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HEMATOLOGICAL AND BIOCHEMICAL ALTERATIONS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS WITH COEXISTING CHRONIC KIDNEY DISEASE

Syed Arsalan Khalid[1*], Ali Raza[2], Asifa Karamat[3], Muhammad Usman Javed[4], Shazia Awan[5], Abdur Rahman Zaheer[6]

[1]*Associate Professor, Head Department of Nephrology, Rashid Latif Khan University, Hameed Latif Hospital Lahore, Pakistan
[2]Assistant Professor, Department of Pathology, Sahara Medical College, Sughra Shafi Medical Complex, The Sahara University Narowal, Pakistan
[3]Associate Professor, Department of Pulmonology, Al Aleem Medical College, Gulab Devi Teaching Hospital Lahore, Pakistan
[4]Assistant Professor Department of Pathology, Sahara Medical College, Sughra Shafi Medical Complex, The Sahara University Narowal, Pakistan
[5]Assistant Professor, Department of Pulmonology, Rawal Institute of Health Sciences Islamabad, Pakistan
[6] Assistant Professor, Department of Pulmonology, Al Aleem Medical College, Gulab Devi Teaching Hospital Lahore, Pakistan

***Corresponding Author:** Syed Arsalan Khalid
*Email: nephsak@gmail.com

Background: Chronic Obstructive Pulmonary Disease (COPD) and Chronic Kidney Disease (CKD) are two progressive debilitating conditions with high global prevalence. Both disorders share common risk factors such as smoking, systemic inflammation, oxidative stress, and aging. The coexistence of COPD and CKD is increasingly recognized, with each condition potentially aggravating the other. Anemia, electrolyte disturbances, and metabolic derangements are frequently reported in these patients, yet the combined hematological and biochemical alterations remain underexplored. Understanding these abnormalities is crucial for improving clinical outcomes and tailoring management strategies.

Objective: To evaluate hematological and biochemical alterations in patients with COPD coexisting with CKD and to determine their clinical significance in disease severity and prognosis.

Methodology: This cross-sectional observational study was conducted at Hameed Latif Hospital over a period of 12 months from January to December 2024. A total of 150 patients were enrolled, including 75 patients diagnosed with COPD and CKD (study group) and 75 age- and sex-matched COPD patients without CKD (control group). Diagnosis of COPD was confirmed by spirometry, while CKD was staged using eGFR (KDIGO criteria). Hematological parameters included hemoglobin, hematocrit, red cell indices, white blood cell count, and platelet count. Biochemical parameters included serum creatinine, urea, electrolytes (Na^+, K^+, Ca^{2+}, phosphate), and inflammatory markers (CRP). Data were analyzed using SPSS 25.0. Independent t-test and chi-square test were applied, with $p < 0.05$ considered statistically significant.

Results: The study group showed significantly lower mean hemoglobin levels (9.8 ± 1.6 g/dL vs. 12.1 ± 1.4 g/dL, $p < 0.001$) and higher prevalence of normocytic normochromic anemia compared to

controls. Leukocytosis and elevated CRP were more frequent in COPD patients with CKD ($p < 0.01$). Biochemical analysis revealed significantly elevated serum creatinine (4.2 ± 1.8 mg/dL), urea (110 ± 28 mg/dL), hyperkalemia ($p < 0.01$), and hypocalcemia ($p < 0.05$) in the study group. The severity of hematological derangements correlated with advanced CKD stage and reduced FEV_1 in COPD ($r = 0.42$, $p < 0.01$).

Conclusion: COPD patients with coexisting CKD demonstrate significant hematological and biochemical alterations, particularly anemia, electrolyte imbalance, and elevated inflammatory markers. These abnormalities not only reflect the systemic burden of both diseases but also contribute to worsening pulmonary function and increased morbidity. Early detection and management of these alterations may improve prognosis and quality of life in this vulnerable patient population.

