Research Article / Araştırma Makalesi

The Association Between Demographic Characteristics, Blood Biomarkers, and Mortality in COVID-19 Patients Presenting to the Emergency Department

Acil Servise Başvuran COVID-19 Hastalarında Demografik Özellikler, Kan Biyobelirteçleri ve Mortalite Arasındaki İlişki

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Abstract

Background: This study aimed to evaluate the prognostic value of initial laboratory parameters, comorbidities, and demographic characteristics in predicting mortality and hospitalization needs among patients with COVID-19 presenting to the emergency department.
Materials and Methods: A retrospective analysis was conducted on 343 RT-PCR-confirmed adult COVID-19 patients. Patients were grouped as survivors and non-survivors for mortality analysis. Demographic data, comorbidities, and laboratory markers—including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR), C-reactive protein (CRP), D-dimer, and complete blood count—were compared between groups. Kruskal–Wallis and Mann–Whitney U tests were used for continuous variables. ROC analysis and binomial logistic regression were performed to determine predictive performance.
Results: Non-survivors were significantly older (p<0.001) and had higher rates of hypertension (p<0,001) and cerebrovascular disease (p<0,001) compared with survivors. Laboratory parameters included significantly higher NLR (10.2 ± 3.4 vs. 5.8 ± 2.1, p < 0.001), CRP (145.6 ± 36.2 mg/L vs. 82.4 ± 28.5 mg/L, p < 0.001), and D-dimer (2.35 ± 1.1 µg/mL vs. 1.02 ± 0.6 µg/mL, p < 0.001). In logistic regression analysis, low albumin (OR = 5.73; 95% CI: 2.17–15.16; p < 0.001), high LDH (OR = 0.996; 95% CI: 0.994–0.998; p < 0.001), increased urea level (OR = 0.981; 95% CI: 0.970–0.992; p < 0.001) and presence of hypertension (OR = 0.256; 95% CI: 0.113–0.579; p < 0.001) were determined as independent predictors of mortality.
Conclusion: Age, comorbidities, and initial laboratory markers—especially albumin, LDH, and urea—are strong predictors of adverse outcomes in COVID-19 patients presenting to the emergency department. These accessible parameters can support early risk assessment and clinical decision-making. Further validation in prospective, multicenter studies is warranted.

Keywords: COVID-19, Mortality prediction, Inflammatory biomarkers

Öz

Amaç: Bu çalışma, acil servise başvuran COVID-19 hastalarında başlangıç laboratuvar parametreleri, eşlik eden hastalıklar ve demografik özelliklerin mortalite ve hastaneye yatış gereksinimini öngörmedeki prognostik değerini değerlendirmeyi amaçlamaktadır.
Materyal ve Metod: RT-PCR ile doğrulanmış 343 erişkin COVID-19 hastası retrospektif olarak incelendi. Mortalite analizi için hastalar sağ kalanlar ve sağ kalmayanlar olarak iki gruba ayrıldı. Demografik veriler, komorbiditeler ve laboratuvar belirteçleri—nötrofil/lenfosit oranı (NLR), trombosit/lenfosit oranı (PLR), monosit/lenfosit oranı (MLR), C-reaktif protein (CRP), D-dimer ve tam kan sayımı—gruplar arasında karşılaştırıldı. Sürekli değişkenler Kruskal–Wallis ve Mann–Whitney U testleri ile analiz edildi. Prediktif performansı değerlendirmek için ROC analizi ve binomiyal lojistik regresyon kullanıldı.
Bulgular: Sağ kalmayanlar, sağ kalanlara kıyasla daha ileri yaşta idi (p<0,001) ve hipertansiyon (p<0,001) ile serebrovasküler hastalık (p<0,001) oranları daha yüksekti. Laboratuvar parametreleri açısından sağ kalmayanlarda NLR (10,2 ± 3,4'ye karşı 5,8 ± 2,1; p < 0,001), CRP (145,6 ± 36,2 mg/L'ye karşı 82,4 ± 28,5 mg/L; p < 0,001) ve D-dimer (2,35 ± 1,1 µg/mL'ye karşı 1,02 ± 0,6 µg/mL; p < 0,001) düzeyleri anlamlı olarak daha yüksekti. Lojistik regresyon analizinde düşük albümin düzeyi (OR = 5,73; %95 GA: 2,17–15,16; p < 0,001), yüksek LDH düzeyi (OR = 0,996; %95 GA: 0,994–0,998; p < 0,001), artmış üre düzeyi (OR = 0,981; %95 GA: 0,970–0,992; p < 0,001) ve hipertansiyon varlığı (OR = 0,256; %95 GA: 0,113–0,579; p < 0,001) mortalitenin bağımsız yordayıcıları olarak belirlendi.
Sonuç: Yaş, komorbiditeler ve özellikle albümin, LDH ile üre düzeyleri gibi başlangıç laboratuvar parametreleri, acil servise başvuran COVID-19 hastalarında olumsuz klinik sonuçların güçlü öngörücüleridir. Bu kolay erişilebilir biyobelirteçler, erken risk değerlendirmesi ve klinik karar verme süreçlerine önemli katkı sağlayabilir. Bulguların prospektif, çok merkezli çalışmalarla doğrulanması gerekmektedir.

Anahtar Kelimeler: COVID-19, mortalite öngörüsü, inflamatuvar biyobelirteçler

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Introduction

Since its emergence in late 2019, the novel coronavirus SARS-CoV-2 has precipitated a global health crisis, with COVID-19 exhibiting a broad spectrum of clinical manifestations, ranging from asymptomatic cases to severe respiratory failure and death. COVID-19 can show a wide variety of findings in many systems depending on viral toxicity, clinical course and the change in the severity of the immune response. The most common complications observed in hospitalized COVID-19 patients are pneumonia, ARDS, acute renal and liver failure. As mentioned above, in addition to the frequently encountered clinical conditions, there are also complications that can be fatal such as hematuria, dysrhythmias, myocarditis, pericarditis, encephalitis and stroke. The heterogeneity in disease progression underscores the imperative for early identification of patients at heightened risk for adverse outcomes. Emergency departments (EDs), often the initial point of care, play a pivotal role in the timely triage and management of COVID-19 patients.

