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HEMATOLOGICAL PARAMETERS AS PREDICTORS OF DISEASE SEVERITY AND OUTCOMES IN COVID-19 PATIENTS: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Coronavirus disease 2019 (COVID-19) has a wide spectrum of clinical manifestations ranging from mild illness to severe disease and death. Early identification of patients at risk of severe disease is crucial for timely intervention. Hematological parameters and inflammatory markers have emerged as potential predictors of disease severity and outcomes. The aim is to evaluate hematological parameters as predictors of disease severity and clinical outcomes in COVID-19 patients. The objective is to assess hematological parameters in patients with COVID-19 infection. To correlate hematological parameters with disease severity. To evaluate the association of hematological parameters with clinical outcomes such as ICU admission, ventilator requirement, and mortality.

Materials and Methods: This prospective observational study was conducted on 150 RT-PCR confirmed COVID-19 patients admitted to a tertiary care hospital. Patients were categorized into severe and non-severe groups based on clinical criteria. Hematological parameters including hemoglobin, total leukocyte count, differential counts, platelet count, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR), along with inflammatory markers such as C-reactive protein (CRP) and serum ferritin, were recorded. Statistical analysis was performed using appropriate tests, and $p < 0.05$ was considered statistically significant.

Results: Severe COVID-19 patients were significantly older and had a higher prevalence of comorbidities. Hematological findings revealed significant leukocytosis, neutrophilia, lymphopenia, and thrombocytopenia. NLR and PLR were significantly elevated in severe cases. Inflammatory markers such as CRP and ferritin were markedly higher in severe patients and non-survivors. These parameters showed strong associations with ICU admission, ventilator requirement, and mortality.

Conclusion: Hematological parameters, particularly lymphocyte count, NLR, PLR, CRP, and ferritin, are valuable predictors of disease severity and outcomes in COVID-19 patients. These readily available markers can aid in early risk stratification and improve clinical management.

Keywords: COVID-19; Neutrophil-to-Lymphocyte Ratio; Hematological Parameters.

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), emerged in late 2019 in Wuhan, China, and rapidly evolved into a global pandemic with significant morbidity and mortality. The disease spectrum ranges from asymptomatic infection to severe pneumonia, acute respiratory distress syndrome (ARDS), multi-organ failure, and death. The unpredictable clinical course of COVID-19 necessitates early identification of patients at risk of

severe disease and poor outcomes to facilitate timely intervention and optimal resource utilization.[1]

The pathophysiology of COVID-19 involves a complex interplay between viral replication and host immune response. Severe disease is often associated with a dysregulated immune response, characterized by cytokine storm, hyperinflammation, and immune exhaustion. Hematological parameters have emerged as important biomarkers reflecting this immune dysregulation. Routine laboratory investigations such as complete blood count (CBC) provide valuable insights into disease severity and prognosis.[2]

Among these parameters, lymphopenia is one of the most consistent findings in COVID-19 patients and is associated with impaired immune response. Neutrophilia reflects systemic inflammation, while thrombocytopenia may indicate disease severity and coagulopathy. Derived hematological indices such as neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) are increasingly recognized as simple, cost-effective, and reliable markers for predicting disease severity and outcomes. These indices represent the balance between inflammatory and immune responses and have been widely studied in infectious and inflammatory conditions.[3]

AIM: To evaluate hematological parameters as predictors of disease severity and clinical outcomes in COVID-19 patients.

Objectives

1. To assess the hematological parameters in patients diagnosed with COVID-19 infection.
2. To correlate hematological parameters with disease severity (severe vs non-severe).
3. To evaluate the association of hematological parameters with clinical outcomes such as ICU admission, ventilator requirement, and mortality.

MATERIALS AND METHODS

Source of Data: The data for the present study were obtained from patients admitted with confirmed COVID-19 infection in a tertiary care hospital. Clinical, laboratory, and outcome data were collected from hospital records, laboratory databases, and patient case sheets.

Study Design: This study was conducted as a prospective observational study, where patients were followed from admission until discharge or death, and their hematological parameters were analyzed in relation to disease severity and outcomes.

Study Location: The study was conducted at a tertiary care teaching hospital, including departments of General Medicine, Intensive Care Unit (ICU), and Central Laboratory.

Study Duration: The study was carried out over a period of 1 year.

Sample Size: A total of 150 patients with confirmed COVID-19 infection were included in the study.

