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Serum Albumin as a Prognostic Marker in Acute Exacerbations of Chronic Obstructive Pulmonary Disease: A Retrospective Study

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Abstract: ***Background**: Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) remain a major global cause of hospitalization, healthcare burden, and mortality. **Methods**: This single-center retrospective cohort study was conducted at Chest Department, Assiut University Hospitals, from July 2022 to March 2023 and aimed to evaluate whether admission serum albumin levels (g/dL) could predict in-hospital mortality among adults hospitalized with AECOPD and to assess their association with the need for noninvasive or invasive mechanical ventilation (NIV/IMV), intensive care unit (ICU) admission, and length of hospital stay (LOS). **Results**: Among 150 patients, hypoalbuminemia (<3.5 g/dL) was significantly associated with systemic inflammation, hypoxemia, prolonged hospitalization, and higher in-hospital mortality. Binary logistic regression identified low serum albumin as an independent predictor of mortality (OR = 0.041, 95% CI: 0.007–0.262, p = 0.001). Serum albumin and mGPS both demonstrated a good performance, with an AUC 0.82, and 0.725 respectively. **Conclusion**: These findings suggest that serum albumin and mGPS are reliable, low-cost prognostic biomarkers that may support early risk stratification in hospitalized patients with AECOPD.***

Keywords: chronic obstructive pulmonary disease, hypoalbuminemia, hospitalization, mortality, prognostic biomarkers, mGPS, AECOPD

1. Introduction

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) remain a major cause of hospitalization, healthcare costs, and mortality internationally [1,2]. Early identification of high-risk patients upon admission is essential for augmenting triage, monitoring, and therapeutic interventions [3]. Several prognostic tools, such as the DECAF (Dyspnoea, Eosinopenia, Consolidation, Acidaemia, Atrial fibrillation) and BAP-65 (Blood urea nitrogen, altered mental status, Pulse, Age ≥65) scores, have been developed to predict in-hospital mortality and the need for ventilatory support in AECOPD [4,5].

Despite this evidence, few studies have evaluated admission serum albumin as an independent predictor alongside established risk scores in AECOPD. Given its low cost and routine availability, validating albumin's prognostic utility could improve early risk stratification and guide clinical decision-making in resource-limited settings [6, 7].

Several studies have investigated the prognostic role of serum albumin in chronic obstructive pulmonary disease (COPD) and other critical illnesses. Zinellu et al., found that serum albumin concentrations are significantly lower in stable COPD patients compared to non-COPD controls, suggesting hypoalbuminaemia as a feature of the condition. [8]. Also, Zeng et al., and Giri et al., reported that the blood urea nitrogen-to-albumin ratio was a strong predictor of short-term mortality among patients with acute exacerbations of COPD [9, 10]. Moreover, Li et al. showed that the CRP-to-albumin ratio was significantly correlated with prognosis in COPD patients. [11].

Despite these findings, only a limited number of studies have evaluated admission serum albumin as a single, independent predictor of outcomes in AECOPD in developing countries. Most existing reports are focused on ICU patients, leaving a knowledge gap in early risk stratification for hospitalized cases.

Therefore, this study aimed to evaluate whether admission serum albumin levels could predict in-hospital mortality and other adverse outcomes in patients with AECOPD.

Acute exacerbations of COPD remain a leading cause of hospital admissions and mortality worldwide. Although several prognostic scores exist, they are often complex and rely on variables not readily available in all healthcare settings. Serum albumin is an inexpensive and routinely measured biomarker, yet its independent prognostic value in AECOPD has not been fully established. Therefore, the current study was designed to determine whether admission serum albumin levels could serve as a reliable predictor of in-hospital mortality and poor outcomes among patients hospitalized with AECOPD.

2. Patients and Methods

Study Design and Participants:
This was a single-center, retrospective cohort study, from July 2022 to March 2023 and conducted at Chest Department, Assiut University Hospitals.

A total of 230 admissions for AECOPD were screened during the study period. After applying exclusion criteria, 150 patients fulfilled eligibility requirements and were included in the final analysis as showed in (**Figure 1**).