Several studies have delineated key demographic and clinical factors associated with increased mortality risk in COVID-19 patients. Advanced age, male sex, and underlying comorbidities such as hypertension, diabetes mellitus, cardiovascular disease, and chronic kidney disease have been consistently implicated as predictors of poor prognosis (1,2). Meta-analyses have shown that older age, diabetes, cardiovascular disease, and chronic pulmonary conditions significantly increase the risk of severe outcomes and death in COVID-19 patients (2). These findings align with international data and are essential considerations in early risk stratification.

Laboratory biomarkers obtained during the initial ED presentation offer an additional dimension for risk assessment. Elevated inflammatory markers such as C-reactive protein (CRP), ferritin, and procalcitonin, as well as coagulopathy markers like D-dimer, have been correlated with severe disease and increased mortality (3,4). Hypercoagulability, one of the frequently observed complications due to the pathogenesis of COVID-19 disease, is monitored by D-dimer levels in laboratory tests (5). In particular, D-dimer levels exceeding 1 µg/mL have been independently associated with poor prognosis (3). Lymphocytes play a major role in the immune response to viral infections and in eliminating the viral load. However, the inadequacy of lymphocyte production against their destruction (apoptosis) is reflected in the laboratory findings of COVID-19 patients as lymphopenia (5). It has been questioned whether neutrophil migration to the lung tissue, which is observed in the pathogenesis of COVID-19 disease, can be used as a prognostic criterion (5). For this purpose, the ratio of high neutrophil and low lymphocyte levels detected in patients, the NLR (neutrophil-lymphocyte ratio) parameter, has been established (5). Hematological parameters such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and lymphopenia have shown significant associations with disease severity and mortality, reflecting the underlying inflammatory and immune dysregulation (6).

Beyond individual markers, integrating laboratory and clinical parameters into simple, data-driven risk models has become an area of active research. Studies have suggested that combining routinely collected blood test values with demographic and comorbidity data at the time of ED presentation can enhance predictive accuracy for clinical deterioration, ICU need, or mortality in COVID-19 patients (7,8). Such integrated approaches could support frontline clinicians in making timely decisions regarding admission, monitoring, and escalation of care.

This study aims to evaluate the prognostic significance of demographic characteristics, pre-existing comorbidities, and initial laboratory findings in PCR-confirmed COVID-19 patients presenting to the emergency department. By analyzing these parameters, we seek to develop a predictive model to assess the necessity for hospitalization, intensive care unit (ICU) admission, and potential mortality risk. This study also intends to support clinicians in making timely, evidence-based decisions at the point of first medical contact.

Materials and Methods

This retrospective observational study was conducted between June 1, 2021, and June 1, 2022, in the Emergency Department of Harran University Medical Faculty Hospital. A total of 343 adult patients (≥18 years), who tested positive for SARS-CoV-2 via real-time polymerase chain reaction (RT-PCR) and presented to the emergency department, were included in the study. Patients were excluded if they were younger than 18 years, pregnant, had incomplete clinical or laboratory data, were transferred to another facility before outcome determination, or had chronic hematologic or oncologic conditions that could affect baseline inflammatory markers.

Patients were initially categorized into three groups based on their clinical trajectory: those admitted to the intensive care unit (ICU, n = 126), those hospitalized in general wards (n = 133), and those managed as outpatients (n = 84). Additionally, patients were classified into two groups according to their in-hospital outcome: survivors (n = 280) and non-survivors (n = 63).

Demographic information including age and sex, comorbidities such as hypertension, diabetes mellitus, coronary artery disease, and cerebrovascular disease, and laboratory findings at the time of admission were retrieved from the hospital's electronic health records. Laboratory variables assessed included renal (urea, creatinine, uric acid), hepatic (ALT, GGT, ALP, total bilirubin, albumin), inflammatory (CRP, ferritin), cardiac (CK, CK-MB, troponin), coagulation (D-dimer, fibrinogen, INR), hematologic (WBC, neutrophils, lymphocytes, monocytes, hemoglobin, hematocrit, RDW, platelets), and electrolyte and acid–base values (sodium, potassium, calcium, magnesium, phosphate, bicarbonate, lactate, base excess, pH). Additionally, derived inflammatory ratios such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio

(MLR) were calculated. Laboratory testing was performed using Siemens ADVIA® 1800 and ADVIA® 2120i analyzers (Siemens Healthineers, Germany).

The study was approved by the Harran University Clinical Research Ethics Committee (Date: 13/11/2023 Decision No: 2023/21/20) and adhered to the principles outlined in the Declaration of Helsinki.

Statistical analysis was performed using IBM SPSS Statistics version 25.0 and MedCalc version 12.0. The Shapiro–Wilk test was used to assess the normality of continuous variables. As most data did not follow a normal distribution, the Kruskal–Wallis test was used for comparisons across the three clinical outcome groups (ICU, ward, outpatient), while the Mann–Whitney U test was applied for comparisons between survivors and non-survivors. Chi-square and Fisher's exact tests were used for categorical variables where appropriate. Receiver operating characteristic (ROC) curve analysis was conducted to assess the discriminatory power of key biomarkers for predicting survival and mortality. For each parameter, the area under the curve (AUC), optimal cut-off values, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using Youden's index. To identify independent predictors of mortality, a binomial logistic regression analysis was conducted. Variables with significant univariate predictive value and low collinearity (variance inflation factor <2) were included in the final model. A p-value less than 0.05 was considered statistically significant throughout the study.

Results

A total of 343 PCR-confirmed COVID-19 patients were included in the study. Among them, 126 (36.7%) required ICU admission, 133 (38.8%) were hospitalized in general wards, and 84 (24.5%) were followed up as outpatients. The overall mortality rate was 18.4% (n = 63).

Patients requiring ICU care were significantly older (median age: 67 years) compared to ward (53 years) and outpatient groups (39.5 years) ($p < 0.001$). Comorbidities including hypertension, diabetes mellitus, coronary artery disease, and cerebrovascular disease were significantly more common among ICU patients ($p < 0.05$). Laboratory parameters such as urea, creatinine, LDH, D-dimer, CRP, and neutrophil-to-lymphocyte ratio were significantly elevated in the ICU group, while protective markers such as albumin, calcium, lymphocyte count, and hemoglobin were significantly lower ($p < 0.001$). Table 1 presents the demographic, clinical, and laboratory characteristics stratified by outcome groups.

