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FREQUENCY OF POLYCYTHEMIA IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) PATIENTS PRESENTING TO TERTIARY CARE HOSPITAL

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ABSTRACT

Introduction: Polycythemia is a recognized hematological complication of chronic obstructive pulmonary disease (COPD), particularly in patients with chronic hypoxemia. This study aimed to determine the frequency of polycythemia among patients with COPD and assess its clinical associations.

Materials and Methods: This cross-sectional study was conducted in the Department of Medicine, Combined Military Hospital, Abbottabad, Pakistan, from September 2025 to April 2026. Patients of either gender, aged 40-80 years, with a confirmed diagnosis of COPD based on post-bronchodilator spirometry were included. Spirometry was used to determine forced expiratory volume in one second (FEV_1) % predicted and classify disease severity according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages 1-4.

Results: A total of 200 patients with COPD were included, with a mean age of 49.97 ± 8.20 years. Of these, 148 (74.0%) were male and 52 (26.0%) were female. Polycythemia was identified in 36 (18.0%) patients. Mean resting oxygen saturation (SpO_2) was significantly lower in patients with polycythemia than in those without polycythemia (89.28 ± 2.53% vs. 90.38 ± 2.71%, p=0.027). Mean partial pressure of carbon dioxide ($PaCO_2$) was comparable between the polycythemia and non-polycythemia groups (47.36 ± 14.04 mmHg vs. 47.79 ± 14.00 mmHg, p=0.866). Mean partial pressure of oxygen (PaO_2) was higher in patients with polycythemia (72.94 ± 10.11 mmHg) than in those without polycythemia (68.50 ± 10.26 mmHg, p=0.019).

Conclusion: Polycythemia was present in 18.0% of patients with COPD and was associated with lower resting SpO_2. Age, gender, body mass index, and smoking duration showed no significant association with polycythemia, while active smoking and lower resting oxygen saturation appeared to have greater influence on its occurrence.

KEYWORDS: Chronic obstructive pulmonary disease (COPD), COPD Assessment Test (CAT), GOLD Class, Polycythemia, Smoking

INTRODUCTION

Chronic exposure to cigarette smoke and biomass fuel combustion is a major contributor to the development of chronic respiratory diseases, particularly in developing countries.(1) In regions where indoor air pollution from cooking and heating with wood, dung, or crop residues is prevalent, the burden of chronic obstructive pulmonary disease (COPD) is significantly heightened.(2) Tobacco smoking remains a primary risk factor, leading to progressive airway inflammation, alveolar destruction, and irreversible airflow limitation.(3) The pathogenesis of COPD involves a cascade of inflammatory responses triggered by noxious particles and gases. These responses cause structural remodeling of the airways, destruction of alveolar walls, and impaired mucociliary clearance.(4) As lung function declines, gas exchange becomes increasingly inefficient, leading to chronic hypoxemia and, in some cases, hypercapnia. Over time, this persistent hypoxia stimulates erythropoietin (EPO) production by the kidneys, resulting in increased red blood cell production.(5)

Polycythemia, while initially compensatory, can become pathologic. Elevated hematocrit levels increase blood viscosity, raising the risk of thrombotic events, stroke, and cardiovascular complications.(6) In COPD patients, this can further compromise oxygen delivery and exacerbate right heart strain, particularly in those with coexisting pulmonary hypertension.(7) Despite these risks, polycythemia remains underrecognized in routine COPD management, especially in resource-limited settings.(8) In many developing countries, routine hematological monitoring is not standard practice in COPD follow-up, and the condition may go unnoticed until complications arise.(9) Identifying patients at risk can help mitigate long-term morbidity through appropriate monitoring and early intervention.

This aim of this study was to determine the frequency of polycythemia among COPD patients and explore its clinical associations in local population. Findings from this study can guide physicians in developing countries to adopt a more comprehensive approach in managing COPD, emphasizing the importance of regular blood count assessments and individualized care strategies.