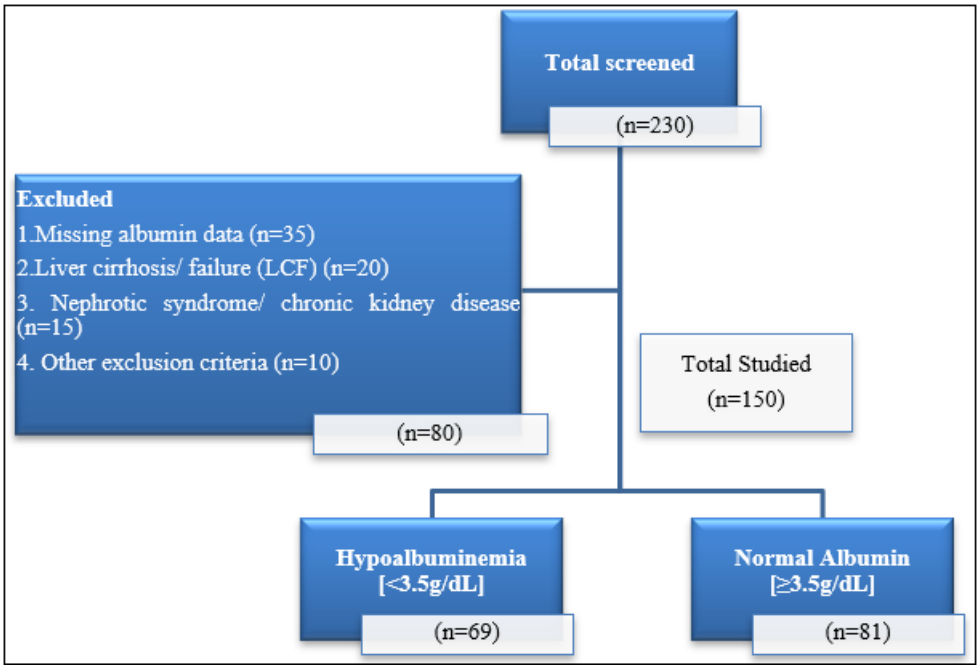

Figure 1: Flowchart of patient selection for the study.

Inclusion and exclusion criteria:
Patients aged ≥ 40 years, with confirmed COPD diagnosis prior to the time of admission, documented by post-bronchodilator spirometry with FEV1/FVC < 0.70 according to GOLD definition within the past 12–24 months, were included. All Patients were categorized as group E according to the ABE classification of the GOLD guidelines **[12].**

However, patients aged <40 years old, or critical patients who needed ICU admission at the time of first evaluation in emergency room, patients who had other significant pulmonary diseases e.g. bronchiectasis, pulmonary fibrosis, lung cancer, or active pulmonary tuberculosis (to avoid confusing effects on inflammation and albumin levels) , Chronic systemic diseases affecting albumin or CRP e.g. chronic liver disease (e.g., cirrhosis, hepatitis), chronic kidney disease and or autoimmune or rheumatologic diseases (e.g., rheumatoid arthritis, SLE), Active systemic infection other than AECOPD: e.g. Sepsis, urinary tract infection, or any extra-pulmonary infection documented at admission ,Any active cancer, as malignancy strongly modifies CRP, albumin, and inflammatory scores , Recent major interventions: history of major surgery, trauma, or blood transfusion within the last 4 weeks ,Use of immunosuppressive therapy: long-term corticosteroids (>10 mg prednisolone equivalent daily),chemotherapy, or biologic immunosuppressants within the past 3 months ,Malnutrition or hypoalbuminemia unrelated to COPD: documented protein–energy malnutrition, nephrotic syndrome, or gastrointestinal protein-losing enteropathy and patients with missing baseline CRP, albumin, or other essential variables required for CAR/mGPS calculation were excluded.

Randomization/ Masking:
Randomization and masking were not applicable, as data collectors required full awareness of the study protocol.

Clinical and Laboratory assessment:
We utilized the hospital's electronic medical record, laboratory information system and ICU/procedure logs to identify AECOPD admissions and extract data. A simple case-report form captured demographics, smoking, BMI, spirometry (most recent FEV1% predicted), vital signs, ABG results, chest X-ray, laboratory tests, treatments, and outcomes (need for NIV/IMV, ICU transfer, length of stay, and in-hospital death.

Serum albumin measured via: venous blood was collected in a serum separator tube, allowed to clot, and centrifuged; albumin was measured within 24 hours of admission. Results were reported in g/dL. For analysis, albumin was used both as a continuous variable and in categories i.e. <3.5 g/dL hypoalbuminemia and ≥3.5 g/dL normal.

