Demographics, cardiopulmonary comorbidities, laboratory data and length of hospital stay in patients with acute exacerbation of chronic obstructive pulmonary disease at high altitude: A comparative study

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Abstract. Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is known to impose a significant burden on patients, but its demographic and clinical features in patients with AECOPD at high altitude (HA) still need to be addressed. A total of 142 patients with AECOPD at HA [>2,500 meters (m)] and 142 patients with AECOPD at low altitude (LA) (<500 m) as controls, matched 1:1 by age and sex, encountered at West China Hospital of Sichuan University (Chengdu, China) between January 2023 and December 2023, were retrospectively analyzed. Demographics, cardiopulmonary comorbidities, laboratory data and length of hospital stay (LOHS) of patients with AECOPD at HA and LA were comparatively analyzed. Univariate and multivariate binary logistic regression analyses were used to identify factors associated with prolonged LOHS in patients with AECOPD at HA. Compared to the LA group, patients with AECOPD at HA, regardless of sex and age, demonstrate certain different demographic and clinical features, including more Tibetans and non-smokers, different prevalences of cardiopulmonary comorbidities and indicators in blood routine and biochemical tests, particularly higher hemoglobin levels and eosinophils count, which were negatively associated with LOHS. The present findings highlight that these differences could play an important role in the evaluation and prognosis of AECOPD at HA, and future studies should investigate the mechanisms underlying these differences and explore novel interventions to improve clinical outcomes for patients with AECOPD at HA.

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Introduction

Acute exacerbation is a common event for chronic obstructive pulmonary disease (COPD), the third leading cause of death worldwide, and is characterized by worsened dyspnea, cough and sputum within 14 days, which is often related to elevated pulmonary and systemic inflammation (1). Due to ethnic and lifestyle differences, patients with acute exacerbation of COPD (AECOPD) at high altitude (HA) may exhibit distinct disease patterns. Previous studies showed that in highlands of Peru and China, the disease burden in patients with COPD was mainly attributed to the use of biomass fuels rather than smoking (2,3), with a confirmed genetic association between the Tibetans and susceptibility to COPD (4), indicating that environmental and genetic factors may uniquely affect AECOPD progression in HA populations.

Furthermore, when exposed to the hypobaric and hypoxic environment at HA, AECOPD patients not only experience exacerbated gas exchange and hypoxia with subsequent higher rates of complications such as pulmonary hypertension (PH) (5-7), but also exhibit increased inflammation and oxidative stress (8,9), which may further result in prolonged hospitalization, increased medical costs and higher mortality risks. However, demographic and clinical features of patients with AECOPD at HA have not been well elucidated.

The present study aimed to systematically compare the demographics, cardiopulmonary comorbidities and laboratory

data of patients with AECOPD residing at HA and low altitude (LA), and identify factors associated with prolonged length of hospital stay (LOHS) in patients with AECOPD at HA to offer insights for the evaluation and prognosis of these patients.

Patients and methods

Subjects. A total of 142 patients with AECOPD at HA [>2,500 meters (m)] who were hospitalized in West China Hospital of Sichuan University (Chengdu, China) between January 1, 2023 and December 31, 2023 and comprised of 102 males and 40 females with a median age of 68.25 years and an age range of 46 to 93 years, were retrospectively recruited. These patients were natives and long-term (>10 years) immigrants in Qinghai-Tibet Plateau. For each patient, an age- and sex-matched control from LA (<500 m) who was hospitalized during the same period, selected through simple random sampling when multiple candidates met the criteria, was identified (Fig. 1). The inclusion criteria were: i) A discharge diagnosis of AECOPD, characterized by increased dyspnea and/or cough and sputum within 14 days, based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2024 Report (10); ii) patients aged ≥40 years at admission; and iii) availability of complete baseline and clinical data. The exclusion criteria were: i) Patients not hospitalized for the first time due to AECOPD at West China Hospital of Sichuan University; ii) patients whose respiratory difficulties were primarily caused by factors other than AECOPD, such as pneumothorax, pleural effusion, acute coronary syndrome or pulmonary embolism; iii) patients who died during hospitalization or were discharged against medical advice; and iv) patients with incomplete baseline or clinical data. All of the patients included in the study were consecutive and hospitalized patients. Data for this study was collected through a retrospective search of the hospital's electronic system between February 9, 2024 and May 17, 2024.

