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General Medicine

RENAL DYSFUNCTION IN COPD: A CROSS-SECTIONAL STUDY ON PREVALENCE AND PREDICTORS

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ABSTRACT Chronic obstructive pulmonary disease (COPD) is a progressive yet largely preventable lung disorder characterized by persistent airflow limitation due to chronic inflammation and prolonged exposure to harmful pollutants such as cigarette smoke and biomass fuel emissions. While COPD is primarily a respiratory disease, it has systemic consequences, including renal dysfunction, which remains underexplored. The mechanisms underlying renal dysfunction in COPD are thought to involve chronic hypoxia, systemic inflammation, and nephrotoxic effects of commonly used medications. Despite these potential links, the prevalence and clinical impact of renal dysfunction in COPD patients are not well understood. This cross-sectional study aimed to evaluate renal function in COPD patients and its association with disease severity, anemia, and other clinical parameters. We enrolled 100 COPD patients who met the GOLD criteria over a two-year period at Dr. Pinnamaneni Siddhartha Institute of Medical Sciences & Research Foundation (Dr. PSIMS & RF). Renal function was assessed using blood urea levels, serum creatinine, and estimated glomerular filtration rate (eGFR). Additional parameters, including hemoglobin levels, serum albumin, and serum sodium, were analyzed. Among the study population, 25% had renal dysfunction (eGFR < 60 mL/min/1.73m²). A substantial correlation was observed between eGFR and serum creatinine levels ($p<0.001$), while blood urea levels also showed a significant association with renal dysfunction ($p=0.02$). However, anemia, hyponatremia, and hypoalbuminemia did not demonstrate significant correlations with renal dysfunction. COPD severity, based on spirometry, also did not significantly influence renal dysfunction ($p=0.32$). These findings suggest that renal dysfunction in COPD is a common yet often asymptomatic comorbidity that is not solely dependent on pulmonary function decline. Given the burden of renal dysfunction in COPD, routine renal function screening should be considered for early detection and intervention. Future investigation must emphasize longitudinal studies to establish causality and assess the effect of early intervention on disease progression and survival.

KEYWORDS :

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive, long-term respiratory condition marked by persistent and irreversible airflow limitation. It primarily results from prolonged exposure to environmental pollutants, including tobacco smoke and biomass fuel emissions. It is a major cause of illness and mortality globally and is typically connected with emphysema and chronic bronchitis [1]. With approximately 3.5 million deaths per year, COPD is currently the fourth leading cause of mortality globally and is expected to rise to the third position by 2030 [2]. In India, COPD accounts for approximately half a million deaths annually, with an estimated prevalence of 3.49% [3]. However, underdiagnosis is likely, as many prevalence studies rely on symptom-based questionnaires rather than spirometry, suggesting the actual burden may be higher. Beyond mortality, COPD significantly impacts quality of life, productivity, and healthcare costs. While COPD primarily affects the lungs, its systemic manifestations are increasingly recognized [4]. Among these, renal dysfunction is a critical but understudied comorbidity [5]. Impaired renal function in COPD patients may arise from chronic hypoxia, systemic inflammation, or shared risk factors such as smoking and aging. Additionally, medications used in COPD management, such as corticosteroids and diuretics, may further exacerbate renal dysfunction [6]. Understanding the prevalence and mechanisms of renal dysfunction in COPD is essential, as it can influence disease progression, treatment outcomes, and overall prognosis. This study aims to evaluate renal function in COPD patients, with a specific focus on determining the prevalence of renal failure in this population. By exploring the interplay between COPD and renal health, this research seeks to improve patient management and highlight the need for integrated care approaches.

MATERIALS AND METHODS

This cross-sectional study was conducted at Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation (Dr. PSIMS & RF), a tertiary care hospital in Andhra Pradesh, over a two-year period (November 2018 to October 2020). We enrolled a total of 100 individuals diagnosed with COPD as per the GOLD criteria [7] from both the outpatient and inpatient departments. We included patients above the age of 18 years who met the GOLD-defined criteria for COPD, while we excluded those with comorbid conditions known to cause renal dysfunction, such as diabetes mellitus, hypertension, primary renal diseases (including renal stones and polycystic kidney disease), cirrhosis, cardiac failure, coronary artery disease, or those receiving nephrotoxic medications.

We conducted a comprehensive clinical evaluation for all patients, which included detailed history-taking, with a particular focus on smoking habits and prior treatment history, along with a thorough physical examination. To verify airflow limitation in stable patients, we utilized a portable ultrasonic spirometer (Easy-One, NDD Medical Technologies) in compliance with the American Thoracic Society's standards [8]. We also conducted laboratory investigations, including complete blood count, serum albumin, renal function tests, and serum electrolyte levels. Additionally, we performed imaging studies, including chest radiographs and ultrasonography of the abdomen and pelvis, to assess any structural abnormalities.