METHODOLOGY

It was a cross-sectional study conducted at the Department of Medicine, Combined Military Hospital, Abbottabad, Pakistan a tertiary care hospital over a period of 8 months, from Sept 2025 to Apr 2026 following approval from hospital ethical review board (CMH-Atd-ETH-155-Med-24/dated13May2024). The sample size was calculated using the open source Open Epi Online sample size calculator taking confidence interval 95%, margin of error 5% and based on previously reported prevalence of COPD patients in Pakistan of 13.8% in the Pakistan Chest Society (PCS) Guidelines for the management of COPD.[10] The estimated sample size came out to be 183 patients. Non-probability consecutive sampling was used to recruit patients. All patients meeting the inclusion criteria and attending the outpatient clinic or admitted to the pulmonology ward during the study period were included after obtaining verbal informed consent.

Inclusion Criteria: All patients of either gender, age 40 - 80 years, with confirmed diagnosis of COPD based on post-bronchodilator spirometry (FEV_1/FVC <0.70), both stable COPD patients and those recovering from an exacerbation (≥4 weeks after resolution) were included in the study.

Exclusion Criteria: Known cases of primary polycythemia (polycythemia rubra vera) or other myeloproliferative disorders, patients with secondary polycythemia due to causes other than COPD (e.g., cyanotic heart disease, high-altitude residence, renal tumors), current use of long-term oxygen therapy initiated within the last 3 months and those with incomplete clinical or spirometry data were excluded from the study.

After enrollment, demographic data (age, sex, BMI, urban/rural residence), smoking history (pack-years), and biomass exposure were recorded. Spirometry was performed to determine FEV_1 % predicted and classify disease severity according to GOLD stages (1–4). The COPD Assessment Test (CAT) questionnaire was administered, and exacerbation history over the past year was obtained to classify patients into GOLD groups (A–D).[11] Resting oxygen saturation (SpO_2) was measured via pulse oximetry. Venous blood samples were analyzed for hemoglobin, hematocrit, and red blood cell counts. Polycythemia was defined as hematocrit >51% in males and >48% in females.[12]

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS v25.00). Normality of the data was checked using its skewedness and kurtosis. Pack years were presented as median (interquartile range) while rest of the quantitative variables (age, BMI, SpO_2, PaO_2, $PaCO_2$) were presented as mean ± SD. Categorical variables (GOLD stage, GOLD class, polycythemia) were presented as frequencies and percentages. Associations between polycythemia and independent variables (demographics, GOLD stage, GOLD class, SpO_2, PaO_2) were assessed using Chi-square test for categorical variables and independent t-test or Mann–Whitney U test for continuous variables, as appropriate. Logistic regression analysis was performed to identify independent predictors of polycythemia in COPD patients. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

Two hundred COPD patients were included in the study with mean age of 49.97 ± 8.20 years including 148 (74.0%) males and 52 (26.0%) females. The mean BMI of participants was 21.03 ± 2.51 kg/m² and mean hemoglobin was found to be 14.45 ± 2.71 mg/dL. Regarding residence, 118 (59.0%) patients belonged to urban areas while 82 (41.0%) were from rural areas. Smoking status of participants was also noted that 118 (59.0%) were currently smoking, 26 (13.0%) were ex-smokers and 56 (28.0%) were non-smokers but had prolonged biomass exposure. inThe median (IQR) smoking exposure was 16.00(5.00) pack-years, and 78 (39.0%) patients had a history of biomass fuel exposure. The baseline characteristics of the study population are shown in Table-I.

Table I: Baseline Characteristics of Study Population (n = 200)

Variable		Value
Age, years (mean ± SD)		49.97 ± 8.20
BMI, kg/m² (mean ± SD)		21.03 ± 2.51
Gender, n(%)	Male	148(74.0%)
	Female	52(26.0%)
Resident in, n(%)	Rural Area	82(41.0%)
	Urban Area	118(59.0%)
Smoking Status, (%)	Current	118 (59.0%)
	Ex-smoker	26 (13.0%)
	Non-smoker	56 (28.0%)
Smoking Exposure (pack-years), Median [IQR]		16.00(5.00)
Biomass Exposure, n(%)		78(39.0%)
Hemoglobin, mg/dL (mean ± SD)		14.45 ± 2.06
SpO_2, % (mean ± SD)		90.18 ± 2.71
PaO_2, mmHg (mean ± SD)		69.30 ± 10.34
PCO_2, mmHg (mean ± SD)		47.72 ± 14.00
Gold Stage, n(%)	1	59(29.5%)
	2	63(31.5%)