Inclusion Criteria

- Patients aged ≥18 years.
- Patients with confirmed COVID-19 infection by RT-PCR.
- Patients with complete hematological and clinical data.

Exclusion Criteria

- Patients with known hematological disorders (e.g., leukemia, lymphoma).
- Patients receiving chemotherapy or immunosuppressive therapy.
- Patients with incomplete medical records.

Procedure and Methodology: All patients with RT-PCR confirmed COVID-19 infection were enrolled in the study. After admission, detailed clinical history, demographic data, comorbidities, and clinical findings were recorded. Patients were categorized into severe and non-severe groups based on WHO and institutional guidelines, including clinical parameters such as respiratory rate, oxygen saturation, and need for ICU care.

Hematological parameters including hemoglobin, total leukocyte count, differential count, platelet count, absolute neutrophil count, absolute lymphocyte count, NLR, and PLR were recorded at admission. Patients were followed throughout their hospital stay to assess outcomes such as recovery, ICU admission, ventilator requirement, and mortality.

Sample Processing: Venous blood samples were collected under aseptic precautions and transferred into EDTA tubes. Samples were analyzed using an automated hematology analyzer. All parameters including complete blood count and derived indices (NLR, PLR) were calculated using standard laboratory methods.

Statistical Methods: Data were entered into Microsoft Excel and analyzed using SPSS software (version 20.0). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages.

- Independent t-test / Mann-Whitney U test was used for comparison of continuous variables.
- Chi-square test was used for categorical variables.
- Logistic regression analysis was performed to identify predictors of severity and outcome.
- A p-value < 0.05 was considered statistically significant.

Data Collection

Data were collected using a pre-designed proforma including:

- Demographic details (age, sex)
- Clinical features and comorbidities
- Hematological parameters (CBC, NLR, PLR)
- Clinical severity classification
- Outcome measures (ICU admission, ventilator support, duration of hospital stay, mortality)

All collected data were compiled, coded, and analyzed systematically to assess the predictive value of hematological parameters.

RESULTS

[Table 1] presents the baseline clinical profile of 150 COVID-19 patients and compares non-severe cases (n=96) with severe cases (n=54). The overall mean age of the study population was 49.3 ± 14.8 years. Patients in the severe group were significantly older, with a mean age of 57.2 ± 12.6 years, compared to 44.8 ± 13.1 years in the non-severe group. This difference was statistically highly significant (t = 5.63, 95% CI: 8.1 to 16.7, $p < 0.001$), indicating that advancing age was strongly associated with greater disease severity.

Male patients constituted 61.3% of the total study population. A greater proportion of males was observed in the severe group (74.1%) compared to the non-severe group (54.2%), and this association was statistically significant ($\chi^2 = 5.69$, OR 2.42, 95% CI: 1.16 to 5.06, $p = 0.017$). This suggests that male sex was associated with a higher likelihood of severe COVID-19 disease.

With regard to comorbidities, diabetes mellitus was present in 30.7% of all patients. It was significantly more common among severe cases (46.3%) than non-severe cases (21.9%) ($\chi^2 = 9.72$, OR 3.08, 95% CI: 1.49 to 6.38, $p = 0.002$). Similarly, hypertension was noted in 27.3% of patients overall, with a significantly higher prevalence in the severe group (42.6%) compared to the non-severe group (18.8%) ($\chi^2 = 9.88$, OR 3.20, 95% CI: 1.50 to 6.82, $p = 0.002$). Overall, any comorbidity was found in 46.0% of the study population, but was markedly higher in severe cases (66.7%) than in non-severe cases (34.4%), with a highly significant association ($\chi^2 = 14.58$, OR 3.81, 95% CI: 1.88 to 7.71, $p < 0.001$).

Clinical outcomes also differed substantially between the two groups. ICU admission was required in 26.0% of all patients, but the proportion was dramatically higher in the severe group (59.3%) compared to the non-severe group (7.3%). This difference was highly significant ($\chi^2 = 47.96$, OR 18.52, 95% CI: 7.22 to 47.49, $p < 0.001$). Ventilator requirement was seen in 14.0% of total cases and was far more common in severe patients (35.2%) than in non-severe patients (2.1%) ($\chi^2 = 32.94$, OR 25.59, 95% CI: 5.66 to 115.69, $p < 0.001$). Mortality was observed in 9.3% of the entire study population, with only 1.0% deaths in the non-severe group compared to 24.1% in the severe group, showing a statistically highly significant difference ($\chi^2 = 21.86$, OR 30.18, 95% CI: 3.76 to 242.19, $p < 0.001$).

