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Correlation of C-Reactive Protein Level (CRP) And Neutrophil-Lymphocytes Ratio (NLR) As A Marker of Severity in COPD Patients

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Abstract

Introduction: Chronic Obstructive Pulmonary Disease (COPD) has been believed to be characterized by respiratory disease. Breathing comes in fogged waves, carrying the familiar pressure of ill air. Ongoing respiratory symptoms and decreased airflow are the hallmarks of chronic obstructive pulmonary disease (COPD).

Aims and objectives:

Aim

- Association of CRP and NLR with severity of COPD

Objectives of The Study:

1. Calculate the neutrophil and lymphocyte ratio in COPD Patients.
2. To estimate the serum C-reactive protein (CRP) in COPD Patients.
3. To Compare the predictive value of CRP and NLR across different COPD to assess severity of COPD.

Material and method:

Study Design: The study was designed as a prospective observational study.

Study Place: The current study was carried out at Shri Venkateshwara University's General Medicine Department in Gajraula, Uttar Pradesh.

Study Period: the study was conducted over the course of eighteen months.

Study Participants: The study included patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) who fulfilled the inclusion and exclusion criteria.

Sample Size: Total Sample Size is 50.

Result: The present study included 50 patients diagnosed with COPD, with a mean age of 59.0 ± 11.3 years (range: 41–79 years). A male predominance was observed, with 64.0% males and 36.0% females, reflecting the higher exposure of males to established COPD risk factors such as smoking and occupational hazards.

Discussion: The mean neutrophil percentage was 59.6 ± 9.7%, with values ranging from 40.0% to 79.0%, indicating a predominance of neutrophils in the peripheral blood of COPD patients.

Keywords: Abnormalities, COPD, C-Reactive Protein, Neutrophil-Lymphocytes Ratio, Pulmonary Function Test.

Introduction

Ongoing respiratory symptoms and decreased airflow are the hallmarks of chronic obstructive pulmonary disease (COPD), which is caused by abnormalities in the airways and/or alveoli. These abnormalities are usually brought on by dangerous particles or gases and are molded by specific host variables.[1] It appears in a number of clinical forms, such as chronic bronchitis and emphysema. Exacerbations, or abrupt periods of severe respiratory symptoms, are a prevalent feature of the illness.[2] Due to its substantial health and socioeconomic impacts, it poses a major burden to healthcare systems and contributes considerably to worldwide morbidity and mortality, ranking as the sixth most common cause of death in 2019.[3, 4] The main risk factor for COPD is smoking, while environmental and genetic variables also play a role. Exposure to biomass emissions, occupational dust and fumes, air pollution, passive smoking, chronic asthma, and TB are among the environmental dangers.[10]

The conserved acute-phase protein known as C-reactive protein (CRP) was discovered in 1930 as a result of its interaction with Pneumococcus. When there is inflammation, such as in infections, rheumatoid arthritis, and cardiovascular conditions, its levels up dramatically—by at least 25%.[15]

The inflammatory state of COPD patients during both stable and exacerbation phases is reflected in C-reactive protein (CRP), which the liver produces in reaction to inflammation and tissue damage. Hospitalizations, mortality, and the severity of the disease are all greatly impacted by exacerbations, which are frequently brought on by infections. Increased CRP levels are a valuable diagnostic for COPD diagnosis and prognosis, and they are correlated with disease severity and quality of life.[16.] Neutrophil-to-lymphocyte ratio (NLR) is a blood-based biomarker that reflects both innate immunity (by neutrophils) and adaptive immunity (via lymphocytes).[17]. NLR was initially proposed by Gunay et al. as a straightforward, affordable and easily quantifiable indicator of the degree of inflammation in COPD patients.[20] Its increase during exacerbations and its usefulness in predicting both exacerbation risk and death have been confirmed by later research.[21]

Aims and objectives

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Study Participants: The study included patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) who fulfilled the inclusion and exclusion criteria.