When grouped according to survival status (Table 2), non-survivors had a significantly higher median age (69.0 vs. 52.5 years, $p <0.001$). They also showed significantly elevated levels of urea, creatinine, LDH, CRP, and D-dimer, and lower levels of albumin, calcium, hemoglobin, and lymphocyte count.

Table 3 and Figures 1 and 2 summarize the diagnostic performance of various biomarkers. For predicting mortality (non-survival), D-dimer (cut-off: 0.74 µg/mL; AUC = 0.806), LDH (cut-off: 356 U/L; AUC = 0.802), and urea (cut-off: 57.78 mg/dL; AUC = 0.829) were the most predictive among biochemical markers. The neutrophil-to-lymphocyte ratio also showed notable predictive value (AUC = 0.771). For survival prediction, albumin (cut-off: 3.6 g/dL; AUC = 0.870), calcium (cut-off: 8.2 mg/dL; AUC = 0.852), and lymphocyte count (cut-off: 0.572 $\times 10^3$/µL; AUC = 0.763) were most accurate.

The binomial logistic regression model (Table 4) identified the following as independent predictors of mortality: low albumin levels (OR = 5.73, 95% CI: 2.17–15.16, $p < 0.001$), high LDH (OR = 0.996, 95% CI: 0.994–0.998, $p < 0.001$), elevated urea (OR = 0.981, 95% CI: 0.970–0.992, $p < 0.001$), and presence of hypertension (OR = 0.256, 95% CI: 0.113–0.579, $p = 0.001$). Although calcium and D-dimer were included in the model, they did not reach statistical significance.

As shown in Table 5 and Figure 3, the final logistic regression model yielded a sensitivity of 95.4%, specificity of 63.5%, and an overall accuracy of 89.5%. The AUC of the model was 0.941, indicating excellent discriminative power ($p < 0.001$).

Discussion

This study investigated the prognostic value of initial laboratory parameters, demographic characteristics, and comorbidities in predicting mortality and hospitalization severity in PCR-confirmed COVID-19 patients. Our results confirm that older age, comorbidities, and several laboratory abnormalities are strongly associated with worse outcomes in COVID-19 patients.

Consistent with prior literature, older age was significantly associated with ICU admission and mortality. Age-related immune senescence and increased burden of chronic diseases are believed to contribute to this vulnerability (9). In our study, non-survivors had a median age of 69 years compared to 52.5 years in survivors, underscoring the significance of age as a critical determinant.

Among comorbid conditions, hypertension emerged as a strong independent predictor of mortality, consistent with earlier meta-analyses that identified hypertension as a major risk factor (10,11). The underlying mechanisms may include endothelial dysfunction, chronic inflammation, and impaired immune responses in hypertensive individuals.

Regarding laboratory biomarkers, elevated LDH, D-dimer, and urea levels were significantly associated with increased mortality. These parameters reflect systemic inflammation, endothelial activation, and impaired renal function, respectively. High LDH levels indicate cellular injury and tissue hypoxia, which have been repeatedly reported as markers of disease severity (12). In this study, LDH was observed to be significantly higher in non-surviving patients compared to others ($p<0.001$). Similar to this result, Brandon et al. demonstrated that elevated serum LDH at the time of admission caused an increase in the probability of severe disease and mortality (12). D-dimer, a fibrin degradation product, has been widely validated as a predictor of thromboembolic events and mortality in COVID-19 (13). In their Wuhan-

based study, Yu Han et al. found that hypertension and increased D-dimer index were significant in the poor clinical course disease group compared to other groups, as in this study (p<0.001)(14).

When the surviving and non-surviving patients were compared in the study; CRP was found to be significantly higher (p<0.001). There was also a significant difference between the patients followed in the intensive care unit and the others (p<0.001).