The mean duration of hospital stay in the total study population was 9.8 ± 4.6 days. Severe patients had a significantly longer hospital stay (14.1 ± 4.8 days) than non-severe patients (7.4 ± 2.9 days), and this difference was statistically highly significant (t = 10.53, 95% CI: 5.4 to 8.0, $p < 0.001$).

Table 1: Baseline Clinical Profile and Disease Severity in COVID-19 Patients (n = 150)

Variable	Total (n=150)	Non-severe (n=96)	Severe (n=54)	Test of significance	95% CI	p value
Age (years), Mean ± SD	49.3 ± 14.8	44.8 ± 13.1	57.2 ± 12.6	t = 5.63	8.1 to 16.7	<0.001
Male sex, n (%)	92 (61.3)	52 (54.2)	40 (74.1)	$\chi^2 = 5.69$	OR 2.42 (1.16 to 5.06)	0.017
Diabetes mellitus, n (%)	46 (30.7)	21 (21.9)	25 (46.3)	$\chi^2 = 9.72$	OR 3.08 (1.49 to 6.38)	0.002
Hypertension, n (%)	41 (27.3)	18 (18.8)	23 (42.6)	$\chi^2 = 9.88$	OR 3.20 (1.50 to 6.82)	0.002
Any comorbidity, n (%)	69 (46.0)	33 (34.4)	36 (66.7)	$\chi^2 = 14.58$	OR 3.81 (1.88 to 7.71)	<0.001
ICU admission, n (%)	39 (26.0)	7 (7.3)	32 (59.3)	$\chi^2 = 47.96$	OR 18.52 (7.22 to 47.49)	<0.001
Ventilator requirement, n (%)	21 (14.0)	2 (2.1)	19 (35.2)	$\chi^2 = 32.94$	OR 25.59 (5.66 to 115.69)	<0.001
Mortality, n (%)	14 (9.3)	1 (1.0)	13 (24.1)	$\chi^2 = 21.86$	OR 30.18 (3.76 to 242.19)	<0.001
Hospital stay (days), Mean ± SD	9.8 ± 4.6	7.4 ± 2.9	14.1 ± 4.8	t = 10.53	5.4 to 8.0	<0.001

Table 2: Hematological Parameters in Patients Diagnosed with COVID-19 Infection (n = 150)

Hematological Parameter	Mean ± SD	Reference value	Test of significance	95% CI of mean difference	p value
Hemoglobin (g/dL)	12.1 ± 1.9	13.0	t = -5.81	-1.21 to -0.59	<0.001
Total leukocyte count (/mm³)	9,842 ± 3,216	8,000	t = 7.03	1,325 to 2,359	<0.001
Neutrophils (%)	72.8 ± 11.6	60.0	t = 13.51	10.93 to 14.67	<0.001
Lymphocytes (%)	18.7 ± 8.4	30.0	t = -16.48	-12.66 to -9.94	<0.001
Absolute neutrophil count (/mm³)	7,126 ± 2,944	4,500	t = 10.92	2,151 to 3,101	<0.001
Absolute lymphocyte count (/mm³)	1,284 ± 612	2,000	t = -14.31	-815 to -617	<0.001
Platelet count (lakhs/mm³)	2.08 ± 0.71	2.50	t = -7.24	-0.53 to -0.30	<0.001
NLR	5.92 ± 3.74	3.00	t = 9.56	2.32 to 3.52	<0.001
PLR	186.7 ± 74.5	150.0	t = 6.03	24.68 to 48.72	<0.001
CRP (mg/L)	34.8 ± 19.6	6.0	t = 18.01	25.64 to 31.96	<0.001
Serum ferritin (ng/mL)	428.6 ± 188.4	300.0	t = 8.38	98.27 to 158.93	<0.001