Sample Size: The sample size was calculated using the formula:

$n = Z\ \alpha/2^{2}\ P(100-P)\ / d^{2}$

Where:

n = required sample size

Z = standard normal variate at 95% confidence level (1.96)

P = expected prevalence (13% or 0.13)

d = precision (10% of prevalence)

The calculated sample size was 45.24, which was rounded off to 50. Therefore, a total of 50 patients were included in the study.

Inclusion Criteria

Patients were included in the study if they met the following criteria:

- Patients aged more than 40 years.
- Patients with a confirmed diagnosis of COPD based on Pulmonary Function Test (PFT) findings in accordance with the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines.
- Patients willing to provide informed written consent.

Exclusion Criteria

Patients were excluded from the study if they had:

- Age below 40 years.
- Chronic bronchial asthma.
- Chronic bronchiectasis.
- Other primary emphysematous disorders not related to COPD.
- Any acute infection or inflammatory condition that could alter inflammatory markers.

Statistical Analysis

SPSS version 22.0 (SPSS Inc., Chicago, USA) was used for all statistical analyses. Before analysis, data was input and cleansed. After determining if the distribution was normal, continuous variables were reported as mean ± standard deviation (SD). Frequencies and percentages were used to summarize categorical variables. The Student's independent sample t-test was used to evaluate parametric data in order to compare groups. The Chi-square test was used to assess relationships between categorical variables. A p-value of less than 0.05 was deemed statistically significant, and all statistical tests were two-tailed.

Result

Table 1: Age and Sex Distribution of COPD Patients

		Mean	Std. Deviation	Minimum	Maximum
Age		59.0	11.3	41	79
				Frequency	Percentage
Sex	Male			32	64.0
	Female			18	36.0

Table 1 shows the age and sex distribution of COPD patients. The mean age was 59.0 years with a standard deviation of 11.3, ranging from 41 to 79 years. Among the 50 participants, 32 (64.0%) were males and 18 (36.0%) were females, indicating a predominance of male patients.

Figure 1: Age and Sex Distribution of COPD Patients

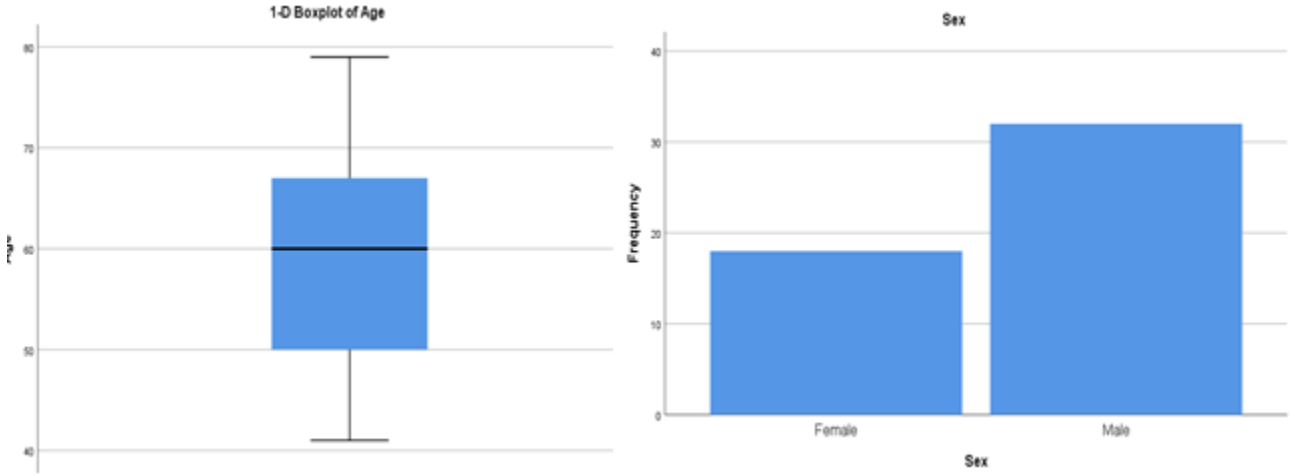


Table 2: Occupational and Lifestyle Factors Among COPD Patients (Smoking, Alcohol, Diet)