The study was approved by the Ethics Committee of West China Hospital of Sichuan University (Chengdu, China; approval no. 2024-85) and conducted following the Helsinki Declaration.

Data collection. Baseline information, including age, sex, smoking status and ethnicity, as well as cardiopulmonary comorbidities, laboratory data and LOHS, which was defined as the period from admission to discharge, were collected. Considering the impact of chronic hypoxia at HA on blood, immune and metabolic functions (11), laboratory data mainly encompassed blood routine tests [hemoglobin (Hb), platelets (PLT), white blood cells (WBC), neutrophils (NEU), eosinophils (EOS) and lymphocytes (LYM)], liver function [total bilirubin (TB), direct bilirubin (DB), indirect bilirubin (IB), aspartate transaminase (AST), alanine transaminase (ALT), gamma-glutamyl transferase (GGT), lactate dehydrogenase (LDH)], kidney function [urea, creatinine (Cr), uric acid (UA)] and metabolic indicators [glucose (Glu), total cholesterol (TC), triglycerides (TG) and low-density lipoprotein (LDL)]. These laboratory data were collected upon admission and all measurements complied with standard methods and technical requirements. Furthermore, cardiopulmonary comorbidities were investigated, including hypertension, pulmonary heart disease (PHD), PH, respiratory failure, pneumonia, pulmonary tuberculosis, coronary heart disease (CHD) and bronchiectasis.

Table I. Demographics and length of hospital stay of patients with acute exacerbation of chronic obstructive pulmonary disease at HA and LA.

Characteristic	HA (n=142)	LA (n=142)	P-value
Age, years	68.25±9.36	68.25±9.36	>0.999
Sex			>0.999
Male	102 (71.8)	102 (71.8)	
Female	40 (28.2)	40 (28.2)	
Smoking			0.015
Yes	77 (54.2)	97 (68.3)	
No	65 (45.8)	45 (31.7)	
Ethnicity			<0.001
Han	39 (27.5)	141 (99.3)	
Tibetan	101 (71.1)	0 (0)	
Other	2 (1.4)	1 (0.7)	
LOHS, days	13.00 (9.00, 18.00)	11.00 (9.00, 16.00)	0.259

Values are expressed as the mean ± standard deviation, the median (interquartile range) or n (%). HA, high altitude; LA, low altitude; LOHS, length of hospital stay.

Table II. Cardiopulmonary comorbidities of patients with acute exacerbation of chronic obstructive pulmonary disease at HA and LA.

Comorbidity	HA (n=142)	LA (n=142)
Hypertension	58 (40.85)	34 (23.94)
Pulmonary heart disease	50 (35.21)	81 (57.04)
Pulmonary hypertension	41 (28.90)	31 (21.80)
Respiratory failure	36 (25.35)	78 (54.93)
Pneumonia	33 (23.24)	26 (18.31)
Pulmonary tuberculosis	16 (11.27)	0 (0.00)
Bronchiectasis	0 (0.00)	16 (11.27)
Coronary heart disease	16 (11.27)	8 (5.63)

Values are expressed as n (%). HA, high altitude; LA, low altitude.

