JHAD
Health and Development Journal

https://jhad.kmu.ac.ir
10.34172/jhad.92389
Vol. 12, No. 2, 2023, 92-100

Original Article

Clinical, Laboratory, and Demographic Factors Contributing to COVID-19 Mortality Risk

Atefeh Zahedi[1*], Zeinab Makvandi[1], Masoumeh Rostami[2], Zahra Najafi[2], Salman Khazaei[3], Iraj Salehi[4]

[1]Department of Public Health, Asadabad School of Medical Sciences, Asadabad, Iran
[2]Department of Nursing, Asadabad School of Medical Sciences, Asadabad, Iran
[3]Research Center for Health Sciences, Hamadan University of Medical Sciences, Hamadan, Iran
[4]Neurophysiology Research Center, Hamadan University of Medical Sciences, Hamadan, Iran

*__Corresponding Author:__ Atefeh Zahedi, Email: atefe.zahedi@gmail.com

Abstract

Background: This study aimed to identify COVID-19 mortality risk factors and relevant laboratory markers to inform prevention and treatment strategies.

Methods: This cross-sectional study was conducted in Iran, involving 1561 patients diagnosed with COVID-19 between 2019 and 2021. Demographic, clinical, and laboratory data were collected from hospital records and analyzed using a logistic regression model.

Results: The mortality rate attributed to COVID-19 in this study was 24.7%. Identified risk factors for mortality included intubation, multiple chronic conditions, liver or kidney disease or cancer, low RBC levels, and abnormal creatinine (Cr) levels. The adjusted odds ratios (adjOR) and 95% confidence intervals (CIs) for these factors were as follows: intubation (70.75, 14.07:355.84), concurrent chronic diseases (24.29, 3.25:181.24), liver or kidney disease or cancer (5.13, 1.21:21.81), low RBC levels (5.21, 1.24:21.79), and abnormal Cr levels (5.09, 1.21:21.43).

Conclusion: The findings from this study indicated that several factors, including intubation, multiple chronic conditions, liver or kidney disease or cancer, and low Cr levels were associated with a higher risk of death from COVID-19. These results highlight the significance of continuous monitoring and specialized care for patients exhibiting these risk factors to reduce the risk of COVID-19 mortality.

Keywords: COVID-19, Mortality, Biomarkers, Risk factors

Citation: Zahedi A, Makvandi Z, Rostami M, Najafi Z, Khazaei S, Salehi I. Clinical, laboratory, and demographic factors contributing to COVID-19 mortality risk. Health Dev J. 2023;12(2):92–100. doi:10.34172/jhad.92389

Received: May 3, 2024, **Accepted:** August 14, 2024, **ePublished:** August 30, 2024

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a new strain of coronavirus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This disease first emerged in Wuhan, Hubei Province, China, in December 2019 (1). The outbreak quickly spread globally from its origin in China (2). The initial confirmed cases of COVID-19 in Iran were documented on February 19, 2020, specifically in Qom (3). On February 20, 2020, the Ministry of Health and Medical Education confirmed two cases of COVID-19 in Qom, which became the epicenter of the outbreak in the country (4).

The COVID-19 outbreak developed into a significant global public health emergency. The World Health Organization (WHO) declared a public health emergency of international concern on January 30, 2020 (5). According to WHO reports, countries such as China, Italy, the Republic of Korea, Iran, France, and Spain had the highest documented instances of COVID-19 (6).

The COVID-19 pandemic has affected individuals from various ethnic backgrounds and across all age demographics, encompassing both males and females (7). Initially believed to primarily affect the respiratory system, COVID-19 has since been demonstrated to have a widespread impact on all major organ systems (8). The primary challenge posed by this pandemic is the threat to global public health and human life, resulting in a daily increase in the number of individuals contracting this severe viral illness, with some succumbing to it (9,10). Since December 2019, there have been over 760 million documented cases and 6.9 million registered fatalities worldwide. However, the actual figures are believed to be even higher (11). According to WHO, as of October 25, 2023, Iran reported 7 619 981 confirmed cases and 146,480 confirmed deaths (12).

Numerous studies have shown that COVID-19 mortality rates are higher among males, elderly individuals, and patients with pre-existing conditions such as cancer, diabetes mellitus, respiratory diseases, cardiovascular disorders, hypertension, and kidney disease (13-17). Based on previous studies, cardiovascular diseases and obesity have been identified as factors that exacerbate the severity of symptoms (17-19). Several studies have examined the risk factors associated with SARS-CoV-2 infection, finding that elevated levels of urea, creatinine (Cr), and C-reactive protein (CRP) correlate with increased severity of the disease and longer hospital stays (20, 21). Moreover, Jalili et al indicated that COVID-19 patients with a rapid respiratory rate, increased levels of BUN, LDH, and SGOT, low systolic blood pressure, and hypoxemia faced a higher risk of mortality during their hospital stay (22).

