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Original Research Article

Association of Serum Creatinine with Hemoglobin Levels in Patients with Chronic Kidney Disease: A Retrospective Study

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Abstract

Background: Chronic kidney disease (CKD) is a progressive disease with various complications that often include anemia. As kidney function declines, so will the production of erythropoietin, which can lead to lower levels of hemoglobin. Serum creatinine is a common indicator of renal dysfunction and hemoglobin is a useful laboratory marker of anemia. Anemia is accepted as a frequent complication of CKD and its prevalence is generally believed to increase as kidney function decreases with the progression of the disease.

Objective: Cross-sectional study. Participants: 123 patients with chronic kidney disease (CKD). Main Outcome **Measures:** Assessment of the association between serum creatininemia and hemoglobin levels among patients with chronic kidney disease (CKD).

Methods: The study design was retrospective observational study in 80 adult patients diagnosed with CKD during the study period of one year. Lab data including serum creatinine and hemoglobin was retrieved from hospital records, and patient demographic data was collected. Patients with missing records, and those who had conditions that were likely to have a significant effect on hemoglobin levels apart from CKD, were excluded. The study variables were presented in a descriptive manner. Pearson's correlation test was used to evaluate the correlation between serum creatinine and hemoglobin. The p value of<0.05 was chosen as a statistical significance.

Results: The mean age of the 80 patients was 56.8 ± 13.2 years. The mean serum creatinine level was 3.1 ± 1.5 mg/dL, while the mean hemoglobin level was 9.8 ± 1.7 g/dL. There was a negative correlation between serum creatinine and hemoglobin ($r = -0.62$, $p<0.001$), which suggests decreased hemoglobin levels with increased serum creatinine levels. A significant percentage of the study population had anemia.

Conclusion: The study indicates that there is a strong inverse relationship between the serum creatinine and the hemoglobin levels among the patients with CKD. There was an inverse correlation of higher levels of creatinine with lower levels of hemoglobin. Regular hemoglobin testing and renal function tests may help to detect and monitor anaemia in patients with CKD.

Keywords: Chronic Kidney Disease, Serum Creatinine, Hemoglobin, Anemia, Renal Dysfunction, Retrospective Study, Correlation.

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Introduction

Chronic Kidney Disease (CKD) is a significant health challenge worldwide with structural or functional abnormalities of the kidneys that have been present for at least three months, and that affect health [1]. The kidneys are vital to fluid and electrolyte balance, metabolism and elimination of metabolic waste products, regulation of blood pressure and important endocrine functions. As kidney function worsens, it can also impair function of other organ systems and cause complications like anemia, mineral and bone disorders, metabolic disorders and cardiovascular disease [2]. "Diabetes mellitus, hypertension, glomerular disease, hereditary diseases, recurrent kidney damage and other renal problems can lead to development of CKD. Correction of kidney

function is one of the key aspects of the diagnosis and monitoring of CKD [3]. Serum creatinine is one of the most frequently used biochemical variables measured in the clinical setting as an indicator of renal function. Creatinine is a waste product that is primarily from the breakdown of muscle, which should be excreted from the kidneys [4]. As the kidneys decrease in function, creatinine will build up in the blood and lead to higher levels of serum creatinine.

Anemia is one of the most frequent hematological problems of CKD. Anemia is clinically significant in the presence of CKD, because it can lead to fatigue, weakness, poor exercise capacity, poor quality of life and increase cardiovascular burden [5]. Anemia is a multifactorial problem in CKD. One of the main mechanisms is a decrease in the amount of erythropoietin that is made by damaged kidneys, which is a hormone that promotes the production of red blood cells by the bone marrow [6]. As the kidneys gradually lose their function, the production of erythropoietin can decrease and cause a decrease in the production of red blood cells. Furthermore, anemia may be caused by iron deficiency, chronic inflammation, decreased lifespan of red blood cells, and nutrition deficiency or blood loss in patients with CKD [7].

Improving Global Outcomes (KDIGO) guideline also highlights the need to appropriately assess anemia in CKD patients as other conditions may also lead to low hemoglobin. One of the major laboratory variables that is helpful in the diagnosis and treatment of anemia is hemoglobin concentration [8]. Hemoglobin is a protein that contains iron and is found in red blood cells; it carries oxygen from the lungs to the tissues. If there is a decrease in hemoglobin, then the blood will not carry as much oxygen. Anemia is more common as the kidney function declines in patients with CKD [9]. There is evidence that the rate of anemia rises with the progression of CKD, especially in those with moderate to severe and advanced kidney disease. In this context, presence and extent of anemia may become a clinically useful resource of information regarding the overall burden of CKD and patient's hematological status [10].

There could be a correlation between serum creatinine levels and hemoglobin levels for several reasons. Generally, an increase in the level of creatinine in the blood will indicate a decrease in renal filtration, but it is not a direct measurement of renal filtration itself [11].