Statistical analysis. SPSS software version 29 (IBM Corp.) was used for all statistical analyses. Normally distributed data were expressed as the mean ± standard deviation, while skewed data were reported as the median (interquartile range). The independent-sample t-test (two-tailed) and the Mann-Whitney U test were employed for comparing normally and skewed distributed data, respectively. Chi-square tests were used to compare categorical variables. Fisher's exact test was used to compare categorical variables with frequencies of <5, such as ethnicity. Furthermore, since

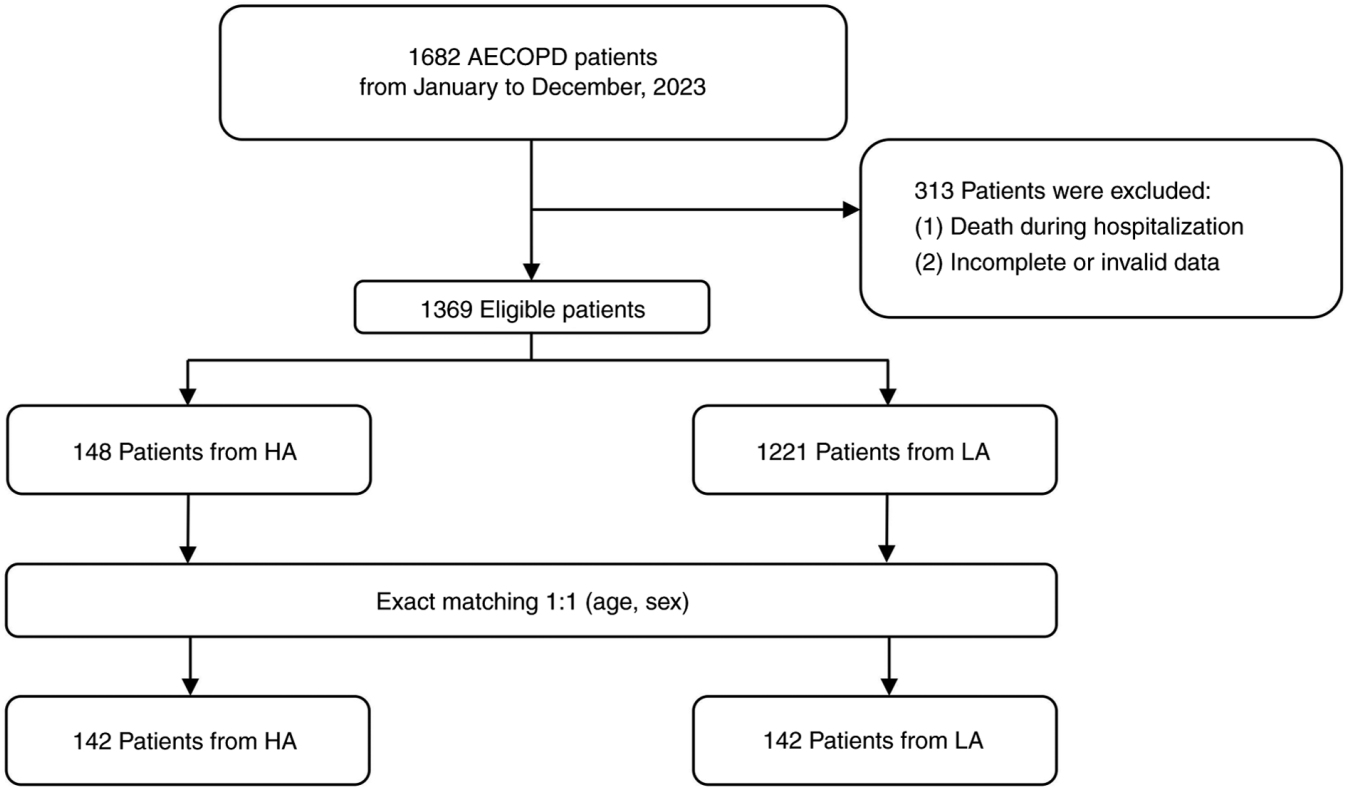

Figure 1. Flowchart of patients' selection. AECOPD, acute exacerbation of chronic obstructive pulmonary disease; HA, high altitude; LA, low altitude.

there is no standardized definition for prolonged LOHS in patients with AECOPD and previous research emphasized the heterogeneity of LOHS among patients from different hospitals (12), the 75th percentile was predefined as the cut-off for prolonged LOHS, referencing established methodologies (13). Accordingly, prolonged LOHS was defined as >18 inpatient days for patients from HA (Table I). Univariate and multivariate binary logistic regression analyses were performed using the binary logistic regression model to identify factors related to prolonged LOHS in patients from HA. Receiver operating characteristic (ROC) curve analysis was used to identify the cut-off values of variables for logistic regression analysis. P<0.05 was considered to indicate statistical significance.