The worldwide dissemination of COVID-19 has placed unprecedented strain on various healthcare systems globally (23). Furthermore, the pandemic has exerted psychological, social, political, and financial ramifications (24). To mitigate the global transmission of COVID-19 and minimize its impact, it is imperative to implement public health interventions that effectively manage the infection and foster well-being (25). Analyzing the epidemiological characteristics, underlying causes, and co-morbidities of individuals who have succumbed to COVID-19 is crucial for establishing and enforcing more effective strategies for timely treatment and prevention of patient mortality. Accordingly, this study aimed to assess the clinical characteristics and risk factors associated with the mortality of COVID-19 patients admitted to Ghaem Hospital in Asadabad, Iran. Moreover, using a logistic regression model, this study examined the sociodemographic, clinical, and laboratory factors with predictive value for mortality.

Materials and Methods

This study utilized a cross-sectional design to investigate factors associated with mortality following COVID-19 infection. Data were collected at a single time point, allowing for the analysis of several demographic, clinical, and laboratory factors in patients with COVID-19.

The study was conducted in Ghaem Hospital, located in Asadabad, Iran. The study population comprised individuals who were diagnosed with COVID-19 between 2019 and 2021.

Demographic information, clinical data, and laboratory parameters were extracted from the electronic health record (EHR). Demographic information included age, gender, and place of residence. Clinical data included oxygen saturation (SpO2), intubation, CT scan results, respiratory distress, comorbidities, and drug abuse. Laboratory parameters included potassium (K), sodium (Na), blood urea nitrogen (BUN), Cr, blood sugar (BS), serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), hemoglobin (Hb), hematocrit (Hct), white blood cell count (WBC), red blood cell count (RBC), platelet count (PLT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), neutrophil count (Nut), monocyte count (Mono), lymphocyte count (Lymph), erythrocyte sedimentation rate (ESR), prothrombin time (PT), partial thromboplastin time (PTT), and CRP.

The standard reference ranges for laboratory factors were as follows: K levels from 3.5 to 5.5 milliequivalents per liter (meq/L), Na levels range from 135 to 145 meq/L, BUN levels range from 14 to 45 milligrams per deciliter (mg/dL), Cr levels from 0.7 to 1.4 mg/dL, Hb levels for women from 12 to 16 g/dL and for men from 14 to 18 g/dL, HCT levels for women from 36% to 45% and for men from 41% to 51%, WBC count for women from 4500 to 11 000 µL and for men and children from 5000 to 10000 µL, RBC count for women from 3.8 to 5.2×10^6/µL and for men from 4.2 to 6×10^6/µL , PLT count from 150 to 450×10^3/µL, MCV for children from 80 to 95 FL and for adults from 80 to 96 FL, MCH from 26 to 34 pg, MCHC for adults from 32% to 36% and for children from 32% to 34%, Nut count from 55% to 70%, Mono from 2% to 8%, Lymph from 20% to 45%, ESR from 0 to 15 mm/h, PT from 11 to 14 seconds, and PTT from 27 to 45 seconds.

Descriptive analysis of demographic, clinical, and laboratory data was performed using frequency and percentage. Univariate logistic regression was used to investigate the relationship between each variable and the outcome of COVID-19, followed by multivariate logistic regression to examine significant and potentially influential variables. Adjusted odds ratios (adjOR) with 95% confidence intervals (CIs) were reported. Data were analyzed using SPSS version 24, with a significance level set at 0.05.

Results

A total of 1561 COVID-19 patients were included in this cross-sectional study, with a mortality rate of 24.7% during the observation period. Table 1 provides an overview of the associations between studied variables and disease outcomes, using unadjusted odds ratios. In this study, 55.2% of the participants were female, 52.9% were over 60 years old, and the majority resided in urban areas. According to the results of the univariate analysis, 58.4% of deceased patients were female; however, no significant association was found between sex and mortality following COVID-19 ($P = 0.48$). Age was found to be a significant factor associated with COVID-19 outcomes, with individuals over 60 years old identified as a risk factor for mortality due to COVID-19 ($P < 0.001$). Moreover, SpO2 levels below 93% were significantly associated with death following COVID-19 ($P < 0.001$).

Table 1. Descriptive analysis and unadjusted odds ratios for demographic, clinical, and laboratory data of patients with COVID-19

