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Research Article

Association of Albuminuria and Oxygen Saturation in Patients with COPD: A Cross-Sectional Study

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ABSTRACT

Background & Objectives: Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of morbidity and mortality, often complicated by comorbidities such as cardiovascular disease. Albuminuria, assessed by urine albumin-to-creatinine ratio (UACR), is a marker of endothelial dysfunction and adverse outcomes. This study aimed to investigate the prevalence of albuminuria in COPD patients and its association with oxygenation status and disease severity.

Materials and Methods: A cross-sectional study was conducted among 70 COPD patients at Tribhuvan University Teaching Hospital, Kathmandu. UACR was measured from spot urine samples, and patients were classified into GOLD groups (A–D). Arterial partial pressure of oxygen (PaO_2) was obtained via arterial blood gas analysis, and peripheral oxygen saturation (SpO_2) was measured by pulse oximetry. Statistical analysis was performed using SPSS.

Results: Among the participants, 42.9% had normal UACR, 52.9% had microalbuminuria, and 4.3% had macroalbuminuria. The prevalence of albuminuria was higher in GOLD Group D patients (67.5%). Patients with albuminuria had lower mean PaO_2 compared to those without, indicating an association between hypoxemia and higher UACR values (p=0.042).

Conclusion: Albuminuria is common in COPD patients and is associated with both greater disease severity and lower oxygen levels. Screening for albuminuria may help identify high-risk COPD patients for earlier cardiovascular and renal risk management.

Keywords: Chronic Obstructive Pulmonary Disease, Albuminuria, UACR, PaO_2, Hypoxemia.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a major global health burden, with a worldwide prevalence of 10.3% among adults aged 30-79 years in 2019 [1]. COPD is characterized by irreversible airflow limitation and symptoms such as dyspnea, cough, and sputum production [2]. The condition is a major cause of morbidity and mortality worldwide, with the Global Initiative for Chronic Obstructive Lung Disease (GOLD) ranking it as a top global health burden. The disease is often accompanied by comorbidities, including cardiovascular diseases, osteoporosis, and depression, which complicate its management [3]. Air pollution is a significant risk factor for COPD, with particulate matter, sulfur dioxide, nitrogen dioxide, and ozone being key pollutants affecting respiratory health [4]. Albuminuria is prevalent in patients with COPD and is associated with increased mortality and disease severity. Studies have shown that 24% of COPD patients exhibit albuminuria which is linked to a 54% higher risk of all-cause mortality [5,6]. Albuminuria is also associated with accelerated lung function decline and increased risk of incident COPD, with each standard deviation increase in log-transformed albuminuria corresponding to a 15% higher risk of moderate-to-severe COPD [7].

The association between albuminuria and COPD severity, particularly in relation to oxygen saturation levels, remains poorly understood in Nepalese populations. This study was designed to address this gap by assessing the relationship between albuminuria, oxygenation status, and disease severity in patients with COPD.

MATERIALS AND METHODS

This study was conducted as a cross-sectional observational study to evaluate the prevalence of albuminuria and its correlation with oxygen saturation levels and disease severity in patients with Chronic Obstructive Pulmonary Disease (COPD). The study was performed at Tribhuvan University Teaching Hospital (TUTH) in Kathmandu, Nepal, and included 70 eligible participants with a confirmed diagnosis of COPD. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants.

Selection of Participants

The study included adult patients diagnosed with COPD, both in stable condition and during acute exacerbations (AECOPD). Including both groups allowed us to capture the full clinical spectrum of COPD as it is encountered in real-world hospital practice. Since PaO_2 is expected to vary between stable and exacerbation states, subgroup analysis was performed to account for these differences. This approach enabled us to evaluate whether albuminuria was consistently associated with hypoxemia across the different clinical phases of COPD.

Inclusion Criteria:

- Adult patients aged 40 years and above.
- Diagnosed with COPD according to GOLD criteria.
- Patients willing to participate and provide written informed consent.

Exclusion Criteria:

- Presence of other systemic diseases, including active kidney disease, malignancy, or other major comorbidities.
- Patients not willing to participate in the study or provide consent.