		Frequency	Percent
Occupation	Farmer	11	22.0
	Labourer	11	22.0
	Office worker	15	30.0
	Retired	13	26.0
	Total	50	100.0
Alcohol	No	35	70.0
	Yes	15	30.0
Smoking	No	12	24.0
	Yes	38	76.0
Diet	Non-Veg	25	50.0
	Veg	25	50.0

Table 2 shows the occupational and lifestyle characteristics of COPD patients. Farmers and labourers each constituted 22.0% of the study population, while office workers were 30.0% and retired individuals 26.0%. Alcohol consumption was reported by 30.0% of patients, and smoking by 76.0%. Dietary patterns were evenly distributed, with 50.0% consuming vegetarian and 50.0% non-vegetarian diets.

Figure 2: Occupational and Lifestyle Factors Among COPD Patients (Smoking, Alcohol, Diet)

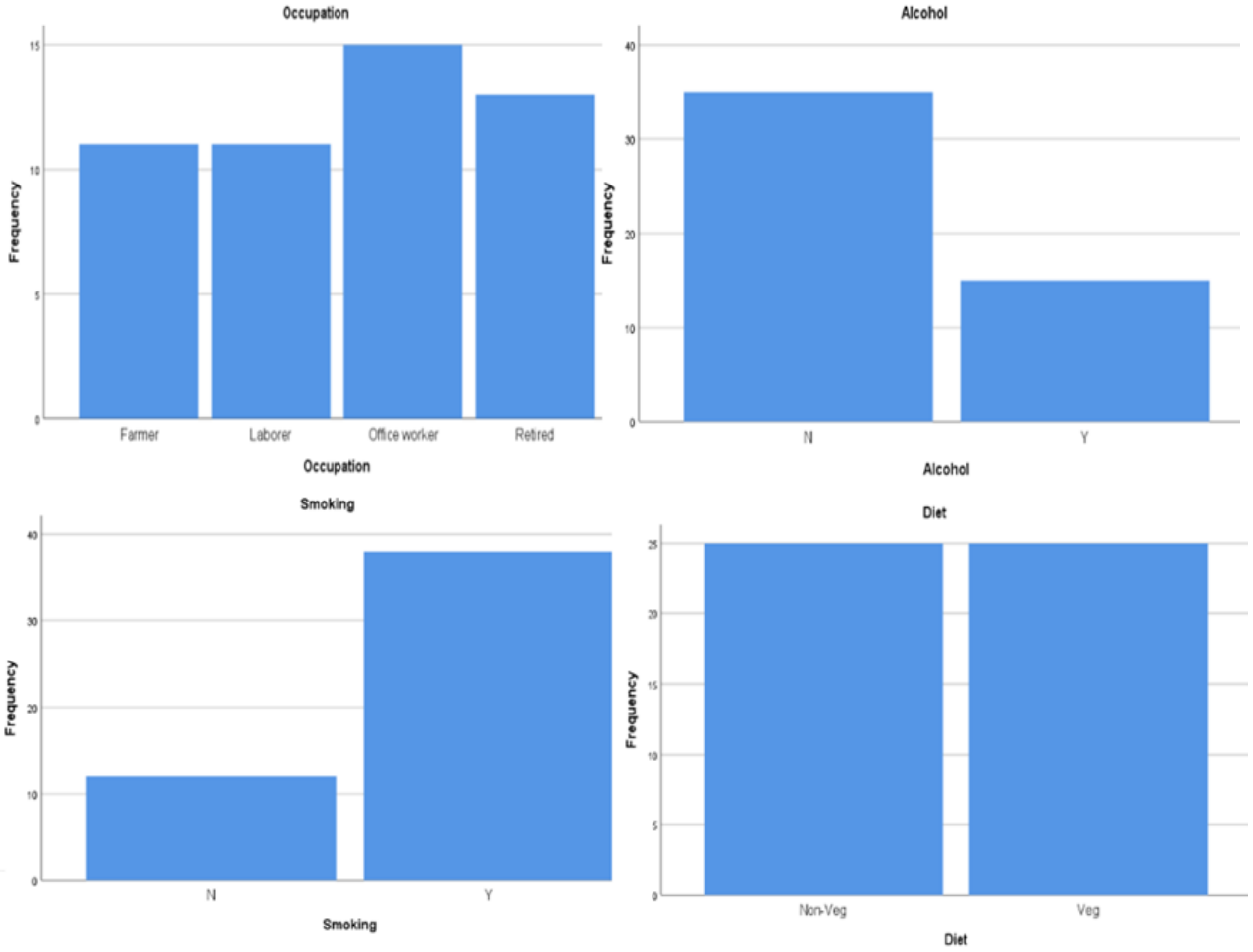


Table 3: Mean Neutrophil and Lymphocyte Percentages of study subjects

Parameter	Mean	Std. Deviation	Minimum	Maximum
Neutrophils (%)	59.6	9.7	40.0	79.0
Lymphocytes (%)	27.7	7.3	10.0	38.0

