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Original Article

Correlation Between Renal Function and Haematological Parameters in Chronic Kidney Disease Patients in North Karnataka

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ABSTRACT

Background: Chronic kidney disease (CKD) is a progressive condition associated with significant haematological derangements, most notably anaemia. The interplay between declining renal function and haematological parameters remains an area of active clinical investigation.
Objectives: To evaluate the correlation between renal function markers (serum creatinine and blood urea) and haematological parameters (haemoglobin, red blood cell count, and packed cell volume) in patients with CKD, and to determine the prevalence of anaemia across different CKD stages.
Methods: This cross-sectional study included 100 patients diagnosed with CKD (Stages 3b–5). Serum creatinine, blood urea, haemoglobin (Hb), red blood cell count (RBC), and packed cell volume (PCV) were measured. Pearson correlation coefficients were computed, and one-way ANOVA was used to compare parameters across CKD stages.
Results: The mean age was 52.9 ± 16.6 years with male predominance (58%). The majority (71%) were in CKD Stage 5. Serum creatinine showed significant negative correlations with Hb ($r = -0.373$, $p = 0.0001$), RBC ($r = -0.279$, $p = 0.005$), and PCV ($r = -0.351$, $p = 0.0003$). Blood urea also showed significant negative correlations with all three haematological parameters ($p < 0.05$). Hb, PCV, and creatinine differed significantly across CKD stages (ANOVA, $p < 0.05$). The overall prevalence of anaemia was 89%, increasing from 66.7% in Stage 3b to 91.5% in Stage 5.
Conclusion: Declining renal function is significantly associated with worsening haematological parameters in patients with CKD. The high prevalence of anaemia underscores the need for early haematological monitoring and timely intervention in CKD management.

Keywords: *Chronic Kidney Disease, Anaemia, Haemoglobin, Creatinine, Renal Function, Haematological Parameters.*

INTRODUCTION

Chronic kidney disease (CKD) is a growing global health burden, affecting 10–13% of the population worldwide and contributing significantly to morbidity and mortality [1]. Defined as a progressive, irreversible decline in glomerular filtration rate (GFR) persisting for 3 or more months [2], its prevalence continues to rise owing to rising rates of diabetes, hypertension, and population ageing [3]. Anaemia is among the most common complications of CKD, primarily driven by reduced renal erythropoietin (EPO) production, with additional contributions from iron deficiency, chronic inflammation, and uremic toxin accumulation [4,5]. Its prevalence increases with advancing CKD stages, ranging from approximately 27% in Stage 1 to over 75% in Stage 5 [9], and is associated with adverse outcomes, including cardiovascular

complications, diminished quality of life, and increased mortality [10]. Haematological parameters such as haemoglobin (Hb), red blood cell count (RBC), and packed cell volume (PCV) are key indicators of anaemia severity. In contrast, serum creatinine and blood urea serve as surrogate markers of renal function [6,7]. Several studies have reported an inverse relationship between renal function markers and haematological indices [8]; however, the strength of these correlations varies across populations, underscoring the need for data from diverse clinical settings [11]. Early identification and management of anaemia in CKD can improve patient outcomes and reduce cardiovascular morbidity [12]. This study, therefore, aims to quantify these correlations and assess the anaemia burden in a hospital-based CKD population.

METHODOLOGY

A hospital-based cross-sectional study was conducted at a tertiary care hospital in North Karnataka, with Institutional Ethics Committee approval. The sample size was calculated using a correlation coefficient formula assuming an expected correlation (r = 0.3), 95% confidence interval, and 80% power, yielding a minimum sample size of 85. Considering exclusions and incomplete data, 100 patients were included. Patients with AKI, active infections, recent blood transfusions, haematological malignancies, chronic liver disease, or those on erythropoietin therapy were excluded. Demographic and laboratory data, including age, gender, CKD stage, serum creatinine (mg/dL), blood urea (mg/dL), haemoglobin (g/dL), RBC count (million/µL), and PCV (%), were recorded. CKD staging was based on estimated GFR as per KDIGO guidelines, and anaemia was defined as Hb < 11 g/dL [13]. Data were expressed as mean ± SD. Pearson's correlation coefficient assessed the relationship between renal and haematological parameters, and one-way ANOVA compared means across CKD stages. A p-value < 0.05 was considered statistically significant

RESULTS

Demographic Profile: The study comprised 100 CKD patients with a mean age of 52.9 ± 16.6 years (range: 10–91 years). Males constituted 58% (n = 58) and females 42% (n = 42). The largest age group was 41–60 years (39%), followed by 61–80 years (34%). The majority of patients were classified as CKD Stage 5 (71%), followed by Stage 4 (26%) and Stage 3b (3%). The demographic profile is summarised in Table 1.