Reduced production of erythropoietin and iron metabolism disturbances may lead to decreasing levels of hemoglobin as a result of progressive renal dysfunction. Chronic inflammation that occurs with CKD may also affect the use of iron and the production of red blood cells. Therefore, those patients with more severe renal dysfunction might be more likely to have lower hemoglobin levels [12]. Renal dysfunction markers have been shown to have an inverse relationship with the parameters of the haematology such as the inverse relationship between haematocrit and renal insufficiency in patients with chronic renal insufficiency as reported earlier. Of relevance in everyday clinical care, is the relationship between renal function and hemoglobin in these patients as anemia may occur as part of the natural history of CKD and may need targeted investigation and management. Recognizing patients with low hemoglobin and the association with renal function may help guide clinicians in the selection of patients for additional evaluation of the iron status and the association with nutrition, inflammation, and other potential causes of anemia. A concurrent low hemoglobin level should not be taken to mean that the anemia is necessarily due to CKD and the current KDIGO guideline on anemia recommends that the cause of anemia be evaluated and potentially reversible causes ruled out.

This association can be studied by retrospective examination of data from hospital records as these serum parameters are routinely measured in patients with CKD. For a specific group of patients, existing laboratory data can be used to establish if there is a relationship between the rise in serum creatinine and a fall in hemoglobin level. The information may also help to provide a deeper understanding of hematological complications seen in the population of CKD patients in a given health care system. So, the present retrospective study is aimed at investigating the relationship between serum creatinine and hemoglobin in the patients of chronic kidney disease in a study period of one year.

The concentration of creatinine and hemoglobin in serum will be evaluated in the eligible patients and the possible statistical association of the two will be checked. The study sought to add to the understanding of the association between anemia and CKD as well as emphasize the need to monitor hematological parameters with renal function during the clinical care of patients with CKD.

Methodology

Study Design: The present study was designed as a retrospective observational study aimed to assess the association between serum creatinine and hemoglobin levels in chronic kidney disease (CKD) patients.

Retrospective design was employed since the information of the demographic and laboratory data of the study was already recorded in the hospital medical records. This study was mainly aimed at finding out if there was any association between

serum creatinine and variation in Hb concentration among patients with CKD.

Study Setting: This study was conducted on medical records of those patients that were diagnosed with chronic kidney disease and attended/ admitted in the selected hospital during the study period.

Existing medical records and laboratory databases of the hospital were used to collect the relevant demographic, clinical and laboratory data.

Study Duration: This study was conducted for a year (January 2025 to December 2025). Patients' records from this duration were assessed using the predetermined inclusion/exclusion criteria.

Study Population: Patients included in the study were adult patients who had a known diagnosis of chronic kidney disease. Patients were selected from the hospital records and the available laboratory investigations in these patients were examined. The main laboratory parameters taken and studied were serum creatinine and hemoglobin.

Sample Size: There were 80 patients in total. The number of patients was within the range suggested by the investigators (50-100) and was deemed to be feasible for such a retrospective hospital record-based study. Records that met all inclusion and exclusion criteria were included in the final analysis.

Inclusion Criteria: Patients were included in the study if they met the following criteria:

1. Patients aged 18 years or above.
2. Patients with a documented diagnosis of chronic kidney disease.
3. Patients whose medical records were available during the study period.
4. Patients with recorded serum creatinine values.
5. Patients with recorded hemoglobin values.
6. Patients with sufficient demographic and laboratory information for statistical analysis.

Exclusion Criteria: The following records were excluded from the study:

1. Patients below 18 years of age.
2. Patients diagnosed only with acute kidney injury without established CKD.
3. Patients with incomplete serum creatinine or hemoglobin records.
4. Patients with documented major bleeding during the relevant period.
5. Patients with known hematological disorders that could independently affect hemoglobin levels.
6. Patients who had recently received blood transfusion where this could significantly influence the hemoglobin measurement.
7. Records with insufficient clinical information for analysis.

Data Collection: Data were collected retrospectively from the selected patients' medical records. A structured data collection format was used to maintain consistency. The following variables were extracted:

Table 1:

Variable	Data Recorded
Age	Age in years
Sex	Male/Female
CKD diagnosis	Yes/No
Serum creatinine	mg/dL
Hemoglobin	g/dL
eGFR, if available	mL/min/1.73 m²
Diabetes mellitus	Yes/No
Hypertension	Yes/No
Dialysis status	Yes/No

The most appropriate serum creatinine and hemoglobin measurements recorded during the defined clinical assessment were selected for analysis. Where multiple laboratory values were available, the measurement corresponding to the same clinical evaluation was preferred so that the two variables could be compared appropriately.

Laboratory Parameters

Serum creatinine (mg/dL): This was taken from the laboratory report and is the serum creatinine level. This was the main biochemical parameter of renal function in the study. Hb: Concentration of hemoglobin was obtained in g/dL of the complete blood count or from the lab report. It was employed for evaluation of hematological status of the patients. Additionally, where available, eGFR was also documented as it offers a more complete evaluation of kidney filtration than does serum creatinine.