To evaluate renal function, we utilized four-variable MDRD (Modification of Diet in Renal Disease) formula, which calculates the eGFR as follows: eGFR=186× (Serum Creatinine) ^-1.154×(Age)^-0.203× [0.742 if female] × [1.210 if Black] [9]. Utilizing the KDOQI (Kidney Disease Outcomes Quality Initiative) standards from the National Kidney Foundation, we defined renal failure as an eGFR of <60mL/min [10]. We also assessed additional parameters, including hyponatremia, having a blood sodium level below 135mEq/L, hypoalbuminemia as a serum albumin level below 3.5g/dL, along with anemia as hemoglobin levels below 13g/dL in males and 12g/dL in the females.

RESULTS

Among the 100 COPD patients, 36% had mild COPD, 46% had moderate COPD, and 18% had severe COPD based on spirometry findings. The mean FEV_1% predicted was 56.2 ± 14.3%, indicating varying degrees of airflow limitation.

A comparison between COPD severity and renal dysfunction showed that the proportion of patients with renal dysfunction increased with COPD severity (16.7% in mild, 28.3% in moderate, and 33.3% in

severe COPD). Though, this association had not been statistically significant ($p = 0.32$), suggesting that renal dysfunction in COPD may be influenced more through systemic factors such as chronic hypoxia, oxidative stress, and medication effects rather than lung function decline alone. The distribution of COPD severity is shown in Table 1.

Table 1: Spirometry and COPD Severity Findings

COPD Severity (Spirometry Classification)	Frequency (%)
Mild ($FEV_1 \geq 80\%$)	36 (36%)
Moderate (FEV_1 50–79%)	46 (46%)
Severe ($FEV_1 < 50\%$)	18 (18%)
Mean FEV_1% Predicted	56.2 ± 14.3%

Renal function assessment revealed that 25 percent of the study population had an eGFR < 60 mL/min/1.73m², indicating renal dysfunction. The mean eGFR was 79.61 ± 26.37 mL/min/1.73m² (normal renal function: 90.79 ± 19.35, renal dysfunction: 46.05 ± 12.28).

Serum creatinine was significantly greater in the renal dysfunction group ($p < 0.001$). The mean creatinine level was 1.08 ± 0.39 mg/dL, with normal renal function patients having 0.90 ± 0.19 mg/dL and renal dysfunction patients having 1.61 ± 0.35 mg/dL.

Similarly, blood urea levels were significantly greater in renal dysfunction patients ($p < 0.001$). Mean blood urea level was 37.96 ± 22.46 mg/dL, with normal renal function patients having 31.41 ± 16.44 mg/dL, while those with renal dysfunction had 57.60 ± 26.67 mg/dL. Table 2 summarizes renal function parameters.

Table 2: Renal Function and Biochemical Parameters

Parameter	Normal eGFR (≥60)	Renal Dysfunction (<60)	Total	p-value
eGFR (mL/min/1.73m²)	90.79 ± 19.35	46.05 ± 12.28	79.61 ± 26.37	<0.001
Serum Creatinine (mg/dL)	0.90 ± 0.19	1.61 ± 0.35	1.08 ± 0.39	<0.001
Blood Urea (mg/dL)	31.41 ± 16.44	57.60 ± 26.67	37.96 ± 22.46	<0.001

A comparison between patients with normal renal function (eGFR ≥ 60 mL/min/1.73m²) and those with renal dysfunction (eGFR < 60 mL/min/1.73m²) revealed no significant difference in gender distribution ($p = 1.00$).

The mean age of patients was 61.28 ± 10.72 years. Those with renal dysfunction were older (64.52 ± 9.49 years vs. 60.20 ± 10.94 years, $p = 0.08$), though the difference was not statistically significant.

Among hematological parameters, hemoglobin (Hb) levels were lower in renal dysfunction patients (10.91 ± 2.10 g/dL vs. 11.75 ± 2.48 g/dL, $p = 0.13$), but association had not been statistically significant. Total leukocyte count (TC) was slightly higher in renal dysfunction patients ($p = 0.17$), while platelet count (PLT) exhibited no significant difference ($p = 0.73$).

Among biochemical markers, serum sodium levels were lower in renal dysfunction patients (134.68 ± 4.49 vs. 136.80 ± 5.74, $p = 0.10$), but this was not statistically significant. Serum albumin levels were slightly higher in renal dysfunction patients, but association had not been significant ($p = 0.53$).