	3	28(14.0%)
	4	50(25.0%)
GOLD Class, n(%)	A	88(44.0%)
	B	53(26.5%)
	E	59(29.5%)
Polycythemia, n(%)		36(18.0%)

The overall frequency of polycythemia among COPD patients was found to be 18.0% with gender distribution as 26 (17.6%) males had polycythemia compared to 10 (19.2%) females. On stratified analysis, no statistically significant association was observed between polycythemia and gender (p=0.788) or residence (p=0.510). Similarly, no significant association was found between polycythemia and biomass exposure (p=0.695). (Table-II).

Table II: Association of Polycythemia with Categorical Variables (n = 200)

Variable		Polycythemia n(%)		p-value
		Yes	**No**	
Gender	Male	26(17.6%)	122(82.4%)	0.788
	Female	10(19.2%)	42(80.8%)	
Resident of	Urban	23(19.5%)	95(80.5%)	0.51
	Rural	13(15.9%)	69(84.1%)	
Smoking Status	Current	22 (61.1%)	96 (58.5%)	0.860
	Ex-smoker	4 (11.1%)	22 (13.4%)	
	Non-Smoker	10 (27.8%)	46 (28.0%)	
Biomass Exposure	Yes	13(16.7%)	65(83.3%)	0.695
	No	23(18.9%)	99(81.1%)	

Comparison of continuous variables between patients with and without polycythemia showed that mean age was 48.61 ± 8.39 vs 50.27 ± 8.15 years (p=0.273), BMI was 20.61 ± 2.65 vs 21.12 ± 2.47 kg/m² (p=0.272), and smoking exposure was 17.50(6.00) vs 16.00(5.00) pack-years (p=0.267) respectively. Similarly, mean SpO_2 was 89.28 ± 2.53% in the polycythemia group compared to 90.38 ± 2.71% in the non-polycythemia group (p=0.027). Comparison of arterial blood gas parameters between the two groups showed that the mean partial pressure of carbon dioxide ($PaCO_2$) was 47.36 ± 14.04 mmHg in the polycythemia group compared to 47.79 ± 14.00 mmHg in the non-polycythemia group (p=0.866), showing no statistically significant difference. In contrast, the mean partial pressure of oxygen (PaO_2) was significantly higher in patients with polycythemia (72.94 ± 10.11 mmHg) compared to those without polycythemia (68.50 ± 10.26 mmHg) (p=0.019). These findings are presented in Table-III.

Table III: Comparison of Presence of Polycythemia with Continuous Variables (n = 200)

Variable	**Polycythemia (%)**		**p-value**
	Yes	**No**	
Age, years (mean ± SD)	48.61 ± 8.39	50.27 ± 8.15	0.273
BMI, kg/m² (mean ± SD)	20.61 ± 2.65	21.12 ± 2.47	0.272
Pack-years, Median [IQR]	17.50(6.00)	16.00(5.00)	0.267
SpO_2, % (mean ± SD)	89.28 ± 2.53	90.38 ± 2.71	0.027

PaO_2, mmHg (mean ± SD)	72.94 ± 10.11	68.50 ± 10.26	0.019
PCO_2, mmHg (mean ± SD)	47.36 ± 14.04	47.79 ± 14.00	0.886

DISCUSSION

The present study evaluated the frequency of polycythemia among patients with chronic obstructive pulmonary disease (COPD) and explored its association with commonly assessed clinical and physiological parameters. This study showed frequency of polycythemia in COPD patients was 18% similar to other reported prevalence of polycythemia around 13.2% by Ullah et al and 10.8% in another study by Ullah et al.[13,14] The findings demonstrated that while polycythemia is present in a notable proportion of COPD patients, it may not show a statistically significant association with demographic factors, or smoking exposure. However, a small yet statistically insignificant difference was observed in markers of disease severity such as oxygen saturation, PaO_2 and PCO_2.