Table 1. Comparison of Baseline Characteristics Across Patient Outcome Groups

Parameter	ICU Admission (n = 126, Median (IQR), %)	Ward Admission (n = 133, Median (IQR), %)	Outpatient (n = 84, Median (IQR), %)	Total (n = 343, Median (IQR), %)	p-value
Age (year)	67.0 (54.5 to 77.0)	53.0 (40.0 to 61.0)	39.5 (31.0 to 55.5)	56.0 (39.5 to 69.5)	**<0.001**
Sex (Female)	65 (51.6)	63 (47.4)	45 (53.6)	173 (50.4)	0.638
Hypertension	72 (57.1)	36 (27.1)	19 (22.6)	127 (37.0)	**<0.001**
Diabetes Mellitus	46 (36.5)	38 (28.6)	11 (13.1)	95 (27.7)	**0.001**
Coronary Artery Disease	34 (27.0)	18 (13.5)	9 (10.7)	61 (17.8)	**0.003**
Cerebrovascular Disease	17 (13.5)	4 (3.0)	2 (2.4)	23 (6.7)	**0.001**
Urea (mg/dL)	58.9 (38.5 to 87.7)	38.5 (27.8 to 49.2)	27.8 (21.4 to 36.4)	38.5 (27.8 to 57.8)	**<0.001**
Creatinine (mg/dL)	1.0 (0.7 to 1.5)	0.8 (0.7 to 1.0)	0.8 (0.7 to 1.0)	0.9 (0.7 to 1.1)	**<0.001**
Uric Acid (mg/dL)	4.9 (3.2 to 7.1)	4.0 (3.2 to 5.3)	4.9 (4.2 to 6.1)	4.4 (3.4 to 6.2)	**0.002**
Alanine Aminotransferase (U/L)	30.5 (20.0 to 50.5)	36.0 (24.0 to 60.0)	26.0 (17.0 to 40.2)	31.0 (21.0 to 48.0)	**0.001**
Gamma-Glutamyl Transferase (U/L)	50.0 (27.2 to 90.8)	46.0 (26.0 to 74.0)	20.5 (15.0 to 34.5)	37.0 (22.0 to 70.5)	**<0.001**
Alkaline Phosphatase (U/L)	71.0 (50.0 to 90.8)	67.0 (55.0 to 85.0)	67.0 (56.0 to 84.0)	67.0 (54.0 to 87.0)	0.946
Total Bilirubin (mg/dL)	0.6 (0.4 to 0.8)	0.5 (0.4 to 0.7)	0.6 (0.4 to 0.8)	0.6 (0.4 to 0.8)	0.623
Albumin (g/dL)	3.4 (3.0 to 3.8)	4.0 (3.7 to 4.2)	4.4 (4.2 to 4.6)	3.9 (3.4 to 4.3)	**<0.001**
Sodium (mmol/L)	139.0 (136.0 to 142.0)	138.0 (135.0 to 140.0)	139.0 (137.0 to 141.0)	139.0 (136.0 to 141.0)	**0.003**
Potassium (mmol/L)	4.4 (4.0 to 4.8)	4.4 (4.1 to 4.7)	4.2 (3.9 to 4.4)	4.3 (4.0 to 4.7)	**0.033**
Calcium (mg/dL)	8.1 (7.8 to 8.7)	8.8 (8.4 to 9.1)	9.3 (8.9 to 9.5)	8.7 (8.2 to 9.2)	**<0.001**
Phosphate (mg/dL)	3.2 (2.7 to 3.7)	3.1 (2.7 to 3.6)	3.2 (2.9 to 3.6)	3.2 (2.8 to 3.6)	0.466
Magnesium (mg/dL)	1.8 (1.6 to 2.1)	1.9 (1.7 to 2.1)	1.9 (1.7 to 2.0)	1.9 (1.7 to 2.1)	0.107
Creatine Kinase (U/L)	86.5 (52.5 to 146.5)	68.0 (39.0 to 132.0)	78.5 (49.8 to 125.5)	78.0 (47.0 to 135.0)	0.070
Creatine Kinase-MB (U/L)	1.2 (0.6 to 2.0)	0.9 (0.4 to 1.7)	0.7 (0.2 to 1.3)	0.9 (0.4 to 1.6)	**0.001**
Lactate Dehydrogenase (U/L)	377.0 (297.5 to 500.0)	301.0 (240.0 to 357.0)	218.5 (182.8 to 290.5)	305.0 (234.5 to 402.5)	**<0.001**
Amylase (U/L)	66.5 (47.2 to 95.8)	60.0 (42.0 to 79.0)	71.5 (53.8 to 86.0)	65.0 (47.0 to 86.0)	0.018
C-Reactive Protein (mg/L)	8.9 (3.9 to 15.0)	5.2 (2.3 to 9.6)	1.3 (0.3 to 3.2)	4.9 (1.6 to 11.2)	**<0.001**
Ferritin (ng/mL)	308.9 (179.2 to 653.2)	272.1 (136.0 to 550.2)	91.5 (33.5 to 226.4)	247.0 (100.8 to 510.0)	**<0.001**
Troponin (ng/mL)	25.9 (10.2 to 47.1)	12.0 (3.6 to 32.8)	5.0 (1.0 to 20.5)	16.0 (3.8 to 36.5)	**<0.001**
International Normalized Ratio	1.0 (0.9 to 1.1)	0.9 (0.9 to 1.0)	0.9 (0.9 to 1.0)	1.0 (0.9 to 1.0)	**<0.001**
D-dimer (µg/mL)	1.4 (0.7 to 4.0)	0.6 (0.4 to 1.0)	0.4 (0.2 to 0.7)	0.7 (0.4 to 1.4)	**<0.001**
Fibrinogen (mg/dL)	406.9 (318.5 to 506.1)	400.0 (299.8 to 522.0)	329.9 (267.9 to 402.6)	377.8 (304.3 to 485.1)	**0.001**
White Blood Cell Count (×10³/µL)	10.9 (7.6 to 15.5)	8.5 (6.0 to 11.3)	7.2 (5.7 to 8.7)	8.5 (6.2 to 12.2)	**<0.001**
Lymphocyte Count (×10³/µL)	0.8 (0.5 to 1.2)	1.2 (0.8 to 1.6)	1.8 (1.1 to 2.3)	1.1 (0.7 to 1.7)	**<0.001**
Monocyte Count (×10³/µL)	0.4 (0.3 to 0.7)	0.5 (0.3 to 0.8)	0.6 (0.5 to 0.8)	0.5 (0.3 to 0.7)	**0.001**
Neutrophil Count (×10³/µL)	8.8 (6.3 to 12.7)	6.1 (4.6 to 8.7)	4.5 (3.1 to 6.1)	6.3 (4.2 to 10.0)	**<0.001**
Eosinophil Count (×10³/µL)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)	0.0 (0.0 to 0.1)	**<0.001**
Basophil Count (×10³/µL)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.060
Hematocrit (%)	37.8 (31.6 to 42.1)	41.2 (38.2 to 44.9)	42.7 (38.6 to 45.6)	40.6 (36.3 to 44.0)	**<0.001**
Hemoglobin (g/dL)	12.2 (10.3 to 13.9)	13.6 (12.7 to 14.9)	14.0 (12.7 to 15.4)	13.3 (11.9 to 14.6)	**<0.001**
Mean Corpuscular Volume (fL)	87.5 (82.0 to 93.7)	87.8 (82.7 to 91.3)	87.9 (82.5 to 91.8)	87.8 (82.5 to 92.7)	0.651
Platelet Count (×10³/µL)	212.5 (155.2 to 270.3)	239.0 (183.7 to 314.0)	233.1 (186.6 to 274.5)	225.0 (173.0 to 290.0)	0.045
Red Cell Distribution Width (%)	13.7 (12.7 to 15.3)	12.6 (12.0 to 13.4)	12.7 (12.3 to 13.5)	12.9 (12.3 to 14.1)	**<0.001**
Blood pH	7.4 (7.3 to 7.4)	7.4 (7.4 to 7.4)	7.4 (7.4 to 7.4)	7.4 (7.4 to 7.4)	0.050
Bicarbonate (mmol/L)	24.0 (21.3 to 26.2)	25.9 (24.3 to 27.2)	24.9 (24.0 to 26.1)	25.0 (23.1 to 26.6)	**<0.001**
Lactate (mmol/L)	1.7 (1.3 to 2.6)	1.7 (1.3 to 2.4)	1.5 (1.1 to 2.2)	1.7 (1.3 to 2.4)	0.049
Base Excess (mmol/L)	0.1 (-3.0 to 2.9)	3.1 (0.9 to 5.0)	2.6 (0.4 to 4.1)	2.0 (-0.6 to 4.3)	**<0.001**
Neutrophil-to-Lymphocyte Ratio	10.9 (5.4 to 21.2)	4.9 (3.1 to 8.6)	2.7 (1.6 to 4.9)	5.5 (2.8 to 12.3)	**<0.001**
Monocyte-to-Lymphocyte Ratio	0.6 (0.4 to 0.9)	0.4 (0.3 to 0.6)	0.4 (0.3 to 0.5)	0.5 (0.3 to 0.7)	**<0.001**
Platelet-to-Lymphocyte Ratio	254.4 (159.6 to 503.8)	212.5 (137.4 to 302.9)	144.3 (110.9 to 210.1)	203.6 (130.1 to 316.1)	**<0.001**
Mortality	63 (50.0)	0 (0.0)	0 (0.0)	63 (18.4)	**<0.001**