[Table 2] shows the hematological and inflammatory parameters of 150 COVID-19 patients in comparison with standard reference values. The mean hemoglobin level in the study population was 12.1 ± 1.9 g/dL, which was significantly lower than the reference value of 13.0 g/dL (t = -5.81, 95% CI: -1.21 to -0.59, p < 0.001). This indicates the presence of mild anemia in a considerable proportion of patients. The total leukocyte count was 9,842 ± 3,216/mm³, which was significantly higher than the reference value of 8,000/mm³ (t = 7.03, 95% CI: 1,325 to 2,359, p < 0.001), suggesting leukocytosis. Similarly, the mean neutrophil percentage was 72.8 ± 11.6%, significantly above the reference level of 60.0% (t = 13.51, 95% CI: 10.93 to 14.67, p < 0.001), indicating marked neutrophilia. In contrast, the mean lymphocyte percentage was 18.7 ± 8.4%, which was significantly lower than the normal reference of 30.0% (t = -16.48, 95% CI: -12.66 to -9.94, p < 0.001), demonstrating significant lymphopenia.

Absolute counts also reflected similar changes. The absolute neutrophil count was 7,126 ± 2,944/mm³, significantly higher than the reference value of 4,500/mm³ (t = 10.92, 95% CI: 2,151 to 3,101, p < 0.001). On the other hand, the absolute lymphocyte count was 1,284 ± 612/mm³, significantly lower than the reference value of 2,000/mm³ (t = -14.31, 95% CI: -815 to -617, p < 0.001). Platelet count was also reduced, with a mean value of 2.08 ± 0.71 lakhs/mm³ compared to the reference value of 2.50 lakhs/mm³ (t = -7.24, 95% CI: -0.53 to -0.30, p < 0.001), suggesting relative thrombocytopenia.

Among the derived inflammatory indices, the neutrophil-to-lymphocyte ratio (NLR) was 5.92 ± 3.74, significantly higher than the reference value of 3.00 (t = 9.56, 95% CI: 2.32 to 3.52, p < 0.001). Likewise, the platelet-to-lymphocyte ratio (PLR) was 186.7 ± 74.5, significantly elevated compared to the reference value of 150.0 (t = 6.03, 95% CI: 24.68 to 48.72, p < 0.001). These findings reflect increased systemic inflammation and immune dysregulation in COVID-19 patients.

Inflammatory markers were also markedly raised. The mean CRP level was 34.8 ± 19.6 mg/L, far above the reference value of 6.0 mg/L (t = 18.01, 95% CI: 25.64 to 31.96, p < 0.001). Similarly, mean serum ferritin was 428.6 ± 188.4 ng/mL, significantly higher than the reference value of 300.0 ng/mL (t = 8.38, 95% CI: 98.27 to 158.93, p < 0.001). Overall, [Table 2] demonstrates that COVID-19 patients had significant leukocytosis, neutrophilia, lymphopenia, decreased platelet count, and elevated inflammatory markers such as NLR, PLR, CRP, and ferritin, indicating a marked inflammatory state.

Table 3: Correlation of Hematological Parameters with Disease Severity (Severe vs Non-severe) (n = 150)

Parameter	Non-severe (n=96) Mean ± SD	Severe (n=54) Mean ± SD	Test of significance	95% CI of difference	p value
Hemoglobin (g/dL)	12.6 ± 1.7	11.2 ± 1.8	t = 4.73	0.81 to 1.99	<0.001
Total leukocyte count (/mm³)	8,716 ± 2,541	11,844 ± 3,412	t = 6.46	2,172 to 4,084	<0.001
Neutrophils (%)	68.4 ± 9.8	80.5 ± 9.3	t = 7.42	8.88 to 15.32	<0.001
Lymphocytes (%)	22.6 ± 7.2	11.9 ± 5.4	t = 9.42	8.45 to 12.95	<0.001
Absolute neutrophil count (/mm³)	6,114 ± 2,203	8,924 ± 3,115	t = 6.53	1,961 to 3,659	<0.001
Absolute lymphocyte count (/mm³)	1,548 ± 574	812 ± 346	t = 9.68	585 to 887	<0.001
Platelet count (lakhs/mm³)	2.26 ± 0.64	1.76 ± 0.72	t = 4.40	0.28 to 0.72	<0.001
NLR	3.94 ± 1.81	9.43 ± 3.88	t = 11.34	4.53 to 6.45	<0.001
PLR	164.8 ± 56.2	225.7 ± 82.4	t = 5.20	37.78 to 84.02	<0.001
CRP (mg/L)	24.6 ± 12.8	53.1 ± 18.4	t = 10.84	23.31 to 33.69	<0.001
Ferritin (ng/mL)	344.7 ± 121.6	577.8 ± 204.3	t = 8.50	178.91 to 287.29	<0.001

[Table 3] compares the hematological parameters between non-severe and severe COVID-19 patients. Hemoglobin levels were significantly lower in severe cases (11.2 ± 1.8 g/dL) compared to non-severe cases (12.6 ± 1.7 g/dL), with a statistically highly significant difference (t = 4.73, 95% CI: 0.81 to 1.99, p < 0.001). This suggests that lower hemoglobin levels were associated with greater disease severity.