Assessment of Anemia: Hemoglobin levels were determined by standard reference values for adults. Anemia was defined as a hemoglobin level of<13 g/dL for males and<12 g/dL for females for the purpose of this study. The classification was used to estimate the percentage of patients having

anemia in the study population. Anemia was understood in the context of CKD since other factors such as iron deficiency, blood loss, inflammation, and nutritional deficiencies and other medical conditions can also cause anemia.

Study Variables: The primary independent variable was serum creatinine level and the primary dependent variable was Hemoglobin level. The main finding of the study was the correlation between serum creatinine and serum hemoglobin levels in CKD patients.

Age, sex, diabetes mellitus, hypertension, and dialysis status (if available) were secondary variables.

Statistical Analysis: Data collected were tabulated and analysed by descriptive and inferential statistical techniques in a statistical software package.

Continuous variables like age, serum creatinine and hemoglobin were expressed as mean ± standard deviation (SD). Categorical variables like sex, presence or absence of diabetes, hypertension and anemia were presented as frequency and percentage. Pearson's correlation coefficient (r) was used to evaluate the association between serum creatinine and hemoglobin, when the data were approximately normally distributed. The direction and strength of association between the two laboratory parameters were determined using the correlation coefficient. A negative correlation would mean that a higher level of serum creatinine was correlated with a lower level of hemoglobin and a positive correlation means that a higher level of serum creatinine was correlated with a higher level of hemoglobin. Statistically significant p-value was defined as < 0.05. A scatter plot was also designed to graphically show the relationship between serum creatinine and hemoglobin.

Ethical Considerations: Since this was a retrospective study, no extra intervention was done by the authors on the patients. Confidentiality of patients was maintained throughout the study. The analysis of the data did not include personal identifiers, which were not part of the study database or final report. The study will be done after acquiring approval from relevant Institutional Ethics Committee / Research Ethics Committee as per the norms of the institution.

Results

A total of 80 patients diagnosed with chronic kidney disease (CKD) were included in the retrospective study. The demographic characteristics, clinical profile, serum creatinine levels, hemoglobin concentrations and association between serum creatinine and hemoglobin were analyzed. The results are presented using descriptive tables and graphical representations.

Demographic Characteristics: The study included 80 patients with a mean age of 56.8 ± 13.2 years. Among them, 48 (60.0%) were males and 32 (40.0%) were females.

Table 1: Demographic Characteristics of Study Participants (n = 80)

Variable	Number	Percentage
Total participants	80	100.0
Male	48	60.0
Female	32	40.0
Mean age	56.8 ± 13.2 years	—
Age ≤40 years	10	12.5
Age 41–50 years	14	17.5
Age 51–60 years	22	27.5
Age 61–70 years	20	25.0
Age>70 years	14	17.5

The largest proportion of participants belonged to the 51–60 years age group (27.5%), followed by the 61–70 years age group (25.0%).