C-reactive protein (CRP). CRP was measured on serum using an immunoturbidimetric method and reported in mg/L. When available from the same admission draw, CRP was used to compute sensitivity analyses such as the CRP/albumin ratio or the Glasgow Prognostic Score. From the above data we calculated the modified Glasgow Prognostic Score (mGPS) for each admission for sensitivity analyses when both components were available.

The modified Glasgow Prognostic Score (mGPS) was determined using serum C-reactive protein (CRP) and albumin levels. Patients were classified as low risk (score 0)

if CRP was ≤10 mg/L, regardless of albumin concentration. An intermediate risk score (1) was assigned when CRP was >10 mg/L with albumin ≥35 g/L, and a high-risk score (2) when CRP was >10 mg/L with albumin <35 g/L. Patients with hypoalbuminemia (<35 g/L) in the presence of normal CRP (≤10 mg/L) were assigned a score of 0.

We recorded initiation and timing of non-invasive ventilation and invasive mechanical ventilation, ICU transfers, length of stay and in-hospital death.

Statistical Analysis:
Data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Quantitative variables were presented as mean ± SD or median (IQR), and qualitative variables as frequencies and percentages. Group comparisons used t-test or Mann–Whitney U test, as appropriate. A p-value <0.05 was considered statistically significant." P value considered significant if < 0.05.

Ethical consideration:
The study protocol was reviewed and approved by the Ethics Committee of the Faculty of Medicine, Assiut University (IRB no. 04-2025-300715). All procedures were conducted in accordance with the ethical standards of the institutional research committee and the 1964 Helsinki Declaration and its later amendments.

3. Results

This study was conducted on a total of 150 AECOPD patients.

Baseline characteristics of patients stratified by albumin status
Patients with hypoalbuminemia were slightly older than those with normal albumin levels (64.67 ± 7.11 vs. 62.20 ± 8.29 years), with a small standardized mean difference (SMD = 0.32). Gender distribution was comparable, with males predominating in both groups and a negligible imbalance (SMD = 0.08). Body mass index (BMI) categories showed some variation between groups, particularly in obesity prevalence, which was higher among hypoalbuminemic patients; however, the overall imbalance remained small (SMD = 0.28). Smoking status, were similarly distributed between groups, with a low (SMD = 0.15) as shown in **Table 1.**

Table 1: Baseline characteristics of patients stratified by albumin status

Variable	Parameter	Hypoalbuminemia N=69	Normal N=81	SMD
Age (years)	Mean ± SD	64.67 ± 7.11	62.20 ± 8.29	0.32
	Min-max	43-75	43-75	
Gender	Male (n=117)	55 (79.7%)	62 (76.5%)	0.08
	Female (n=33)	14 (20.3%)	19 (23.5%)	
BMI (kg/m2)	Underweight (n=6)	4 (5.8%)	2 (2.5%)	0.28
	Healthy (n=37)	15 (21.7%)	22 (27.2%)	
	Overweight (n=61)	24 (34.8%)	37 (45.7%)	
	Obesity (n=46)	26 (37.7%)	20 (24.7%)	
Smoking status	Non-smoker (n=38)	15 (21.7%)	23 (28.4%)	0.15
	Current smoker (n=59)	27 (39.1%)	32 (39.5%)	
	Ex-smoker (n=53)	27 (39.1%)	26 (32.1%)	

Data are expressed as mean ± standard deviation (SD), minimum–maximum, or number (percentage). Statistical tests used included independent t-test for continuous variables and chi-square test with odds ratios for categorical variables. Pooled SD method was used for continuous variables, SMD for proportions was used for categorical variables. **Abbreviations:** SMD: standard mean deviation, BMI: body mass index.

Comorbidities of patients according to albumin status
Hypertension and diabetes mellitus were similarly prevalent in both groups, with negligible standardized mean differences (SMD = 0.08 for each). Ischemic heart disease showed a slightly higher prevalence among patients with hypoalbuminemia; however, the imbalance remained small (SMD = 0.15). Likewise, chronic kidney disease was more frequently observed in the hypoalbuminemia group, though the corresponding SMD (0.18) still reflected a small and clinically acceptable difference **(Table 2).**

Table 2: Comorbidities of patients according to albumin status

Variable	Parameter	Hypoalbuminemia N=69	Normal N=81	SMD
HTN	No (n=62)	30 (43.5%)	32 (39.5%)	0.08
	Yes (n=88)	39 (56.5%)	49 (60.5%)	
DM	No (n=101)	45 (65.2%)	56 (69.1%)	0.08
	Yes (n=49)	24 (34.8%)	25 (30.9%)	
IHD	No (n=118)	52 (75.4%)	66 (81.5%)	0.15
	Yes (n=32)	17 (24.6%)	15 (18.5%)	
CKD	No (n=129)	57 (82.6%)	72 (88.9%)	0.18
	Yes (n=21)	12 (17.4%)	9 (11.1%)	

Data are presented as number (percentage). Statistical analysis was performed using chi-square test for categorical variables. Pooled SD method was used for continuous variables, SMD for proportions was used for categorical variables. **Abbreviations:** SMD: standard mean deviation, HTN: hypertension, DM: diabetes mellitus, IHD: ischemic heart disease, CKD: chronic kidney disease.

