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ORIGINAL RESEARCH

Factors Affecting Hospitalization Length and in-Hospital Death Due to COVID-19 Infection in Saudi Arabia: A Single-Center Retrospective Analysis

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Background: The emerging COVID-19 coronavirus disease has widely spread, causing a serious worldwide pandemic. Disease severity and mortality risk can be predicted using an analysis of COVID-19 clinical characteristics. Finding out what influences patients' hospitalization length and in-hospital mortality is crucial for decision-making and planning for emergencies. The goal of this study is to identify the factors that influence hospital stay length and in-hospital death due to COVID-19 infection.

Methods: This cross-sectional study was conducted from August to October 2020 and included 630 patients with a confirmed diagnosis of COVID-19 infection. Using odds ratios (OR) and 95% confidence intervals (CI), a multivariable logistic regression model was used to assess the variables that are linked to longer hospital stays and in-hospital deaths.

Results: Most patients were male (64.3%), and most were older than 40 years (81.4%). The mean length of hospital stay (LoHS) was 10.4±11.6 days. The overall death rate among these COVID-19 cases was 14.3%. Non-survivors were older, had more comorbidities, had prolonged LoHS with increased ICU admission rates and mechanical ventilation usage, and had a more severe condition than survivors. ICU admission, low serum albumin, and elevated LDH levels were associated with longer LoHS, while ICU admission, DM, and respiratory diseases as comorbidities, total leukocytic count, and serum albumin were predictors of mortality.

Conclusion: Longer LoHS due to COVID-19 infection was linked to ICU admission, low serum albumin, and elevated LDH levels, while the independent predictors of in-hospital death were ICU admission, DM, and respiratory diseases as comorbidities, total leukocytic count, and serum albumin.

Keywords: COVID-19, Saudi Arabia, hospital stay, Al-Ahsa

Introduction

A novel beta-coronavirus known as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused an outbreak of infection in Wuhan, China, in December 2019. The World Health Organization (WHO) has named the disease caused by SARS-CoV-2 as coronavirus disease 2019. (COVID-19).[1]

The novel coronavirus infected people in the same way as other coronaviruses, most notably the severe acute respiratory syndrome coronavirus (SARS-CoV), the bat SARS-like CoV, and the Middle East respiratory syndrome coronavirus (MERS-CoV). SARS-CoV-2, like SARS-CoV-1, enters human cells via the angiotensin-converting enzyme 2

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(ACE-2) receptor.[2] The primary mode of transmission of SARS-CoV-2 is via respiratory droplets produced by an infected person while coughing or sneezing.[3]

SARS-CoV-2 infection appears to have a broad clinical spectrum, encompassing asymptomatic infection, mild upper respiratory tract illness, and severe viral pneumonia with respiratory failure and even death, with many patients hospitalized with pneumonia.[4–6]

Recent studies have shown that the disease's symptoms vary from one region to another because of their different demographics and other health problems.[7] COVID-19 patients present with varying levels of severity. Mild and moderate cases represent more than 80% of total cases, and the duration of hospital admission for patients with COVID-19 varies widely from patient to patient. Hospital care varies from general ward-based care to intensive care, where patients may need intubation and mechanical ventilation.[8–12] The healthcare system's readiness was put to the test by this pandemic, which is dependent on indicators of severity and factors affecting the length of hospital admissions.[7] Predicting and understanding hospital bed demand for patients with COVID-19 and focusing on the most seriously ill patients and those who are rapidly deteriorating gives crucial proof for contingency planning and decision-making.[8,13] This study aims to identify various factors that influence hospital admission duration and in-hospital mortality due to the COVID-19 infection.

Subjects and Methods

Study Design and Setting

This retrospective study included 630 adult individuals, aged 18 years or older, hospitalized in King Fahad Hospital, Al-Ahsa, Saudi Arabia, in the period from August to October 2020. King Fahad Hospital is a 500-bed general hospital in Al-Hofuf, the biggest hospital in the city area of Al-Ahsa. It was one of the key referral hospitals in Al-Ahsa City to receive COVID-19 patients at the onset of the coronavirus pandemic in the area.