Table 1: Demographic and Clinical Profile of Study Participants (N = 100)

Variable	Category	n (%)
Gender	Male	58 (58.0%)
	Female	42 (42.0%)
Age Group	≤20 years	4 (4.0%)
	21–40 years	21 (21.0%)
	41–60 years	39 (39.0%)
	61–80 years	34 (34.0%)
	>80 years	2 (2.0%)
CKD Stage	Stage 3b	3 (3.0%)
	Stage 4	26 (26.0%)
	Stage 5	71 (71.0%)

Renal and Haematological Parameters across CKD Stages: The mean serum creatinine increased progressively from Stage 3b (1.97 ± 0.15 mg/dL) to Stage 5 (7.01 ± 3.00 mg/dL), while haemoglobin declined from 10.67 ± 2.61 g/dL in Stage 3b to 8.46 ± 1.92 g/dL in Stage 5. Similar declines were observed in RBC and PCV. One-way ANOVA revealed statistically significant differences across CKD stages for creatinine ($F = 25.36$, $p < 0.001$), urea ($F = 5.39$, $p = 0.006$), haemoglobin ($F = 3.80$, $p = 0.026$), and PCV ($F = 3.29$, $p = 0.042$). However, the difference in RBC count across stages did not reach statistical significance ($F = 1.88$, $p = 0.157$). These findings are presented in Table 2.

Table 2: Comparison of Renal and Haematological Parameters across CKD Stages (Mean ± SD)

Parameter	Stage 3b (n=3)	Stage 4 (n=26)	Stage 5 (n=71)	F-value
Creatinine (mg/dL)	1.97 ± 0.15	3.11 ± 0.73	7.01 ± 3.00	25.36*
Urea (mg/dL)	50.33 ± 25.01	75.19 ± 37.66	103.31 ± 46.71	5.39*
Hb (g/dL)	10.67 ± 2.61	9.43 ± 1.98	8.46 ± 1.92	3.80*
RBC (million/µL)	3.87 ± 0.84	3.38 ± 0.84	3.13 ± 0.81	1.88
PCV (%)	31.93 ± 6.60	28.32 ± 6.07	25.64 ± 5.78	3.29*

*p < 0.05 (statistically significant); ANOVA test applied

Correlation Between Renal Function and Haematological Parameters: Pearson's correlation analysis revealed significant negative correlations between serum creatinine and all three haematological parameters: Hb ($r = -0.373$, $p = 0.0001$), RBC ($r = -0.279$, $p = 0.005$), and PCV ($r = -0.351$, $p = 0.0003$). Blood urea also demonstrated significant negative correlations with Hb ($r = -0.234$, $p = 0.019$), RBC ($r = -0.236$, $p = 0.018$), and PCV ($r = -0.228$, $p = 0.023$). The strongest correlation was observed between serum creatinine and haemoglobin. These results are detailed in Table 3.

Table 3: Correlation Between Renal Function and Haematological Parameters

Renal Parameter	Hematological Parameter	Pearson r	p-value	Significance
Creatinine	Hb	-0.373	0.0001	HS
Creatinine	RBC	-0.279	0.0049	HS
Creatinine	PCV	-0.351	0.0003	HS
Urea	Hb	-0.234	0.0189	S
Urea	RBC	-0.236	0.0179	S
Urea	PCV	-0.228	0.0227	S

HS = Highly Significant ($p < 0.01$); S = Significant ($p < 0.05$)