Inflammatory markers findings of AECOPD patients according to albumin status

Patients with hypoalbuminemia had higher mean white blood cell counts compared with those with normal albumin levels (11.07 ± 3.21 vs. 10.17 ± 2.93 ×10⁹/L), with a small standardized mean difference (SMD = 0.29). C-reactive protein levels were markedly elevated in the hypoalbuminemia group relative to the normal albumin group (28.18 ± 19.75 vs. 19.95 ± 15.02 mg/L), demonstrating a moderate imbalance between groups (SMD = 0.47). In contrast, erythrocyte sedimentation rate values were comparable between the two groups (38.84 ± 14.30 vs. 36.62 ± 12.40 mm/hr), with a small SMD of 0.17 **(Table 3).**

Table 3: Inflammatory markers findings of AECOPD patients according to albumin status

Variable	Parameter	Hypoalbuminemia N=69	Normal N=81	SMD
WBC (×10⁹/L)	Mean ± SD	11.07 ± 3.21	10.17 ± 2.93	0.29
	Min-max	3.5-18.2	3.5-17.5	
CRP (mg/L)	Mean ± SD	28.18 ± 19.75	19.95 ± 15.02	0.47
	Min-max	0.5-106.5	1.00-74.3	
ESR (mm/hr)	Mean ± SD	38.84 ± 14.30	36.62 ± 12.40	0.17
	Min-max	3-74	6-65	

Data are expressed as mean ± standard deviation (SD) and minimum–maximum values. Statistical comparisons were made using independent t-test. Pooled SD method was used for continuous variables, SMD for proportions was used for categorial variables. **Abbreviations:** SMD: standard mean deviation, WBC: white blood cell count, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate.

Arterial blood gases among patients admitted with AECOPD, stratified by serum albumin

Arterial pH values were comparable between patients with hypoalbuminemia and those with normal albumin levels (7.40 ± 0.27 vs. 7.41 ± 0.02), with a negligible standardized mean difference (SMD = 0.06). Similarly, partial pressure of carbon dioxide was slightly higher in the hypoalbuminemia group (51.01 ± 8.31 vs. 49.67 ± 7.81 mmHg), reflecting a small imbalance between groups (SMD = 0.17). In contrast, oxygenation parameters differed more noticeably. Patients with hypoalbuminemia had lower mean partial pressure of oxygen (60.54 ± 6.57 vs. 63.93 ± 7.92 mmHg), corresponding to a moderate SMD of 0.46. Peripheral oxygen saturation was also reduced in the hypoalbuminemia group compared with the normal albumin group (91.85 ± 1.46 vs. 93.07 ± 1.61%), with a large standardized mean difference (SMD = 0.79; **Table 4).**

Table 4: Arterial blood gases among patients admitted with AECOPD, stratified by serum albumin

Variable	Parameter	Hypoalbuminemia N=69	Normal N=81	SMD
pH	Mean ± SD	7.40 ± 0.27	7.41 ± 0.02	0.06
	Min-max	7.32-7.45	7.34-7.46	
PaCO2 (mmHg)	Mean ± SD	51.01 ± 8.31	49.67 ± 7.81	0.17
	Min-max	35-71.5	35-72.6	
PaO2 (mmHg)	Mean ± SD	60.54 ± 6.57	63.93 ± 7.92	0.46
	Min-max	44-75	46.4-79.4	
SpO2 (%)	Mean ± SD	91.85 ± 1.46	93.07 ± 1.61	0.79
	Min-max	87-96.1	89.2-96	

Data are expressed as mean ± standard deviation (SD) and minimum–maximum values. Statistical comparisons were performed using independent t-test. Pooled SD method was used for continuous variables, SMD for proportions was used for categorical variables. **Abbreviations:** SMD: standard mean deviation, SD: standard deviation, mmHg: millimeters of mercury, PaCO2: arterial partial pressure of carbon dioxide, PaO2: arterial partial pressure of oxygen, SO2: arterial oxygen saturation.