Study Population

Adult patients with COVID-19 of both sexes and of varying ages who were confirmed SARS-CoV-2 positive by real-time reverse transcriptase-polymerase chain reaction (RT-PCR) testing upon admission were included in the study. Our analysis was limited to patients who had both fully complete electronic medical records (EMRs) and LoHS durations of more than a single day. Patients hospitalized for other conditions who were discovered to be positive during their stay were not included. The final study included 630 patients who met the predetermined criteria.

Data Collection

Trained research assistants extracted the data from patient files. A well-designed and organized checklist was used to extract patient medical records information. The following data were retrieved in addition to hospital admission and discharge dates: sociodemographic data like age, sex, smoking status, and nationality, clinical factors such as presenting symptoms, comorbidities (depending on whether the patient has a verified diagnosis of any of the following disorders: diabetes mellitus, hypertension, cardiovascular, respiratory, hepatic, or chronic kidney disease), laboratory results, and the outcome. The severity of COVID-19 was graded as mild to moderate, or severe. Patients with mild to moderate COVID-19 showed symptoms with or without pneumonia but no hypoxia, while if any of the following criteria were fulfilled, the condition was classified as severe: (1) dyspnea (≥30 breaths/min), (2) low blood oxygen saturation of less than 93%, (3) PaO2/FiO2 ratio 300, (4) pulmonary infiltration > 50% within 24–48 hours.[14]

Statistical Analysis

Data were analyzed using a statistical package for social science (SPSS) program for Windows version 24 (SPSS Inc. Chicago, IL, USA). The mean and standard deviation were used for normally distributed data; otherwise, the median and interquartile range were used for non-normally distributed ones, while categorical data were expressed as numbers and percentages. A Chi-square (X^2) was used to compare two groups of categorical data. The Mann–Whitney test was used as appropriate to compare two groups of quantitative variables. Linear/logistic regression analyses were used to predict risk factors for longer hospital stay and mortality, with a confidence interval of 95% ($p < 0.05$) to represent the statistical significance of the results. The multivariate regression model included univariate logistic regression variables with p values < 0.05 as predictors of hospital stay or mortality. All statistical analyses used two-sided hypothesis tests with a $P < 0.05$ significance level.

Ethical Considerations

The Institutional Review Board at King Faisal University approved this study (KFU-REC-2023-MAR-ETHICS651) and waived patient consent due to the study's retrospective nature. The study was performed according to the Helsinki Declaration, and all data were collected, coded, and analyzed to ensure data integrity and patient privacy.

Results

Sociodemographic, Clinical, and Laboratory Characteristics

This retrospective study included 630 patients hospitalized with COVID-19 at King Fahad Hospital, Al-Hofuf, KSA. As shown in Table 1, the majority of the patients were males (64.1%), and most patients admitted were older than 40 years (81.2%), with a median age of 55 years. The majority of patients were Saudi (78.1%) and others were of other nationalities. The most common comorbidities in COVID-19 patients were diabetes mellitus (DM) and hypertension

Table 1 Sociodemographic, Clinical, and Laboratory Characteristics of COVID-19 Cases

Variables	No. (%)
Age (years)	
(Median=55, range=19–94 years)	
<20	4 (0.6%)
20–39	114 (18.2%)
40–60	290 (46%)
>60	222 (35.2)
Gender	
Male	404 (64.1%)
Female	226 (35.9%)
Nationality	
Saudi	492 (78.1%)
Non-Saudi	138 (21.9%)
Smoking	
Smoker	9 (1.4%)
Non-smoker	621 (98.6%)
Comorbidities:	
DM	205 (32.5%)
HTN	168 (26.7%)
CVD	44 (7%)
Respiratory diseases	29 (4.6)
CKD	25 (4%)
Hepatic diseases	2 (0.3%)
Disease severity	
Mild to moderate	525 (83.3%)
Severe	105 (16.7%)
Hospitalization duration (days)	
(Median= 7 days, range=1–155 days)	
< 7 days	272 (43.2%)
≥ 7 days	358 (56.8%)

(*Continued*)

Table 1 (Continued).