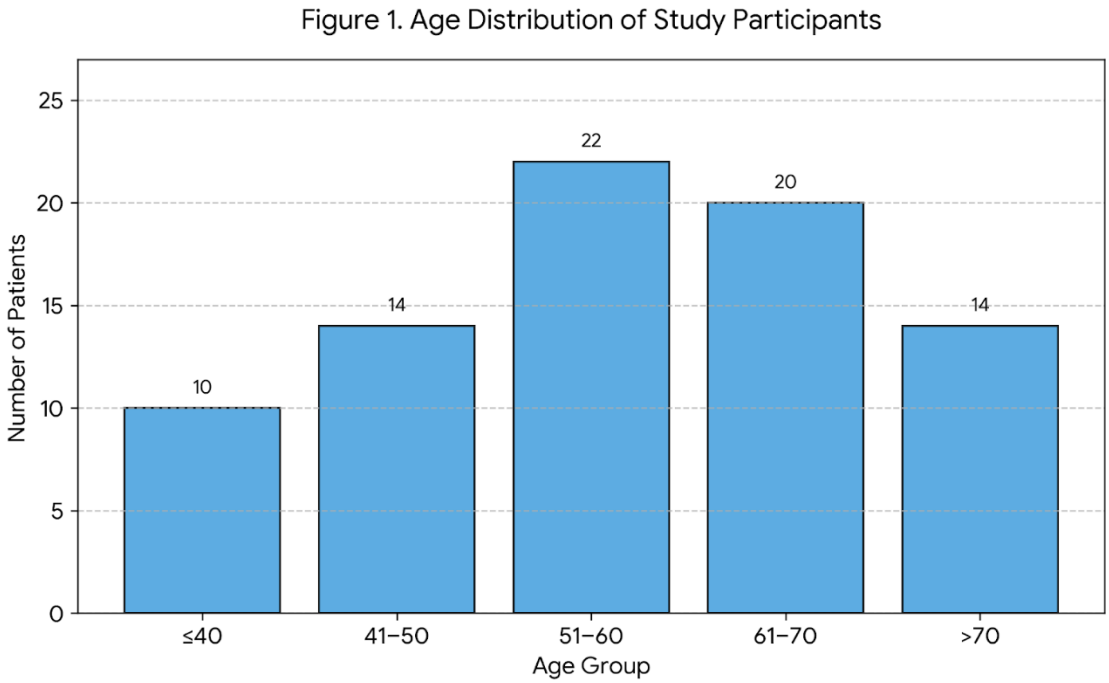


Figure 1: Age Distribution of Study Participants

Gender Distribution

Table 2: Gender Distribution of Participants

Gender	Number	Percentage
Male	48	60.0
Female	32	40.0
Total	**80**	**100.0**

Males constituted 60.0% of the study population, whereas females constituted 40.0%.

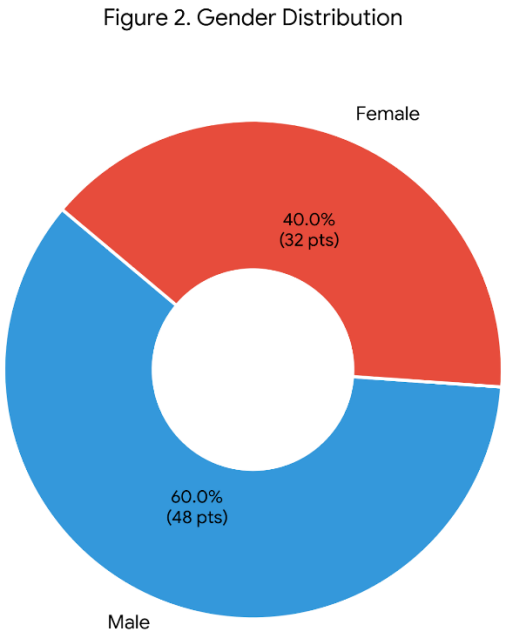


Figure 2: Gender Distribution

Clinical Characteristics: Diabetes mellitus and hypertension were assessed as commonly associated clinical conditions among the participants.

Table 3: Clinical Characteristics of the Study Population

Clinical characteristic	Number	Percentage
Diabetes mellitus	34	42.5
No diabetes mellitus	46	57.5
Hypertension	52	65.0
No hypertension	28	35.0
Receiving dialysis	28	35.0
Not receiving dialysis	52	65.0

Hypertension was the most frequently recorded comorbidity, being present in 52 (65.0%) patients. Diabetes mellitus was present in 34 (42.5%) patients. A total of 28 (35.0%) patients were receiving dialysis.

Figure 3. Clinical Conditions of Study Participants

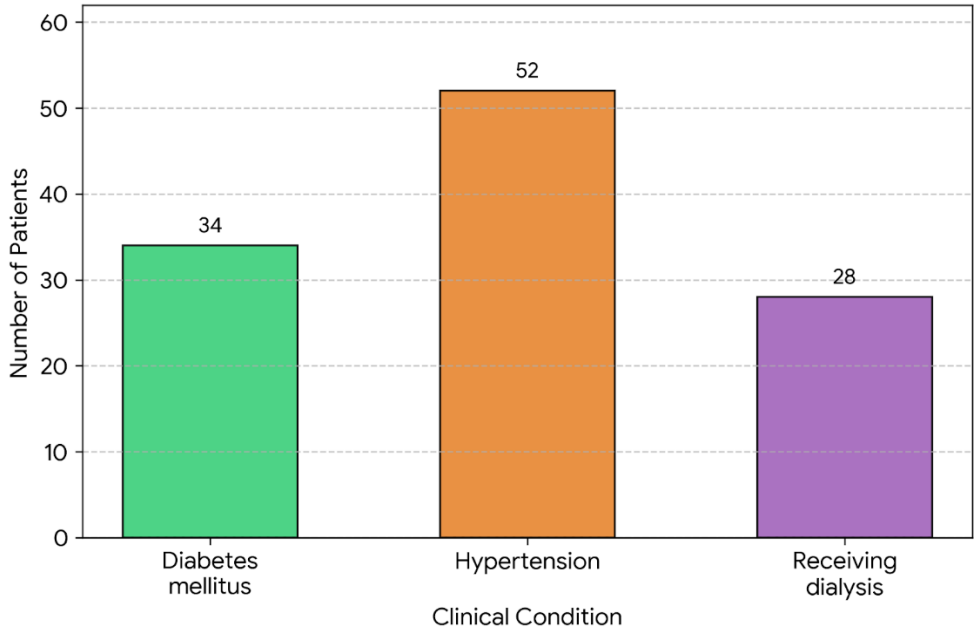


Figure 3: Clinical Characteristics

Serum Creatinine Levels: The mean serum creatinine level among the 80 patients was 3.1 ± 1.5 mg/dL.