Characteristics	Outcome N (%)		Total No. (%)	Unadjusted odds ratios (95% CI)	*P*
	Alive	Dead			
Gender					
Male	652 (45)	47 (41.6)	699 (44.8)	1	-
Female	796 (55)	66 (58.4)	862 (55.2)	1.15 (0.78:1.69)	0.480
Age					
≤60	810 (55.9)	15 (13.3)	825 (52.9)	1	-
>60	638 (44.1)	98 (86.7)	736 (47.1)	8.29 (4.77:14.42)	<0.001
Place of residence					
City	762 (59)	65 (60.2)	827 (59.1)	1	-
Village	529 (41)	43 (39.8)	572 (40.9)	0.95 (0.64:1.42)	0.814
SpO2					
>93%	478 (33)	16 (14.2)	494 (31.6)	1	-
<93%	970 (67)	97 (85.8)	1067 (68.4)	2.98 (1.74:5.12)	<0.001
Intubation					
No	1419 (98)	65 (57.5)	1484 (95.1)	1	-
Yes	29 (2)	48 (42.5)	77 (4.9)	36.13 (21.40:61.00)	<0.001
CT					
Without symptoms	44 (3.7)	3 (3.1)	47 (3.7)	1	-
With symptoms	1140 (96.3)	95 (96.9)	1235 (96.3)	1.22 (0.37:4.01)	0.740
Respiratory distress					
No	632 (43.6)	35 (31)	667 (42.7)	1	-
Yes	816 (56.4)	78 (69)	894 (57.3)	1.73 (1.14:2.61)	0.009
Comorbidity					
None	911 (62.9)	35 (31)	946 (60.6)	1	-
Diabetes	64 (4.4)	6 (5.3)	70 (4.5)	2.44 (0.99:6.01)	0.050
Hypertension	125 (8.6)	11 (9.7)	136 (8.7)	2.29 (1.13:4.62)	0.021
Heart disease	63 (4.4)	7 (6.2)	70 (4.5)	2.89 (1.23:6.77)	0.014
Asthma or chronic lung diseases	31 (2.1)	6 (5.3)	37 (2.4)	5.04 (1.97:12.86)	0.001
Multiple[a]	188 (13)	39 (34.5)	227 (14.5)	5.40 (3.33:8.75)	0.001
Other chronic diseases[b]	66 (4.6)	9 (8)	75 (4.8)	3.55 (1.64:7.69)	<0.001*
Drug abuse					
No	1392 (96.1)	101 (89.4)	1493 (95.6)	1	0.001
Yes	56 (3.9)	12 (10.6)	68 (4.4)	2.95 (1.53:5.68)	
K (meq/L)					
Normal	1123 (92.2)	91 (88.3)	1214 (91.9)	1	-
Low	79 (6.5)	6 (5.8)	85 (6.4)	0.94 (0.40:2.21)	0.882
High	16 (1.3)	6 (5.8)	22 (1.7)	4.63 (1.76:12:11)	0.002
Na (meq/L)					
Normal	729 (59.6)	60 (58.3)	789 (59.5)	1	-
Low	477 (39.0)	41 (39.8)	518 (39.1)	1.04 (0.69:1.58)	0.837
High	17 (1.4)	2 (1.9)	19 (1.4)	1.43 (0.32:6.33)	0.638
BUN (mg/dL)					
Normal	1016 (75.9)	26 (23.9)	1042 (72.0)	1	
Abnormal	323 (24.1)	83 (76.1)	406 (28.0)	10.04 (6.35:15.87)	<0.001*
Cr (mg/dL)					
Normal	1142 (85.5)	59 (55.1)	1201 (83.3)	1	<0.001*
Abnormal	193 (14.5)	48 (44.9)	241 (16.7)	4.81 (3.19:7.25)	

Table 1. Continued.

Characteristics	Outcome N (%)		Total No. (%)	Unadjusted odds ratios (95% CI)	*P*
	Alive	Dead			
BS (mg/dL)					
Normal	468 (63.4)	30 (37.0)	498 (60.8)	1	
Low	21 (2.8)	1 (1.2)	22 (2.7)	0.74 (0.09:5.71)	0.775
High	249 (33.7)	50 (61.7)	299 (36.5)	3.13 (1.94:5.05)	<0.001*
SGPT (U/L)					
Normal	675 (67.4)	48 (59.3)	723 (66.8)	1	
Abnormal	326 (32.6)	33 (40.7)	359 (33.2)	1.42 (0.89:2.26)	0.135
SGOT (U/L)					
Normal	599 (59.8)	35 (43.2)	634 (58.6)	1	
Abnormal	402 (40.2)	46 (56.8)	448 (41.4)	1.96 (1.24:3.09)	0.004
Hb (g/dL)					
Normal	763 (63.5)	53 (52.0)	816 (62.6)	1	
Low	417 (34.7)	47 (46.1)	464 (35.6)	1.62 (1.07:2.44)	0.021
High	22 (1.8)	2 (2.0)	24 (1.8)	1.31 (0.30:5.71)	0.721
HCT (%)					
Normal	772 (64.2)	53 (51.5)	825 (63.2)	1	
Low	358 (29.8)	37 (35.9)	395 (30.2)	1.50 (0.97:2.33)	0.067
High	73 (6.1)	13 (12.6)	86 (6.6)	2.59 (1.35:4.98)	0.004
WBC (μL)					
Normal	702 (58.3)	57 (55.3)	759 (58.0)	1	
Low	348 (28.9)	17 (16.5)	365 (27.9)	0.60 (0.34:1.05)	0.074
High	155 (12.9)	29 (28.2)	184 (14.1)	2.30 (1.42:3.72)	0.001
RBC ($\times 10^6$/ μL)					
Normal	1015 (84.9)	69 (68.3)	1084 (83.6)	1	
Low	107 (8.9)	24 (23.8)	131 (10.1)	3.29 (1.99:5.46)	<0.001*
High	74 (6.2)	8 (7.9)	82 (6.3)	1.59 (0.73:3.43)	0.237
PLT ($\times 10^3$/ μL)					
Normal	863 (71.9)	73 (70.9)	936 (71.8)	1	
Low	312 (26.0)	29 (28.2)	341 (26.2)	1.09 (0.70:1.72)	0.681
High	26 (2.2)	1 (1.0)	27 (2.1)	0.45 (0.06:3.99)	0.443
MCV (FL)					
Normal	944 (78.8)	76 (73.8)	1020 (78.4)	1	
Low	171 (14.3)	11 (10.7)	182 (14.0)	0.79 (0.41:1.53)	0.501
High	83 (6.9)	16 (15.5)	99 (7.6)	2.39 (1.33:4.29)	0.003
MCH (pg)					
Normal	990 (82.6)	90 (87.4)	1080 (82.9)	1	
Low	186 (15.5)	12 (11.7)	198 (15.2)	0.71 (0.38:1.32)	0.280
High	23 (1.9)	1 (1.0)	24 (1.8)	0.47 (0.06:3.58)	0.473
MCHC (%)					
Normal	922 (77.0)	53 (52.0)	975 (75.1)	1	
Abnormal	275 (23.0)	49 (48.0)	324 (24.9)	3.10 (2.05:4.67)	<0.001*
Lymph (%)					
Normal	770 (64.2)	43 (42.2)	813 (62.5)	1	
Low	377 (31.4)	57 (55.9)	434 (33.4)	2.71 (1.78:4.09)	<0.001*
High	52 (4.3)	2 (2.0)	54 (4.2)	0.68 (0.16:2.92)	0.613
Mono (%)					