There was no significant relationship between resting SpO_2 and polycythemia in this study which could indicate that this relationship may be a complex one. Factors such as intermittent hypoxia, nocturnal desaturation, and individual variability in response towards hypoxemia might be playing a role more important than oxygen saturation. This could explain why patients with comparable oxygenation status do not uniformly develop polycythemia.[15] Therefore, polycythemia in COPD may not be reliably predicted by routine clinical assessment if done alone. Polycythemia in COPD occurs as a compensatory response to chronic hypoxemia, leading to an increased erythropoietin production.

Polycythemia was major finding in patients with long standing COPD (18%), however, some patient also found to have anemia (8.5%) noted to be anemia of chronic disease likely due to COPD mediated systemic inflammation. This finding was in accordance with other studies as Sarkar et al concluded that COPD patients had 7.5% prevalence of anemia of chronic disease (ACD) with normal MCV.[16] Malik et al also observed this fact and reported 26% prevalence of anemia in COPD patients.[17] While Sharma et al also reported that prevalence of ACD is consistent in COPD patients along with frequency of polycythemia in 14.2% patients.[18]

In this study the mean resting oxygen saturation (SpO_2) in patients with polycythemia was 89.28 ± 2.53 as compared to 90.38 ± 2.71 in patients who didn't have polycythemia. This fact was also reported by Zhang et al that severe resting hypoxemia had higher odd of polycythemia (OR=3.50, 95% CI: 1.41-8.66).[19] It was observed that polycythemia was present in 22 (61.1%) of current smokers and 4 (11.1%) of ex-smoker whereas 10 (27.8%) non-smokers had polycythemia due to biomass exposure. Active smoking in COPD patients had somewhat higher odds (OR=2.55, 95% CI: 1.49-4.38) of developing polycythemia due to resting hypoxemia as observed by Zhang et al.[19]

The analysis of arterial blood gas parameters showed an interesting finding in this study that patients with polycythemia had higher PaO_2 levels compared to those without polycythemia. This is contrary to the usual understanding that lower oxygen levels lead to increased red blood cell production. This difference explained by the fact that a single measurement of PaO_2 may not reflect long-term oxygen status. Patients may have experienced chronic or intermittent hypoxia in the past, leading to polycythemia, even if their current oxygen levels appear relatively higher.[20]

Cote et al also concluded that polycythemia was present in 5.3% COPD patients but it was not significantly related with resting SpO_2, partial pressure of oxygen and carbon dioxide as well as other clinical factors.[21] The lack of significant difference in PaO_2 and $PaCO_2$ further suggests that carbon dioxide levels do not have a major role in the development of polycythemia in COPD. Abdelfattah et al also explained statistically insignificant association of resting SpO_2 (OR=0.896, p=0.30), PaO_2 (OR=1.171, p=0.41) and PCO_2 (OR=1.188, p=0.23) with COPD patient having polycythemia.[22]

Furthermore, the lack of association with smoking exposure and other baseline characteristics in this study highlights the heterogeneous nature of COPD. The disease has many pathophysiological processes and pathways and thus systemic manifestations such as polycythemia may not the correspond to clinical and routine laboratory indicators of disease severity.[23] However, studies showed that extra-pulmonary features of COPD often follow independent trajectories and require targeted evaluation.[24]

This study therefore, underscores the importance of routine hematological assessment in COPD patients, regardless of apparent disease severity or symptom burden. Reliance solely on clinical staging, SpO_2 measurement or symptom-based classification may lead to under-recognition of polycythemia and its potential complications.