Binarized first regression analysis of predictors of in-hospital mortality among patients with AECOPD

As shown in **Table 5,** serum albumin level emerged as a significant independent predictor of in-hospital mortality, with lower albumin levels being strongly associated with increased mortality risk (OR = 0.041, 95% CI: 0.007–0.262, p = 0.001). ESR also showed a statistically significant association with mortality (p = 0.018). In contrast, age did not demonstrate a statistically significant association with in-hospital mortality (OR = 1.068, 95% CI: 0.977–1.167, p = 0.148).

Table 5: Binarized first regression analysis of predictors of in-hospital mortality among patients with AECOPD

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Age	.066	.045	2.096	1	.148	1.068	.977	1.167
	Albumin	-3.184	.941	11.451	1	.001	.041	.007	.262
	ESR	2.037	.022	2.737	1	.018	0.037	.093	1.083
	Constant	2.761	4.133	.446	1	.504	15.817		
a. Variable(s) entered on step 1: Age, Albumin, ESR									

Statistical test: Binarized first regression analysis. Values are presented as regression coefficient (B), standard error (S.E.), Wald chi-square statistic (Wald), odds ratio (Exp(B)), and 95% confidence interval (CI). Variables were entered using the enter method. A p value ≤ 0.05 was considered statistically significant. **Abbreviations** AECOPD = Acute Exacerbation of Chronic Obstructive Pulmonary Disease; ESR = Erythrocyte Sedimentation Rate.

In-hospital and short-term outcomes by albumin group

Clinical outcomes were significantly worse among patients with hypoalbuminemia compared to those with normal albumin levels. ICU admission was required in 40.6% of hypoalbuminemia patients versus 23.5% in the normal albumin group. Similarly, the need for non-invasive ventilation (NIV) or invasive mechanical ventilation (IMV) was higher in the hypoalbuminemia group (52.2%) compared to the normal group (29.6%) (p<0.001, CI (0.17-0.36). Mean hospital stay was prolonged in hypoalbuminemia patients (8.24 ± 3.62 days) compared to

those with normal albumin (5.87 ± 2.87 days). In-hospital mortality was markedly higher among hypoalbuminemia patients (18.8%) than those with normal albumin (3.7%) **(Figure 2).**

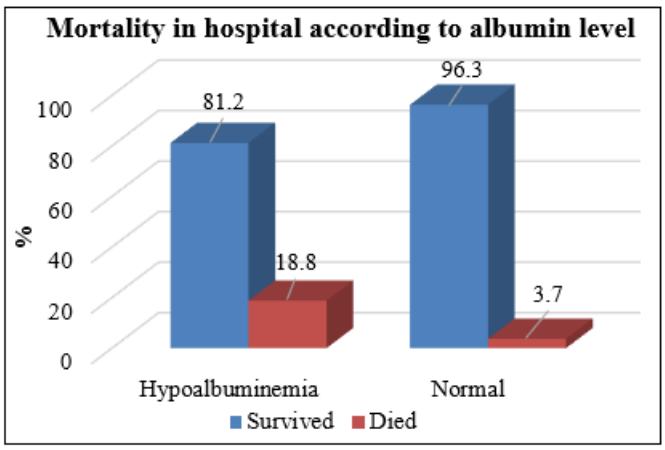

Figure 2: In hospital mortality rate according to albumin level.

ROC Curve Analysis for Serum Albumin, CAR, and mGPS in Predicting Mortality or Poor Outcomes

ROC curve analysis revealed that serum albumin, C-reactive protein/albumin ratio (CAR), and the modified Glasgow Prognostic Score (mGPS) showed variable discriminatory abilities for predicting mortality or poor outcomes. Serum albumin demonstrated a very high performance, with an AUC of 0.82 at a cut-off of 1.72 g/dL, providing a sensitivity of 100% but specificity (77%), with PPV of 50% and NPV of 0.81%. The mGPS had high performance, with an AUC of 0.725 at a cut-off of 1.5, yielding sensitivity of 81%, specificity of 60%, PPV of 67%, and NPV of 76%. In contrast, CAR showed moderate predictive accuracy with an AUC of 0.706 at a cut-off of 4.03, achieving sensitivity of 94%, specificity of 36%, PPV of 59%, and NPV of 85.5%. **(Figure 3).**