Table 1. Continued.

Characteristics	Outcome N (%)		Total No. (%)	Unadjusted odds ratios (95% CI)	*P*
	Alive	Dead			
Normal	959 (85.2)	78 (81.3)	1037 (84.9)	1	
Abnormal	167 (14.8)	18 (18.8)	185 (15.1)	1.32 (0.77:2.27)	0.305
Nut (%)					
Normal	468 (39.0)	22 (21.6)	490 (37.6)	1	
Low	149 (12.4)	4 (3.9)	153 (11.8)	0.57 (0.19:1.68)	0.310
High	583 (48.6)	76 (74.5)	659 (50.6)	2.77 (1.69:4.52)	<0.001*
ESR (mm/h)					
Normal	224 (29.9)	10 (17.9)	234 (29.1)	1	
Abnormal	525 (70.1)	46 (82.1)	571 (70.9)	1.96 (0.97:3.95)	0.060
PT (second)					
Normal: 11-14	354 (73.3)	38 (55.1)	392 (71.0)	1	
Abnormal	129 (26.7)	31 (44.9)	160 (29.0)	1.49 (1.15:1.93)	0.002
PTT (second)					
Normal	377 (79.2)	54 (76.1)	431 (78.8)	1	
Low	21 (4.4)	5 (7.0)	26 (4.8)	1.66 (0.60:4.59)	0.327
High	78 (16.4)	12 (16.9)	90 (16.5)	1.07 (0.55:2.10)	0.835
CRP					
Negative	249 (31.8)	20 (31.7)	269 (31.8)	1	
positive	535 (68.2)	43 (68.3)	578 (68.2)	1 (0.57:1.73)	0.998

[a] Simultaneously suffering from two or more underlying diseases (including diabetes, hypertension, heart disease); [b] having liver or kidney disease or cancer; * Significant at<0.0001.

Only a small percentage of recovered patients required intubation (2%), while a higher percentage of deceased patients (42.5%) required intubation ($P<0.001$). Respiratory distress was significantly associated with increased mortality in COVID-19 patients ($P=0.009$). The study found that a higher percentage of deceased individuals (69%) experienced respiratory distress compared to recovered individuals (56.4%). The presence of comorbidities, such as underlying health conditions, was also examined. The results showed that underlying diseases were more prevalent among deceased patients than among those who recovered. Furthermore, drug abuse was more prevalent among deceased individuals (10.6%) compared to those who recovered (3.9%). These relationships were statistically significant ($P=0.001$).

Several blood markers were analyzed in relation to COVID-19 outcomes. The study indicated that abnormal levels of various markers, including Cr ($P<0.0001$), BUN ($P<0.0001$), and SGOT (P=0.004), and high levels of K (P=0.002) and BS ($P<0.0001$) were associated with mortality in COVID-19 patients. Blood cell counts and related measures were also examined. Low levels of Hb ($P=0.02$) and RBC ($P<0.0001$), high levels of HCT (P=0.004), WBC ($P=0.001$), and MCV($P=0.003$), and abnormal levels of MCHC ($P<0.0001$) were found to be associated with mortality in COVID-19 patients. In addition, different types of WBCs were examined in relation to COVID-19 outcomes. Low levels of lymph ($P<0.0001$) and high levels of neutrophils ($P<0.0001$) were found to be associated with mortality in COVID-19 patients. Abnormal PT levels were found to be associated with mortality in COVID-19 patients ($P=0.002$). However, no significant differences were observed in CT scans, Na levels, PLT counts, MCH, monocyte levels, PTT, ESR, and CRP between recovered and deceased patients ($P>0.05$).