The total leukocyte count was significantly higher in severe patients (11,844 ± 3,412/mm³) than in non-severe patients (8,716 ± 2,541/mm³) (t = 6.46, 95% CI: 2,172 to 4,084, p < 0.001), indicating more pronounced leukocytosis in severe disease. Similarly, neutrophil percentage was markedly elevated in severe cases (80.5 ± 9.3%) compared to non-severe cases (68.4 ± 9.8%) (t = 7.42, 95% CI: 8.88 to 15.32, p < 0.001). In contrast, lymphocyte percentage was significantly lower in severe cases (11.9 ± 5.4%) than in non-severe cases (22.6 ± 7.2%) (t = 9.42, 95% CI: 8.45 to 12.95, p < 0.001), demonstrating marked lymphopenia with increasing severity.

Absolute counts followed the same pattern. Absolute neutrophil count was significantly higher in severe patients (8,924 ± 3,115/mm³) compared to non-severe patients (6,114 ± 2,203/mm³) (t = 6.53, 95% CI: 1,961 to 3,659, p < 0.001). Absolute lymphocyte count was significantly reduced in severe patients (812 ± 346/mm³) compared to non-severe patients (1,548 ± 574/mm³) (t = 9.68, 95% CI: 585 to 887, p < 0.001). Platelet count was also significantly lower in the severe group (1.76 ± 0.72 lakhs/mm³) than in the non-severe group (2.26 ± 0.64 lakhs/mm³) (t = 4.40, 95% CI: 0.28 to 0.72, p < 0.001).

The derived inflammatory indices showed marked elevation with severity. NLR was 9.43 ± 3.88 in severe cases compared to 3.94 ± 1.81 in non-severe cases (t = 11.34, 95% CI: 4.53 to 6.45, p < 0.001). Likewise, PLR was significantly higher in severe

patients (225.7 ± 82.4) than in non-severe patients (164.8 ± 56.2) (t = 5.20, 95% CI: 37.78 to 84.02, p < 0.001). Inflammatory markers also showed significant increases in the severe group, with CRP levels of 53.1 ± 18.4 mg/L versus 24.6 ± 12.8 mg/L in the non-severe group (t = 10.84, 95% CI: 23.31 to 33.69, p < 0.001), and ferritin levels of 577.8 ± 204.3 ng/mL versus 344.7 ± 121.6 ng/mL (t = 8.50, 95% CI: 178.91 to 287.29, p < 0.001).

Table 4A: Association of Hematological Parameters with ICU Admission (n = 150)

Parameter	No ICU (n=111) Mean ± SD	ICU required (n=39) Mean ± SD	Test of significance	95% CI of difference	p value
Hemoglobin (g/dL)	12.4 ± 1.8	11.1 ± 1.9	t = 3.87	0.63 to 1.97	<0.001
TLC (/mm³)	8,964 ± 2,648	12,338 ± 3,591	t = 6.39	2,332 to 4,416	<0.001
ALC (/mm³)	1,446 ± 558	826 ± 392	t = 6.68	436 to 804	<0.001
Platelet count (lakhs/mm³)	2.19 ± 0.66	1.71 ± 0.73	t = 3.87	0.24 to 0.72	<0.001
NLR	4.48 ± 2.26	9.96 ± 4.01	t = 9.93	4.39 to 6.57	<0.001
PLR	170.6 ± 60.8	232.4 ± 79.3	t = 5.01	37.42 to 86.18	<0.001

In [Table 4A], patients who required ICU admission had significantly lower hemoglobin (11.1 ± 1.9 g/dL) compared to those not requiring ICU care (12.4 ± 1.8 g/dL), with a statistically significant difference (t = 3.87, 95% CI: 0.63 to 1.97, p < 0.001). Total leukocyte count was markedly higher in ICU patients (12,338 ± 3,591/mm³) than non-ICU patients (8,964 ± 2,648/mm³) (t = 6.39, 95% CI: 2,332 to 4,416, p < 0.001). Absolute lymphocyte count was significantly reduced in ICU patients (826 ± 392/mm³) compared to non-ICU patients (1,446 ± 558/mm³) (t = 6.68, 95% CI: 436 to 804, p < 0.001). Platelet count was lower, while NLR and PLR were significantly higher in ICU patients, indicating that worsening hematological derangement was strongly associated with ICU requirement.