Table 3: Comparison of Renal Dysfunction with Clinical Variables

Variable	Normal eGFR (≥60)	Renal Dysfunction (<60)	Total	p-value
Age (years)	60.20 ± 10.94	64.52 ± 9.49	61.28 ± 10.72	0.08
Hemoglobin (g/dL)	11.75 ± 2.48	10.91 ± 2.10	11.54 ± 2.41	0.13
Serum Sodium (mEq/L)	136.80 ± 5.74	134.68 ± 4.49	136.27 ± 5.51	0.10
Serum Albumin (g/dL)	3.36 ± 0.62	3.45 ± 0.52	3.39 ± 0.60	0.53
Total WBC Count (cells/mm³)	8071.87 ± 2162.58	8728.00 ± 1600.92	8235.90 ± 2049.05	0.17
Platelet Count (lacs/mm³)	2.42 ± 1.03	2.50 ± 0.88	2.44 ± 0.99	0.73

Ultrasonography findings revealed that 82% of patients had no significant abdominal abnormalities, while renal parenchymal changes were present in 8% of patients. Other incidental findings included cholelithiasis (1%), hepatomegaly (1%), mild splenomegaly (1%), and a right adrenal cyst (1%).

Table 4: Ultrasound Findings in COPD Patients

Findings	Frequency (%)
Bilateral Grade II Renal Parenchymal Changes	2 (2%)
Grade I Renal Parenchymal Changes	6 (6%)
Cholelithiasis	1 (1%)
Grade I Fatty Liver	6 (6%)
Hepatomegaly	1 (1%)
Mild Splenomegaly	1 (1%)
Right Adrenal Cyst	1 (1%)
No Abnormality Detected (NAD)	82 (82%)

DISCUSSION

In this study, we observed that 25% of COPD patients exhibited renal dysfunction, as indicated by an eGFR < 60 mL/min/1.73m². This finding aligns with previous reports that estimate the prevalence of renal dysfunction in COPD to range between 20% and 45%, depending on study populations and diagnostic criteria. We discovered a strong correlation ($p < 0.001$) between serum creatinine and eGFR, reinforcing the role of creatinine as a key indicator of renal function in COPD patients. Blood urea levels were also significantly associated with renal dysfunction ($p = 0.02$), further suggesting that chronic hypoxia, systemic inflammation, and medication-related nephrotoxicity contribute to renal dysfunction in this population.

One of the most important findings of our study is the lack of a significant association between renal dysfunction and COPD severity ($p = 0.32$). This challenges the conventional assumption that renal dysfunction is directly linked to the extent of airflow limitation. Instead, our results suggest that In COPD patients, systemic factors such as inflammation, endothelial injury, oxidative stress, and chronic hypoxia contribute more significantly to renal dysfunction than the decline in pulmonary function alone. These findings are in line with prior research, including studies published in the European Respiratory Journal (2019) [11] and the International Journal of COPD (2021) [12], both of which reported that renal dysfunction can occur across all COPD stages and is not necessarily correlated with spirometric severity. This has significant clinical implications, as it indicates that even patients with mild to moderate COPD may develop renal dysfunction, reinforcing the need for routine renal function assessment irrespective of disease severity.

In addition to renal dysfunction, we found a high prevalence of anemia (75%) and hypoalbuminemia (48%) among COPD patients. While anemia is a well-documented systemic complication of COPD, our analysis revealed no statistically significant correlation between anemia and renal dysfunction ($p = 0.21$). This suggests that anemia in COPD is more likely due to chronic inflammation, erythropoietin resistance, nutritional deficiencies, and impaired iron metabolism, rather than being directly caused by renal dysfunction. This aligns with findings from a study published in the Journal of Clinical Medicine (2021), which concluded that anemia in COPD is primarily associated with systemic inflammatory burden rather than renal dysfunction [13].

Similarly, hypoalbuminemia was present in nearly half of our study population (48%), but it did not demonstrate a statistically significant association with renal dysfunction ($p = 0.82$). Previous studies have suggested that hypoalbuminemia in COPD reflects chronic inflammation, malnutrition, and hypermetabolism rather than primary renal dysfunction. Given that low serum albumin levels have been linked to increased mortality and disease progression in COPD, its high prevalence in our study reinforces the importance of nutritional assessment and targeted interventions to improve overall patient outcomes.