Table 3 summarizes the distribution of neutrophil and lymphocyte percentages among the study participants. The mean neutrophil percentage was 59.6 ± 9.7%, with values ranging from 40.0% to 79.0%, indicating a predominance of neutrophils in the peripheral blood of COPD patients. The mean lymphocyte percentage was 27.7 ± 7.3%, with a minimum of 10.0% and a maximum of 38.0%.

Figure 3: Mean Neutrophil and Lymphocyte Percentages of study subjects

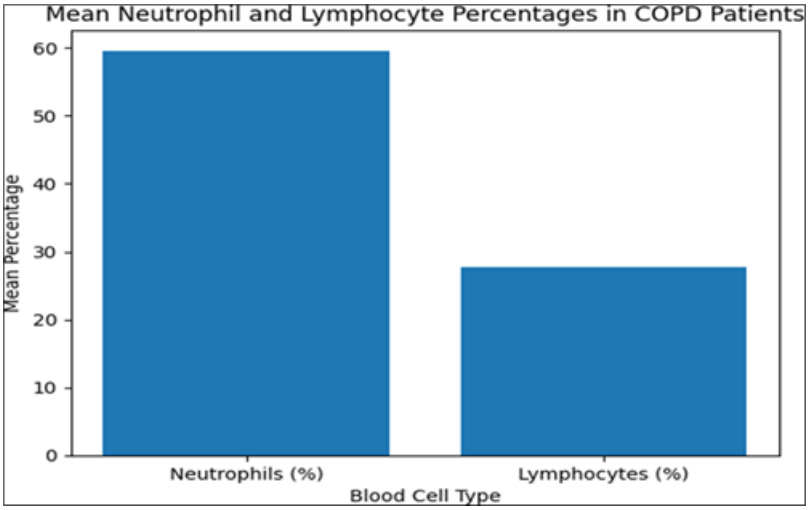


Table 4: Mean Neutrophil-Lymphocyte Ratio (NLR) in Study Participants

Mean	N	Std. Deviation	Mini mum	Maxi mum
2.44	50	1.31	1.21	7.70

Table 4 shows that the mean Neutrophil–Lymphocyte Ratio (NLR) among the 50 study participants was 2.44 ± 1.31, with values ranging from 1.21 to 7.70. This indicates a generally mild-to-moderate level of systemic inflammation in the study population. While most participants clustered around lower NLR values, the wide range and relatively high maximum suggest that a subset had markedly elevated inflammatory status, reflecting heterogeneity in disease severity or inflammatory burden within the study.