Results

Demographics and cardiopulmonary comorbidities compared between patients with AECOPD at HA and LA. The age in each of the two groups was 68.25±9.36 years, with the same gender distribution of 102 males (71.8%) and 40 females (28.2%). In the LA group, there were 141 Han individuals (99.3%) and 97 smokers (68.3%). Compared to patients at LA, patients at HA had a higher percentage of Tibetans (n=101, 71.1%) and non-smokers (n=65, 45.8%). Furthermore, the prevalences of cardiopulmonary comorbidities differed between the two groups. In the patients at HA, the most prevalent cardiopulmonary comorbidities were hypertension (40.85%), PHD (35.21%) and PH (28.90%). Respiratory failure was observed in 25.35% of patients and pneumonia was found in 23.24%. Another two notable comorbidities, pulmonary tuberculosis and CHD, affected 11.27% of the patients, respectively. In the LA group, PHD was the most common comorbidity, affecting 57.04% of patients, followed by respiratory failure in 54.93%. Hypertension was observed in 23.94% of patients and PH in 21.80%. Pneumonia was present in 18.31%, while bronchiectasis was found in 11.27% and CHD was observed in 5.63%. Demographics of the two groups are shown in Table I, while the cardiopulmonary comorbidities are listed in Table II.

Laboratory data of patients with AECOPD at HA and LA. Significant differences in laboratory indicators were observed between the two groups (Table III). The HA group exhibited significantly elevated levels of Hb at 145.92±34.50 g/l compared to 129.00 (118.50, 143.00) g/l in the LA group (P<0.001), with a higher EOS count at 0.14 (0.06, 0.24) x10^9/l in comparison to 0.06 (0.00, 0.18) x10^9/l in the LA group (P<0.001). Furthermore, lower counts of WBC (P<0.001) and NEU (P<0.001) were also observed in the patients at HA. In terms of liver and kidney function, the HA group demonstrated higher levels of TB (P<0.001), DB (P<0.001), IB (P<0.001), AST (P=0.023), ALT (P=0.001) and GGT (P<0.001), along with lower levels of urea (P=0.015) and Cr (P=0.034). Regarding metabolic indicators, TG (P=0.050) was higher, but Glu (P=0.002) and TC (P<0.001) were notably lower in the HA group.

Factors associated with prolonged LOHS in patients with AECOPD at HA. An increased median LOHS was revealed in the HA group (13 days) vs. the LA group (11 days), although the difference did not reach any statistical significance (P=0.259) (Table I). Of note, markedly higher Hb levels and

Table III. Laboratory data of patients with acute exacerbation of chronic obstructive pulmonary disease at HA and LA.