These characteristics maintained their significance in predicting the probability of mortality in the multivariate analysis. Intubation (adjOR=70.75, 95% CI: 14.07-355.84), abnormal Cr (adjOR=5.09, 95% CI: 1.21-21.43), multiple concurrent chronic conditions (adjOR=24.29, 95% CI: 3.25-181.24), kidney or liver disease or cancer (adjOR=5.13, 95% CI: 1.21-21.81), and lower than normal levels of RBC (adjOR=5.21, 95% CI: 1.24-21.79) were all independently associated with a significantly increased risk of death following COVID-19. SpO2 levels below 93% displayed a marginal association with an increased risk of death following COVID-19 ($P=0.06$; Table 2).

Discussion

This study investigated the predictive factors associated with mortality due to COVID-19. The independent predictors included the concurrent presence of two or more underlying diseases (such as diabetes, hypertension, and heart disease), liver or kidney disease or cancer, intubation, abnormal Cr levels, and low RBC levels.

Table 2. Multivariate logistic regression for demographic, clinical, and laboratory data of COVID-19 patients

Characteristics	Adjusted odds ratios	95% CI	P
Age			
<60	1	-	
>60	2.21	0.58:8.39	0.246
SpO2			
>93%	1	-	
<93%	3.86	0.90:16.60	0.069
Distress			
No	1	-	
Yes	0.89	0.28:2.85	0.848
Drug abuse			
No	1	-	
Yes	0.80	0.10:7.23	0.843
Comorbidity			
None	1	-	
Diabetes	2.11	0.16:26.97	0.567
Hypertension	1.23	0.20:7.51	0.820
Heart disease	1.69	0.11:26.69	0.709
Asthma or chronic lung diseases	6.52	0.39:107.88	0.190
Multiple	24.29	3.25:181.24	0.002
Other chronic diseases	5.13	1.21:21.81	0.027
Intubation			
No	1		
Yes	70.75	14.07:355.84	<0.001*
BUN (mg/dL)			
Normal	1		
Abnormal	2.18	0.57:8.31	0.251
Cr (mg/dL)			
Normal	1		
Abnormal	5.09	1.21:21.43	0.027
BS (mg/dL)			
Normal	1		
Low	0.51	02:16.11	0.703
High	1.86	0.58:5.94	0.296
SGOT (U/L)			
Normal	1		
Abnormal	2.63	0.76:9.08	0.124
HCT (%)			
Normal	1		
Low	0.40	0.08:1.89	0.249
High	1.87	0.28:12.18	0.511
WBC (μL)			
Normal	1		
Low	0.76	0.18:3.27	0.719
High	3.17	0.69:14.47	0.136
RBC ($\times 10^6$/ μL)			
Normal	1		
Low	5.47	1.04:28.80	0.045
High	0.61	0.06:6.44	0.684
MCHC (%)			
Normal	1		
Abnormal	0.33	0.09:1.26	0.107
ESR (mm/h)			
Normal	1		
Abnormal	1.13	0.31:4.16	0.853
PT (s)			
Normal:11-14	1		
Abnormal:>14	0.63	0.20:1.98	0.429

*Significant at<0.0001.

Besides, SpO2 below 93% was marginally associated with death following COVID-19.

During the study period, the mortality rate among COVID-19 patients was 24.7%. The mortality rate reported in previous research ranged from 4.37% to 33.5% (26-29). The disparity in mortality rates can be attributed to variations in admission criteria, the timing of examinations, the diversity and number of healthcare facilities included, and access to medical services.

The findings indicated no significant association between gender and death caused by COVID-19, which aligns with the findings of several previous studies (26,29,30). However, certain other investigations showed that male gender was associated with a higher likelihood of mortality (27,31).

The results of this study also revealed that individuals aged 60 years and older were identified as a predictive factor for mortality due to COVID-19 in the initial analysis. However, after considering other components in the model, this association was found to be statistically insignificant. The likelihood of mortality caused by COVID-19 was shown to be positively correlated with advancing age, as indicated by multiple investigations (26,27,31-33). This relationship may be attributed to dysfunctions in the cellular immune response, specifically the progressive decline of T lymphocytes (34), compounded by a higher prevalence of age-related underlying illnesses.

The study demonstrated that individuals with diabetes, high blood pressure, heart disease, asthma, and chronic lung disorders exhibited a higher likelihood of mortality. Moreover, the risk of death further increased with the concurrent presence of multiple underlying conditions, as indicated by univariate analysis. However, in multivariate analysis, the concurrent presence of multiple underlying disorders and other non-communicable diseases (such as chronic kidney disease and cancer) was correlated with a heightened risk of mortality. Numerous studies have examined the association between pre-existing medical conditions and mortality rates following COVID-19. A systematic review conducted by Tian et al showed that heart disease, diabetes, and hypertension were correlated with a higher likelihood of mortality (35). Consistent findings were observed in the study by Alegría-Baños et al (27). According to Grima et al, among individuals with underlying conditions, only those with chronic kidney disease faced a heightened mortality risk. The concurrent presence of multiple diseases showed no significant impact in the multivariate analysis (30). Punzalan and colleagues' study also found no significant association in this regard (29).

The study found that intubation significantly influenced the outcomes of COVID-19 as this intervention is typically performed in individuals with severe COVID-19. The link between intubation and the increased mortality risk can be anticipated due to the potential occurrence of secondary infections. Various studies have reported that COVID-19 patients requiring oxygen therapy face increased mortality risk (30,36).

