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ORIGINAL ARTICLE

Association of red cell distribution width with chronic obstructive pulmonary disease severity

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disease that has substantial morbidity and mortality worldwide. A widely used blood parameter, called Red Cell Distribution Width (RDW), has been proposed as a marker of inflammation and disease severity in COPD. Our objective is to find the correlation between RDW and COPD severity based on Global Initiative for Chronic Obstructive Lung Disease (GOLD) classification.

Methods: This cross-sectional study was carried out in the Pulmonology Department, Khyber Teaching Hospital, Peshawar from 23-05-2025 to 03-04-2026. Non-probability consecutive sampling was used to recruit a total of 258 confirmed cases of COPD. Demographic and clinical information was taken. The severity of COPD was determined by the GOLD staging. RDW was determined by complete blood count (CBC) and classified as high (>14.5%) or normal (≤14.5%). The data were analyzed using SPSS-27 and the Chi-square test, One-way ANOVA and Pearson correlation coefficient with $p<0.05$ as significant value.

Results: The mean age of the participants was 62.9±10.3 years and 68.2% were male. 57.8% of patients were found to have an elevated RDW. A majority of patients had severe to very severe disease (GOLD III-IV) (49.6%) and the majority were in GOLD II (35.7%) and III (31.4%). There was a strong correlation between RDW and COPD severity ($p<0.001$), as it rose from 26.3% in GOLD I to 83.0% in GOLD IV. Mean RDW rose significantly across stages (13.4±0.8% to 16.2±1.7%). A negative correlation was found between RDW and FEV_1 (% predicted) ($r=-0.58$, $p<0.001$). **Conclusion**: An increased RDW was significantly related to the severity of COPD and lung function, which indicated its potential to be a simple, low-cost biomarker for disease evaluation.

Keywords: COPD, GOLD Classification, Inflammation, Pulmonary Function

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Introduction

A debilitating respiratory condition of progressive nature, Chronic Obstructive Pulmonary Disease (COPD) is a condition where an individual feels continuous limitation to airflow that is only reversible

partially and might be recurrent with acute exacerbations (1).

It includes diseases such as asthma, emphysema and chronic bronchitis and is caused mainly by cigarette smoking and exposure to noxious gases and particles (2). COPD is a major problem for public health worldwide with third ranking among the World Health Organization (WHO) leading causes for deaths worldwide[3]. The individual quality of life is also compromised along with consumption of resources in healthcare settings (1).

Accurately evaluating the severity of disease is crucial for proper management and treatment of COPD. The condition is typically categorized using the "Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines", that are based on spirometry results, evaluation of symptomatology and clinical history of exacerbations (2,3).

However, COPD is also linked with multisystem manifestations that may not be reflected by the GOLD guidelines, these include metabolic syndrome, heart disease, anemia of chronic disease (4). Therefore, it is necessary that other cost-effective biomarkers be explored through studies to highlight the systemic involvement as well.

"Red Cell Distribution Width (RDW)" is a parameter that is routinely measured in full blood counts, reflects the size variability among circulating erythrocytes. It is used to present alternative diagnosis of different anemias, RDW is also raised in multisystem disease including heart diseases, inflammation and diabetes mellitus. Patients with chronic diseases having increased RDW have increased morbidity and mortality (5).

COPD may cause widespread inflammation in the body that may alter normal generation of red blood cells leading to elevated RDW (6). Recent research has linked increased RDW with the rising severity of COPD. Patients with severe airflow limitation and those with more acute flare-ups of COPD can present with high levels of RDW (6,7). This suggests a possible significance of RDW to be used in measuring the severity of COPD. RDW is a low cost test and widely available with easy utilization in resource limited environments.

As new evidence continues to emerge, the local studies are still scarce with regards to utilization of RDW as a severity marker in COPD (8). This necessitates new studies to be undertaken at local level to explore the association between levels of RDW and severity of COPD using GOLD classification diagnosis criteria (8).