Table 4B: Association of Hematological Parameters with Ventilator Requirement (n = 150)

Parameter	No ventilator (n=129) Mean ± SD	Ventilator required (n=21) Mean ± SD	Test of significance	95% CI of difference	p value
Hemoglobin (g/dL)	12.3 ± 1.8	10.8 ± 1.7	t = 3.56	0.67 to 2.33	<0.001
TLC (/mm³)	9,214 ± 2,941	13,701 ± 3,482	t = 6.16	3,046 to 5,928	<0.001
ALC (/mm³)	1,378 ± 566	694 ± 281	t = 5.40	434 to 934	<0.001
Platelet count (lakhs/mm³)	2.14 ± 0.69	1.62 ± 0.66	t = 3.20	0.20 to 0.84	0.002
NLR	5.11 ± 2.84	11.92 ± 4.24	t = 10.00	5.39 to 8.23	<0.001
PLR	178.4 ± 67.1	248.6 ± 86.2	t = 4.25	37.54 to 102.86	<0.001

[Table 4B] shows a similar pattern in relation to ventilator requirement. Patients who required ventilatory support had significantly lower hemoglobin (10.8 ± 1.7 g/dL) compared to those not requiring ventilation (12.3 ± 1.8 g/dL) (t = 3.56, 95% CI: 0.67 to 2.33, p < 0.001). Total leukocyte count was substantially higher in ventilated patients (13,701 ± 3,482/mm³) than in non-ventilated patients (9,214 ± 2,941/mm³) (t = 6.16, 95% CI: 3,046 to 5,928, p < 0.001). Absolute lymphocyte count was significantly lower in ventilated patients (694 ± 281/mm³) compared to non-ventilated patients (1,378 ± 566/mm³) (t = 5.40, 95% CI: 434 to 934, p < 0.001). Platelet count was also significantly reduced, whereas NLR and PLR were markedly higher in patients who required ventilator support. These findings indicate that elevated inflammatory hematological markers were strongly associated with respiratory deterioration.

Table 4C: Association of Hematological Parameters with Mortality (n = 150)

Parameter	Survivors (n=136) Mean ± SD	Non-survivors (n=14) Mean ± SD	Test of significance	95% CI of difference	p value
Hemoglobin (g/dL)	12.3 ± 1.8	10.4 ± 1.5	t = 3.94	0.98 to 2.82	<0.001
TLC (/mm³)	9,411 ± 3,004	14,026 ± 3,268	t = 5.58	2,981 to 6,249	<0.001
ALC (/mm³)	1,351 ± 574	612 ± 248	t = 4.79	434 to 1,044	<0.001
Platelet count (lakhs/mm³)	2.12 ± 0.69	1.48 ± 0.58	t = 3.44	0.27 to 1.01	0.001
NLR	5.36 ± 3.02	13.64 ± 4.12	t = 9.61	6.58 to 10.98	<0.001
PLR	181.2 ± 69.4	266.8 ± 88.1	t = 4.49	47.95 to 123.25	<0.001
CRP (mg/L)	31.9 ± 16.8	63.7 ± 18.9	t = 6.33	21.94 to 41.66	<0.001
Ferritin (ng/mL)	401.8 ± 170.6	688.9 ± 224.8	t = 6.11	194.52 to 379.68	<0.001

[Table 4C] demonstrates the relationship between hematological parameters and mortality. Non-survivors had significantly lower hemoglobin (10.4 ± 1.5 g/dL) compared to survivors (12.3 ± 1.8 g/dL) (t = 3.94, 95% CI: 0.98 to 2.82, p < 0.001). Total leukocyte count was considerably higher in non-survivors (14,026 ± 3,268/mm³) than in survivors (9,411 ± 3,004/mm³) (t = 5.58, 95% CI: 2,981 to 6,249, p < 0.001). Absolute lymphocyte count was markedly lower in non-survivors (612 ± 248/mm³)

than in survivors (1,351 ± 574/mm³) (t = 4.79, 95% CI: 434 to 1,044, p < 0.001). Platelet count was also significantly lower among non-survivors, while NLR and PLR were substantially higher. In addition, inflammatory markers such as CRP and ferritin were significantly elevated in non-survivors, with CRP at 63.7 ± 18.9 mg/L versus 31.9 ± 16.8 mg/L in survivors, and ferritin at 688.9 ± 224.8 ng/mL versus 401.8 ± 170.6 ng/mL, both with p < 0.001.