Figure 4: Mean Neutrophil-Lymphocyte Ratio (NLR) in Study Participants

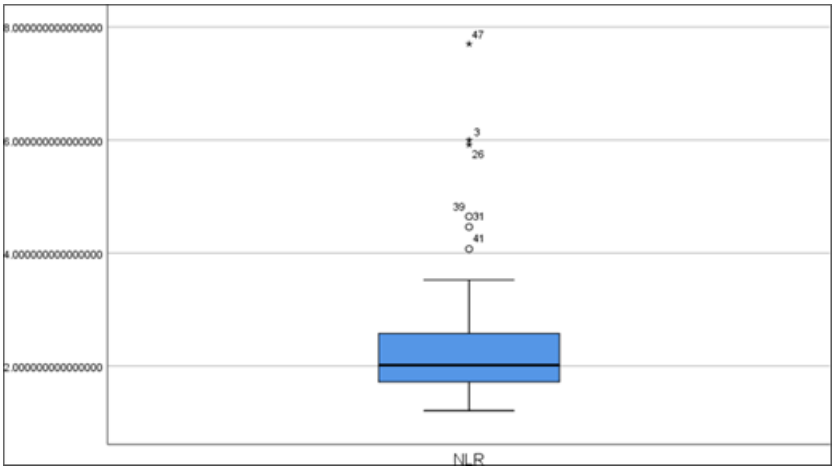


Table 5: C-Reactive Protein (CRP) Levels in COPD Patients

Mean	N	Std. Deviation	Minimum	Maximum
54.1128	50	48.57814	3.52	211.00

Table 5 demonstrates that the mean C-reactive protein (CRP) level among the 50 COPD patients was 54.11 ± 48.58 mg/L, with a wide range from 3.52 mg/L to 211.00 mg/L. This markedly elevated mean CRP indicates the presence of

significant systemic inflammation in the study population, which is characteristic of COPD, particularly during moderate to severe disease states or exacerbations. The large standard deviation and broad range highlight substantial inter-individual variability, suggesting that while some patients had relatively low inflammatory activity, others exhibited very high CRP levels, reflecting differences in disease severity, acute inflammatory status, or associated comorbid conditions.

Figure 5: C-Reactive Protein (CRP) Levels in COPD Patients

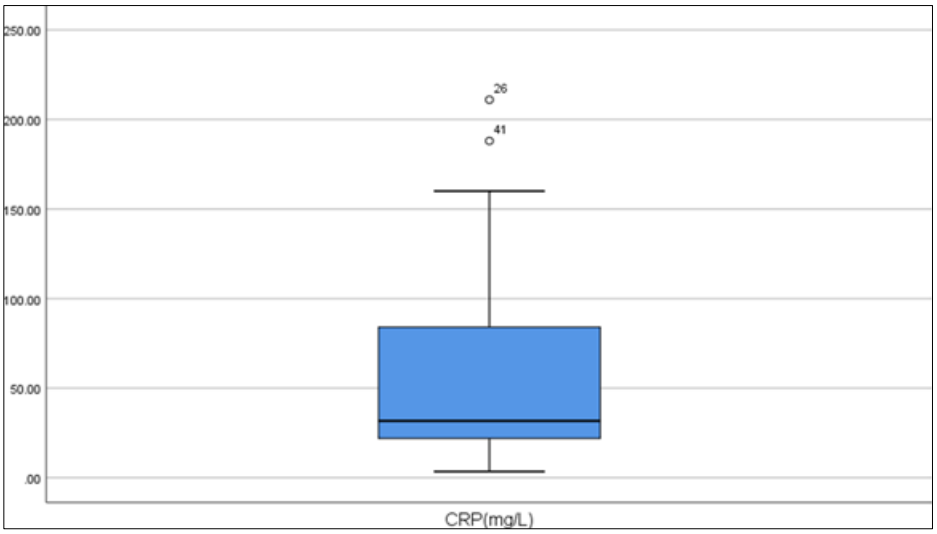


Table 6: Mean CRP Levels Across COPD Severity Grades

COPD_Severity	Mean	N	Std. Deviation	Minimum	Maximum
Moderate	24.5648	33	11.08130	3.52	45.30
Severe	92.0000	13	16.07794	64.00	124.00
Very Severe	174.7500	4	31.17023	140.00	211.00
Total	54.1128	50	48.57814	3.52	211.00
ANOVA Test applied, F Value- 249.71, p value-<0.001, significant					

Table 6 demonstrates a clear and progressive rise in mean C-reactive protein (CRP) levels with increasing COPD severity. Patients with moderate COPD had a mean CRP of 24.56 ± 11.08 mg/L, which increased markedly in severe COPD to 92.00 ± 16.08 mg/L, and was highest in the very severe group at 174.75 ± 31.17 mg/L. This graded increase indicates a strong association between disease severity and systemic inflammation. The ANOVA result ($F = 249.71$, $p < 0.001$) confirms that the differences in CRP levels across severity grades are highly statistically significant, supporting the role of CRP as a reliable inflammatory marker reflecting COPD severity.