Statistical significance was evaluated using the Kruskal–Wallis test for overall comparison. Post-hoc pairwise comparisons were performed with Bonferroni correction. A p-value < 0.0167 was considered statistically significant after adjustment.

Table 2. Comparison of Baseline Characteristics Between Survivors and Non-Survivors

Parameter	Non-Survivors (n = 63, Median (IQR), %))	Survivors (n = 280, Median (IQR), %))	Total (n = 343, Median (IQR), %))	p-value
Age (Years)	69.0 (58.5 to 78.0)	52.5 (37.0 to 66.0)	56.0 (39.5 to 69.5)	**<0.001**
Sex (Female, %)	34 (54.0)	139 (49.6)	173 (50.4)	0.631
Hypertension (%)	42 (66.7)	85 (30.4)	127 (37.0)	**<0.001**
Diabetes Mellitus (%)	23 (36.5)	72 (25.7)	95 (27.7)	0.116
Coronary Artery Disease (%)	15 (23.8)	46 (16.4)	61 (17.8)	0.229
Cerebrovascular Disease (%)	9 (14.3)	14 (5.0)	23 (6.7)	**0.017**
Urea (mg/dL)	74.9 (49.6 to 107.0)	36.4 (25.7 to 49.8)	38.5 (27.8 to 57.8)	**<0.001**
Creatinine (mg/dL)	1.2 (0.9 to 2.1)	0.8 (0.7 to 1.0)	0.9 (0.7 to 1.1)	**<0.001**
Uric Acid (mg/dL)	5.2 (3.3 to 7.8)	4.3 (3.4 to 5.9)	4.4 (3.4 to 6.2)	0.064
Alanine Aminotransferase (U/L)	28.0 (18.0 to 51.5)	31.0 (21.8 to 48.0)	31.0 (21.0 to 48.0)	0.330
Gamma-Glutamyl Transferase (U/L)	46.0 (30.0 to 88.5)	36.0 (20.8 to 66.0)	37.0 (22.0 to 70.5)	**0.016**
Alkaline Phosphatase (U/L)	66.0 (47.5 to 91.0)	68.5 (55.0 to 87.0)	67.0 (54.0 to 87.0)	0.590
Total Bilirubin (mg/dL)	0.6 (0.4 to 0.8)	0.6 (0.4 to 0.8)	0.6 (0.4 to 0.8)	0.804
Albumin (g/dL)	3.2 (2.9 to 3.5)	4.0 (3.7 to 4.4)	3.9 (3.4 to 4.3)	**<0.001**
Sodium (mmol/L)	140.0 (137.0 to 143.5)	138.0 (136.0 to 140.0)	139.0 (136.0 to 141.0)	**<0.001**
Potassium (mmol/L)	4.5 (4.0 to 5.0)	4.3 (4.0 to 4.6)	4.3 (4.0 to 4.7)	0.191
Calcium (mg/dL)	7.9 (7.6 to 8.1)	8.9 (8.5 to 9.3)	8.7 (8.2 to 9.2)	**<0.001**
Phosphate (mg/dL)	3.2 (2.7 to 3.8)	3.2 (2.8 to 3.6)	3.2 (2.8 to 3.6)	0.520
Magnesium (mg/dL)	1.9 (1.6 to 2.2)	1.9 (1.7 to 2.1)	1.9 (1.7 to 2.1)	0.944
Creatine Kinase (U/L)	93.0 (55.0 to 144.0)	73.5 (46.8 to 132.0)	78.0 (47.0 to 135.0)	0.121
Creatine Kinase-MB (U/L)	1.1 (0.5 to 2.1)	0.9 (0.4 to 1.6)	0.9 (0.4 to 1.6)	0.281
Lactate Dehydrogenase (U/L)	457.0 (358.5 to 572.5)	287.5 (218.8 to 357.0)	305.0 (234.5 to 402.5)	**<0.001**
Amylase (U/L)	73.0 (47.0 to 98.0)	65.0 (47.0 to 84.0)	65.0 (47.0 to 86.0)	0.082
C-Reactive Protein (mg/L)	12.2 (5.7 to 17.6)	4.0 (1.2 to 8.9)	4.9 (1.6 to 11.2)	**<0.001**
Ferritin (ng/mL)	391.1 (172.4 to 735.2)	229.5 (93.2 to 457.6)	247.0 (100.8 to 510.0)	**0.003**
Troponin (ng/mL)	24.9 (7.8 to 41.8)	12.4 (3.5 to 34.2)	16.0 (3.8 to 36.5)	**0.022**
INR (unitless)	1.0 (0.9 to 1.1)	0.9 (0.9 to 1.0)	1.0 (0.9 to 1.0)	**<0.001**
D-dimer (µg/mL)	1.9 (0.8 to 5.8)	0.6 (0.3 to 1.0)	0.7 (0.4 to 1.4)	**<0.001**
Fibrinogen (mg/dL)	384.9 (316.1 to 534.3)	370.9 (299.5 to 466.0)	377.8 (304.3 to 485.1)	0.256
White Blood Cell Count (×10³/µL)	11.7 (7.6 to 16.9)	8.2 (6.2 to 11.4)	8.5 (6.2 to 12.2)	**<0.001**
Lymphocyte Count (×10³/µL)	0.6 (0.4 to 1.0)	1.2 (0.8 to 1.9)	1.1 (0.7 to 1.7)	**<0.001**
Monocyte Count (×10³/µL)	0.4 (0.2 to 0.6)	0.5 (0.4 to 0.8)	0.5 (0.3 to 0.7)	**0.001**
Neutrophil Count (×10³/µL)	10.1 (6.3 to 15.2)	6.0 (3.9 to 8.9)	6.3 (4.2 to 10.0)	**<0.001**
Eosinophil Count (×10³/µL)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.1)	**0.001**
Basophil Count (×10³/µL)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.888
Hematocrit (%)	35.1 (31.0 to 41.0)	41.0 (37.7 to 44.9)	40.6 (36.3 to 44.0)	**<0.001**
Hemoglobin (g/dL)	11.7 (10.0 to 13.5)	13.5 (12.3 to 14.8)	13.3 (11.9 to 14.6)	**<0.001**
Mean Corpuscular Volume (fL)	87.3 (81.4 to 93.7)	87.8 (82.6 to 92.0)	87.8 (82.5 to 92.7)	0.705
Platelet Count (×10³/µL)	198.0 (151.7 to 240.3)	235.5 (181.8 to 302.5)	225.0 (173.0 to 290.0)	**<0.001**
Red Cell Distribution Width (%)	14.1 (13.3 to 15.4)	12.7 (12.1 to 13.6)	12.9 (12.3 to 14.1)	**<0.001**
Blood pH	7.4 (7.3 to 7.4)	7.4 (7.4 to 7.4)	7.4 (7.4 to 7.4)	**0.001**
Bicarbonate (mmol/L)	22.6 (20.3 to 25.5)	25.3 (23.7 to 26.7)	25.0 (23.1 to 26.6)	**<0.001**
Lactate (mmol/L)	1.8 (1.4 to 2.6)	1.6 (1.3 to 2.4)	1.7 (1.3 to 2.4)	0.221
Base Excess (mmol/L)	-1.7 (-3.6 to 2.4)	2.6 (-0.0 to 4.4)	2.0 (-0.6 to 4.3)	**<0.001**
Neutrophil-to-Lymphocyte Ratio	14.3 (7.4 to 28.8)	4.6 (2.5 to 8.8)	5.5 (2.8 to 12.3)	**<0.001**
Monocyte-to-Lymphocyte Ratio	0.6 (0.5 to 0.9)	0.4 (0.3 to 0.6)	0.5 (0.3 to 0.7)	**<0.001**
Platelet-to-Lymphocyte Ratio	303.8 (175.2 to 572.1)	190.6 (122.9 to 295.2)	203.6 (130.1 to 316.1)	**<0.001**