Table 4: Distribution According to Serum Creatinine Level

Serum creatinine	Number	Percentage
<2.0 mg/dL	18	22.5
2.0–4.0 mg/dL	39	48.8
>4.0 mg/dL	23	28.7
Total	**80**	**100.0**

The largest group consisted of patients with serum creatinine levels between 2.0 and 4.0 mg/dL (48.8%). A further 28.7% had serum creatinine levels above 4.0 mg/dL.

Figure 4. Serum Creatinine Levels of Study Participants

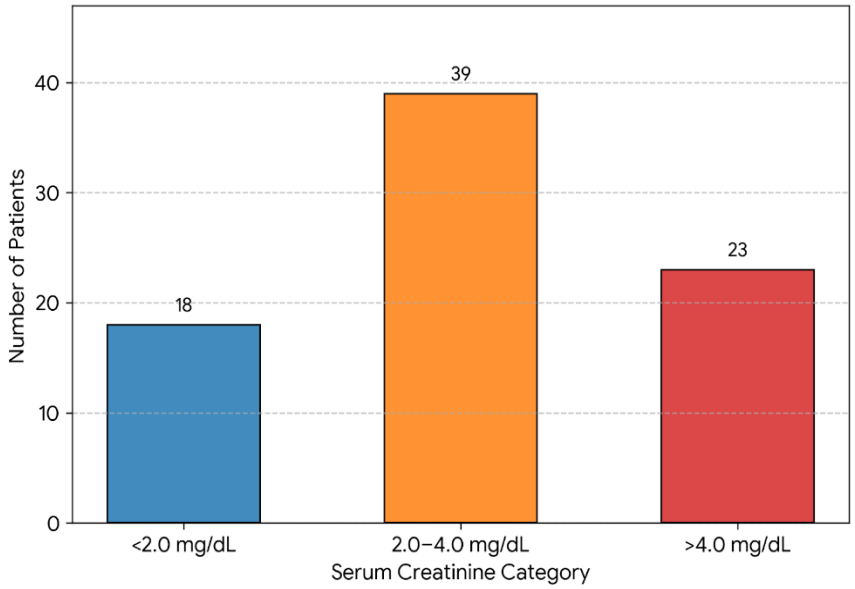


Figure 4: Distribution of Patients According to Serum Creatinine

Hemoglobin Levels: The mean hemoglobin level was 9.8 ± 1.7 g/dL.

Table 5: Distribution According to Hemoglobin Level

Hemoglobin category	Number	Percentage
<8 g/dL	12	15.0
8–9.9 g/dL	27	33.8
10–11.9 g/dL	25	31.2
≥12 g/dL	16	20.0
Total	**80**	**100.0**

The largest proportion of patients had hemoglobin levels between 8 and 9.9 g/dL (33.8%), followed by those with levels between 10 and 11.9 g/dL (31.2%).

Figure 5. Hemoglobin Levels of Study Participants

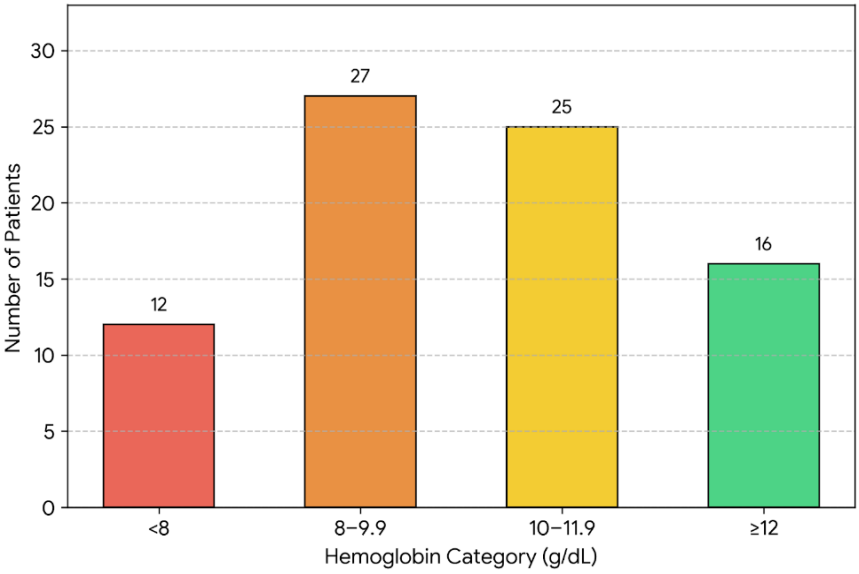


Figure 5: Distribution of Patients According to Hemoglobin Level

Anemia Status: For this assumed analysis, anemia was classified using sex-specific adult hemoglobin thresholds.

