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Dr. ASM Julfekar Helal
Associate Professor, Department of Nephrology, Ad-Din Medical College Hospital, Dhaka, Bangladesh

Dr. Kaneez Fatema
Consultant, Department of Dermatology, Islamic Bank Hospital Mirpur, Dhaka, Bangladesh

Corresponding Author:
Dr. ASM Julfekar Helal
Associate Professor, Department of Nephrology, Ad-Din Medical College Hospital, Dhaka, Bangladesh
E-mail: julfekarhelal@yahoo.com

Prevalence of anemia in chronic kidney disease patients: A study in a tertiary care hospital in Bangladesh

ASM Julfekar Helal and Kaneez Fatema

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Abstract
Background: Anemia frequently complicates chronic kidney disease (CKD) due to decreased erythropoietin production, iron deficiency, and chronic inflammation. It increases morbidity, and cardiovascular risks while reducing the quality of life of patients. Its prevalence varies by disease severity and healthcare access. Assessing its burden is crucial for early diagnosis and effective management in CKD patients. This study aimed to assess the prevalence of anemia in chronic kidney disease patients.
Methods: This hospital-based cross-sectional study was conducted at the Department of Nephrology, Aichi Medical College and Hospital, Dhaka, Bangladesh, from January 2023 to December 2024. A total of 217 CKD patients were enrolled using a purposive sampling technique. Hematological examinations, including hemoglobin level assessment, were performed to detect anemia. Demographic and clinical characteristics of the participants were documented using a predesigned questionnaire. Data were analyzed using MS Office tools.
Results: Anemia prevalence was 41%, with similar rates in both genders. It was more common in urban (57.4%) than rural (26.7%) residents and highest in high-income individuals (47.1%). Former smokers (43.7%) had slightly higher anemia rates than never-smokers (43.2%), while current smokers had the lowest (26.5%). Anemia increased with CKD severity (7.4% in stage 1 to 86.7% in stage 5) and comorbidity severity (71.4% in very high-index patients).
Conclusion: Anemia is a prevalent complication in chronic kidney disease, increasing with disease progression and comorbidity severity. Early screening and targeted management are essential to reduce its burden, enhance patient outcomes, and improve the quality of life in affected individuals.

Keywords: Anemia, chronic kidney disease, CKD hemoglobin, prevalence, tertiary care hospital

Introduction
Anemia is a frequent and serious complication of chronic kidney disease (CKD), contributing to increased morbidity, mortality, and diminished quality of life [1]. It arises from multiple factors, including decreased erythropoietin (EPO) production, iron deficiency, and chronic inflammation. Understanding the prevalence and causes of anemia in CKD is essential for effective management and better patient outcomes [2]. CKD is a progressive condition marked by a gradual decline in kidney function, resulting in waste accumulation and fluid imbalances [3]. One of the key functions of the kidneys is the production of EPO, a hormone that stimulates red blood cell formation in the bone marrow. As kidney function deteriorates, EPO production declines, leading to reduced red blood cell production and subsequent anemia [4]. This condition is further aggravated by the shortened lifespan of red blood cells and the effects of uremic toxins, which suppress erythropoiesis [5]. Iron deficiency is another major contributor to anemia in CKD. Iron is essential for hemoglobin synthesis, and its deficiency impairs red blood cell production. CKD patients often experience iron deficiency due to insufficient dietary intake, poor absorption, and increased iron losses during dialysis [6]. Additionally, chronic inflammation in CKD leads to elevated hepcidin levels, which inhibit iron absorption and reduce iron availability from body stores, contributing to functional iron deficiency [7]. The prevalence of anemia in CKD patients varies by population and diagnostic criteria. In Bangladesh, studies report a high burden of anemia among CKD patients.