Data Collection

Data was collected over a period of 6 months, with both inpatient and outpatient COPD patients being recruited. The following assessments were carried out:

1. ***Albuminuria Assessment (UACR):*** A spot urine sample was collected from each participant. The urine albumin-to-creatinine ratio (UACR) was measured to assess the degree of albuminuria. UACR values were classified as normal (<3 mg/mmol), microalbuminuria (3–30 mg/mmol), and macroalbuminuria (>30 mg/mmol) (KDIGO, 2012).
2. ***Oxygen Saturation and Hypoxemia Measurement:*** Arterial blood gas (ABG) analysis was performed to determine the partial pressure of oxygen (PaO_2) in the blood. Peripheral oxygen saturation (SpO_2) was also measured by pulse oximetry. However, PaO_2 was the main variable analyzed in relation to albuminuria and COPD severity.
3. ***Spirometry and COPD Assessment:*** Spirometry was conducted according to GOLD guidelines to assess airflow limitation. Patients were categorized into GOLD spirometric stages (I–IV) based on FEV_1 % predicted, and into GOLD groups (A–D) using symptom burden (mMRC, CAT) and exacerbation history. For the purposes of this study, GOLD groups (A–D) were used in the main analysis.
4. ***Cardiovascular Disease (CVD) Screening:*** A detailed history of cardiovascular disease was taken, and participants were screened for conditions such as hypertension, ischemic heart disease, and heart failure using clinical examination and diagnostic tests such as ECG and echocardiography.
5. ***Other Clinical Parameters:*** Demographic data (age, sex, BMI, occupation, smoking history, exposure to biomass fuel), comorbidities, and clinical features (such as symptoms of dyspnea and cough) were recorded.

Ethical Considerations

The study was approved by the institutional ethics committee at Tribhuvan University Teaching Hospital (Ref: 177(6-11)E^2 077/078). Written informed consent was obtained from all participants before data collection. The study adhered to the ethical principles outlined by the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants. To compare PaO_2 values across different categories of albuminuria (normal, microalbuminuria, and macroalbuminuria), a one-way ANOVA test was applied. Similarly, the relationship between COPD severity (GOLD groups) and albuminuria was

evaluated using ANOVA. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 70 COPD patients were included in the study. The mean age of the participants was 70.43 ± 9.42 years, with the majority aged between 65-74 years (44.29%). There were more female participants (61.43%) than male participants (38.57%) (Figure 1), and most participants (68.6%) had a body mass index (BMI) between 18.5 and 22.9 kg/m^2 (Figure 2).

Most participants (70%) were smokers, while 21.43% were exposed to both smoking and biomass fuel. The study also revealed that 68.6% of participants resided in rural areas, and 44.29% were dependent (Table 1).

The prevalence of albuminuria was high in this cohort. Among participants, 42.9% had normal UACR values, 52.9% had microalbuminuria, and 4.3% had macroalbuminuria. The proportion of albuminuria increased with COPD severity, as shown in Table 2.