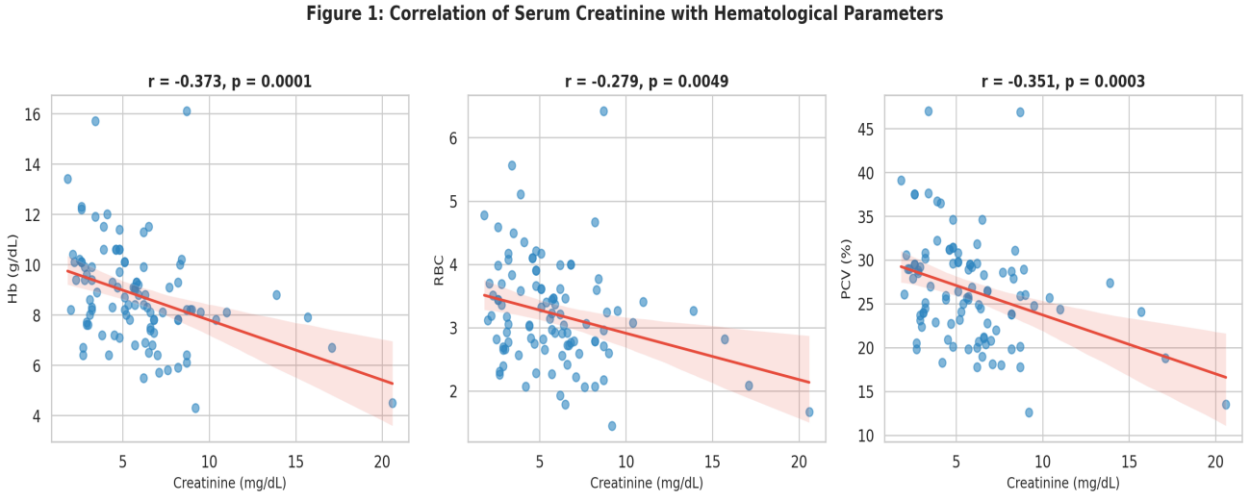

Figure 1: Scatter plots showing the correlation of serum creatinine with Hb, RBC, and PCV

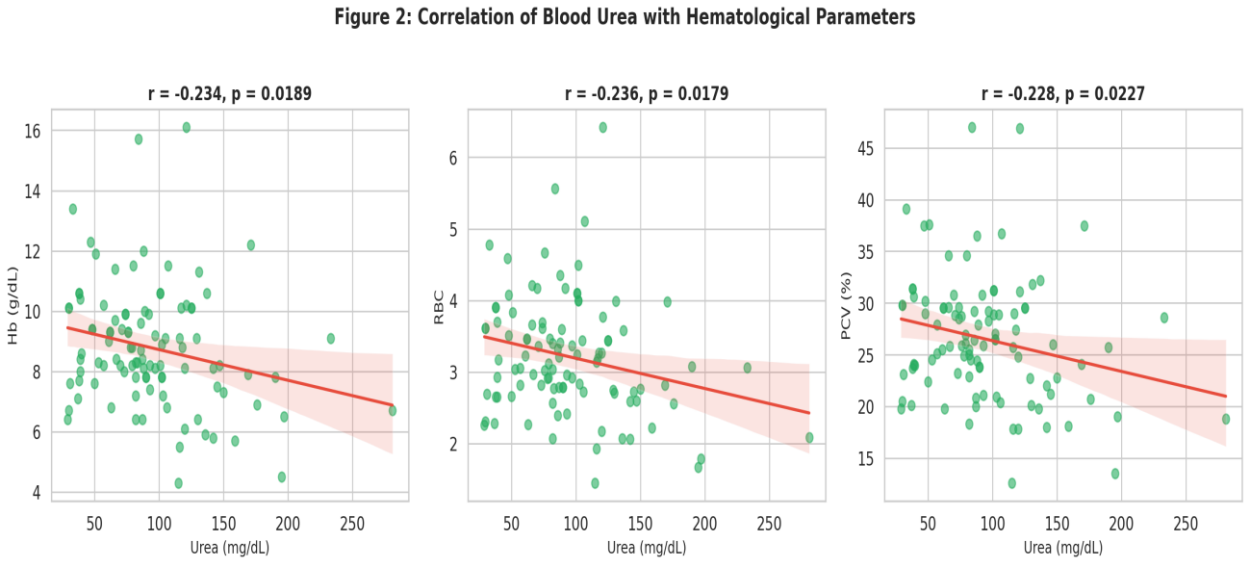

Figure 2: Scatter plots showing the correlation of blood urea with Hb, RBC, and PCV