For instance, a study conducted at Dhaka National Medical College found that 58.41% of CKD patients had anemia [8]. Another study at Mymensingh Medical College reported that 65% of CKD patients were anemic, with a higher prevalence in advanced CKD stages [9]. These findings highlight the significant burden of anemia among Bangladeshi CKD patients. Anemia in CKD is associated with various adverse health outcomes. The reduced oxygen-carrying capacity of anemic blood leads to compensatory mechanisms such as increased cardiac output, which, over time, may result in left ventricular hypertrophy and heart failure. Furthermore, anemia contributes to fatigue, diminished exercise capacity, cognitive impairment, and an overall decline in quality of life [10]. Management of anemia in CKD involves treating underlying causes and may include iron supplementation, erythropoiesis-stimulating agents (ESAs), and correction of vitamin B12 or folate deficiencies. Iron supplementation can be given orally or intravenously, with intravenous administration being preferred in dialysis patients due to its higher efficacy [11]. ESAs are used to stimulate red blood cell production in patients with inadequate endogenous EPO production. However, their use requires careful monitoring due to risks such as hypertension and increased thrombotic events [12]. Recent advancements in anemia management have introduced novel therapeutic agents. Hypoxia-inducible factor prolyl hydroxylase inhibitors (HIF-PHIs) are a promising new class of drugs that stabilize hypoxia-inducible factors, thereby increasing endogenous EPO production, improving iron metabolism, and reducing hepcidin levels. These agents present an alternative to traditional ESAs and are currently being studied in clinical trials [13]. Indeed, anemia is a prevalent and serious complication in CKD patients, arising from decreased EPO production, iron deficiency, and chronic inflammation. The high prevalence of anemia among CKD patients in Bangladesh highlights the need for routine screening and appropriate management to reduce complications. Advances in therapeutic strategies hold promise for improving outcomes in CKD-related anemia.

Methodology

This hospital-based cross-sectional study was conducted at the Department of Nephrology, Aichi Medical College and Hospital, Dhaka, Bangladesh, from January 2023 to December 2024. A total of 217 CKD patients aged 18 years and above, with a confirmed diagnosis of CKD, were enrolled using purposive sampling. Demographic data were collected through patient interviews, and relevant medical history and laboratory parameters were obtained by reviewing medical records. Bivariate and multivariate logistic regression analyses were conducted to identify independent factors associated with anemia in CKD patients. The comorbidities were analyzed using the modified Charlson comorbidity index [14]. As per the inclusion criteria, patients with CKD stages 3 to 5, who were aged 18 years or older and willing to provide written informed consent, were included in the study. These patients were recruited from the emergency medical outpatient department, general outpatient departments (OPDs), renal clinics, dialysis units, and medical wards. The exclusion criteria consisted of patients on dialysis, those with a known cause of anemia other than CKD, patients with known malignancies, pregnant women, and those unwilling to participate. Data were analyzed using MS Office tools to perform statistical analysis and identify key contributing factors for anemia among CKD patients in Bangladesh.

Results

Among the 217 participants, 41% had anemia. The highest prevalence was found in the 45-59 years age group (44.3%), followed by 42.2% in the 60-80 years group. The 30-44 years group had a prevalence of 37.5%, while the 18-29 years group had 28.6%. The least prevalence was in the >80 years age group (40.0%). Prevalence rates of anemia were nearly identical across both genders, with a similar percentage of males and females affected. Anemia was more prevalent in urban residents (57.4%) compared to rural residents (26.7%). The highest prevalence of anemia (47.1%) was observed in the high-income group (>25,000 BDT). Among the total participants, 43.2% of never-smokers had anemia, followed by 43.7% of former smokers. The lowest prevalence (26.5%) was found in current smokers, with only 1 participant (1.1%) having anemia with unknown smoking status. The prevalence of anemia increased with CKD stage: 7.4% in stage 1, 10.0% in stage 2, 25.0% in stage 3a, 47.5% in stage 3b, 83.7% in stage 4, and the highest (86.7%) in stage 5 CKD. Among participants, 37.3% of diabetic nephropathy (DN) patients, 60.0% of hypertensive nephropathy (HN) patients, 27.3% of glomerulonephritis (GN) patients, and 40.0% of polycystic kidney disease (PKD) patients had anemia. Anemia prevalence increased with the severity of comorbidities: 26.5% in patients with a low comorbidity index (≤3), 51.6% in those with a moderate index (4-5), 62.9% in those with a high index (6-7), and 71.4% in those with a very high index (≥8).