COPD is a chronic lung disease that can cause a lot of illness and death. The ability to assess severity is crucial to effective disease management, but current tools may not reflect the systemic effects. The Red Cell Distribution Width (RDW) is a laboratory measure that is easy to obtain and inexpensive, and has been identified as a possible marker of inflammation and severity of disease. The objective of this study is to assess the relationship of RDW with the severity of COPD (including the number of exacerbations) based on the available limited local data. The results could be useful to justify the use of RDW as an easily available biomarker to assess and manage COPD patients.

Methods

The study was a cross-sectional study, which was performed in Department of Pulmonology, Khyber Teaching Hospital, Peshawar, between 23/05/2025 and 30/04/2026, with approval of hospital IRB committee with reference number:

522/DME/KMC; dated: 23/05/2025. The sample size was determined using the OpenEpi software and was based on the expected frequency of elevated RDW in the patient with COPD (59.2%) (9), a 95% confidence level and a margin of error of 6%.

Data collection was done using Non probability consecutive sampling. Patients with confirmed diagnosis of COPD, age ≥18 years, both females and males were included in the study. Patients with acute exacerbation of COPD at the time of admission, chronic disease that could intrude with the results (such as chronic kidney disease, malignancy etc) and blood abnormalities that could lead to a rise in RDW in addition to the COPD were excluded from the study. Patients with active inflammation/infection were also excluded.

COPD was defined as a progressive respiratory disease characterized by persistent airflow limitation confirmed by spirometry (reduced FEV_1/FVC ratio) and classified according to GOLD staging as mild (GOLD I), moderate (GOLD II), severe (GOLD III), or very severe (GOLD IV). Acute exacerbation of COPD was defined as a sudden worsening of respiratory symptoms requiring additional treatment with corticosteroids, antibiotics, or hospitalization and was confirmed through medical record review. RDW was measured as the percentage variation in erythrocyte size on complete blood count, with values above the normal reference range (11.5%–14.5%) considered elevated (5).

The data was collected on a predesigned structured proforma. Demographic information like age, gender, residency, any comorbidities were recorded. Clinical history including symptoms, duration of the disease, length of hospitalizations and relevant examination was performed and recorded. COPD severity was classified according to GOLDs classification. Venous samples for blood was collected under aseptic conditions and were analyzed in hospital laboratory for RDW analysis. The data was collected by the researcher on a predesigned structured questionnaire.

Data analysis was done through SPSS version 27. The demographic values were summarized through descriptive statistics. Shapiro Wilk test was used to determine the normality of data. Mean ± Standard Deviation (SD) was counted for continuous values if the data is normal. In case of non-normal distribution, median and interquartile range was used. The categorical values like RDW, COPD severity and age groups were presented by frequencies and percentages. GOLD classification was used to classify COPD severity. Chi-square test or Fisher's exact test was used to find RDW variability with different classes of severity of COPD. A p-value of less than or equal to 0.05 was taken as a significant.

Results

This study includes 258 patients. The mean age of the patients were 62.9 ± 10.3 years, havig mean BMI of 27.98 ± 4.5, predominantly male 176 (68.2%). Elevated RDW (>14.5%) was observed in 149 (57.8%) patients. The majority of participants had moderate to severe COPD according to GOLD classification.

Table 1: Demographic and Clinical Characteristics of Study Participants (n=258)

Variable	Value
Gender	
Male	176 (68.2%)
Female	82 (31.8%)
Residence	
Rural	154 (59.7%)
Urban	104 (40.3%)
RDW	
Elevated (>14.5%)	149 (57.8%)
Normal (≤14.5%)	109 (42.2%)

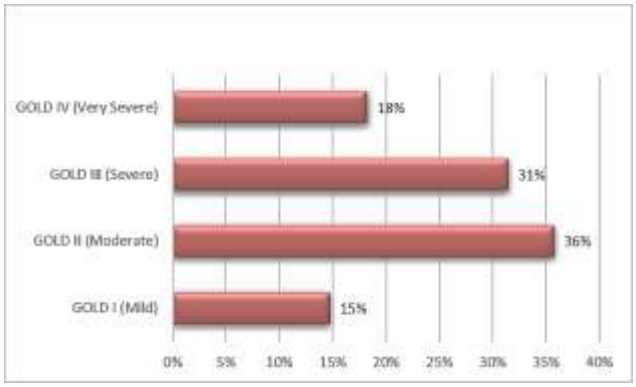

Figure 1: Distribution of Patients According to GOLD Classification (n=258)