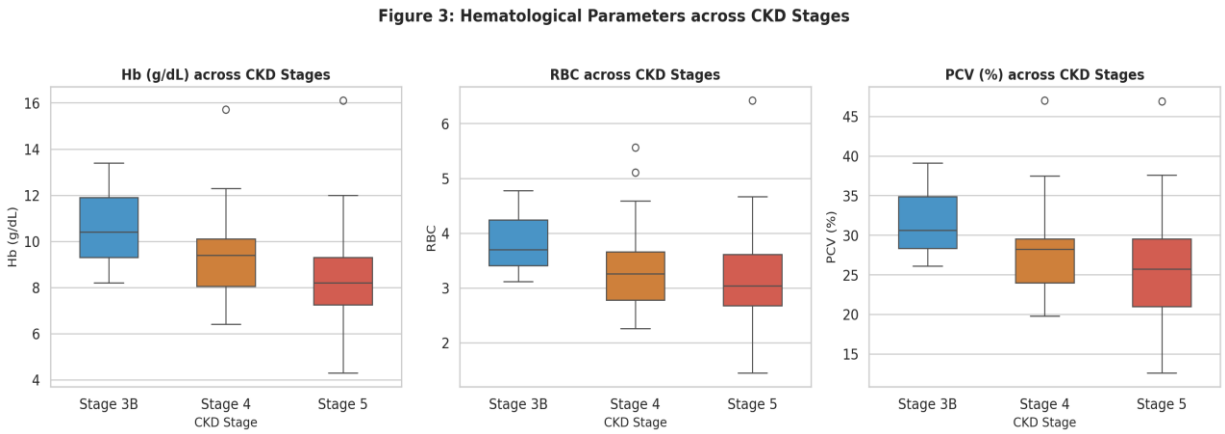

Figure 3: Box plots comparing haematological parameters across CKD stages

Prevalence of Anaemia: The overall prevalence of anaemia (Hb < 11 g/dL) in the study population was 89% (n = 89). The prevalence increased with advancing CKD stages: 66.7% in Stage 3b, 84.6% in Stage 4, and 91.5% in Stage 5 (Table 4, Figure 4).

Table 4: Prevalence of Anaemia across CKD Stages

CKD Stage	Total (n)	Anaemic (n)	Prevalence (%)
Stage 3b	3	2	66.7
Stage 4	26	22	84.6
Stage 5	71	65	91.5
Overall	100	89	89.0

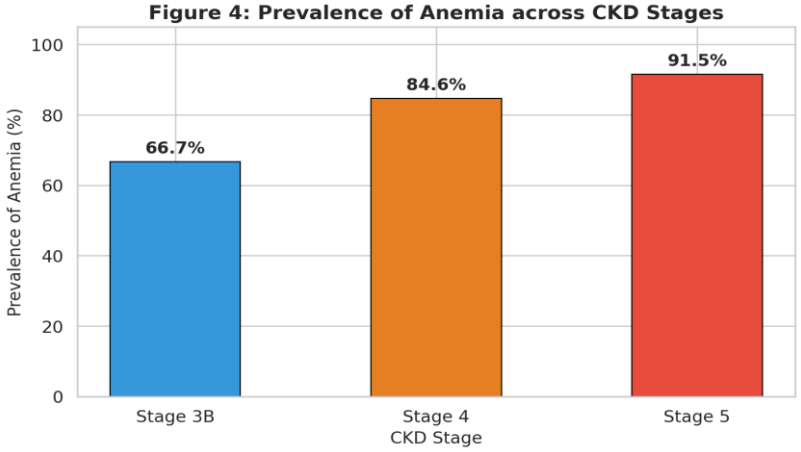

Figure 4: Prevalence of anaemia (%) across CKD stages

DISCUSSION

The significant inverse correlation between serum creatinine and haemoglobin ($r = -0.373$, $p < 0.001$) in this study is consistent with the pathophysiology of renal anaemia, where progressive nephron loss reduces erythropoietin production [4]. The male predominance (58%) and mean age (52.9 years) are comparable to findings by Suresh et al. [6] and Afshar et al. [8], reflecting the typical CKD demographic profile.

Our creatinine–Hb correlation aligns with Basu et al. [5] ($r = -0.42$) and Shahab et al. [9] ($r = -0.51$), with the slightly lower coefficient in our study likely reflecting the heterogeneous distribution of CKD stages. Blood urea showed weaker correlations with haematological parameters compared to creatinine, consistent with Agarwal et al. [7], who noted that urea is confounded by dietary protein intake and catabolic state. The progressive decline in Hb and PCV across CKD stages, with significant ANOVA differences, mirrors the graded deterioration reported by Hayat et al. [10]. The non-significant RBC difference across stages ($p = 0.157$) may reflect compensatory erythropoietic mechanisms and the small Stage 3b subgroup ($n = 3$).

The overall anaemia prevalence of 89% exceeds the 50–70% reported in Western populations [11] but is consistent with South Asian data; Kulkarni et al. [12] reported 91.4% among Indian CKD patients. The stage-wise increase from 66.7% to 91.5% mirrors findings by Chandra et al. [14]. The high prevalence even in Stage 3b highlights the need for early screening per KDIGO guidelines [13], as timely management with iron supplementation and ESAs can reduce cardiovascular morbidity and improve quality of life [15]. There are some limitations to the study, such as the cross-sectional design, which precludes causal inference and the small Stage 3b subgroup (n = 3), which limits the generalizability of stage-specific comparisons. Larger, multicentre longitudinal studies are warranted.

CONCLUSION

Renal function markers, particularly serum creatinine, showed significant negative correlations with haemoglobin, RBC count, and PCV in CKD patients, with haematological parameters declining progressively as CKD advanced. The high anaemia prevalence (89%) underscores the need for early and regular haematological monitoring and timely intervention to improve cardiovascular outcomes and quality of life in CKD patients.

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