Parameter	Normal range	HA (n=142)	LA (n=142)	P-value
Blood routine				
Hb, g/l	115.00-150.00	145.92±34.50	129.00 (118.50, 143.00)	<0.001
PLT, x10^9/l	100.00-300.00	165.00 (127.75, 226.75)	167.50 (123,00, 231.50)	0.935
WBC, x10^9/l	3.50-9.50	5.90 (4.78, 7.31)	6.76 (5.50, 9.18)	<0.001
NEU, x10^9/l	1.80-6.30	3.95 (3.09, 5.52)	4.94 (3.75, 7.35)	<0.001
EOS, x10^9/l	0.02-0.52	0.14 (0.06, 0.24)	0.06 (0.00, 0.18)	<0.001
LYM, x10^9/l	1.10-3.20	1.04 (0.76, 1.45)	1.13±0.60	0.779
Liver function				
TB, μmol/l	3.20-20.50	13.50 (9.88, 19.10)	9.65 (7.30, 14.18)	<0.001
DB, μmol/l	<6.80	5.45 (3.50, 8.00)	3.65 (2.60, 5.53)	<0.001
IB, μmol/l	<20.00	7.45 (5.30, 11.70)	5.75 (4.28, 8.93)	<0.001
AST, IU/l	<35.00	25.50 (18.75, 36.00)	22.00 (17.00, 28.25)	0.023
ALT, IU/l	<40.00	24.00 (15.00, 37.00)	17.00 (12.00, 29.25)	0.001
GGT, IU/l	<45.00	52.00 (25.75, 92.25)	23.50 (14.00, 41.75)	<0.001
LDH, μmol/l	120.00-250.00	205.00 (164.00, 278.75)	196.00 (170.25, 249.75)	0.664
Kidney function				
Urea, μmol/l	2.60-7.50	4.77 (3.60, 6.51)	5.48 (4.03, 7.63)	0.015
Cr, μmol/l	48.00-79.00	67.50 (51.90, 80.18)	71.75 (57.45, 87.00)	0.034
UA, μmol/l	155.00-357.00	296.50 (210.35, 361.25)	258.50 (189.50, 338.75)	0.079
Metabolic indicators				
Glu, mmol/l	3.90-6.10	4.98 (4.36, 6.30)	5.70 (4.75, 7.23)	0.002
TC, mmol/l	2.80-5.17	3.76±1.02	4.20 (3.46, 5.03)	<0.001
TG, mmol/l	0.29-1.70	1.00 (0.76, 1.28)	0.91 (0.69, 1.20)	0.050
LDL, mmol/l	<3.40	2.16±0.80	2.29±0.82	0.159

Values are expressed as the mean ± standard deviation or the median (interquartile range). ALT, alanine transaminase; AST, aspartate transaminase; Cr, creatinine; DB, direct bilirubin; EOS, eosinophil; GGT, gamma-glutamyl transferase; Glu, glucose; HA, high altitude; Hb, hemoglobin; IB, indirect bilirubin; LA, low altitude; LDH, lactate dehydrogenase; LDL, low-density lipoprotein; LYM, lymphocyte; NEU, neutrophil; PLT, platelet; TB, total bilirubin; TC, total cholesterol; TG, triglycerides; UA, uric acid; WBC, white blood cell.

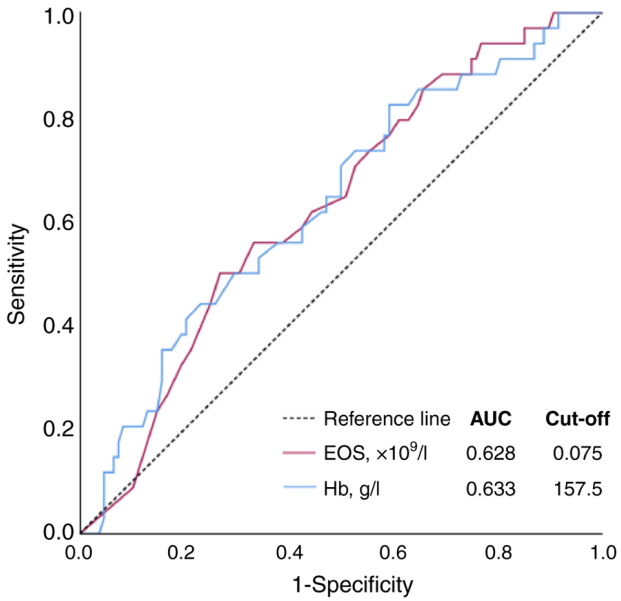

Figure 2. Receiver operating characteristic curve of variables for logistic regression analysis and cut-off of the variables. AUC, area under the curve; EOS, eosinophil; Hb, hemoglobin.