DISCUSSION

[Table 1] Baseline Clinical Profile and Disease Severity in COVID-19 Patients

In the present study, severe COVID-19 patients were significantly older than non-severe patients (57.2 ± 12.6 vs 44.8 ± 13.1 years, p < 0.001), indicating that advancing age was strongly associated with greater disease severity. A similar observation was reported by Awoke et al. (2023),[1] who found that disease severity increased with age and was associated with hematological variations, and by Tjendra et al. (2020),[2] who demonstrated that older age was one of the strongest risk factors for poor outcomes in COVID-19 patients. These findings support the present study and suggest that immunosenescence and increased comorbidity burden contribute significantly to disease progression.

Male predominance was observed in the present study, particularly in the severe group (74.1% vs 54.2%, p = 0.017). This is in agreement with Awale et al. (2022),[3] who reported a higher proportion of males among hospitalized COVID-19 patients, and Tjendra et al. (2020),[2] who also noted worse outcomes among men. The higher severity among males may be attributed to differences in immune response, hormonal influence, and comorbidity profiles.

Comorbid conditions such as diabetes mellitus and hypertension were significantly more frequent in severe patients in the present study. This finding is consistent with Taj et al. (2021),[4] who reported that underlying comorbidities significantly influence disease severity and progression. The significantly higher rate of overall comorbidity in severe cases further reinforces that pre-existing systemic conditions amplify inflammatory responses and worsen prognosis.

The outcome measures in the present study also showed significantly higher ICU admission, ventilator requirement, mortality, and longer hospital stay in severe patients. These findings are comparable with Awoke et al. (2023),[1] who reported that severe cases required intensive care and had worse outcomes, and Tjendra et al. (2020),[2] who described similar progression patterns in critically ill patients. Thus, Table 1 confirms that age, male sex, and comorbidities are important determinants of adverse outcomes.

[Table 2] Hematological Parameters in Patients Diagnosed with COVID-19 Infection

The present study demonstrated significant hematological alterations including leukocytosis, neutrophilia, lymphopenia, thrombocytopenia, and elevated NLR, PLR, CRP, and ferritin. These findings are in agreement with Alamin et al. (2021),[5] who identified lymphopenia as a common laboratory abnormality in COVID-19, and Waris et al. (2021),[6] who reported that hematological changes reflect disease severity and systemic inflammation.

The significant lymphopenia observed in the present study is strongly supported by Szklanna et al. (2021),[7] who demonstrated that lymphopenia is associated with severe disease, and Tjendra et al. (2020),[2] who emphasized lymphocyte count as an important prognostic indicator. The reduced lymphocyte count observed in the present study highlights immune suppression as a key feature of COVID-19.

The presence of thrombocytopenia and elevated leukocyte and neutrophil counts in the present study is consistent with Alamin et al. (2021),[5] who reported that these parameters are associated with disease progression. Neutrophilia reflects an exaggerated inflammatory response, while thrombocytopenia may result from platelet consumption and endothelial damage.

Elevated NLR and PLR in the present study are comparable with findings of Waris et al. (2021),[6] and Szklanna et al. (2021),[7] who demonstrated that these indices are strong predictors of disease severity. Similarly, elevated CRP and ferritin levels in the present study are in agreement with Alizad et al. (2023),[8] and Liang et al. (2021),[9] both of whom reported strong associations between inflammatory markers and disease severity. Thus, Table 2 confirms that hematological and inflammatory markers are reliable indicators of systemic inflammation in COVID-19.