Figure 6: Mean CRP Levels Across COPD Severity Grade

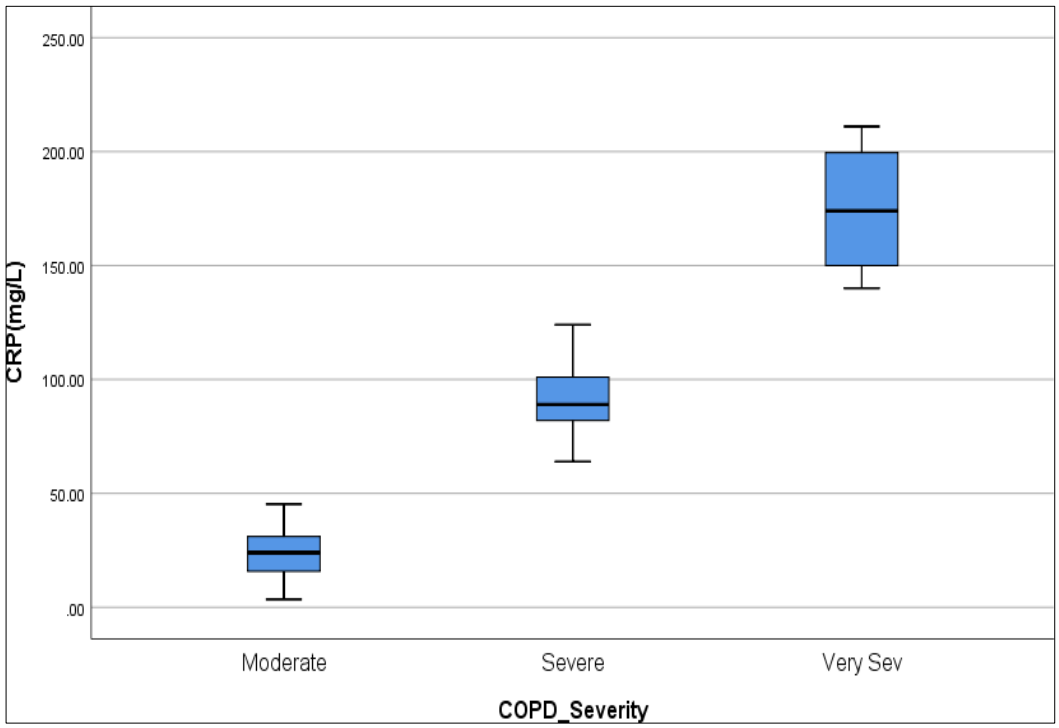


Table 7: Correlation Between CRP and COPD Severity (Spearman/Pearson)

		CRP (mg/L)	COPD Severity
CRP (mg/L)	Pearson Correlation	1	.954
	Sig. (2-tailed)		.000
	N	50	50
COPD Severity	Pearson Correlation	.954	1
	Sig. (2-tailed)	.000	
	N	50	50
Correlation is significant at the 0.01 level (2-tailed).			

The severity of COPD is positively correlated with serum C-reactive protein (CRP) levels, as shown in Table 7. The nearly perfect linear association indicated by the Pearson correlation value ($r = 0.954$) demonstrates that CRP levels significantly increase as COPD severity increases. The observed link is unlikely to be the result of chance, given this association was highly statistically significant ($p < 0.001$). All things considered, our results demonstrate that CRP is a reliable indicator of systemic inflammation that accurately reflects the severity of the disease in COPD patients and validates its use in evaluating and tracking the course of the illness.

Figure 7: Correlation Between CRP and COPD Severity (Spearman/Pearson).

