinical, and Behavioral Characteristics among Dialysis-Dependent Adult CKD Patients (N = 284)*

Variables	Category	Anemia (Yes)	Anemia (No)	Total (%)
Sex	Male	118 (65.5%)	62 (34.4%)	180 (63.4%)
	Female	89 (85.6%)	15 (14.4%)	104 (36.6%)
Age (years)	16-30	9 (60%)	6 (40%)	15 (5%)

**Data Analysis:** Data were analyzed using SPSS version 24. Results were presented using Microsoft Word 2016 in the form of tables and graphs.

## RESULTS

A total of 284 patients were included in the study. The age of the participants ranged from 16 to 86 years, with a mean age of 50.61 years ( $\pm 20.98$  SD). The demographic characteristic of the study population is presented in Table 1 & 2.

**Table 1**

*Descriptive Statistics of Patient Age*

	N	Minimum	Maximum	Mean	Std. Deviation
Age	284	16	86	50.61	20.980
Valid N	284				

This table summarizes the age-related descriptive statistics of the study population, including mean, standard deviation, minimum, and maximum values.

Out of the total 284 patients, 180 (63.4%) were male and 104 (36.6%) were female (Table 2, Figure 1).

**Table 2**

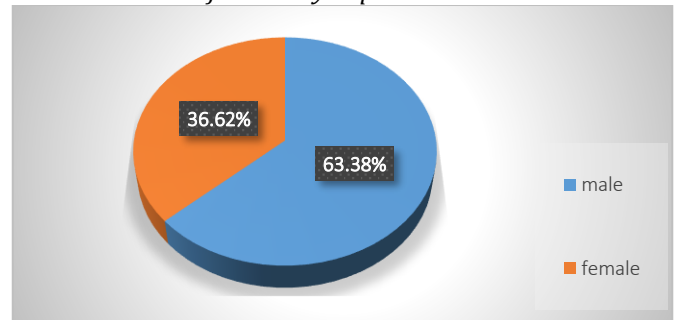
*Gender Distribution of the Study Population*

	Frequency	Percent	
Valid	Male	180	63.4
	Female	104	36.6
Total	284	100.0	

This table presents the number and percentage of male and female patients included in the study cohort.

**Figure 1**

*Sex Distribution of the Study Population*



*This figure illustrates the proportion of male and female patients included in the study.*

To explore the burden and distribution of anemia among patients undergoing maintenance hemodialysis, we analyzed key demographic, clinical, and behavioral characteristics in relation to anemia status. Understanding these associations may help identify vulnerable groups at higher risk of anemia and guide personalized treatment strategies. Table 3 presents the distribution of anemia across variables such as sex, age, educational level, duration of CKD, smoking history, and comorbidities like diabetes and hypertension.

	31-45	57 (77.1%)	17 (22.9%)	74 (26%)
	46-60	73 (75.2%)	24 (24.8%)	97 (34.1%)
	61-75	61 (78.2%)	17 (21.8%)	78 (27.5%)
	>75	18 (90.0%)	2 (10.0%)	20 (7.0%)
Educational Status	Illiterate	56 (88.9%)	7 (11.1%)	63 (22.2%)
	Read & Write Only	41 (80.4%)	10 (19.6%)	51 (18.0%)
	Primary	35 (77.8%)	10 (22.2%)	45 (15.8%)
	Secondary	38 (71.7%)	15 (28.3%)	53 (18.7%)
Duration of CKD	College+	48 (66.6%)	24 (33.4%)	72 (25.3%)
	≤1 year	72 (65.5%)	38 (34.5%)	110 (38.7%)
	1-2 years	59 (74.7%)	20 (25.3%)	79 (27.8%)
	2-3 years	39 (84.8%)	7 (15.2%)	46 (16.2%)
Ever Smoked	>3 years	44 (89.8%)	5 (10.2%)	49 (17.3%)
	Yes (n = 24)	18 (75.0%)	6 (25.0%)	24 (8.5%)
Currently Smoking	No (n = 260)	189 (72.7%)	71 (27.3%)	260 (91.5%)
	Yes (n = 4)	3 (75.0%)	1 (25.0%)	4 (1.4%)
Diabetes	No (n = 280)	204 (72.8%)	76 (27.1%)	280 (98.6%)
	Yes (n = 124)	103 (83.1%)	21 (16.9%)	124 (43.7%)
Hypertension	No (n = 160)	104 (65.0%)	56 (35.0%)	160 (56.3%)
	Yes (n = 195)	154 (79.0%)	41 (21.0%)	195 (68.7%)
	No (n = 89)	46 (51.7%)	43 (48.3%)	89 (31.3%)