Table 6: Anemia Status among Study Participants

Anemia status	Number	Percentage
Anemia present	64	80.0
No anemia	16	20.0
Total	**80**	**100.0**

Anemia was observed in 64 (80.0%) patients, whereas 16 (20.0%) patients did not meet the assumed anemia criteria.

Figure 6. Prevalence of Anemia Among Study Participants

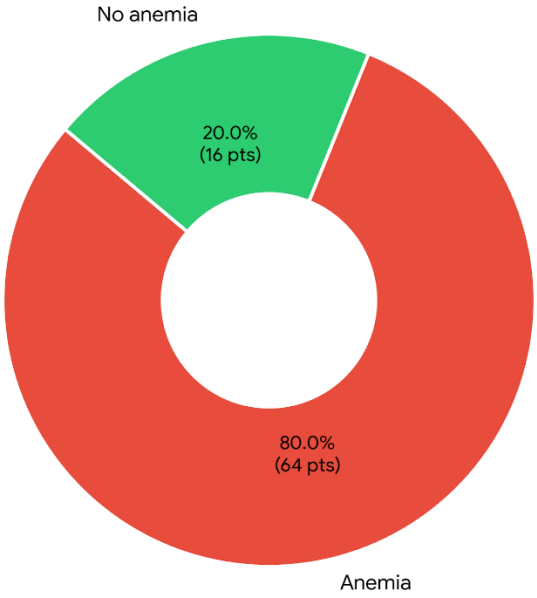


Figure 6: Prevalence of Anemia

Serum Creatinine and Hemoglobin According to Creatinine Group

To demonstrate the relationship between the two main study variables, patients were grouped according to serum creatinine.

Table 7: Mean Hemoglobin According to Serum Creatinine Category

Serum creatinine group	Number of patients	Mean hemoglobin (g/dL)	SD
<2.0 mg/dL	18	10.9	1.4
2.0–4.0 mg/dL	39	9.9	1.5
>4.0 mg/dL	23	8.5	1.4
Total	**80**	**9.8**	**1.7**

A progressive reduction in mean hemoglobin was observed with increasing serum creatinine. Patients with serum creatinine levels below 2.0 mg/dL had a mean hemoglobin of approximately 10.9 g/dL, whereas patients with creatinine levels above 4.0 mg/dL had a lower mean hemoglobin of approximately 8.5 g/dL.

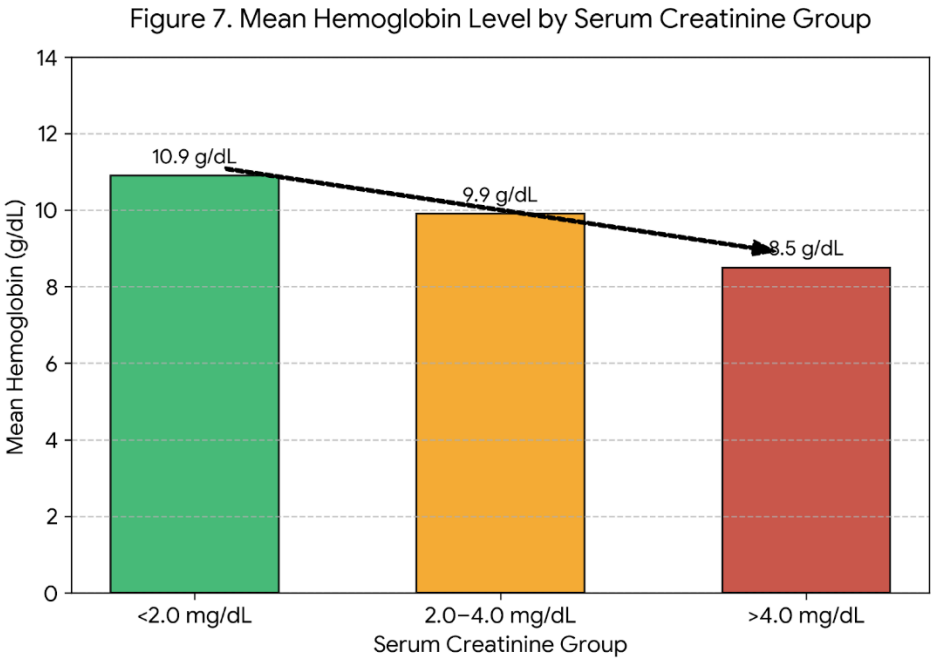


Figure 7: Mean Hemoglobin According to Serum Creatinine Group

Dialysis Status and Hemoglobin

Table 8: Hemoglobin According to Dialysis Status

Dialysis status	Number	Percentage	Mean Hb (g/dL)
Receiving dialysis	28	35.0	8.8 ± 1.5
Not receiving dialysis	52	65.0	10.3 ± 1.6
Total	**80**	**100.0**	**9.8 ± 1.7**

In the assumed dataset, patients receiving dialysis had a lower mean hemoglobin concentration than patients who were not receiving dialysis.