EOS count were observed in patients at HA compared with those at LA, which were identified as the two key factors influencing prolonged LOHS at HA by univariate and multivariate binary logistic regression analyses. The results of the univariate binary logistic regression analyses presented in Table IV indicated that patients with AECOPD at HA with prolonged LOHS had a lower Hb level (P=0.027) and EOS count (P=0.027). ROC curve analysis was used to identify the cut-off values of variables for logistic regression analysis (Fig. 2). Consequently, 157.5 g/l was determined as the cut-off for Hb [area under curve (AUC)=0.633; sensitivity, 40.7%; specificity, 82.4%], while the cut-off for EOS was determined to be 0.075x10^9/l (AUC=0.628; sensitivity, 73.1%; specificity, 50.0%). Based on these findings, Hb and EOS were included as covariates in the multivariate logistic regression model. Continuous variables were converted into categorical variables according to the established cut-off values. The results indicated that Hb <157.5 g/l [odds ratio (OR): 3.356, 95% confidence interval (CI): 1.257-8.964] and EOS <0.075x10^9/l (OR: 2.849, 95% CI: 1.255-6.467) were significantly associated with prolonged LOHS in patients with AECOPD at HA, as shown in Table V.

Table IV. Demographics and laboratory data of patients with acute exacerbation of chronic obstructive pulmonary disease at HA with non-prolonged and prolonged LOHS.

Variables	Non-prolonged LOHS (n=108)	Prolonged LOHS (n=34)	OR (95% CI)	P-value
Demographics				
Age, years	68.00±8.94	69.06±10.76	1.012 (0.971-1.055)	0.565
Sex			0.894 (0.375-2.131)	0.801
Male	77 (71.3)	25 (73.5)		
Female	31 (28.7)	9 (26.5)		
Smoking			0.934 (0.431-2.023)	0.863
No	49 (45.4)	16 (47.1)		
Yes	59 (54.6)	18 (52.9)		
Blood routine				
Hb, g/l	149.56±34.41	134.35±32.62	0.987 (0.975-0.999)	0.027
PLT, x10^9/l	165.50 (129.25, 221.50)	182.53±100.48	1.000 (0.996-1.005)	0.914
WBC, x10^9/l	5.93 (4.98, 7.29)	5.49 (4.43, 8.18)	1.007 (0.883-1.149)	0.917
NEU, x10^9/l	3.95 (3.05, 5.15)	3.88 (3.12, 6.87)	1.087 (0.954-1.239)	0.210
EOS, x10^9/l	0.14 (0.06, 0.28)	0.08 (0.03, 0.17)	0.032 (0.002-0.671)	0.027
LYM, x10^9/l	1.19±0.50	0.89 (0.63, 1.20)	0.506 (0.225-1.137)	0.099
Liver function				
TB, μmol/l	13.40 (10.10, 19.78)	13.95 (8.78, 18.33)	1.001 (971-1.033)	0.928
DB, μmol/l	5.45 (3.50, 7.90)	5.45 (3.88, 8.15)	1.023 (0.983-1.065)	0.267
IB, μmol/l	8.05 (5.45, 11.85)	7.86±4.46	0.945 (0.873-1.023)	0.163
AST, IU/l	26.00 (19.00, 37.50)	24.00 (14.75, 31.50)	0.994 (0.977-1.011)	0.503
ALT, IU/l	23.50 (17.25, 37.75)	24.00 (13.75, 37.00)	0.992 (0.974-1.010)	0.367
GGT, IU/l	49.00 (26.25, 91.25)	55.50 (21.75, 103.50)	1.000 (0.996-1.005)	0.929
LDH, μmol/l	205.00 (165.25, 278.75)	225.94±85.33	0.999 (0.995-1.002)	0.551
Kidney function				
Urea, μmol/l	4.94 (3.83, 6.52)	4.40 (3.28, 6.62)	1.035 (0.971-1.104)	0.292
Cr, μmol/l	69.10 (57.25, 79.80)	58.25 (47.00, 88.58)	1.000 (0.996-1.004)	0.878
UA, μmol/l	303.59±108.67	248.00 (170.00, 336.00)	1.000 (0.997-1.003)	0.753
Metabolic indicators				
Glu, mmol/l	4.93 (4.27, 6.29)	5.18 (4.47, 6.26)	1.008 (0.873-1.164)	0.916
TC, mmol/l	3.83±1.02	3.53±0.99	0.743 (0.499-1.105)	0.142
TG, mmol/l	1.00 (0.78, 1.33)	1.06±0.41	0.728 (0.319-1.664)	0.452
LDL, mmol/l	2.22±0.81	1.97±0.75	0.671 (0.404-1.116)	0.125