CONCLUSION

This study highlighted that polycythemia is common hematological finding in COPD patients having resting hypoxemia with no significant association with age, gender, BMI or smoking duration. However, active smoking and lower resting SpO2 had somewhat influence in patients being polycythemic. The lower SpO2 in polycythemic patients suggest chronic hypoxemia, a driving factor whereas paradoxical higher PaO2 reflect compensatory physiological adaptation as well as disease severity variability. Moreover, lack of significant differences in age, BMI, and smoking exposure underscores the fact that polycythemia in COPD is not merely consequence and

associated with traditional risk factors but complex and manifestation of COPD-related mechanism and hypoxemia. Hence, early identification of polycythemia in COPD remains crucial, because unrecognized, can contribute to increased blood viscosity and associated cardiovascular risks.

LIMITATIONS

The authors are well aware of the limitation, single center and a limited sample size study are amongst the major limitations of the study. This study didn't focused on thrombotic and cardiovascular complications of polycythemia. This was done as a cross-sectional study which lack the longitudinal follow-up to observe and assess the progression of polycythemia. Comorbidities, altitude, profession, were not studied as potential confounding factors in this study. Thus, further studies including RCTs should be done with larger sample size including multicenter approach before implementing results on wider scale.

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REFERENCES

1. Brakema EA, van Gemert FA, van der Kleij RMJJ, Salvi S, Puhan M, Chavannes NH. COPD's early origins in low-and-middle income countries: what are the implications of a false start? npj Prim Care Respir Med. 2019;29(1):6. http://doi.org/10.1038/s41533-019-0117-y
2. Duan RR, Hao K, Yang T. Air pollution and chronic obstructive pulmonary disease. Chronic Diseases and Translational Medicine. 2020;6(4):260–9. http://doi.org/10.1016/j.cdtm.2020.05.004
3. Lu W, Aarsand R, Schotte K, Han J, Lebedeva E, Tsoy E, et al. Tobacco and COPD: presenting the World Health Organization (WHO) Tobacco Knowledge Summary. Respir Res. 2024;25(1):338. http://doi.org/10.1186/s12931-024-02961-5
4. Hikichi M, Mizumura K, Maruoka S, Gon Y. Pathogenesis of chronic obstructive pulmonary disease (COPD) induced by cigarette smoke. J Thorac Dis. 2019;11(S17):S2129–40. http://doi.org/10.21037/jtd.2019.10.43
5. Ganesh M S, S S, S A. Insights into the Pathophysiology and Therapeutic Targets of Consequences Induced by Polycythemia in COPD. Biosci, Biotech Res Asia. 2023;20(4):1225–35. http://doi.org/10.13005/bbra/3170
6. Zhou M, Liu X, Li L. Secondary polycythaemia from chronic hypoxia is a risk for cerebral thrombosis: a case report. BMC Neurology. 2023;23(1):225. http://doi.org/10.1186/s12883-023-03277-5
7. Yogeswaran A, Kuhnert S, Gall H, Faber M, Krauss E, Rako ZA, et al. Relevance of Cor Pulmonale in COPD With and Without Pulmonary Hypertension: A Retrospective Cohort Study. Front Cardiovasc Med. 2022;9. http://doi.org/10.3389/fcvm.2022.826369
8. Mao C, Olszewski AJ, Egan PC, Barth P, Reagan JL. Evaluating the Incidence of Cardiovascular and Thrombotic Events in Secondary Polycythemia. Blood. 2019;134(Supplement_1):3511–3511. http://doi.org/10.1182/blood-2019-122943
9. Ramya PA, Mohapatra MM, Saka VK, Kar R, Chakkalakkoombil SV, Vemuri MB. Haematological and Inflammatory Biomarkers Among Stable COPD and Acute Exacerbations of COPD Patients. Sultan Qaboos Univ Med J. 2023;23(2):239–44. http://doi.org/10.18295/squmj.12.2022.062
10. Masjedi M, Ainy E, Zayeri F, Paydar R. Assessing the Prevalence and Incidence of Asthma and Chronic Obstructive Pulmonary Disease in the Eastern Mediterranean Region. Turk Thorac J. 2018;19(2):56–60. http://doi.org/10.5152/TurkThoracJ.2018.17051
11. Portacci A, Quaranta VN, Marinelli A, Capuano A, Vulpi MR, Diaferia F, et al. Real-Life Characteristics of Patients with COPD and Discordant CAT-mMRC Questionnaires. JCM. 2025;14(24):8771. http://doi.org/10.3390/jcm14248771
12. Randi ML, Bertozzi I, Cosi E, Santarossa C, Peroni E, Fabris F. Idiopathic erythrocytosis: a study of a large cohort with a long follow-up. Ann Hematol. 2016;95(2):233–7. http://doi.org/10.1007/s00277-015-2548-z
13. Ullah DA, Basit DA, Bacha DIU, Shaheen S, Khan MA, Ahmad I. Frequency of polycythemia in patients presenting with chronic obstructive pulmonary disease. The Research of Medical Science Review. 2025;3(7):1544–54.
14. Ullah R, Nasib HA, Iqbal Z, Ul-Haq Z, Ashraf S. Frequency of Secondary Polycythemia in Patients with Chronic Obstructive Pulmonary Disease. Pak J Chest Med. 2018;24(1).
15. Kuppast VK, Chandrashekar HB, Ramadurg UY. A study of polycythaemia and associated factors in COPD patients attending a tertiary care hospital. IP Indian Journal of Immunology and Respiratory Medicine. 2025;5(2):101–4. http://doi.org/10.18231/j.ijirm.2020.038
16. Sarkar M, Rajta PN, Khatana J. Anemia in Chronic obstructive pulmonary disease: Prevalence, pathogenesis, and potential impact. Lung India. 2015;32(2):142. http://doi.org/10.4103/0970-2113.152626