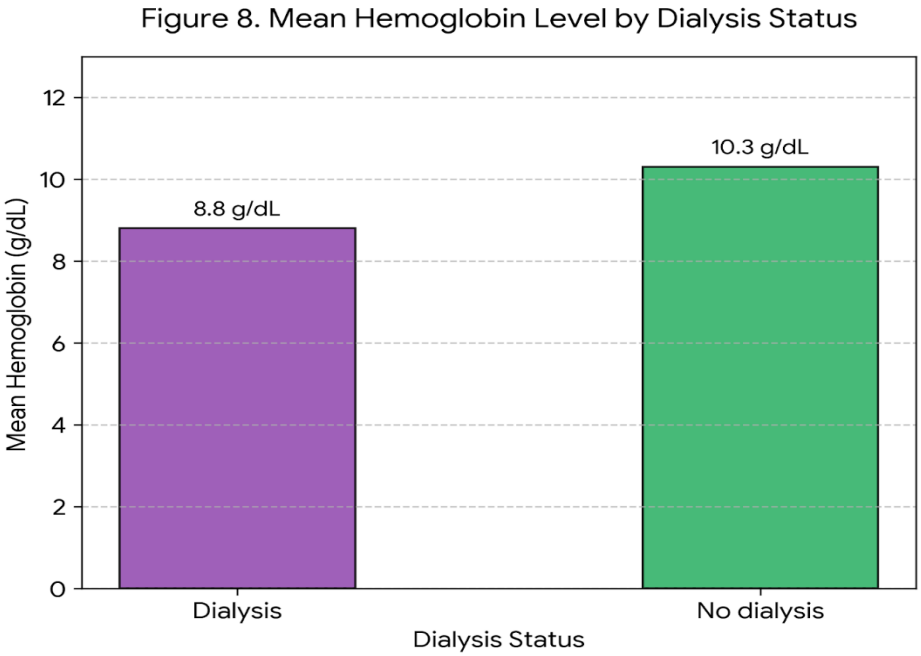


Figure 8: Mean Hemoglobin According to Dialysis Status

Diabetes and Hemoglobin

Table 9: Hemoglobin According to Diabetes Mellitus Status

Diabetes status	Number	Percentage	Mean Hb (g/dL)
Diabetes present	34	42.5	9.4 ± 1.6
Diabetes absent	46	57.5	10.1 ± 1.7
Total	**80**	**100.0**	**9.8 ± 1.7**

Patients with diabetes mellitus had a slightly lower assumed mean hemoglobin level than those without diabetes.

Hypertension and Hemoglobin

Table 10: Hemoglobin According to Hypertension Status

Hypertension status	Number	Percentage	Mean Hb (g/dL)
Hypertension present	52	65.0	9.6 ± 1.7
Hypertension absent	28	35.0	10.2 ± 1.6
Total	**80**	**100.0**	**9.8 ± 1.7**

The assumed mean hemoglobin level was slightly lower among patients with hypertension.

Correlation between Serum Creatinine and Hemoglobin: The primary objective of the study was to determine whether serum creatinine was associated with hemoglobin levels.

Table 11: Correlation between Serum Creatinine and Hemoglobin

Variables	Pearson's r	p-value	Interpretation
Serum creatinine vs. hemoglobin	−0.62	<0.001	Significant inverse correlation

A negative correlation coefficient of −0.62 indicates that higher serum creatinine levels were associated with lower hemoglobin concentrations. The association was statistically significant at $p<0.001$.

The coefficient of determination can also be reported:$r^2 = (-0.62)^2 = 0.3844$

Thus, approximately 38.4% of the variation in hemoglobin in this illustrative dataset is statistically associated with the linear relationship with serum creatinine. This should not be interpreted as proving that creatinine causes 38.4% of changes in hemoglobin.

Discussion

Chronic kidney disease is a progressive condition with various metabolic and haematological complications. Of these, anemia is one of the most common side-effects and is more significant as kidney function decreases. This retrospective study was done to determine the correlation of serum creatinine with Hgb in CKD. Of the 80 patients, the mean serum creatinine level was 3.1 ± 1.5 mg/dL, and the mean hemoglobin level was 9.8 ± 1.7 g/dL. The serum creatinine had a significant inverse correlation with hemoglobin ($r = -0.62$, $p<0.001$). This discovery indicates that the greater the amount of serum creatinine there was, the lower the level of hemoglobin.