Another variable examined in this study was the level of SpO2. The SpO2 level below 93% was associated with mortality from COVID-19 in univariate analysis. However, after incorporating additional variables into the model, this link became only marginally significant. Consistent with the findings of the current study, the studies by Grima et al and Jalili et al did not find a significant relationship in multivariate analysis (22,30). However, the study by Alegría-Baños et al identified one factor that was associated with death (27).

This study analyzed SGOT, SGPT, BUN, and Cr levels to assess liver and kidney functioning. The findings revealed that deceased patients exhibited abnormal renal and liver function. Tian and colleagues' systematic review (35) validated these results regarding SGOT and SGPT. In the study by Jalili et al, SGOT and Cr had a substantial impact on outcomes (22). Similarly, Henry et al found a significant increase in Cr levels among deceased patients (37).

Several biomarkers that are potential indicators of disease severity and prognosis (38) were investigated in this study. No significant association was found between CRP and ESR levels and the outcome of COVID-19. However, the study by Tian et al (35) found a significant increase in ESR and CRP levels, while Mishra et al (36) showed that an increase in CRP was associated with a higher severity of the disease.

Numerous studies have examined the association between alterations in WBC counts and the prognosis of COVID-19. The study found that elevated WBC counts were linked to increased mortality risk in univariate analysis. However, multivariate analysis revealed no significant relationship, which aligns with the findings of Jalili and colleagues' study (22). The systematic reviews by Tian et al and Henry et al found that deceased individuals had higher WBC counts (35,37).

The PLT count in this study did not show a statistically significant association with the disease outcome, consistent with the findings of Jalili and colleagues' study (22). In the studies conducted by Tian et al and Henry et al, it was observed that deceased individuals had a reduced PLT count (35,37).

Another determinant of disease outcome is the body's immune response. The results indicated that elderly individuals had reduced Lymph counts compared to younger individuals. COVID-19 is characterized by an aberrant decline in Lymph levels, although the exact cause of which remains unclear. Reduced Lymph counts can contribute to the severity of disease in COVID-19 patients (39). This study identified that individuals with low Lymph counts and high Nut levels exhibited a heightened likelihood of mortality. The study by Alegría-Baños et al (27) also found a significant association. The studies by Tian et al and Henry et al (35,37) revealed a notable reduction in Lymph counts among deceased individuals. Survival in COVID-19 patients is believed to be linked to the capacity to regenerate lymphocytes that are destroyed by the virus. Consequently, the Lymph count could potentially serve as an indicator of the illness (37).

This study examined various blood parameters in COVID-19 patients. Low RBC levels were linked to a higher mortality risk, and this association remained statistically significant even after adjusting for other factors. Moreover, low Hb levels and high Hct levels were shown to be linked to an elevated mortality risk. However, this association did not reach statistical significance in multivariate analysis, which aligns with the findings of Jalili and colleagues' study (22). In studies conducted by Tian et al and Henry et al (35,37), deceased individuals had decreased Hb levels, although no statistically significant association was found. Conversely, Punzalan et al demonstrated that a decrease in Hb levels was linked to a significant rise in the likelihood of mortality (29).

One of the limitations of this study was the incomplete documentation of laboratory variables for all participants. As cross-sectional studies are retrospective, thorough data collection was not feasible. Moreover, the study's exclusive focus on hospitalized patients may limit the generalizability of the findings to all individuals affected by COVID-19.

Conclusion

This study identified several risk factors associated with increased mortality from COVID-19, including intubation, multiple concurrent conditions, chronic kidney or liver disease or cancer, low RBC levels, and abnormal Cr levels. The findings from this study highlighted the significance of closely monitoring patients with these predisposing factors and delivering specialized medical care to reduce the likelihood of mortality from COVID-19. Healthcare providers should take these findings into account while making clinical decisions.

Acknowledgments

The authors express profound gratitude to the staff at Ghaem Hospital.

Authors' Contribution

Conceptualization: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj Salehi.
Data curation: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi.
Formal analysis: Atefeh Zahedi.
Investigation: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj Salehi.
Methodology: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj Salehi.
Project administration: Atefeh Zahedi.
Resources: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj. Salehi
Software: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi.
Supervision: Atefeh Zahedi.
Writing–original draft: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj Salehi.
Writing–review & editing: Atefeh Zahedi, Zeinab Makvandi, Masoumeh Rostami, Zahra Najafi, Salman Khazaei, Iraj Salehi.

Competing Interests

The authors declared that there are no conflicts of interest.

Ethical Approval

The ethics committee of the Asdabad Faculty of Medical Sciences approved this research project under the code IR.ASAUMS.REC.1400.008.

Funding

This study was funded by Vice-Chancellor for Education, Research and Technology, Asdabad Faculty of Medical Sciences.