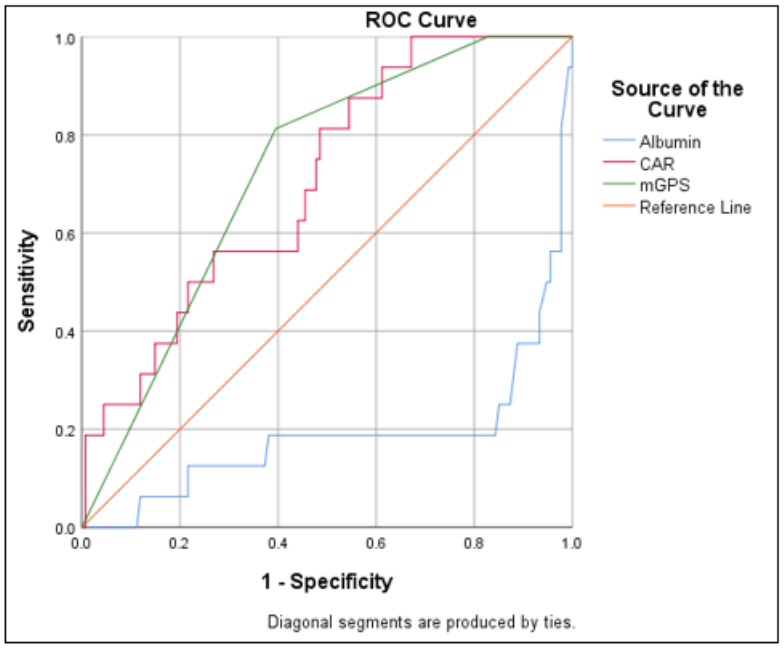

Figure (3): ROC Curve Analysis for Serum Albumin, CAR, and mGPS in Predicting Mortality or Poor Outcomes.

4. Discussion

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) persist a major cause of hospitalization, healthcare costs, and mortality international. This single-center retrospective cohort study aimed to evaluate whether admission serum albumin levels (g/dL) could predict in-hospital mortality among adults hospitalized with AECOPD and to assess their association with the need for noninvasive or invasive mechanical ventilation (NIV/IMV), intensive care unit (ICU) admission, and length of hospital stay (LOS).

In our study, the hypoalbuminemia group was marginally older (64.67 ± 7.11 vs 62.20 ± 8.29 years).There were no meaningful differences in gender, smoking status, or BMI categories. Age was associated with lower serum albumin, reflecting cumulative effects of comorbidities, nutritional decline, and chronic inflammation in older patients. Zinellu et al., conducted a systematic review and meta-analysis and found that serum albumin levels were significantly lower in patients with chronic obstructive pulmonary disease compared with healthy controls. They attributed this reduction to systemic inflammation, oxidative stress and malnutrition, factors that tend to worsen with advancing age and disease severity. These findings support our observation that older age may contribute to hypoalbuminemia through chronic systemic and nutritional mechanisms [8]. Because age demonstrated a borderline imbalance, it should be controlled for in multivariable prognostic models to avoid confounding the albumin outcome relationships.

In the present study, Hypertension, diabetes, ischemic heart disease, and CKD were numerically more frequent in the hypoalbuminemia group but differences did not exceed the predefined standardized mean difference threshold.

Although Huang et al. demonstrated in COVID-19 patients that a higher blood urea nitrogen-to-albumin ratio (BAR) reflected systemic inflammation, renal dysfunction, and catabolic stress, similar mechanisms are biologically plausible in COPD, where comorbidities such as chronic kidney and cardiovascular disease may contribute to lower albumin levels. Several COPD studies have since used composite indices such as BAR to predict short-term outcomes during exacerbations. [13] .Even though differences were not statistically significant, the trend suggested including comorbidities (especially CKD, cardiovascular disease) as covariates in prognostic models was prudent, to reduce confounding.