## DISCUSSION

The overall prevalence of anemia in our study cohort was 73.0% (207 out of 284 patients). This high prevalence was observed across all age groups and comorbidity statuses, with notably higher rates among female patients and those with diabetes or hypertension (Table 3).

The overall prevalence of anemia among patients with chronic kidney disease (CKD) in a study conducted across selected hospitals in Addis Ababa, Ethiopia, was found to be 53.5%. (15) This prevalence is notably higher than that reported in other regions, including Korea (44.9%), Tanzania (33%), the United States (15%), the United Kingdom (6.76%), and Dessie, Ethiopia (39.5%). (16-19)

The prevalence of anemia was significantly higher in females (85.6%) compared to males (65.5%), suggesting possible sex-related differences in erythropoiesis or nutritional status among dialysis patients. A study conducted in selected hospitals of Addis Ababa, Ethiopia, demonstrated that female patients were approximately twice as likely to develop anemia compared to their male counterparts. (15) Anemia prevalence also increased with advancing age, peaking at 90% in patients older than 75 years. This aligns with existing evidence that older CKD patients are more prone to anemia due to cumulative comorbidities and reduced bone marrow responsiveness.

Educational status also showed a gradient: illiterate patients had the highest anemia burden (88.9%), while those with college or higher education had a relatively lower prevalence (66.6%), potentially reflecting better health literacy, nutrition, and healthcare access.

A notable trend was observed with the duration of CKD: anemia prevalence progressively increased with longer disease duration, reaching 89.8% in those with CKD for more than three years. This suggests a cumulative impact of renal insufficiency on erythropoietin production and iron handling over time.

Among behavioral factors, anemia was slightly more prevalent in ever-smokers (75.0%) than non-smokers

(72.7%). Diabetic patients had significantly more anemia (83.1%) than non-diabetics (65.0%), indicating the contribution of diabetes-related inflammation and erythropoietin resistance. Similarly, hypertension was associated with higher anemia prevalence (79.0% vs. 51.7%), possibly due to vascular and hemodynamic effects influencing erythropoiesis. A study conducted in selected hospitals of Addis Ababa, Ethiopia, indicated that patients with diabetes mellitus were approximately twice as likely to develop anemia compared to non-diabetic patients. Similarly, patients with hypertension had nearly three times higher odds of developing anemia compared to non-hypertensive individuals. (15)

## CONCLUSION

Our study reveals a high overall prevalence of anemia (73.0%) among dialysis-dependent CKD patients, with increased vulnerability observed in females, the elderly, individuals with diabetes or hypertension, those with lower educational attainment, and patients with longer CKD duration. These findings are consistent with regional and international data, particularly studies from Ethiopia, highlighting similar risk patterns. The strong associations between anemia and common comorbidities such as diabetes and hypertension underscore the need for integrated management strategies targeting early detection and correction of anemia in CKD. Addressing modifiable factors such as health literacy and chronic disease control could play a pivotal role in improving outcomes for this high-risk population.

## Disclaimer

This study exclusively involved patients with end-stage renal disease (ESRD) who were dependent on maintenance hemodialysis. Therefore, the findings may not be generalizable to patients with earlier stages of chronic kidney disease (CKD) or those managed with peritoneal dialysis or conservative treatment modalities.

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