Hyponatremia was observed in 37% of our study population, yet it did not show a significant correlation with renal dysfunction ($p = 0.23$). Hyponatremia in COPD has been attributed to multiple factors, including diuretic use, chronic hypoxia, fluid retention, and inappropriate antidiuretic hormone secretion (SIADH). A study published in the International Journal of COPD (2022) similarly reported that hyponatremia in COPD is more commonly associated with cardiac dysfunction and systemic volume overload rather than

direct renal dysfunction [14]. Given that hyponatremia has been linked to increased morbidity and mortality in COPD patients, its presence in a significant proportion of our cohort highlights value of careful electrolyte monitoring as well as timely intervention, particularly in elderly patients and those with frequent exacerbations.

Our findings reinforce the evolving recognition of COPD as a systemic disease rather than a condition confined to the lungs [15]. While COPD is primarily characterized by airflow limitation, it is now widely understood that chronic inflammation, oxidative stress, and endothelial dysfunction have far-reaching effects on multiple organ systems, including the kidneys. The high prevalence of renal dysfunction, anemia, and electrolyte imbalances in our study highlights the need for a more comprehensive, multidisciplinary approach to COPD management, integrating routine renal function screening, nutritional evaluation, and electrolyte monitoring as essential components of patient care.

Considering our investigation's advantages, it must be noted that it has some drawbacks. Cross-sectional design limits our ability to establish a causal link between COPD and renal dysfunction. Follow-up studies are required to determine whether COPD directly contributes to renal decline over time or if renal dysfunction occurs independently. Additionally, while we excluded patients with pre-existing renal disease, diabetes, hypertension, and cardiovascular comorbidities, we recognize the possibility that undiagnosed subclinical kidney disease may have been present prior to COPD diagnosis, potentially influencing our results. Another limitation is the absence of a control group (age-matched non-COPD individuals), which would have provided a stronger basis for comparison. Future research should focus on prospective cohort studies that track renal function in COPD patients over time, with the goal of identifying modifiable risk factors and intervention strategies.

Another important area for further investigation is the impact of COPD medications on renal function. Although our study acknowledges the potential nephrotoxic effects of corticosteroids, diuretics, and bronchodilators, we did not analyze medication history separately. Given that chronic corticosteroid use has been associated with proteinuria and glomerular damage, and that diuretics can contribute to electrolyte disturbances and volume depletion, future studies should evaluate whether specific COPD treatments exacerbate renal dysfunction and whether dose modifications could mitigate these risks.

Overall, our investigation offers insightful observations into the burden of renal dysfunction in COPD patients and reinforces the need for early screening and a multidisciplinary approach to disease management. The lack of correlation between renal dysfunction and COPD severity suggests that systemic mechanisms play a dominant role, rather than lung function decline alone. These findings highlight the necessity of integrating renal function assessment into routine COPD care to enable early detection, timely intervention, and improved long-term patient outcomes.

CONCLUSION

This study demonstrates that renal dysfunction is a common yet often overlooked comorbidity in COPD, considering 25% of patients exhibiting impaired renal function. The absence of a significant correlation between renal dysfunction and COPD severity suggests that renal dysfunction is not merely a consequence of declining lung function but is influenced by systemic factors such as chronic hypoxia, inflammation, and oxidative stress. The significant association between eGFR and serum creatinine highlights the importance of monitoring renal function in COPD patients, even in those with mild to moderate disease.

Despite the high prevalence of anemia, hypoalbuminemia, and hyponatremia, these parameters were not significantly associated with renal dysfunction, suggesting that COPD-related anemia and electrolyte imbalances arise from multiple mechanisms rather than direct renal involvement. This reinforces the need for a holistic approach to COPD management that includes nutritional support, electrolyte monitoring, and routine renal function assessment.

Given the potential implications of undiagnosed renal dysfunction in COPD, routine screening should be considered in standard COPD care protocols. Early detection and intervention could help prevent further deterioration of kidney function, reduce cardiovascular risk, and optimize pharmacological management by adjusting drug dosages based on renal function. Future investigation must emphasise longitudinal studies to better understand the trajectory of renal dysfunction in COPD and evaluate whether early intervention strategies can improve patient outcomes

Limitations

The cross-sectional design of our study makes it difficult to demonstrate a link between renal dysfunction along with COPD. Being a single-centre study, the findings may not be fully generalizable. Although major comorbidities were excluded, the possibility of pre-existing subclinical renal dysfunction before COPD diagnosis cannot be ruled out. Additionally, we did not assess the long-term impact of COPD medications or inflammatory markers that could further explain disease interactions. Future multicenter, prospective cohort studies should assess long-term renal function trajectories in COPD patients and evaluate whether early nephroprotective interventions can improve clinical outcomes.

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