[Table 3] Correlation of Hematological Parameters with Disease Severity (Severe vs Non-severe)

The present study showed that severe COVID-19 patients had significantly lower hemoglobin, lymphocyte count, and platelet count, along with significantly higher TLC, neutrophils, NLR, PLR, CRP, and ferritin. These findings are consistent with Awoke et al. (2023),[1] who reported similar hematological derangements in severe cases, and Tjendra et al. (2020),[2] who highlighted the role of inflammatory markers in predicting severity.

Marked lymphopenia in severe cases in the present study is supported by Taj et al. (2021),[4] who demonstrated its association with poor outcomes, and Tjendra et al. (2020),[2] who emphasized its predictive value. The findings reinforce that lymphocyte depletion is a hallmark of severe COVID-19.

The significantly lower platelet count in severe cases aligns with findings of Alamin et al. (2021),[5] suggesting platelet consumption and coagulopathy in severe disease. Elevated NLR and PLR in severe patients are consistent with Waris et al. (2021),[6] and

Szklanna et al. (2021),[7] confirming their role as markers of severity.

Elevated CRP and ferritin levels in severe patients are in agreement with Liang et al. (2021),[9] indicating hyperinflammation and cytokine storm. Thus, [Table 3] strongly supports the role of hematological parameters in differentiating severe from non-severe disease.

[Table 4A, 4B, and 4C] Association of Hematological Parameters with ICU Admission, Ventilator Requirement, and Mortality

In the present study, patients requiring ICU admission showed significantly lower hemoglobin, lymphocyte count, and platelet count, along with higher TLC, NLR, and PLR. These findings are comparable with Ok et al. (2021),[10] who reported that hematological parameters are useful predictors of ICU requirement, and Asghar et al. (2020),[11] who demonstrated that elevated NLR predicts severe disease and need for critical care.

Similarly, patients requiring ventilator support had significantly deranged hematological parameters, which is consistent with Al-Saadi et al. (2022),[12] who reported that hematological changes correlate with respiratory deterioration, and Alizad et al. (2023),[8] who found CRP to be a strong predictor of severe progression.

Mortality analysis in the present study revealed that non-survivors had significantly lower hemoglobin, lymphocyte count, and platelet count, and markedly higher TLC, NLR, PLR, CRP, and ferritin. These findings are consistent with Tjendra et al. (2020),[2] who reported elevated inflammatory markers in non-survivors, and Waris et al. (2021),[6] who confirmed NLR as a predictor of mortality. Additionally, Liang et al. (2021),[9] and Alizad et al. (2023),[8] also reported strong associations of ferritin and CRP with mortality.

CONCLUSION

The present prospective observational study highlights the significant role of hematological parameters as reliable predictors of disease severity and clinical outcomes in COVID-19 patients. The findings demonstrated that advancing age, male gender, and the presence of comorbidities such as diabetes mellitus and hypertension were strongly associated with severe disease and adverse outcomes. Severe COVID-19 patients exhibited a markedly higher requirement for ICU admission, ventilatory support, prolonged hospital stay, and increased mortality, emphasizing the importance of early risk stratification.

Hematological analysis revealed that COVID-19 infection is characterized by a distinct pattern of laboratory abnormalities, including leukocytosis, neutrophilia, lymphopenia, and thrombocytopenia. Among these, lymphopenia emerged as a consistent and significant marker associated with disease severity and poor prognosis. The study also demonstrated that derived inflammatory indices such as neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were significantly elevated in severe cases and in patients with adverse outcomes, including ICU admission, ventilator requirement, and mortality. These indices reflect the imbalance between inflammatory response and immune regulation and serve as simple, cost-effective tools for clinical assessment.

Furthermore, inflammatory biomarkers such as C-reactive protein (CRP) and serum ferritin were significantly elevated in severe cases and non-survivors, indicating a hyperinflammatory state contributing to disease progression. The strong association between these parameters and clinical outcomes underscores their prognostic value.

Limitations of the study

1. The study was conducted in a single tertiary care center, limiting the generalizability of the findings.
2. The sample size of 150 patients, although adequate, may not represent the entire population.
3. Being a prospective observational study, causal relationships could not be definitively established.
4. Only baseline hematological parameters were assessed; serial monitoring was not uniformly performed.
5. The influence of treatment modalities on hematological parameters and outcomes was not evaluated.
6. Other important inflammatory markers such as IL-6 and D-dimer were not included in the study.
7. Potential confounding factors such as nutritional status and severity of comorbidities were not fully adjusted.
8. Variability in timing of sample collection during the disease course may have affected results.

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