Figure 1 demonstrate that most patients were in GOLD II 92 (35.7%), followed by GOLD III 81 (31.4%), GOLD IV 47 (18.2%), and GOLD I 38 (14.7%). Nearly half of the participants 128 (49.6%) had severe to very severe COPD (GOLD III–IV), indicating a substantial burden of advanced disease in the study population.

The severity of COPD is closely correlated with the RDW status ($p < 0.001$). The proportion of elevated RDW was greater in the more advanced GOLD stages compared with the normal RDW, with 10 (26.3%) of the patients in the GOLD I group having elevated RDW, compared with 39 (83.0%) in the GOLD IV group. Table 2 shows that high RDW is significantly related to increased severity of COPD as suggested by these findings.

Table 2: Association Between RDW Status and COPD Severity

GOLD Stage	Normal RDW n (%)	Elevated RDW n (%)	P value
GOLD I	28 (73.7)	10 (26.3)	<0.001
GOLD II	50 (54.3)	42 (45.7)	
GOLD III	23 (28.4)	58 (71.6)	
GOLD IV	8 (17.0)	39 (83.0)	
Total	109 (42.2)	149 (57.8)	

Chi-square are used, p value <0.05 is significant

The mean RDW increased progressively with disease severity, rising from 13.4 ± 0.8% in GOLD I patients to 14.1 ± 1.1% in GOLD II, 15.3 ± 1.4% in GOLD III, and 16.2 ± 1.7% in GOLD IV patients. The mean RDW values were statistically different between the GOLD stages ($p < 0.001$), with a higher level of RDW associated with worse severity of COPD (table 3).

Table 3: Comparison of Mean RDW Across GOLD Stages

GOLD Stage	Mean RDW (%) ± SD	P value
GOLD I	13.4 ± 0.8	<0.001
GOLD II	14.1 ± 1.1	
GOLD III	15.3 ± 1.4	
GOLD IV	16.2 ± 1.7	

One-Way ANOVA are used, p value >0.05 is significant

A significant negative correlation was observed between RDW and FEV_1 (% predicted), indicating that higher RDW values were associated with worsening pulmonary function (p value <0.001).

Discussion

The aim of the present study was to explore the relationship between Red Cell Distribution Width (RDW) and the severity of Chronic Obstructive Pulmonary Disease (COPD). Results showed that higher RDW was widely found in COPD patients and was significantly related to greater severity of COPD, as classified by GOLD. Additionally, significant inverse correlation was observed between RDW and FEV_1 (% predicted), thus indicating that the higher the RDW is, the more severe the pulmonary function is.

As for demographical data, the average age of the study population was 62.9 ± 10.3 years and there was a predominance of males (68.2%). The results are similar to those of

recent studies by other authors, such as Yu et al., 2025 (10) and Bari et al., 2025 (11) which reported mean ages of 62-68 years and a greater percentage of males (47-68%) in COPD patients. The age distribution observed is a result of the chronic and progressive nature of COPD, which often occurs in older adults as a result of many years of smoking and exposure to environmental pollutants. The male preponderance is also consistent with smoking rates and the risks of occupational exposure to the chemicals that are reported in other studies in this region.

Current study shows that elevated RDW (>14.5%) was seen in 57.8% of patients. This finding aligns with the previous observations showing that RDW is commonly observed in patients with COPD and to be associated with poor clinical outcomes and higher mortality (12). Increased RDW in COPD could be due to the combination of chronic systemic inflammation, oxidative stress, tissue hypoxia, and decreased erythropoiesis, which all lead to increased heterogeneity in red blood cell size. These pathophysiological mechanisms provide additional evidence of the systemic effects of COPD and not just pulmonary involvement.