Values are expressed as the mean ± standard deviation, the median (interquartile range) or n (%). The odds ratio values compare male vs. female and non-smoking vs. smoking. ALT, alanine transaminase; AST, aspartate transaminase; Cr, creatinine; DB, direct bilirubin; EOS, eosinophil; GGT, gamma-glutamyl transferase; Glu, glucose; HA, high altitude; Hb, hemoglobin; IB, indirect bilirubin; LA, low altitude; LDH, lactate dehydrogenase; LDL, low-density lipoprotein; LOHS, length of hospital stay; LYM, lymphocyte; NEU, neutrophil; OR, odds ratio; PLT, platelet; TB, total bilirubin; TC, total cholesterol; TG, triglycerides; UA, uric acid; WBC, white blood cell.

Table V. Factors associated with patients with acute exacerbation of chronic obstructive pulmonary disease at HA with prolonged length of hospital stay based on univariate and multivariate binary logistic regression analysis.

Variables	Univariate OR (95% CI)	P-value	Multivariate OR (95% CI)	P-value
Hb <157.5 g/l	3.208 (1.226-8.393)	0.018	3.356 (1.257-8.964)	0.016
EOS <0.075 x10^9/l	2.724 (1.229-6.036)	0.014	2.849 (1.255-6.467)	0.012

EOS, eosinophil; HA, high altitude; Hb, hemoglobin; OR, odds ratio.

Discussion

In the present study, patients with AECOPD residing at HA and LA were compared, highlighting the heterogeneity of AECOPD in the two different groups. Compared to the LA group, patients with AECOPD at HA had a higher proportion of Tibetans and non-smokers, and exhibited different prevalences of cardiopulmonary comorbidities, with more hypertension, PH, pneumonia and CHD, and fewer cases of respiratory failure and PHD, as well as different indicators in the blood routine and biochemical tests, particularly higher Hb levels and EOS counts, which were negatively associated with the LOHS.

Compared with patients at LA, patients with AECOPD at HA exhibited significantly higher Hb levels, reflecting the physiological adaptation to chronic hypoxia, achieved by an increased production of red blood cells to enhance the oxygen-carrying capacity (14). Hb <157.5 g/l indicated a lack of adequate compensatory mechanisms, which may impair oxygen delivery efficiency, thereby complicating disease management and leading to prolonged LOHS. However, excessively high Hb levels can pose certain health risks. As demonstrated in the present study, more hypertension and CHD overlapped with AECOPD at HA. Besides a different lifestyle in highlands, a significantly higher median Hb level might facilitate hypertension and increase blood viscosity, ultimately leading to CHD (15-18).