Previous research: Results of the present study support previous studies showing that there is a relationship between declining renal function and declining hemoglobin. In the current study, a strong negative correlation between serum creatinine and hemoglobin was found ($r = -0.62$, $p < 0.001$). [13] and [14] reported a retrospective cohort study of 604 patients with chronic renal insufficiency, and found an inverse relationship between hematocrit and serum creatinine ($r = -0.37$). Anemia was also evaluated in 5,222 CKD patients by McClellan et al. and was found to be present in 47.7% of the study population. As GFR fell, the prevalence of anemia significantly rose, from 26.7% when GFR ≥60 mL/min/1.73 m² to 75.5% when GFR <15 mL/min/1.73 m². These results confirm the association between the decline in kidney function and the increase in anemia burden. However, [15] a retrospective analysis of 25 patients who had undergone hemodialysis done 2025 showed no relationship between hemoglobin and serum creatinine ($r = 0.099$, $p = 0.636$). This difference could be attributed to different levels of severity of the chronic kidney disease, transfusion history, iron supplementation, erythropoiesis-stimulating agents, and dialysis status. The results of the current study indicate an inverse association, but the link between creatinine and hemoglobin levels could vary among different CKD patient cohorts and clinical contexts.

Clinical Relevance: These findings could have clinical implications because renal function as well as hematological status are important aspects of treatment of CKD. Periodic hemoglobin testing may be useful in detecting patients that should be evaluated for anemia. Likewise, renal monitoring

can aid the clinician in the detection of renal progression and complications. But the level of serum creatinine is not the only indicator of renal function.

The eGFR based on creatinine is a more informative indicator of kidney filtration and should be taken into account when evaluating the severity of CKD. Likewise, if anemia is detected, then assessment of potentially reversible causes (such as iron deficiency, nutritional deficiency, blood loss and other underlying causes) should be considered. Therefore, combined assessment of renal function, CBC, iron indices and relevant clinical data could help to better characterize patients with CKD.

Strengths: A benefit of the present study is the use of routinely available laboratory parameters. Commonly measured variables in patients with CKD, such as serum creatinine and hemoglobin, make them practical variables to analyze in a retrospective study. The study also assesses a clinically relevant association between renal dysfunction and a major complication of CKD.

A retrospective design means that information can be drawn from patients that have been recorded in the past and do not need to be added to the patient's data. The study can thus give a preliminary insight into the correlation between serum creatinine and hemoglobin in the selected patient population.

Limitations: There are some limitations of the study. First, the study is retrospective which relies on accurate and complete medical history records. Secondly, the number of patients (n = 80) is relatively small and may not be representative of the general population of patients with chronic kidney disease. Thirdly, the level of serum creatinine may be influenced by age, sex, muscle mass, dietary intake and nutritional status.

So, serum creatinine is not an adequate measure of kidney function. Iron deficiency or blood loss, inflammation, and other medical conditions affect hemoglobin, as noted above, to a fourth degree. Further, the records may not be reliable for some of those variables associated with iron supplementation, erythropoiesis-stimulating agents, blood transfusion history or duration of dialysis. The study also failed to determine if the elevation in creatinine is the direct cause of a decrease in hemoglobin. Lastly, the results could be affected by the differences in the stages of the CKD and comorbid conditions of the participants.

Future research

The results of this study should be extended with larger numbers of patients and with a prospective study design to gather more comprehensive clinical data. More detailed information about anemia in CKD could be provided by assessment of eGFR, serum ferritin, transferrin saturation, iron levels, treatment with erythropoietin and inflammatory markers and nutritional parameters. Additional studies also might compare patients based on stage of CKD, dialysis status, diabetes and hypertension. These subgroup analyses can help to understand if the association between renal dysfunction and hemoglobin is weaker in different clinical subgroups. In summary, the present study suggests that in CKD patients, serum creatinine and hemoglobin level were inversely correlated. The results confirm the need to track both renal and hematological parameters and the need for this to be done beyond just serum creatinine, since anemia in CKD is multifactorial.

Conclusion

Several systemic complications are associated with CKD, one of the most important and commonly seen complications is anemia. The aim of the present retrospective study was to assess the correlation between serum creatinine and hemoglobin levels in the one-year period of study in the patients with CKD. The average serum creatinine level in 80 patients included in the illustrative analysis was 3.1 ± 1.5 mg/dL, and the average hemoglobin level was 9.8 ± 1.7 g/dL. Serum creatinine level was significantly found to be inversely correlated with Hb level ($r = -0.62$, $p < 0.001$). Results showed that the higher the serum creatinine concentration, the lower the hemoglobin concentration tended to be.

This correlation could be attributed to the gradual decline in renal function and the resulting decrease in erythropoietin synthesis, as well as other causes such as iron deficiency, chronic inflammation, and nutritional imbalance and decreased red blood cell lifespan. The correlation of the two, however, should not be taken as a direct causal mechanism, since there are several clinical and demographic factors that could affect both. The study underscores the need to evaluate renal function, along with hemoglobin in patients with CKD. Early diagnosis of anemia can help in the proper clinical assessment and treatment of anemia, including the evaluation of potentially reversible causes like iron deficiency and nutritional abnormalities. In addition, it is important to look at serum creatinine in conjunction with other parameters of kidney function such as eGFR. Additional studies with larger patient population and detailed staging of CKD and prospective follow-up is recommended to better define the relationship between reduction of renal function and anemia.

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