In the present study, most COPD patients were in the GOLD II (35.7%) and GOLD III (31.4%) categories and almost half of the participants were in the severe to very severe disease categories (GOLD III–IV). This is similar to the findings reported by Bari et al. (2025) who reported that majority of COPD patients were in GOLD stages 2 to 4.(12) Previous studies have also shown that progression to GOLD stage simply correlates with higher morbidity and mortality, highlighting the need for simple biomarkers that can help stratify the disease and thus provide an estimate of risk.

One of the significant results from this study was the relationship between the RDW status and severity of COPD. The percentage of patients with high RDW levels gradually rose from 26.3% in GOLD I disease to 83.0% in GOLD IV disease with $p<0.001$. Likewise, mean RDW levels have been found to rise throughout GOLD stages, progressing from 13.4 ± 0.8% in GOLD I to 16.2 ± 1.7% in GOLD IV patients. The same findings were found in the studies by Alparslan et al. (2021) (13) which showed that RDW had a positive, significant correlation with the GOLD staging, and by Aykun (2025) (12) and Arkew et al. (2022) (14) that showed progressive increase of RDW with increase in the severity of the disease, and Patidar et al.that showed progressive increase of RDW with increasing severity of the disease.(12,14,15) Increased systemic inflammation and exacerbation of hypoxemia in more severe COPD stages could explain the progressive increase in RDW with increasing severity. High systemic inflammation and worsening hypoxemia in more severe stages of COPD could be responsible for the progressive increase in RDW with increasing severity.

The other interesting finding of the present study was the significant negative correlation between RDW and FEV_1 (% predicted) ($r = -0.58$, $p<0.001$). This suggests there was a trend for poorer pulmonary function with higher RDW levels. Patidar et al. and Aykun reported inverse correlation between RDW and FEV_1 values (12,15). As the airflow limitation gets worse, systemic hypoxia and inflammatory burden rise, resulting in changes on the production of red blood cells and more variation in the sizes of the erythrocytes. The medium

negative correlation found in our study also confirms the possible use of RDW as an indirect indicator of disease progression and pulmonary impairment.

This is an interesting finding in terms of clinical implications. The parameter of RDW is inexpensive, routinely available and is not an extra cost nor does it require any specialized equipment for obtaining the parameter. It has been shown in several studies to have a value as a prognostic marker that can help to classify patients into risk groups and predict poor outcomes such as increased length of hospital stays and mortality (16,17) Hence, RDW can be a useful complement to the standard clinical and spirometry diagnosis, especially in a health care system that doesn't have access to high-tech biomarkers.

Limitations of study: There are some limitations to keep in mind: Given the cross-sectional study design, it is not possible to draw causal conclusions between increased RDW and progression of COPD. Furthermore, careful exclusion of factors that are known to affect RDW, such as nutritional deficiencies and subclinical hematological abnormalities, might not be sufficient to completely exclude these factors as noted by Nâaroura et al. (2023) (18). In addition, the study was carried out at one facility, and findings might not be applicable to other facilities. Further multicenter prospective research is warranted to determine the prognostic value of RDW in patients with COPD predicting exacerbation, hospitalization and mortality. The results of the present study however, corroborate the increasing body of evidence that demonstrates that RDW is strongly linked with severity of COPD and pulmonary dysfunction.

Conclusion

As RDW rises with increasing GOLD stage and FEV1 falls, these findings indicate that RDW could be a useful simple, inexpensive and easily accessible biomarker to evaluate disease severity among COPD patients. Additional prospective multicenter investigations are suggested to define its prognostic value and its place in the daily clinical practice.