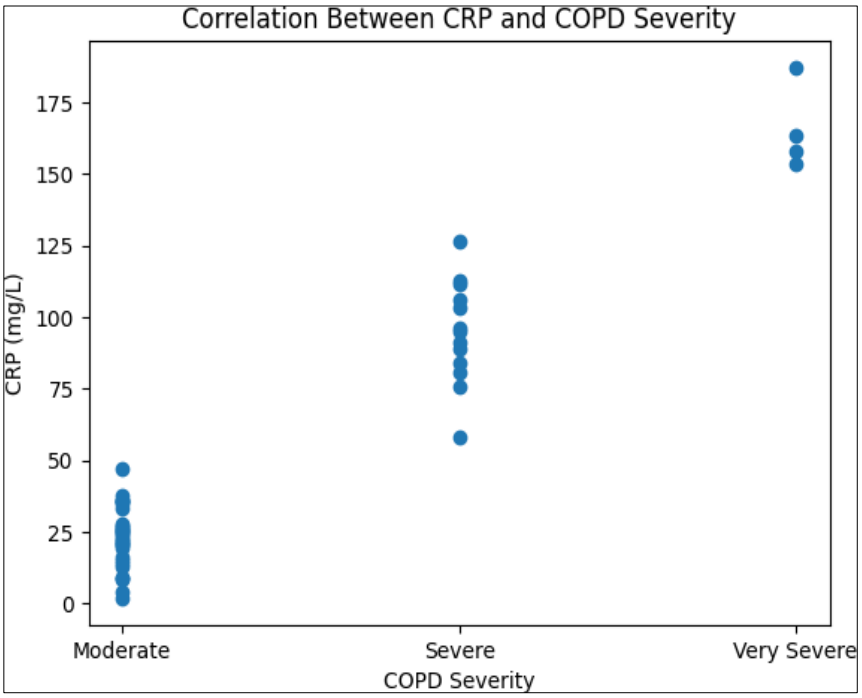
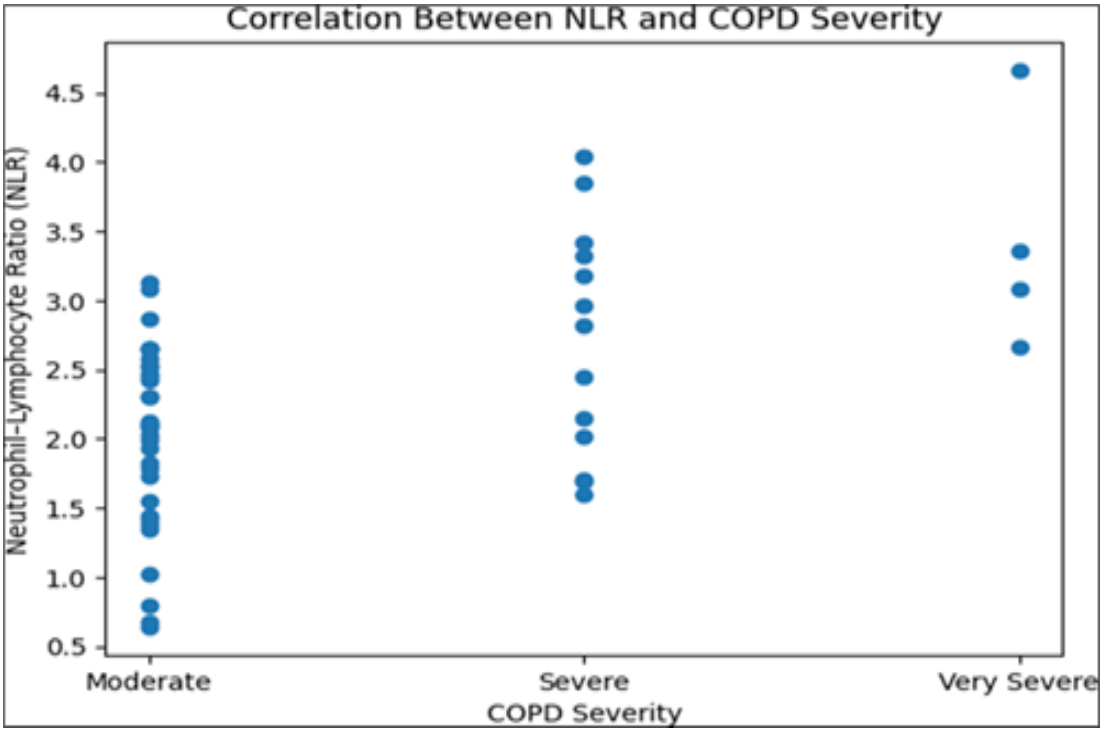