In the present study, inflammatory markers were compared according to albumin status among patients hospitalized with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). It was observed that C-reactive protein (CRP) levels showed a meaningful between-group difference based on effect size measures, while WBC count and ESR showed only small, non-meaningful differences between the groups. This finding suggested that systemic inflammation play a crucial role in the development of hypoalbuminemia during acute exacerbations and highlights CRP as the most sensitive marker of inflammatory burden. These results align with recent studies showing a strong inverse relationship between serum albumin and systemic inflammation, particularly with CRP. Mandal et al.,found that among male patients with stable COPD, lower serum albumin levels were significantly associated with higher CRP levels and low BMI. This supports the notion that systemic inflammation plays a crucial role in the development of hypoalbuminemia during acute exacerbations, and underscores CRP as the most sensitive marker of inflammatory burden [14]. In another multicentre analysis, Viana-Llamas et al., reported that hypoalbuminemia was accompanied by higher levels of high-sensitivity CRP and D-dimer in acutely ill adults, reflecting the combined effect of inflammation and catabolic stress [15]. These findings aligned with the present study, where CRP, but not WBC or ESR, demonstrated a clinically relevant association with hypoalbuminemia, emphasizing CRP's higher sensitivity and earlier response in acute inflammation.

In our cohort there were no meaningful differences in arterial pH or PaCO2 between albumin strata, while PaO2 and SpO2 were markedly lower in the hypoalbuminemia group. This pattern impaired oxygenation without a parallel change in ventilatory parameters suggested that hypoalbuminemia marks worse gas-exchange (likely via worsened V/Q mismatch, diffusion limitation, or impaired perfusion) rather than primary hypoventilation. Several observational and cohort studies supported an association between low serum albumin and poorer pulmonary function, oxygenation and respiratory outcomes in COPD: a large MIMIC-IV analysis and nationwide cohort work have shown that lower albumin was associated with higher risk of acute respiratory failure and with greater in-hospital mortality, and meta-analytic data confirm that serum albumin concentrations are lower in COPD populations compared with controls [6, 8, 11]. These reports were consistent with our finding of worse oxygenation (lower PaO2/SpO2) in hypoalbuminemic patients.

In our regression model admission serum albumin emerged as a strong independent predictor of in-hospital mortality: each 1-unit increase in albumin was associated with some markedly lower odds of death. These results indicated that baseline nutritional/inflammatory status as reflected by serum albumin provides prognostic information beyond routine demographic, inflammatory and gas-exchange measures in our cohort. Several recent studies supported the independent prognostic value of albumin in acute or critical respiratory illness. Using the MIMIC-IV critical-care database, Likewise, multiple studies that examined composite ratios incorporating albumin (for example blood-urea-nitrogen/albumin or RDW/albumin) show that lower albumin in combination with other deranged biomarkers identifies patients at substantially higher risk of short-term mortality evidenced that albumin captured a biologically meaningful signal of vulnerability in AECOPD and critical respiratory illness. For example, Zeng et al., found that an elevated BUN/albumin ratio independently predicted in-hospital and 90-day mortality in patients with AECOPD [9].

Clinically, our data reinforced that admission serum albumin was a simple, low-cost biomarker that flag patients at higher risk during AECOPD and might be useful for early risk stratification. However, albumin was best viewed as one component of a composite prognostic approach: combining albumin with validated severity scores (APACHE/SOFA), gas-exchange indices, and targeted biomarker ratios (e.g., BUN/albumin or CRP/albumin) was likely to yield the most reliable prediction of short-term outcomes. Finally, because our albumin effect estimated was large and confidence intervals were wide, external validation in larger, severity-adjusted cohorts and sensitivity analyses that included serial albumin measurements were needed before recommending a single albumin threshold for clinical decision-making.

This study demonstrated that patients with hypoalbuminemia during acute exacerbations of COPD experienced markedly worse clinical outcomes, including higher rates of ICU admission, increased need for ventilatory support (both NIV and IMV), prolonged hospitalization, and greater in-hospital mortality. These findings reinforce the growing recognition of serum albumin as a robust prognostic indicator in COPD exacerbations. Albumin reflects both the nutritional and inflammatory status of patients; hence, its decline often parallels systemic inflammation and tissue catabolism during acute illness. Chen et al., reported in their study that Patients with COPD who had severe hypoalbuminemia showed a markedly increased risk of developing acute respiratory failure compared with those with normal albumin levels. After adjusting for age, sex, comorbidities, and medication use, severe hypoalbuminemia remained a strong and independent risk factor for acute respiratory failure [6].

Collectively, these studies suggest that integrating albumin into combined biochemical ratios enhances the sensitivity of prognostic assessment tools. Nevertheless, some discrepancies exist across the literature. In resource-limited or policy-variable healthcare settings, albumin's association with ICU admission and ventilatory support may be

influenced by institutional capacity and admission thresholds rather than by patient physiology alone. Moreover, in the study by Baha et al., adjustment for disease severity and comorbidities attenuated the predictive strength of the blood urea nitrogen/albumin ratio, suggesting that hypoalbuminemia may indicate systemic inflammation or catabolic stress more than act as a direct cause of poor outcomes [16].