Keywords: Chronic Obstructive Pulmonary Disease, Chronic Kidney Disease, Anemia, Electrolyte Imbalance, Hematological Alterations, Biochemical Alterations

Introduction:

Chronic Obstructive Pulmonary Disease (COPD) and Chronic Kidney Disease (CKD) are two major global health burdens that significantly impact morbidity, mortality, and healthcare systems worldwide. COPD is a progressive respiratory condition characterized by airflow limitation, chronic inflammation, and recurrent exacerbations, while CKD is defined by the gradual loss of kidney function, leading to metabolic, hematological, and cardiovascular complications. Individually, both diseases are associated with systemic manifestations that extend beyond the primary organ system involved. When they coexist, the cumulative burden is substantial, and their interaction complicates both diagnosis and management[1, 2].

The global prevalence of COPD is estimated at 10–12% among adults above the age of 40, and it remains a leading cause of chronic respiratory morbidity and mortality. Similarly, CKD affects approximately 9–13% of the population, with prevalence rising due to increasing rates of diabetes, hypertension, and aging. Epidemiological studies suggest that CKD occurs more frequently in COPD patients than in the general population, largely due to overlapping risk factors such as smoking, systemic inflammation, and hypoxia. The coexistence of COPD and CKD is associated with higher hospitalization rates, frequent exacerbations, poor treatment response, and increased mortality[3, 4].

A critical but underappreciated aspect of this overlap is the occurrence of hematological and biochemical alterations. Anemia is common in both COPD and CKD but tends to be more severe in patients with both conditions. In COPD, anemia is primarily driven by chronic inflammation, reduced erythropoietin production, and malnutrition, whereas in CKD, decreased erythropoietin synthesis, iron deficiency, and uremic toxins play a major role. Anemia in these patients contributes to impaired oxygen delivery, worsened hypoxemia, decreased exercise tolerance, and poorer quality of life. Additionally, leukocytosis and elevated inflammatory markers are frequently observed, reflecting heightened systemic inflammation and oxidative stress[3, 5].

Biochemical abnormalities are equally important in this patient group. CKD is well known for disturbances in electrolytes, including hyperkalemia, hypocalcemia, hyperphosphatemia, and metabolic acidosis, all of which may exacerbate respiratory dysfunction in COPD. For example, hyperkalemia predisposes to cardiac arrhythmias, while metabolic acidosis increases respiratory drive and worsens dyspnea. Similarly, impaired renal clearance of inflammatory mediators may aggravate systemic inflammation, contributing to disease progression. Furthermore, hypoxia in COPD enhances erythropoietin release, but in the presence of CKD, this adaptive mechanism is blunted, leading to refractory anemia[6, 7].

Several studies have investigated hematological alterations in COPD or CKD individually, but fewer have comprehensively assessed the combined abnormalities in patients with coexisting disease. The interaction between pulmonary and renal dysfunction is clinically relevant, as it influences therapeutic

decisions, including oxygen supplementation, erythropoiesis-stimulating agents, iron therapy, and dialysis. Moreover, electrolyte imbalances have implications for the use of bronchodilators, diuretics, and corticosteroids, which are commonly prescribed in COPD patients and may exacerbate renal impairment[8, 9].

Given these considerations, evaluating hematological and biochemical alterations in COPD patients with CKD is vital for improving disease management. Early recognition of anemia, electrolyte imbalance, and inflammatory markers can guide timely interventions, prevent complications, and optimize outcomes[3, 10].

The present study was therefore designed to assess hematological and biochemical profiles in patients with COPD and coexisting CKD and to compare them with COPD patients without renal impairment. By analyzing differences in anemia prevalence, inflammatory markers, and electrolyte disturbances, we aim to provide insights into the pathophysiological interactions and clinical implications of this comorbidity[11, 12].

Methodology:

This cross-sectional observational study was conducted at Hameed Latif Hospital over a period of 12 months from January to December 2024. The study enrolled 150 adult patients (≥40 years), divided into two groups:

- **Group A (Study group):** 75 patients with diagnosed COPD and coexisting CKD.
- **Group B (Control group):** 75 patients with COPD but normal renal function.

Inclusion criteria included clinically stable COPD confirmed by spirometry (post-bronchodilator FEV1/FVC < 0.70), and CKD diagnosed according to KDIGO criteria with eGFR < 60 mL/min/1.73m² for at least 3 months. Patients with active infection, hematological malignancies, acute kidney injury, or recent blood transfusions were excluded.