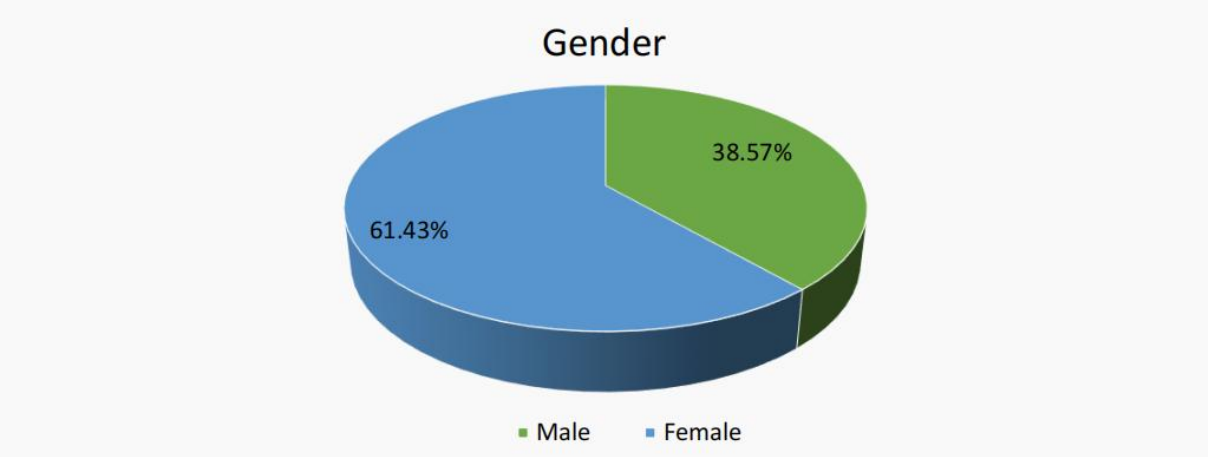

Figure 1: Sex Distribution of patients with COPD

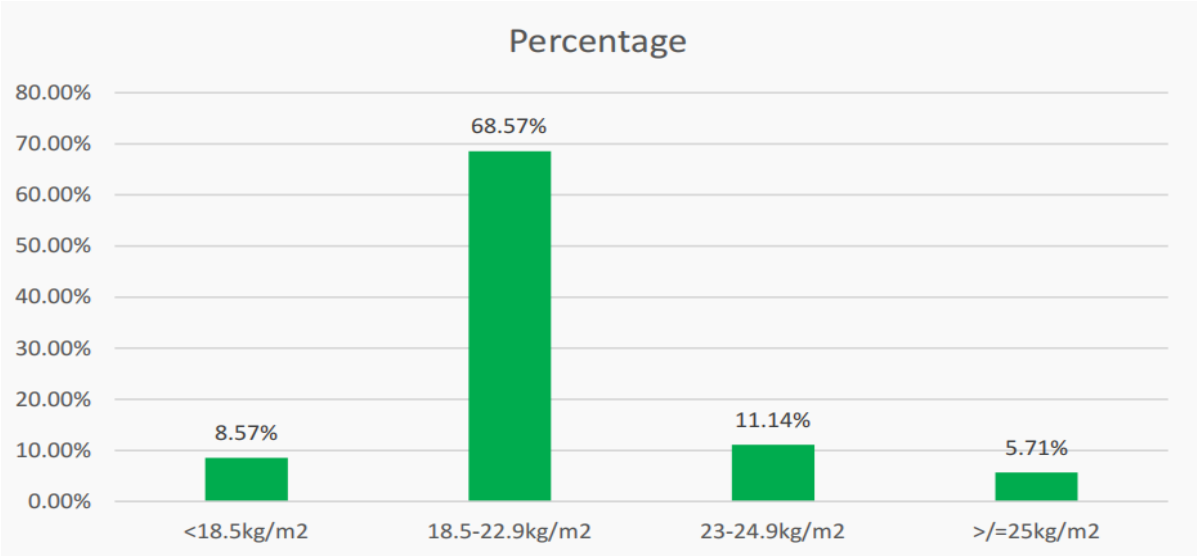

Figure 2: Distribution of participants according to their BMI

Table 1: Baseline Characteristics of participants

Parameters		Outcome
Age (in years)	45-54	5 (7.14)
	55-64	8 (11.43)
	65-74	31 (44.29)
	More than 74	26 (37.14)
	Total	70 (100)
Sex	Male	27 (38.57)
	Female	43 (61.43)
	Total	70 (100)
BMI (kg/m2)	<18.5	6 (8.6)
	18.5-22.9	48 (68.6)
	23-24.9	12 (17.1)
	>24.9	4 (5.7)
	Total	70 (100)
Area of Residence	Rural	48 (68.6)
	Urban	22 (31.4)
	Total	70 (100)
Occupation	Farmer	19 (27.14)
	Housewife	11 (15.71)
	Dependent	31 (44.29)
	Health worker	2 (2.86)
	Government Job	3 (4.29)
	Private Job	4 (5.71)
	Total	70 (100)
Exposure to	Smoking	49 (70)
	Biomass	6 (8.57)
	Both	15 (21.43)
	Total	70 (100)
Smoking Pack Year Distribution	<15	19 (27.14)
	16-30	45 (64.29)
	31-45	3 (4.29)
	46-60	3 (4.29)
	Total	70 (100)
Education level	Illiterate and without formal education	66 (94.29%)
	Primary	1 (1.43)
	Secondary	2 (2.86)
	Above Secondary	1 (1.43)
	Total	70 (100)