Statistical significance was evaluated using the Kruskal–Wallis test for overall comparison. Post-hoc pairwise comparisons were performed with Bonferroni correction. A p-value < 0.0167 was considered statistically significant after adjustment.

CRP is a frequently used marker of inflammation and increases phagocytosis by activating the complement system (15). Some studies are consistent with this study; a significant relationship has been shown between high CRP and mortality (15-18). Pan et al. In a meta-analysis published in 2020, leukocyte and CRP indices were found to be significantly higher in the severe patient group (p<0.05) (16). The increase in the aforementioned markers can also be attributed to cytokine storm, especially in the severe-mortal patient group.

Hypoalbuminemia was the strongest independent predictor in the logistic regression model, aligning with studies indicating its role as a marker of nutritional status, systemic inflammation, and capillary leak syndrome in severe infections (16,19). Likewise, lower serum calcium levels were also associated with mortality, possibly reflecting a dysregulated inflammatory response and poor clinical status (20).

Table 3. Diagnostic Performance of Biomarkers in Predicting Survival and Mortality in COVID-19 Patients

Parameter	Cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC
Non-Survival						
Age (year)	57	80.95	57.86	30.2	93.1	0.742
Urea (mg/dL)	57.78	69.84	84.64	50.6	92.6	0.829
C-Reactive Protein (mg/L)	7.1	71.43	68.21	33.6	91.4	0.746
D-dimer (µg/mL)	0.74	87.3	62.14	36.0	95.6	0.806
Neutrophil /Lymphocyte Ratio	14.3	74.60	70.71	41.9	91.8	0.771
Monocyte/Lymphocyte Ratio	0.6	66.67	59.29	27.6	90.1	0.689
Platelet/Lymphocyte Ratio	234	63.49	57.86	26.8	89.6	0.673
Hypertension	Yes	66.67	69.64	33.1	91.8	0.681
Lactate Dehydrogenase (U/L)	356	76.19	74.29	39.3	93.1	0.802
Survival						
Lymphocyte Count (×10³/µL)	0.572	88.21	50.79	88.85	49.23	0.763
Platelet Count (×10³/µL)	234	50.36	74.6	89.81	25.27	0.658
Hemoglobin (g/dL)	12.57	72.14	63.49	89.78	33.9	0.725
Calcium (mg/dL)	8.2	86.79	74.6	93.82	55.95	0.852
Albumin (g/dL)	3.6	80.36	80.95	94.94	48.11	0.870