Variables	No. (%)
ICU Admission	102 (16.2%)
Mechanical ventilation	77 (12.2%)
Clinical outcomes	
Survived	540 (85.7%)
Died	90 (14.3%)
Hb (13–17g/dL)	
(Median= 13.1, range 5.2–20)	
Low	293 (46.5%)
Normal	328 (52.1%)
High	9 (1.4%)
Platelets ($130–400\times10^3/\mu L$)	
(Median= 241.5, range 11–907)	
Low	36 (5.7%)
Normal	555 (88.1%)
High	39 (6.2%)
TLC ($4–10\times10^9/L$)	
(Median=6.21, range 1.7–108)	
Low	90 (14.2%)
Normal	425 (67.5%)
High	115 (18.3%)
Liver function tests	
ALT (13–69 U/L)	
(Median=38, range 3–1673)	
Normal	510 (81%)
Elevated	120 (19%)
AST (15–46 U/L)	
(Median=37, range 2–926)	
Normal	391 (62.1%)
Elevated	239 (37.9%)
Total bilirubin (3–22 μmol/L)	
(Median=9.1, range 0.5–756)	
Normal	583 (92.5%)
Elevated	47 (7.5%)
Albumin (35–50 g/L)	
(Median=33. 1, range 2.15–64.3)	
Normal	252 (40%)
Low	378 (60%)
Kidney functions	
Urea (3.2–7.1 mmol/L)	
(Median=5.2, range 1.3–61)	
Normal	435 (69%)
Elevated	195 (31%)
Creatinine (46–110 μmol/L)	
(Median=89, range 24–1062)	
Normal	446 (70.8%)
Elevated	184 (29.2%)
RBS (3.9–6.1 mmol/L)	
(Median=7.8, range 2.1–72)	
Normal	151 (24%)
Elevated	479 (76%)

(*Continued*)

Table 1 (Continued).

Variables	No. (%)
LDH (120–246 IU/L)	
(Median=336, range 108–5280)	
Normal	160 (25.4%)
Elevated	470 (74.6%)

Abbreviations: DM, Diabetes Mellitus; HTN, Hypertension; CVD, Cardiovascular Diseases; CKD, Chronic Kidney Diseases; ICU, Intensive Care Unit; Hb, Haemoglobin; TLC, Total Leukocytic Count; ALT, Alanine Aminotransferase; AST, Aspartate Aminotransferase; RBS, Random Blood Sugar; LDH, Lactate Dehydrogenase.

(HTN), which represented 32.5% and 26.7%, respectively. The median duration of the hospital stay is 7 days, with a range of 1–155 days. About 16% of patients were admitted to the ICU, and the overall death rate among these COVID-19 cases was 14.3%.

The laboratory results showed that 46.5% of patients had low hemoglobin levels, 5.7% had thrombocytopenia, 6.2% had thrombocytosis, 18.3% had leukocytosis, and patients who had elevated ALT, AST, total bilirubin, urea, and creatinine were 19%, 37.9%, 7.5%, 31%, and 29.2%, respectively. 60% of patients had low serum albumin levels, and 74.6% had elevated LDH levels.

Comparing the COVID-19 Patients Categorized According to the Length of Their Hospital Stay

Table 2 shows that patients who stayed in the hospital longer were much older, had a higher rate of diabetes, ICU admissions, mechanical ventilation usage, and severe disease, and had a worse outcome. Regarding comparisons of the laboratory indices, patients with longer hospital stays had higher total leukocytic count (TLC), alanine aminotransferase (ALT), and random blood sugar (RBS) but significantly lower serum albumin levels.