Table 2: Distribution of participants according to albumin level

Albumin excretion	Normal	30 (42.9)
	Microalbuminuria	37 (52.9)
	Macroalbuminuria	3 (4.3)
	Total	70 (100)

The association between GOLD groups (A–D) and UACR categories was statistically significant (p = 0.026). Although GOLD groups primarily classify patients based on symptoms and exacerbation risk, in this cohort a higher proportion of patients in

GOLD Group D exhibited albuminuria compared to Groups A–C (Table 3)

The comparison of PaO_2 across UACR categories was statistically significant (p = 0.042). Patients with normal UACR values had a mean PaO_2 of 98.2 ± 40.8 mmHg, compared to 79.7 ± 26.7 mmHg in those with microalbuminuria, and 63.5 ± 7.5 mmHg in patients with macroalbuminuria. These findings indicate that lower arterial oxygen tension is associated with higher levels of albuminuria in COPD patients (Table 4)

exacerbate renal impairment in COPD patients. Given that albuminuria is a marker of endothelial dysfunction, its prevalence could reflect the extent of systemic involvement in COPD, which is often linked to worse cardiovascular and renal outcomes. The relationship observed in this study underscores the potential of albuminuria as a non-invasive biomarker for assessing the severity of COPD and the associated risks for cardiovascular morbidity and mortality.

DISCUSSION

Table 3: Comparison between GOLD ABCD group of COPD between Spot UACR by ANOVA test

GOLD Group	Patients (n, %)	Albuminuria present n (%)	Normal UACR n (%)	Mean UACR ± SD	95% CI	p-value
A	8 (11.4)	1 (12.5)	7 (87.5)	2.29 ± 0.49	1.87–2.70	0.026
B	14 (20.0)	5 (35.7)	9 (64.3)	2.52 ± 0.92	1.98–3.05	
C	8 (11.4)	4 (50.0)	4 (50.0)	4.75 ± 5.38	0.26–9.25	
D	40 (57.1)	27 (67.5)	13 (32.5)	11.40 ± 14.23	6.83–15.96	
Total	70 (100)	37 (52.9)	33 (47.1)	7.82 ± 11.66	5.04–10.60	

Table 4: Comparison between PaO2 and Spot UACR by ANOVA test

UACR Category	Participants (n, %)	Mean PaO_2 ± SD (mmHg)	95% CI	p-value
Normal	30 (42.9)	98.18 ± 40.84	83.20–113.16	0.042
Microalbuminuria	37 (52.9)	79.69 ± 26.71	70.66–88.73	
Macroalbuminuria	3 (4.3)	63.47 ± 7.51	44.82–82.12	
Total	70 (100)	87.18 ± 34.59	78.94–95.43	

The results demonstrate a strong correlation between the severity of COPD, the presence of albuminuria, and reduced oxygen saturation levels. The increasing prevalence of albuminuria in more severe stages of COPD (GOLD Stage D) is consistent with the systemic inflammatory state in COPD, which may lead to endothelial dysfunction and kidney damage. The significant association between lower PaO2 and higher albumin levels suggests that hypoxemia may

This study aimed to investigate the prevalence of albuminuria in patients with Chronic Obstructive Pulmonary Disease (COPD) and to assess its relationship with disease severity and hypoxemia. The results highlight a significant association between the presence of albuminuria and the severity of COPD, as classified by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages, as well as a marked relationship between albuminuria and oxygen saturation levels (PaO2). These findings offer valuable

insights into the pathophysiology of COPD and its systemic effects, particularly in terms of kidney function and cardiovascular risk.