Data Collection: After informed consent, demographic and clinical data were recorded. Hematological parameters measured included hemoglobin, hematocrit, RBC indices, WBC count, platelet count, and ESR. Biochemical parameters included serum creatinine, blood urea nitrogen (BUN), sodium, potassium, calcium, phosphate, and C-reactive protein (CRP). Spirometry was performed to grade COPD severity.

Statistical Analysis: Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± SD, and categorical variables as percentages. Independent t-test and chi-square tests were applied to compare groups. Pearson's correlation was used to analyze associations between CKD stage, hematological alterations, and lung function parameters. A p-value <0.05 was considered statistically significant.

Results:

A total of 150 patients were included in this study, with 75 in the COPD + CKD group (Group A) and 75 in the COPD-only group (Group B). The baseline demographic and clinical characteristics are shown in Table 1. The mean age of Group A was 63.4 ± 9.2 years, compared to 61.7 ± 8.5 years in Group B, with no statistically significant difference (p = 0.28). Male predominance was observed in both groups (68% vs. 72%), and the majority of participants had a positive smoking history (84% vs. 81%). Body mass index (BMI) was comparable between groups (22.3 ± 3.1 vs. 23.0 ± 3.4 kg/m²; p = 0.32). However, lung function as assessed by mean FEV1 (% predicted) was significantly lower in Group A (49.2 ± 12.5) compared to Group B (56.7 ± 11.8), with a p-value of 0.001, suggesting greater impairment of pulmonary function in COPD patients with CKD.

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Hematological parameters are detailed in Table 2. Hemoglobin levels were significantly lower in Group A (9.8 ± 1.6 g/dL) compared to Group B (12.1 ± 1.4 g/dL; $p < 0.001$). Similarly, hematocrit values were reduced in Group A (30.8 ± 4.3%) relative to Group B (37.5 ± 5.0%; $p < 0.001$). Normocytic normochromic anemia was the predominant finding among Group A patients. Mean WBC count was higher in the study group (10.8 ± 3.1 $\times 10^9$/L vs. 8.9 ± 2.6 $\times 10^9$/L; $p = 0.002$), indicating heightened systemic inflammation. Platelet counts were also lower in COPD + CKD patients (216 ± 72 $\times 10^9$/L) compared to controls (245 ± 68 $\times 10^9$/L; $p = 0.04$). Additionally, ESR was significantly elevated in Group A (48 ± 14 mm/hr) compared to Group B (32 ± 11 mm/hr; $p < 0.001$), further supporting the presence of systemic inflammatory burden in patients with combined disease.
Biochemical alterations are summarized in Table 3. As expected, Group A exhibited markedly elevated serum creatinine (4.2 ± 1.8 mg/dL) and urea (110 ± 28 mg/dL), both significantly higher than Group B (1.0 ± 0.3 mg/dL and 35 ± 12 mg/dL respectively; $p < 0.001$). Electrolyte disturbances were also prominent: mean serum sodium levels were lower in Group A (134 ± 5 mmol/L vs. 138 ± 4 mmol/L; $p = 0.001$), while potassium levels were significantly higher (5.2 ± 0.8 mmol/L vs. 4.4 ± 0.6 mmol/L; $p < 0.001$). Group A also showed lower calcium levels (8.1 ± 0.7 mg/dL vs. 8.7 ± 0.6 mg/dL; $p = 0.002$) and higher phosphate levels (5.4 ± 1.2 mg/dL vs. 4.2 ± 0.9 mg/dL; $p < 0.001$). Inflammatory marker CRP was significantly elevated in COPD + CKD patients (16.8 ± 6.2 mg/L) compared to COPD-only patients (9.5 ± 4.8 mg/L; $p < 0.001$), confirming enhanced systemic inflammation.