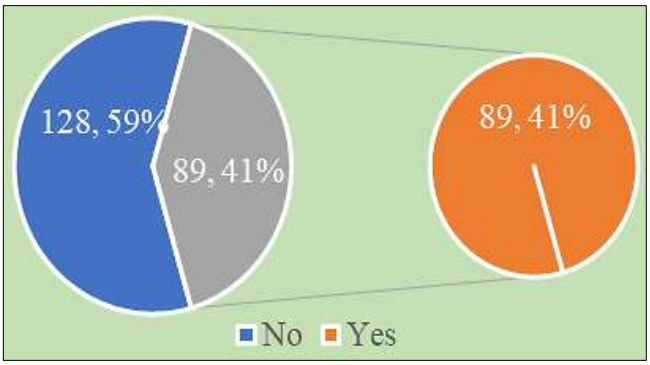

Fig 1: Prevalence of anemia among total cases

Table 1: Prevalence of anemia based on ages

Age (Years)	Total		Anemia	
	N=217	%	n=89	%
18-29	13	6.0%	4	28.6%
30-44	40	18.4%	15	37.5%
45-59	71	32.7%	31	44.3%
60-80	84	38.7%	35	42.2%
>80	9	4.1%	4	40.0%

Table 2: Prevalence of anemia based on gender

Gender	Total		Anemia	
	n	%	n	%
Female	92	42.4%	38	41.30%
Male	125	57.6%	51	40.80%

Table 3: Prevalence of anemia based on residence

Residence	Total		Anemia	
	n	%	n	%
Urban	101	46.5%	58	57.4%
Rural	116	53.5%	31	26.7%

Table 4: Prevalence of anemia based on monthly income

Income (BDT)	Total		Anemia	
	n	%	n	%
Low <10,000	79	36.4%	33	41.8%
Mid 10–25 thousand	104	47.9%	40	38.5%
High >25,000	34	15.7%	16	47.1%

Table 5: Prevalence of anemia based on smoking status

Smoking status	Total		Anemia	
	n	%	n	%
Never	111	51.2%	48	43.2%
Former	71	32.7%	31	43.7%
Current	34	15.7%	9	26.5%
Unknown	1	0.5%	1	1.1%

Table 6: Prevalence of anemia based on CKD stages

CKD stage	Total		Anemia	
	n	%	n	%
1	27	12.4%	2	7.4%
2	40	18.4%	4	10.0%
3a	39	18.0%	10	25.0%
3b	47	21.7%	19	47.5%
4	49	22.6%	41	83.7%
5	15	6.9%	13	86.7%

Table 7: Prevalence of anemia based on causes of CKD

Causes of CKD	Total		Anemia	
	n	%	n	%
DN	51	23.5%	19	37.3%
HN	40	18.4%	24	60.0%
GN	77	35.5%	21	27.3%
PKD	35	16.1%	14	40.0%
Others	14	6.5%	11	79%

DN: Diabetic nephropathy, HN: Hypertensive nephropathy, GN: Glomerulonephritis, PKD: Polycystic kidney disease

Table 8: Prevalence of anemia based on modified Charlson comorbidity index

Index	Total		Anemia	
	n	%	n	%
Low (≤3)	113	52.1%	30	26.5%
Moderate (4-5)	62	28.6%	32	51.6%
High (6-7)	35	16.1%	22	62.9%
Very high (≥8)	7	3.2%	5	71.4%