Regarding inflammatory status, it was observed that WBC and NEU counts were significantly lower in the patients at HA, reflecting suppressed inflammation due to chronic hypoxia, which could act as a protective adaptation to alleviate inflammatory damage on cells and tissues (19). As a result, patients with AECOPD at HA may lack typical inflammatory responses to infections, such as significant increases in WBC and NEU, making early identification of infections more challenging. In the present study, pneumonia and pulmonary tuberculosis were the main cardiopulmonary infectious comorbidities for AECOPD at HA, different from those at LA, which were pneumonia and bronchiectasis, possibly related to significantly lower median NEU in blood at HA than those at LA. On the contrary, a higher median EOS count in the blood at HA was noticeably revealed, present in the majority of Tibetan non-smokers at HA, which indicated, except smoking, other exposures, such as biomass and dust, which may take an important part in AECOPD at HA (20). In addition, the elevation of EOS in patients from HA may indicate an eosinophil-dominated chronic airway inflammation, which, combined with relatively mild pulmonary infection, may contribute to a lower prevalence of respiratory failure and PHD (21,22). Due to a poorer ability to combat infections (23), a relatively lower EOS count (<$0.075x10^9$/l) in patients may contribute to prolonged LOHS. Thus, EOS may serve as a potential biomarker for predicting inhaled corticosteroids responsiveness or hospitalization duration in patients with AECOPD at HA (24,25).

In addition, PH and PHD were the most important cardiopulmonary comorbidities in both groups. PH was more prevalent in patients at HA than LA, mainly owing to the hypoxic environment in highlands, which likely exaggerated pulmonary vasoconstriction and thus remodeling at the inflammatory basis of AECOPD. However, compared to LA, a relatively lower prevalence of PHD was revealed at HA. In fact, in addition to PH, decompensated PHD is dependent on several risk factors, particularly pulmonary infection, which is the most common trigger for AECOPD (26,27).

Furthermore, the HA group showed elevated levels of liver enzymes and bilirubin, while Glu, TC, urea and Cr were lower than those in the LA group, indicating metabolic adaptations to highlands, including increased oxygen consumption, higher basal metabolic rate, regulation of lipid storage and adjustments of renal tubular function (28,29). Although most indicators remained within the normal range, they may indicate potential risks of cardiovascular, metabolic or renal diseases.

There are certain limitations to the present study. The retrospective design limited the completeness of data, particularly the inability to assess long-term follow-up in patients with AECOPD in highlands. Potential confounding factors, such as socioeconomic status, environmental pollution and genetic differences, were not fully controlled, which may have influenced the observed associations and introduced bias. Additionally, the single-center design also restricted the generalizability of the results, necessitating multi-center studies for validation. Lastly, the AUC values for Hb and EOS were moderate with limited predictive ability. By combining multiple symptoms, such as dyspnea, cough and fever, along with imaging studies and other biomarkers, Hb and EOS can offer a more comprehensive assessment of patients with AECOPD at HA, helping physicians develop individualized treatment plans.

In conclusion, patients with AECOPD at HA, regardless of sex and age, exhibit unique demographic and clinical characteristics compared to those at LA, including a higher proportion of Tibetans and non-smokers, along with differences in the prevalences of cardiopulmonary comorbidities, and variations in blood routine and biochemical markers, particularly higher levels of Hb and blood EOS count, and relatively low Hb levels and EOS count in patients at HA may increase the risk of prolonged LOHS. These findings emphasize the significance of these differences in the evaluation and prognosis of AECOPD at HA, highlighting the importance of focusing on them to accurately assess and optimize management strategies, such as improving oxygen therapy, strengthening infection prevention and enhancing management of cardiopulmonary comorbidities. Future studies should investigate the mechanisms underlying these differences and explore novel interventions to improve clinical outcomes for patients with AECOPD at HA.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

YT, BR, and FC made substantial contributions to the conception and design of the study, acquisition, analysis, and interpretation of data, as well as manuscript writing. LL and LC conceived the study, supervised the research, critically reviewed the manuscript for important intellectual content, and confirmed the authenticity of the raw data. All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work, ensuring that any questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of West China Hospital of Sichuan University (approval no. 2024-85) and conducted following the Declaration of Helsinki.

Patient consent for publication

Not applicable.

Competing interests

All the authors declare that they have no competing interests.

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