Table 2 Comparison Between the COVID-19 Patients Categorized According to Their Length of Hospital Stay

Variables	Short Hospital Stay (<7 Days) (N =272)	Long Hospital Stay (≥7 days) (N =358)	p-value
Categorical variables (N, %)			
Gender			
Female	112 (41.2%)	114 (31.8%)	
Male	160 (58.8%)	244 (68.2%)	0.01*
Nationality			
Saudi	234 (86%)	258 (72.1%)	
Non-Saudi	38 (14%)	100 (27.9%)	<0.001*
Smoking			
Smoker	3 (1.1%)	6 (1.7%)	
Non-smoker	269 (98.9%)	352 (98.3%)	0.404
DM			
Yes	73 (26.8%)	132 (36.9%)	
No	199 (73.2%)	226 (63.1%)	0.006*
HTN			
Yes	66 (24.3%)	102 (28.5%)	
No	206 (75.7%)	256 (71.5%)	0.136

(*Continued*)

Table 2 (Continued).

Variables	Short Hospital Stay (<7 Days) (N =272)	Long Hospital Stay (≥7 days) (N =358)	p-value
CVD			
Yes	19 (7%)	25 (7%)	
No	253 (93%)	333 (93%)	0.56
Respiratory diseases			
Yes	9 (3.3%)	20 (5.6%)	
No	263 (96.7%)	338 (94.4%)	0.122
CKD			
Yes	8 (2.9%)	17 (4.8%)	
No	264 (97.1%)	341 (95.2%)	0.173
Hepatic diseases			
Yes	1 (0.4%)	1 (0.3%)	
No	271 (99.6%)	357 (99.7%)	0.677
ICU admission			
Yes	14 (5.1%)	87 (24.3%)	
No	258 (94.9%)	271 (75.7%)	<0.001*
Mechanical ventilation			
Yes	15 (5.5%)	62 (17.3%)	
No	257 (94.5%)	296 (82.7%)	<0.001*
Disease severity			
Mild to moderate	254 (93.4%)	271 (75.7%)	
Severe	18 (6.6%)	87 (24.3%)	<0.001*
Outcome			
Died	19 (7%)	72 (19.8%)	
Discharged	253 (93%)	286 (80.2%)	<0.001*
Continuous variables [Median (interquartile range)]			
Age	53 (19–89)	55 (19–94)	0.027*
Hb	12.9 (7–18.2)	13.2 (5.2–19.8)	0.161
TLC	5.8 (1.7–91.6)	6.6 (1.7–108)	0.008*
Platelets	241 (54–907)	242 (11–751)	0.784
ALT	34 (3–634)	39 (5.1–1673)	0.02*
AST	32 (2.01–869)	43 (3–926)	<0.001
Total Bilirubin	8.8 (1.6–56)	9.3 (0.5–756)	0.261
Albumin	35.5 (12.1–84)	31 (2.15–64.3)	<0.001*
INR	1 (0.8–2.8)	1 (0.7–6.5)	0.623
Urea	4.8 (1.3–37.2)	5.6 (1.9–61)	0.001*
Creatinine	83 (25–1062)	92 (24–1057)	<0.001
RBS	7.4 (3.8–34.4)	8.4 (2.1–72)	0.02*
LDH	284 (115–2428)	382 (108–5280)	<0.001*

Note: *Significant at p-value ≤ 0.05.

Factors Linked to a Longer Hospital Stay

To find risk factors linked to long-term hospitalization, the multivariable model comprised nine candidate variables with a P≤ 0.05 in univariable analysis. According to the findings, ICU admission (P = 0.008, OR 9.434, 95% CI 1.78–49.7), low serum albumin (P <0.001, OR 1.7, 95% CI 1.03–1.1), and elevated LDH on hospital admission (P <0.001, OR 0.997, 95% CI 0.995–0.998) were independent risk factors linked to a longer hospitalization stay in COVID-19 patients as shown in Table 3.