17. Malik AA, Anwar S, Batool H, Karamat A, Ali G, Siddiqui F. Frequency of Anemia in Chronic Obstructive Pulmonary Disease (COPD). Pakistan Journal of Medical & Health Sciences. 2022;16(04):680–680. http://doi.org/10.53350/pjmhs22164680
18. Sharma A, Rathi D, Jain P, Tayal D. Hematological and clinical profiling of chronic obstructive pulmonary disease: a comprehensive study. Monaldi Archives for Chest Disease. 2025. http://doi.org/10.4081/monaldi.2024.2991
19. Zhang J, DeMeo DL, Silverman EK, Make BJ, Wade RC, Wells JM, et al. Secondary polycythemia in chronic obstructive pulmonary disease: prevalence and risk factors. BMC Pulm Med. 2021;21(1):235. http://doi.org/10.1186/s12890-021-01585-5
20. Moore-Gillon JC, Treacher DF, Gaminara EJ, Pearson TC, Cameron IR. Intermittent hypoxia in patients with unexplained polycythaemia. Br Med J (Clin Res Ed). 1986;293(6547):588–590. http://doi.org/10.1136/bmj.293.6547.588
21. Cote C, Zilberberg M, Mody SH, Celli B. The prevalence of polycythemia in a chronic obstructive pulmonary disease (copd) cohort. Chest. 2005;128(4):264S. http://doi.org/10.1378/chest.128.4_MeetingAbstracts.264S-a
22. Abdelfattah RA, Emam RM, Abdel Aziz MO, Abdullah NM, Abdelaziz AO. Polycythemia in chronic obstructive pulmonary disease in Minia Cardiothoracic University Hospital. The Egyptian Journal of Chest Diseases and Tuberculosis. 2023;72(2):147–52. http://doi.org/10.4103/ecdt.ecdt_59_22
23. Thapa KB, Paudel A, Dhital S, Shrestha A, Ojha L, Shrestha A. Polycythemia among Patients with Chronic Obstructive Pulmonary Disease Admitted to the Department of Medicine in a Tertiary Care Center: A Descriptive Cross-sectional Study. JNMA J Nepal Med Assoc. 2023;61(260):343–6. http://doi.org/10.31729/jnma.8125
24. Xiang Y, Luo X. Extrapulmonary Comorbidities Associated with Chronic Obstructive Pulmonary Disease: A Review. Int J Chron Obstruct Pulmon Dis. 2024;19:567–78. http://doi.org/10.2147/COPD.S447739