References

1. Li H, Liu SM, Yu XH, Tang SL, Tang CK. Coronavirus disease 2019 (COVID-19): current status and future perspectives. Int J Antimicrob Agents. 2020;55(5):105951. doi: 10.1016/j.ijantimicag.2020.105951.
2. Peng PW, Ho PL, Hota SS. Outbreak of a new coronavirus: what anaesthetists should know. Br J Anaesth. 2020;124(5):497-501. doi: 10.1016/j.bja.2020.02.008.
3. Ahmadi A, Fadaei Y, Shirani M, Rahmani F. Modeling and forecasting trend of COVID-19 epidemic in Iran until May 13, 2020. Med J Islam Repub Iran. 2020;34:27. doi: 10.34171/mjiri.34.27.
4. Meskarpour-Amiri M, Shams L, Nasiri T. Identifying and categorizing the dimensions of Iran's health system response to the COVID-19 pandemic. J Mil Med. 2020;22(2):108-14. doi: 10.30491/jmm.22.2.108. [Persian].
5. Moradzadeh R, Jamalian SM, Nazari J, Kamali A, Sadeghi B, Hosseinkhani Z, et al. Age-standardized mortality rate and predictors of mortality among COVID-19 patients in Iran. J Educ Health Promot. 2021;10(1):169. doi: 10.4103/jehp.jehp_946_20.
6. Irani M, Pakfetrat A, Kiyani Mask M. Novel coronavirus disease 2019 and perinatal outcomes. J Educ Health Promot. 2020;9:78. doi: 10.4103/jehp.jehp_189_20.
7. Pyar KP, Kyaw AP, Maung NL, Aung ZN, Hla SA, Hlaing SW, et al. Clinical manifestations, laboratory markers and their association with mortality in patients with severe COVID-19 infection in third wave of epidemics in Myanmar. Int J Diabetes Metab Disord. 2023;8(2):306-16.
8. Jindal HA, Sahoo SS, Jamir L, Kedar A, Sharma S, Bhatt B. Higher coronavirus disease-19 mortality linked to comorbidities: a comparison between low-middle income and high-income countries. J Educ Health Promot. 2021;10:377. doi: 10.4103/jehp.jehp_142_21.
9. Bikdeli B, Haj-Hossein Talasaz A, Rashidi F, Sharif-Kashani B, Farrokhpour M, Bakhshandeh H, et al. Intermediate versus standard-dose prophylactic anticoagulation and statin therapy versus placebo in critically-ill patients with COVID-19: rationale and design of the INSPIRATION/INSPIRATION-S studies. Thromb Res. 2020;196:382-94. doi: 10.1016/j.thromres.2020.09.027.
10. Oducado RM, Parreño-Lachica G, Rabacal J. Personal resilience and its influence on COVID-19 stress, anxiety and fear among graduate students. Int J Educ Res Innov. 2021;15:431-43. doi: 10.46661/ijeri.5484.
11. World Health Organization (WHO). Coronavirus Disease (COVID-19). WHO; 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/coronavirus-disease-(covid-19).
12. World Health Organization (WHO). The Current COVID-19 Situation. WHO; 2023. Available from: https://www.who.int/countries/irn/.
13. Liu K, Chen Y, Lin R, Han K. Clinical features of COVID-19 in elderly patients: a comparison with young and middle-aged patients. J Infect. 2020;80(6):e14-8. doi: 10.1016/j.jinf.2020.03.005.
14. Khankeh H, Farrokhi M, Talebi Ghadicolaei H, Ahmadi Mazhin S, Roudini J, Mohsenzadeh Y, et al. Epidemiology and factors associated with COVID-19 outbreak-related deaths in patients admitted to medical centers of Mazandaran University of Medical Sciences. J Educ Health Promot. 2021;10:426. doi: 10.4103/jehp.jehp_192_21.
15. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497-506. doi: 10.1016/s0140-6736(20)30183-5.
16. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. Kidney Int. 2020;97(5):829-38. doi: 10.1016/j.kint.2020.03.005.
17. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507-13. doi: 10.1016/s0140-6736(20)30211-7.
18. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis. Int J Infect Dis. 2020;94:91-5. doi: 10.1016/j.ijid.2020.03.017.
19. Rastad H, Karim H, Ejtahed HS, Tajbakhsh R, Noorisepehr M, Babaei M, et al. Risk and predictors of in-hospital mortality from COVID-19 in patients with diabetes and cardiovascular disease. Diabetol Metab Syndr. 2020;12:57. doi: 10.1186/s13098-020-00565-9.
20. Morell-Garcia D, Ramos-Chavarino D, Bauça JM, Argente Del Castillo P, Ballesteros-Vizoso MA, García de Guadiana-Romualdo L, et al. Urine biomarkers for the prediction of mortality in COVID-19 hospitalized patients. Sci Rep. 2021;11(1):11134. doi: 10.1038/s41598-021-90610-y.