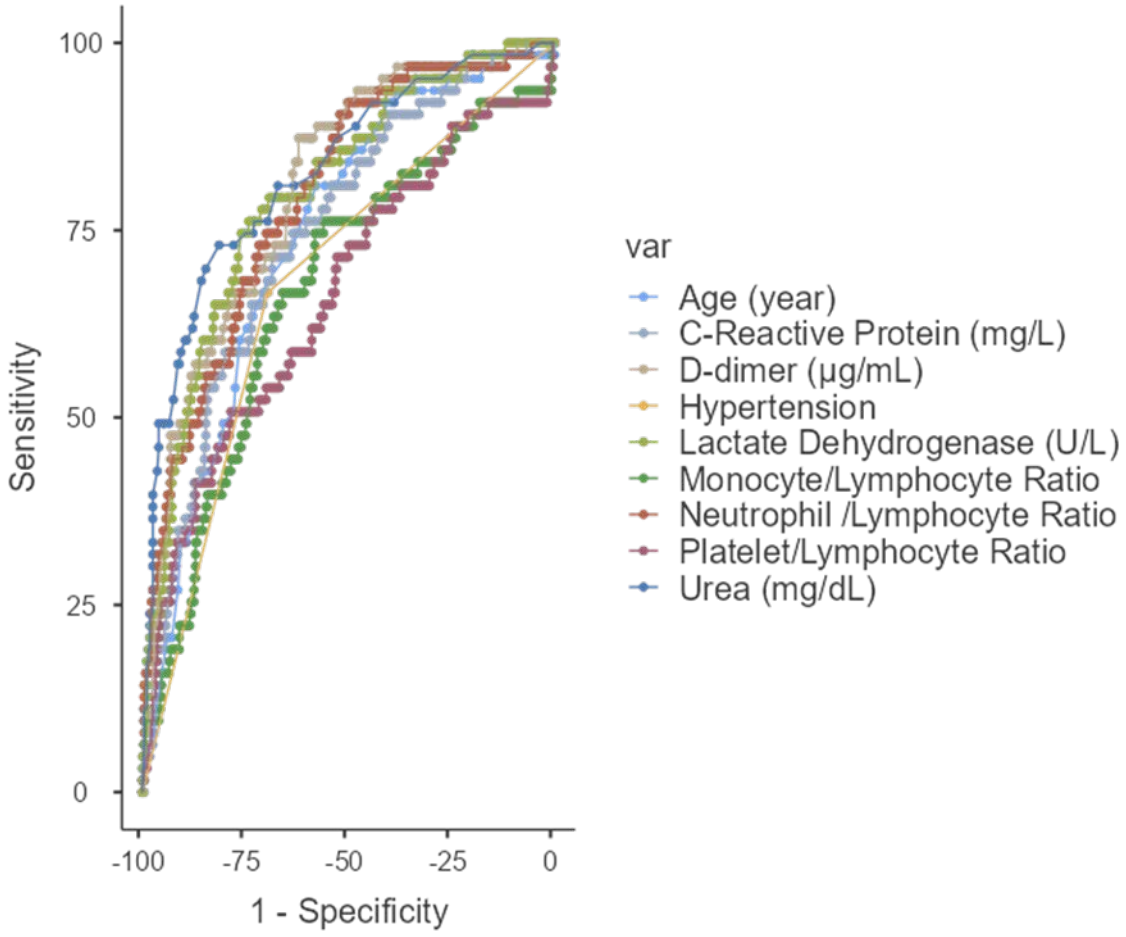

Figure 1. Receiver Operating Characteristic Curve of Parameters for Non-Survival Prediction
Abbreviation; Var, variable

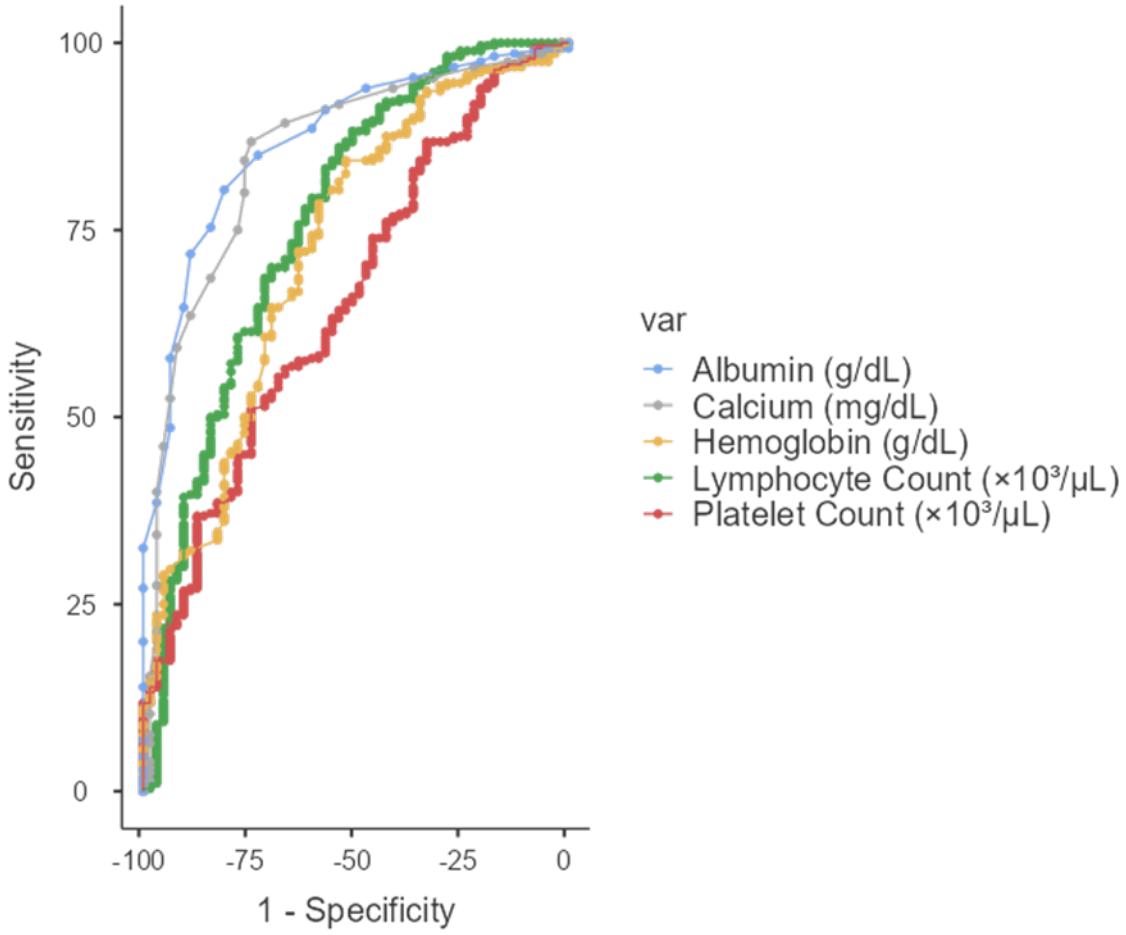

Figure 2. Receiver Operating Characteristic Curve of Parameters for Survival Prediction
Abbreviation; Var, variable