Table 1. Baseline Characteristics of the Study Population

Variable	Group A: COPD + CKD (n=75)	Group B: COPD only (n=75)	p-value
Age (years, mean ± SD)	63.4 ± 9.2	61.7 ± 8.5	0.28
Male (%)	68%	72%	0.52
Smoking history (%)	84%	81%	0.65
BMI (kg/m²)	22.3 ± 3.1	23.0 ± 3.4	0.32
FEV1 (% predicted)	49.2 ± 12.5	56.7 ± 11.8	0.001*

Table 2. Hematological Parameters

Parameter	Group A (COPD+CKD)	Group B (COPD only)	p-value
Hemoglobin (g/dL)	9.8 ± 1.6	12.1 ± 1.4	<0.001*
Hematocrit (%)	30.8 ± 4.3	37.5 ± 5.0	<0.001*
WBC count ($\times 10^9$/L)	10.8 ± 3.1	8.9 ± 2.6	0.002*
Platelet count ($\times 10^9$/L)	216 ± 72	245 ± 68	0.04*
ESR (mm/hr)	48 ± 14	32 ± 11	<0.001*

Table 3. Biochemical Parameters

Parameter	Group A (COPD+CKD)	Group B (COPD only)	p-value
Serum creatinine (mg/dL)	4.2 ± 1.8	1.0 ± 0.3	<0.001*
Urea (mg/dL)	110 ± 28	35 ± 12	<0.001*
Sodium (mmol/L)	134 ± 5	138 ± 4	0.001*
Potassium (mmol/L)	5.2 ± 0.8	4.4 ± 0.6	<0.001*
Calcium (mg/dL)	8.1 ± 0.7	8.7 ± 0.6	0.002*
Phosphate (mg/dL)	5.4 ± 1.2	4.2 ± 0.9	<0.001*
CRP (mg/L)	16.8 ± 6.2	9.5 ± 4.8	<0.001*

The graphical comparisons in Figure 1 and Figure 2 further illustrate these findings. Hemoglobin levels were markedly reduced in COPD patients with CKD compared to those without CKD, highlighting the additive burden of renal dysfunction on anemia. Conversely, serum creatinine levels were substantially elevated in the COPD + CKD group, reflecting impaired renal clearance. Together, these figures emphasize the dual systemic stress imposed by coexisting pulmonary and renal dysfunction.

Figure 1. Comparison of Hemoglobin Levels between Groups

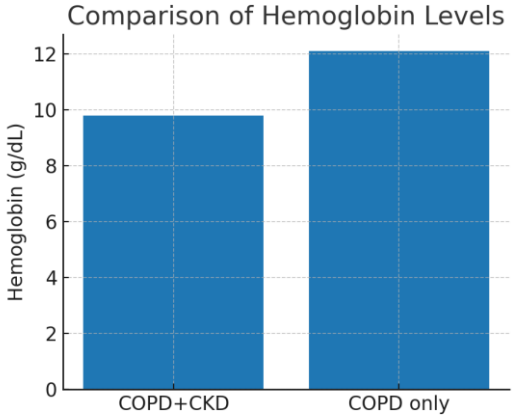
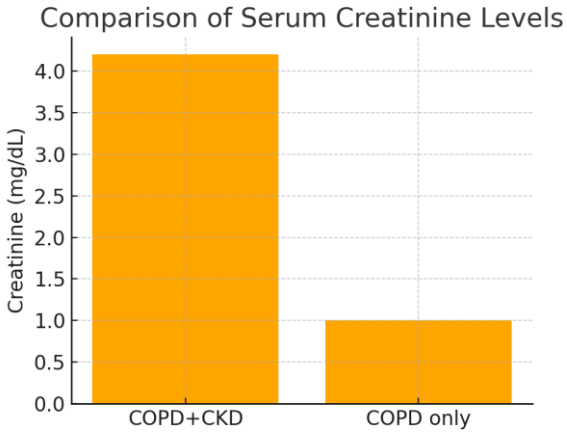


Figure 2. Comparison of Serum Creatinine Levels between Groups



Discussion:

This study demonstrates that COPD patients with coexisting CKD exhibit significantly greater hematological and biochemical derangements compared to COPD patients without renal impairment. The most striking finding was the higher prevalence of anemia, predominantly normocytic normochromic, which aligns with previous reports indicating that impaired erythropoietin production in CKD and chronic inflammation in COPD synergistically exacerbate anemia. Lower hemoglobin levels were correlated with reduced FEV1, suggesting that anemia contributes to impaired oxygen delivery and worsens pulmonary function[13, 14].