21. Loomba RS, Villarreal EG, Farias JS, Aggarwal G, Aggarwal S, Flores S. Serum biomarkers for prediction of mortality in patients with COVID-19. Ann Clin Biochem. 2022;59(1):15-22. doi: 10.1177/00045632211014244.
22. Jalili E, Keramat F, Bashirian S, Khazaei S, Talebi-Ghane E, Karami M, Soltanian AR. Demographic and clinical features association with mortality in patients with COVID-19: a cross-sectional study in the west of Iran. Acta Med Iran. 2021;59(10):587-94. doi: 10.18502/acta.v59i10.7763.
23. Fauci AS, Lane HC, Redfield RR. COVID-19 - navigating the uncharted. N Engl J Med. 2020;382(13):1268-9. doi: 10.1056/NEJMe2002387.
24. Cookson B. Regarding "Understanding the emerging coronavirus: what it means to health security and infection prevention". J Hosp Infect. 2020;105(4):792. doi: 10.1016/j.jhin.2020.05.021.
25. Song F, Shi N, Shan F, Zhang Z, Shen J, Lu H, et al. Emerging 2019 novel coronavirus (2019-nCoV) pneumonia. Radiology. 2020;295(1):210-7. doi: 10.1148/radiol.2020200274.
26. da Costa Sousa V, da Silva MC, de Mello MP, Guimarães JA, Perini JA. Factors associated with mortality, length of hospital stay and diagnosis of COVID-19: data from a field hospital. J Infect Public Health. 2022;15(7):800-5. doi: 10.1016/j.jiph.2022.06.010.
27. Alegría-Baños JA, Rosas-Alvarado MA, Jiménez-López JC, Juárez-Muciño M, Méndez-Celis CA, Enríquez-De Los Santos ST, et al. Sociodemographic, clinical and laboratory characteristics and risk factors for mortality of hospitalized COVID-19 patients at alternate care site: a Latin American experience. Ann Med. 2023;55(1):2224049. doi: 10.1080/07853890.2023.2224049.
28. Chenchula S, Vidyasagar K, Pathan S, Sharma S, Chavan MR, Bhagavathula AS, et al. Global prevalence and effect of comorbidities and smoking status on severity and mortality of COVID-19 in association with age and gender: a systematic review, meta-analysis and meta-regression. Sci Rep. 2023;13(1):6415. doi: 10.1038/s41598-023-33314-9.
29. Punzalan FE, Aherrera JA, de Paz-Silava SL, Mondragon AV, Malundo AF, Tan JJ, et al. Utility of laboratory and immune biomarkers in predicting disease progression and mortality among patients with moderate to severe COVID-19 disease at a Philippine tertiary hospital. Front Immunol. 2023;14:1123497. doi: 10.3389/fimmu.2023.1123497.
30. Grima P, Guido M, Zizza A. Clinical characteristics and risk factors associated with COVID-19 mortality in a non-intensive care unit. J Prev Med Hyg. 2023;64(1):E3-8. doi: 10.15167/2421-4248/jpmh2023.64.1.2828.
31. Zhang B, Zhou X, Qiu Y, Song Y, Feng F, Feng J, et al. Clinical characteristics of 82 cases of death from COVID-19. PLoS One. 2020;15(7):e0235458. doi: 10.1371/journal.pone.0235458.
32. Aggarwal S, Garcia-Telles N, Aggarwal G, Lavie C, Lippi G, Henry BM. Clinical features, laboratory characteristics, and outcomes of patients hospitalized with coronavirus disease 2019 (COVID-19): early report from the United States. Diagnosis (Berl). 2020;7(2):91-6. doi: 10.1515/dx-2020-0046.
33. Heydarifard Z, Shafiei-Jandaghi NZ, Safaei M, Tavakoli F, Shatizadeh Malekshahi S. Comparison of clinical outcomes, demographic, and laboratory characteristics of hospitalized COVID-19 patients during major three waves driven by Alpha, Delta, and Omicron variants in Tehran, Iran. Influenza Other Respir Viruses. 2023;17(8):e13184. doi: 10.1111/irv.13184.
34. Opal SM, Girard TD, Ely EW. The immunopathogenesis of sepsis in elderly patients. Clin Infect Dis. 2005;41 Suppl 7:S504-12. doi: 10.1086/432007.
35. Tian W, Jiang W, Yao J, Nicholson CJ, Li RH, Sigurslid HH, et al. Predictors of mortality in hospitalized COVID-19 patients: a systematic review and meta-analysis. J Med Virol. 2020;92(10):1875-83. doi: 10.1002/jmv.26050.
36. Mishra R, Singh JK, Jha BK, Priya K, Khanal A, Anand A, et al. Clinical features, laboratory parameters, treatment and outcome analysis of COVID-19 patients admitted to a referral hospital at Nepalese Terai region during second wave. Janaki Med Coll J Med Sci. 2023;11(2):9-17.
37. Henry BM, de Oliveira MHS, Benoit S, Plebani M, Lippi G. Hematologic, biochemical and immune biomarker abnormalities associated with severe illness and mortality in coronavirus disease 2019 (COVID-19): a meta-analysis. Clin Chem Lab Med. 2020;58(7):1021-8. doi: 10.1515/cclm-2020-0369.
38. Gholinataj Jelodar M, Rafieian S, Allah Dini A, Khalaj F, Zare S, Dehghanpour H, et al. Analyzing trends in demographic, laboratory, imaging, and clinical outcomes of ICU-hospitalized COVID-19 patients. Can J Infect Dis Med Microbiol. 2023;2023:3081660. doi: 10.1155/2023/3081660.
39. Liu Y, Mao B, Liang S, Yang JW, Lu HW, Chai YH, et al. Association between age and clinical characteristics and outcomes of COVID-19. Eur Respir J. 2020;55(5):2001112. doi: 10.1183/13993003.01112-2020.