The high prevalence of albuminuria in the study population is consistent with previous research that has shown an increased incidence of albuminuria in patients with COPD compared to the general population [8,9]. In this study, 52.9% of participants had microalbuminuria, and 4.3% had macroalbuminuria, indicating that more than half of the COPD patients had abnormal albumin excretion. These findings are in line with earlier studies suggesting that microalbuminuria is common in COPD patients, even in the absence of overt kidney disease [10]. Microalbuminuria is prevalent in patients with COPD and is associated with increased mortality and disease severity. A 12-year follow-up study found that COPD patients with microalbuminuria had a 54% higher risk of all-cause mortality compared to those without [6,11]. The strong prevalence of albuminuria in the study population suggests that routine screening for this condition may provide important prognostic information for COPD patients, especially those with more severe disease.

The results indicate a significant increase in the prevalence of albuminuria as the severity of COPD worsens, with the highest incidence observed in patients with GOLD Stage D (67.5%). This finding is particularly important because it suggests that albuminuria may serve as a simple, non-invasive marker of disease progression in COPD [10,12]. In this study, patients in GOLD Stage D exhibited the highest levels of albuminuria, which is consistent with the fact that GOLD Stage D represents the most severe form of COPD, characterized by frequent exacerbations, low lung function, and significant symptoms. The systemic inflammatory response in these patients likely contributes to vascular damage and endothelial dysfunction, leading to the leakage of albumin into the urine [5,13]. The strong correlation between albuminuria and COPD severity also underscores the potential utility of albuminuria as a biomarker for identifying patients at risk for complications such as cardiovascular diseases (CVD), which are common in advanced COPD.

A noteworthy finding in this study was the significant association between albuminuria and oxygen saturation (PaO2). Patients with normal albumin levels had a mean PaO2 of 98.18 ± 40.84 mmHg, while those with albuminuria had significantly lower PaO2 levels (79.69 ± 26.71 mmHg), and those with macroalbuminuria had the lowest levels (63.47 ± 7.51 mmHg). These results are consistent with the hypothesis that hypoxemia in COPD exacerbates endothelial dysfunction, leading to increased albumin leakage into the urine [14,15]. The relationship between lower oxygen saturation and higher albuminuria may reflect a more generalized systemic involvement in COPD, where hypoxia-induced inflammation could impair kidney function. Hypoxemia is known to trigger a cascade of events, including increased oxidative stress, inflammatory cytokine release, and activation of the renin-angiotensin-aldosterone system (RAAS), all of which can contribute to endothelial dysfunction and glomerular injury [13]. Therefore, albuminuria may serve as an early marker of worsening hypoxemia and a predictor of future cardiovascular events in COPD patients.

While this study provides valuable insights into the association between albuminuria, COPD severity, and hypoxemia, certain

limitations must be acknowledged. First, the cross-sectional design precludes any inference of causality between albuminuria, hypoxemia, and COPD progression. Second, the sample size was relatively small, which may limit the generalizability of the findings. Further studies with larger sample sizes and multi-center designs are needed to confirm these results. Despite these limitations, our findings suggest that routine assessment of albuminuria in COPD patients, particularly those with more severe disease or presenting with hypoxemia, could offer important prognostic information. Monitoring albuminuria may serve as a practical tool for early identification of patients at increased risk of kidney dysfunction and cardiovascular complications, thereby supporting more comprehensive management strategies.

CONCLUSION

This study demonstrates a significant association between albuminuria, disease severity, and hypoxemia in Nepalese patients with COPD. The findings highlight the potential role of albuminuria as a non-invasive marker of disease burden and cardiovascular risk. Early detection of albuminuria may help identify high-risk COPD patients and guide timely interventions to improve overall outcomes.

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Author's Contribution: Conceptualization, data curation, formal analysis, methodology, writing first Draft-**NB, SD;** Investigation, writing, reviewing and editing- **BS; NA, MP.** All authors read the final version and approved towards the final publication.

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