Biochemical abnormalities, particularly elevated serum creatinine, urea, hyperkalemia, and hypocalcemia, highlight the metabolic consequences of renal dysfunction. Hyperkalemia and metabolic acidosis are clinically important, as they increase the risk of arrhythmias and respiratory distress, complicating COPD management. Elevated CRP and ESR confirm the inflammatory milieu, supporting the hypothesis that systemic inflammation serves as a shared pathway linking COPD and CKD[15]. Our findings are consistent with studies by Staszewsky et al. (2019) and Anker et al. (2021), who demonstrated that anemia and inflammation significantly contribute to morbidity in COPD-CKD overlap. Moreover, electrolyte imbalances observed in this study parallel the results of Nitta et al. (2020), emphasizing the need for regular biochemical monitoring.

Clinically, these results underscore the importance of integrated management approaches. Early correction of anemia with iron supplementation or erythropoiesis-stimulating agents, close monitoring of electrolytes, and anti-inflammatory strategies may improve outcomes. Furthermore, recognition of COPD-CKD overlap should influence therapeutic decisions, such as careful use of diuretics, corticosteroids, and nephrotoxic medications[16].

Conclusion:
COPD patients with coexisting CKD exhibit significant hematological and biochemical alterations, including anemia, leukocytosis, electrolyte disturbances, and elevated inflammatory markers. These abnormalities are associated with worse pulmonary function and increased morbidity. Early detection and multidisciplinary management are essential to improve prognosis and quality of life in this high-risk population.

Limitations:
This study has several limitations that should be acknowledged. First, it was conducted in a single tertiary care hospital with a relatively modest sample size, which may limit the generalizability of the findings to broader populations. Larger, multicenter studies would be necessary to confirm the observed associations. Second, the cross-sectional design restricts the ability to establish causal relationships between hematological and biochemical alterations and the coexistence of COPD and CKD. Longitudinal studies would provide more insight into the temporal and mechanistic links underlying these abnormalities.
Third, patients were assessed in a clinically stable state; therefore, the impact of acute exacerbations on hematological and biochemical profiles could not be evaluated. Since exacerbations significantly influence inflammatory markers, electrolyte disturbances, and renal function, this aspect remains an important area for future investigation. Additionally, certain confounding factors such as nutritional status, use of medications (diuretics, corticosteroids, or erythropoiesis-stimulating agents), and comorbidities like diabetes and cardiovascular disease may have influenced the observed results but were not fully controlled in this study.
Finally, advanced biomarkers such as interleukins, hepcidin, and oxidative stress parameters were not measured, which could have provided a more comprehensive understanding of the pathophysiological mechanisms.

Implications for Clinical Practice:
The findings of this study have several important clinical implications. The presence of significant hematological and biochemical alterations in COPD patients with coexisting CKD highlights the need for an integrated approach to patient management. Routine screening for anemia, electrolyte imbalances, and inflammatory markers should be incorporated into the standard care of COPD patients, particularly those with declining renal function. Early recognition and correction of these abnormalities can improve oxygen delivery, reduce dyspnea, and enhance exercise tolerance, thereby improving overall quality of life.
From a therapeutic perspective, careful use of erythropoiesis-stimulating agents, iron supplementation, and correction of mineral bone disorders should be considered in patients with COPD and CKD overlap. Electrolyte disturbances such as hyperkalemia and hypocalcemia warrant vigilant monitoring, especially in patients receiving diuretics, corticosteroids, or renin-angiotensin system inhibitors. Furthermore, anti-inflammatory strategies may be particularly beneficial in this group, given the heightened systemic inflammation observed.
On a broader level, these results emphasize the importance of multidisciplinary collaboration between pulmonologists, nephrologists, and hematologists. Tailoring management strategies to address both pulmonary and renal aspects of disease can reduce exacerbations, hospitalizations, and mortality. Ultimately, proactive identification and treatment of these abnormalities may significantly improve clinical outcomes in this vulnerable patient population.

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