Discussion

The prevalence of anemia in this study was 41%, consistent with several previous studies that report a high prevalence of anemia in CKD patients. Anemia is a common complication of CKD due to multifactorial causes, including reduced erythropoietin production, iron deficiency, and chronic inflammation. In this study, the highest prevalence was found in the 45-59 years age group (44.3%), followed by the 60-80 years group (42.2%). Another study showed that the prevalence of anemia in CKD increases with age, particularly in those over 40 years old [15]. In contrast, the 18-29-year-old age group had a relatively low prevalence of anemia (28.6%), similar to findings by Khan *et al*. (2022), which showed lower anemia prevalence in younger CKD patients [16]. Anemia prevalence was nearly identical across genders, with 41.3% in females and 40.8% in males. This is consistent with the findings by Zhu *et al*. (2020), which found no significant gender differences in anemia prevalence among CKD patients [17]. However, some studies have reported slightly higher anemia rates in females, likely due to factors such as menstruation and pregnancy in women [18]. Urban residents had a significantly higher prevalence of anemia (57.4%) compared to rural residents (26.7%). This disparity may be due to differences in access to healthcare and nutrition, as urban populations tend to have better healthcare facilities and more opportunities for early diagnosis and treatment of anemia. Similar findings have been reported by Sarker *et al*. (2021), who found that urban populations had higher anemia rates, possibly due to better reporting and healthcare access in urban areas [19]. The study also found that the highest prevalence of anemia (47.1%) was observed in the high-income group (>25,000 BDT). This finding is in contrast with several studies that report higher anemia rates in low-income groups, likely due to malnutrition, limited access to healthcare, and socioeconomic disparities [20]. However, higher income may indicate a greater prevalence of other risk factors, such as diabetes and hypertension, which are associated with CKD and anemia. The prevalence of anemia among smokers in this study was lower in current smokers (26.5%) compared to never-smokers (43.2%) and former smokers (43.7%). This is an unexpected finding, as smoking is generally considered a risk factor for anemia in CKD patients due to its role in causing chronic inflammation and impairing erythropoiesis [21]. A possible explanation for the lower prevalence of anemia in current smokers could be the small sample size of current smokers (34 participants), which may have skewed the results. As expected, anemia prevalence increased with the severity of CKD stages. The prevalence was 7.4% in stage 1, rising to 86.7% in stage 5. These findings are consistent with those of Pahl *et al*. (2020), who reported a gradual increase in anemia prevalence as CKD progressed, with the highest rates observed in stage 5 [22]. The worsening anemia in the later stages of CKD is primarily due to declining erythropoietin production and iron deficiency, compounded by the effects of uremic toxins. The study also found that anemia was more prevalent in patients with hypertensive nephropathy (60.0%), followed by diabetic nephropathy (37.3%), glomerulonephritis (27.3%), and polycystic kidney disease (40.0%). These findings are consistent with previous studies, which show that diabetic nephropathy and hypertensive nephropathy are associated with higher rates of anemia due to the progressive nature of these conditions and their impact on kidney function [23]. Finally, anemia prevalence increased with the severity of comorbidities, as measured by the modified Charlson comorbidity index. Anemia was present in 26.5% of patients with a low comorbidity index, rising to 71.4% in those with a very high comorbidity index. This supports findings from other studies, which indicate that the presence of multiple comorbidities exacerbates anemia in CKD patients by further impairing kidney function and increasing the burden of inflammation and iron deficiency [24]. The findings of this study underscore the significant burden of anemia in CKD patients, with factors such as age, CKD stage, comorbidities, and socioeconomic status influencing its prevalence. Early diagnosis and management

of anemia in CKD patients are crucial for improving patient outcomes and reducing the risk of complications.

Conclusion & Recommendation

This study found that anemia is a common complication in chronic kidney disease, with its prevalence increasing as the disease progresses. It was more frequent among urban residents and those with hypertensive nephropathy. The severity of comorbidities was also associated with a higher occurrence of anemia. These findings emphasize the importance of early screening, timely intervention, and appropriate management strategies to reduce the burden of anemia in chronic kidney disease patients and improve their overall health and quality of life.

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