Conflict of Interest: Nil
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References

1. Agustí A, Melén E, DeMeo DL, Breyer-Kohansal R, Faner R. Pathogenesis of chronic obstructive pulmonary disease: understanding the contributions of gene-environment interactions across the lifespan. Lancet Respir Med. 2022;10(5):512-24.
2. Nucera F, Mumby S, Paudel KR, Dharwal V, Di Stefano A, Casolaro V, et al. Role of oxidative stress in the pathogenesis of COPD. Minerva Med. 2022 Feb 10.
3. World Health Organization. Health inequities and their causes . Geneva: World Health Organization; 2017. https://www.who.int/newsroom/facts-in-pictures/detail/health-inequities-and-their-causes
4. Tzanakis N, Koulouris N, Dimakou K, Gourgoulianis K, Kosmas E, Chasapidou G, et al. Classification of COPD patients and compliance to recommended treatment in Greece according to GOLD 2017 report: the RELICO study. BMC Pulm Med. 2021;21(1):216.
5. Xu W, Huo J, Chen G, Yang K, Huang Z, Peng L, et al. Association between red blood cell distribution width to albumin ratio and prognosis of patients with

sepsis: a retrospective cohort study. Front Nutr. 2022; 9:1019502.
6. Karampitsakos T, Dimakou K, Papaioannou O, Chrysikos S, Kaponi M, Bouros D, et al. The role of increased red cell distribution width as a negative prognostic marker in patients with COPD. Pulm Pharmacol Ther. 2020; 60:101877.
7. Marvisi M, Mancini C, Balzarini L, Ramponi S. Red cell distribution width: a new parameter for predicting the risk of exacerbation in COPD patients. Int J Clin Pract. 2021;75(9).
8. Kanwal A, Bashir A, Gohier A, Habib B. Association of red blood cell indices and erythrocyte sedimentation rate in chronic obstructive pulmonary disease (COPD) patients. Pak Armed Forces Med J. 2021;71(2):610.
9. Farman S, Saad M, Adnan U. Red cell distribution width as a prognostic marker in ICU-admitted chronic obstructive pulmonary disease patients: correlation with inflammatory profile and clinical outcomes. Pak J Chest Med. 2024;30(2):219-28.
10. Yu K, Gao A, He Y, Huang Z, Liu W. Red blood cell distribution width and mortality in chronic obstructive pulmonary disease patients with acute respiratory failure: a retrospective study. SciRep.2025;15(1):33391. doi:10.1038/s41598-025-18480-2.
11. Bari MA, Shamsi S, Hasan MJ, Ahmed S. Clinical profile of patients with chronic obstructive pulmonary disease
12. Community Based Med J. 2025;14(2):98-104.
13. Aykun G. Prognostic value of RDW and its contribution to scoring systems in patients with chronic obstructive pulmonary disease [preprint]. Research Square. 2025. doi:10.21203/rs.3.rs-6549201/v1.
14. Alparslan Bekir S, Tuncay E, Gungor S, Yalcinsoy M, Sogukpinar Ö, Gundogus B, et al. Can red blood cell distribution width (RDW) level predict the severity of acute exacerbation of chronic obstructive pulmonary disease (AECOPD)? Int J Clin Pract.2021;75(11). doi:10.1111/ijcp.14730.
15. Arkew M, Gemechu K, Haile K, Asmerom H. Red blood cell distribution width as novel biomarker in cardiovascular diseases: a literature review. J Blood Med. 2022; 13:413-24. doi:10.2147/JBM.S367660.
16. Patidar P, Sharma A, Kurmi N, Takodara S, Syed A. Predictive biomarkers in chronicobstructivepulmonary.JLabPhysicians.2025;17(4):328. doi:10.25259/JLP_186_2024.
17. Saad E, Maamoun B, Nimer A. Increased red blood cell distribution predicts severity of chronic obstructive pulmonary disease exacerbation. J Pers Med.2023;13(5):843. doi:10.3390/jpm13050843.
18. Afzal M. Red cell distribution width (RDW) as a prognostic marker in systemic diseases: a mini review. Indian JHematol Blood Transfus. 2026;42(3):720-6. doi:10.1007/s12288-025-02210-9.
19. Nâaroura A, Amar JB, Ouertani H, Jemia EB, Zaibi H, Aouina H. Could red cell distribution width predict COPD severity? Eur Respir J. 2023;62(Suppl 67). doi:10.1183/13993003.congress2023.PA627.

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All the authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed.	