Clinically, these findings highlight the value of routine serum albumin measurement upon hospital admission for COPD exacerbations. Low albumin levels or elevated albumin-based ratios could serve as early warning indicators, guiding triage decisions and prompting more intensive monitoring or nutritional intervention. Still, before being adopted into standardized prognostic models, further validation through large-scale multicentre prospective studies is warranted to confirm the optimal thresholds and predictive value of these biomarkers.

5. Conclusion

This study demonstrated that admission serum albumin is a powerful, low-cost, and easily measurable prognostic biomarker in patients hospitalized with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). Hypoalbuminemia was significantly associated with greater systemic inflammation, worse oxygenation, longer hospital stay, increased need for ventilatory support, and higher in-hospital mortality.

In multivariable analysis, low serum albumin and elevated ESR remained independent predictors of mortality, suggesting that baseline nutritional and inflammatory status contribute substantially to poor outcomes. Moreover, the modified Glasgow Prognostic Score (mGPS) showed excellent discriminative accuracy, outperforming single inflammatory markers.

These findings highlight the clinical importance of incorporating serum albumin assessment into the routine evaluation of AECOPD patients upon hospital admission. Early identification of hypoalbuminemia could help clinicians stratify risk, optimize monitoring intensity, and guide nutritional or anti-inflammatory interventions to improve short-term outcomes.

6. Limitations

This study has several limitations. Its retrospective design limits causal inference and depends on the accuracy of existing records, introducing potential information bias. As a single-centre study, the results may not be generalizable. Selection bias may exist due to the inclusion of only patients with complete records. The low event count may have reduced statistical power and limited the ability to perform subgroup analyses.

7. Future Scope

Future research should focus on validating the prognostic value of serum albumin in larger, multicentre prospective studies and across different COPD phenotypes. Serial measurements of albumin during hospitalization may further clarify its dynamic relationship with inflammation, nutrition, and recovery. In addition, integrating albumin into composite prognostic indices such as the CRP/albumin ratio, BUN/albumin ratio, or mGPS may enhance the precision of mortality prediction models. Evaluating the impact of targeted nutritional supplementation or albumin-guided therapy on clinical outcomes could also provide new insights for improving patient care and reducing mortality in AECOPD.

List of Abbreviations

AECOPD, acute exacerbation of chronic obstructive pulmonary disease;
ABG, arterial blood gas;
APACHE II, Acute Physiology and Chronic Health Evaluation II;
AUC, area under the curve;
BAR, blood urea nitrogen to albumin ratio;
BMI, body mass index;
BUN, blood urea nitrogen;
CAR, C-reactive protein to albumin ratio;
CI, confidence interval;
CKD, chronic kidney disease;
COPD, chronic obstructive pulmonary disease;
CRP, C-reactive protein;
DECAF, Dyspnoea, Eosinopenia, Consolidation, Acidaemia, Atrial Fibrillation score;
DM, diabetes mellitus;
ESR, erythrocyte sedimentation rate;
Exp(B), exponentiated regression coefficient (odds ratio);
FEV_1, forced expiratory volume in one second;
FVC, forced vital capacity;
GOLD, Global Initiative for Chronic Obstructive Lung Disease;
HTN, hypertension;
ICU, intensive care unit;
IHD, ischemic heart disease;
IMV, invasive mechanical ventilation;
IQR, interquartile range;
LOS, length of stay;
mGPS, modified Glasgow Prognostic Score;
NIV, noninvasive ventilation;
NPV, negative predictive value;
OR, odds ratio;
PaCO2, arterial partial pressure of carbon dioxide;
PaO2, arterial partial pressure of oxygen;
PPV, positive predictive value;
ROC, receiver operating characteristic;
SD, standard deviation;
SO2 / SpO2, arterial oxygen saturation;
WBC, white blood cell count.

Declarations

Ethics approval and consent to participate:
The study was approved by the institutional review board and ethical committee of the Faculty of Medicine- Assiut University in compliance with the Helsinki Declaration (IRB no. 04-2025-300715).

Consent for publication:
Not applicable.

Availability of data and material:
The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests:
The authors declare no conflict of interest.

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Authors' contributions:
MGA, SAE, and MSA: conception and design. MGA, SAE: data collection. MGA, MSA: statistical analysis. MGA, SAE, and MSA: medical writing. All authors revised the manuscript.

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