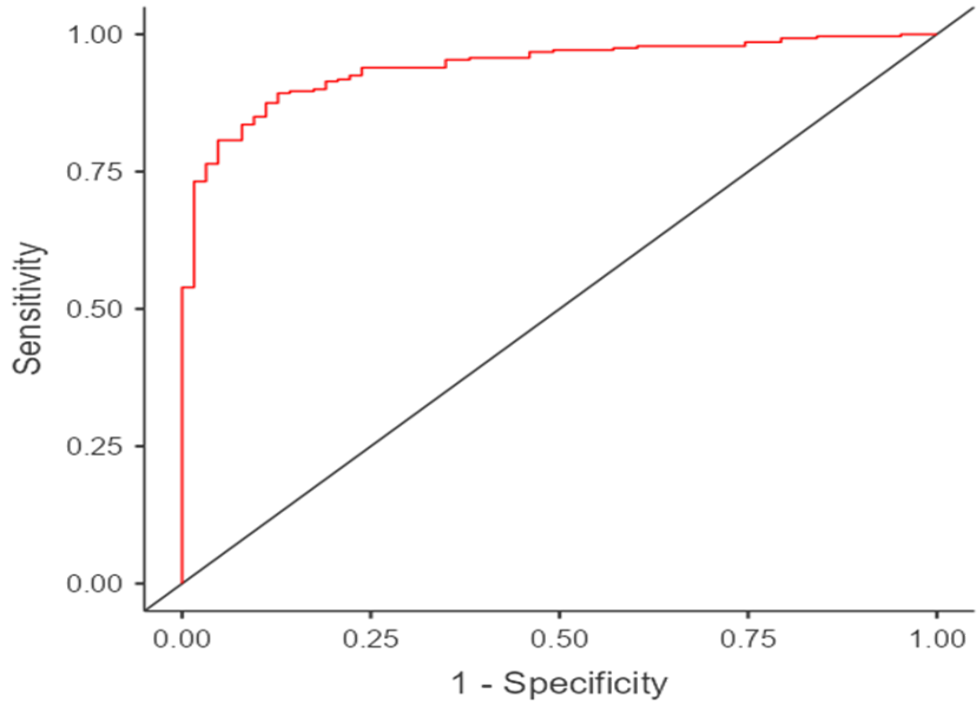

Figure 3. ROC Curve Demonstrating the Discriminative Ability of the Logistic Regression Model for Mortality Prediction in COVID-19 Patients (AUC = 0.941)

Table 4. Binomial Logistic Regression Results Identifying Independent Predictors of Mortality in COVID-19 Patients

Predictor	Estimate	SE	Z	p	Odds Ratio	95% CI Lower	95% CI Upper
D-dimer (µg/mL)	0.03321	0.02834	1.17	0.241	1.03377	0.978	1.093
Lactate Dehydrogenase (U/L)	−0.00430	0.00109	−3.94	< .001	0.99571	0.994	0.998
Albumin (g/dL)	1.74542	0.49644	3.52	< .001	5.72829	2.165	15.156
Urea (mg/dL)	−0.01903	0.00578	−3.29	< .001	0.98115	0.970	0.992
Calcium (mg/dL)	0.58356	0.36236	1.61	0.107	1.79241	0.881	3.647
Hypertension	−1.36132	0.41570	−3.27	0.001	0.25632	0.113	0.579

Table 5. Diagnostic Accuracy Indicators for Mortality Prediction Model

Accuracy	Specificity	Sensitivity	AUC	p-value
0.895	0.635	0.954	0.941	< .001

Inflammatory ratios such as neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), and platelet-to-lymphocyte ratio (PLR) were significantly elevated in ICU patients and non-survivors, echoing their established role as accessible and cost-effective predictors of COVID-19 severity (21,22).

ROC analysis in our study demonstrated that albumin (AUC = 0.870), calcium (AUC = 0.852), and LDH (AUC = 0.802) had the highest discriminatory power for survival and mortality. These findings support the growing interest in incorporating routine biochemical parameters into early risk stratification models.

The final logistic regression model in our study achieved an excellent AUC of 0.941, indicating high discriminative ability. Compared to other studies using combined scoring systems such as NEWS2 or qSOFA, our model based on objective laboratory and clinical data performed favorably (23-25). This suggests that emergency physicians could benefit from a simplified laboratory-based triage tool in pandemic settings. However, this study has several limitations that should be acknowledged. First, it was a retrospective analysis conducted at a single center, which inherently limits the generalizability of the findings and introduces potential selection bias. Second, the study lacks long-term outcome data, preventing us from evaluating patient trajectories beyond the initial hospitalization and acute illness phase. Additionally, some important patient information was not captured—such as specific treatment regimens, the duration of symptoms prior to presentation, and vaccination status—and these unmeasured confounders could have influenced both the biomarker levels and patient outcomes. These limitations should be considered when interpreting our results, and they underscore the need for further prospective, multicenter studies with comprehensive data collection and extended follow-up to validate and expand upon our findings.

In conclusion, our findings emphasize the importance of integrating age, comorbidities, and select laboratory markers—especially albumin, LDH, and urea—into early clinical decision-making to predict COVID-19 outcomes. Such tools can guide admission decisions and resource allocation, especially in high-demand emergency settings.

Ethical Approval: *The study was approved by the Harran University Clinical Research Ethics Committee (Date: 13/11/2023 Decision No: 2023/21/20) and adhered to the principles outlined in the Declaration of Helsinki.*

Author Contributions:
Concept: Ş.A.B., H.B.
Literature Review: Ş.A.B., H.B.
Design : Ş.A.B., H.B.
Data acquisition: Ş.A.B., H.B.
Analysis and interpretation: Ş.A.B., H.B.
Writing manuscript: Ş.A.B., H.B.
Critical revision of manuscript: Ş.A.B., H.B.
Conflict of Interest: *The authors have no conflicts of interest to declare.*
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