Table 8: Correlation Between NLR and COPD Severity

		NLR	COPD Severity
NLR	Pearson Correlation	1	.771
	Sig. (2-tailed)		.000
	N	50	50
COPD Severity	Pearson Correlation	.771	1
	Sig. (2-tailed)	.000	
	N	50	50
Correlation is significant at the 0.01 level (2-tailed).			

The neutrophil–lymphocyte ratio (NLR) and the severity of COPD are strongly positively correlated, as Table 8 demonstrates. NLR significantly rises with increasing COPD severity, according to the Pearson correlation value ($r = 0.771$). The strong statistical significance of this link ($p < 0.001$) indicates that the association is not the result of chance. Although its degree of connection is weaker than that of CRP, our results imply that NLR is a trustworthy and readily available inflammatory measure that indicates rising disease severity in COPD.

Figure 8: Correlation Between NLR and COPD Severity.



Discussion

The present study included 50 patients diagnosed with COPD, with a mean age of 59.0 ± 11.3 years (range: 41–79 years). A male predominance was observed, with 64.0% males and 36.0% females. Regarding occupational and lifestyle characteristics, office workers constituted the largest occupational group (30.0%), followed by retired individuals (26.0%), farmers (22.0%), and labourers (22.0%). A substantial proportion of patients were smokers (76.0%), while 30.0% reported alcohol consumption. Dietary habits were equally distributed between vegetarian and non-vegetarian diets. Present observation that a substantial proportion of patients exhibited clinical signs beyond isolated respiratory symptoms is consistent with the view presented in these studies: elevated CRP and NLR tend to coexist with systemic manifestations of disease and comorbid conditions, further supporting their utility as markers of severity in COPD populations. The mean neutrophil percentage was 59.6 ± 9.7%, with values ranging from 40.0% to 79.0%, indicating a predominance of neutrophils in the peripheral blood of COPD patients. The mean lymphocyte percentage was 27.7 ± 7.3%, with a minimum of 10.0% and a maximum of 38.0%. Present study mean Neutrophil–Lymphocyte Ratio (NLR) among the 50 study participants was 2.44 ± 1.31, with values ranging from 1.21 to 7.70, while the wide upper range suggests that a meaningful subset likely had higher inflammatory burden or more severe phenotype. The mean C-reactive protein (CRP) level among the 50 COPD patients was 54.11 ± 48.58 mg/L, with a wide range from 3.52 mg/L to 211.00 mg/L, suggesting that many participants may have had more severe disease or intercurrent inflammatory triggers at sampling.

Conclusion

The present study demonstrates that systemic inflammation plays a central role in the progression and severity of chronic obstructive pulmonary disease. Both C-reactive protein (CRP) and neutrophil– lymphocyte

ratio (NLR) showed a clear and significant increase with worsening COPD severity, with CRP exhibiting a very strong correlation and excellent discriminatory ability for identifying severe disease. NLR also showed a strong association with disease severity and correlated well with CRP, highlighting its value as a simple, cost-effective inflammatory marker. Although smokers exhibited higher mean inflammatory marker levels, smoking status alone did not significantly influence CRP or NLR, suggesting that inflammation in COPD is more closely related to disease severity and chronic pathological processes rather than smoking exposure per se. Overall, CRP emerges as a robust biomarker for severity stratification in COPD, while NLR serves as a useful adjunct marker, particularly in resource-limited settings, supporting their combined use in clinical assessment and monitoring of COPD patients.

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