Table 3 Risk Factors for the Long Hospital Stay Among COVID-19 Patients

Variable	Univariable Analysis		Multivariable Analysis	
	OR (95% CI)	p-value	AOR (95% CI)	p-value
Age	0.989 (0.978–1)	0.044*	0.993 (0.978–1)	0.352
Sex (male)	1.49 (1.07–2.07)	0.17		
Nationality (Saudi)	2.39 (1.58–3.6)	<0.001*	0.986 (0.971–1.001)	0.076
Smoking (Yes)	1.5 (0.38–6.185)	0.548		
DM (Yes)	1.58 (1.12–2.229)	0.009*	1.7 (1.014–2.881)	0.44
HTN (Yes)	1.24 (0.87–1.78)	0.227		
Respiratory diseases (Yes)	1.73 (0.77–3.871)	0.179		
CVD (Yes)	1.003 (0.54–1.86)	0.993		
CKD (Yes)	1.65 (0.701–3.88)	0.251		
ICU admission (Yes)	5.84 (3.24–10.5)	<0.001*	9.434 (1.78–49.7)	0.008*
Mechanical ventilation (Yes)	3.58 (1.99–6.46)	<0.001*	0.774 (0.172–3.48)	0.738
Disease severity (severe)	4.478 (2.62–7.65)	<0.001*	0.276 (0.056–1.34)	0.113
Hb	0.97 (0.9–1.05)	0.554		
TLC	0.975 (0.945–1.007)	0.129		
Platelets	1 (0.99–1.002)	0.129		
ALT	0.997 (0.994–1)	0.1		
AST	0.997 (0.994–0.99)	0.012*	0.99 (0.99–1)	0.693
Total bilirubin	0.991 (0.972–1)	0.361		
Albumin	1.073 (1.04–1.1)	<0.001*	1.07 (1.03–1.1)	<0.001*
Urea	0.96 (0.93–0.99)	0.009*	1 (0.95–1.06)	0.68
Creatinine	0.99 (0.997–1)	0.049*	0.99 (0.997–1.001)	0.41
LDH	0.997 (0.996–0.998)	<0.001*	0.997 (0.995–0.998)	<0.001*

Note: *Significant at p-value ≤ 0.05.

Comparing the COVID-19 Patients Categorized According to Their Outcome

According to our findings, illustrated in Table 4, patients who died from COVID-19 were older than those who survived hospitalization and were discharged. They were more likely to have comorbidities such as DM and HTN, a longer hospital stay with more ICU admissions and mechanical ventilation usage, and more severe disease.

Laboratory tests showed that patients who did not survive had higher levels of TLC, AST, INR, blood urea, serum creatinine, RBS, and LDH, but much lower levels of serum albumin.

Factors Linked to in-Hospital Death

Multivariate regression model analysis showed that age (P= 0.023; OR 0.951; 95% CI 0.91–0.99), ICU admission (P< 0.001; OR 59.7; 95% CI 20.213–176.487), DM (P= 0.011; OR 4.849; 95% CI 1.440–16.332), respiratory diseases (p= 0.018; OR 7.464; 95% CI 1.411–39.468), TLC (P= 0.049; OR 0.924; 95% CI 0.854–1) and serum albumin (p= 0.001; OR 1.170; 95% CI 1.080–1.267) were independent risk factors associated with in-hospital mortality in COVID patients (Table 5).

Discussion

The SARS-CoV-2 infection outbreak, which began at the end of 2019, has attracted the attention of the entire world. The new coronavirus, SARS-CoV-2, and the illness have been named by the World Health Organization (WHO) as coronavirus disease 2019 (COVID-19).[15] Clinical manifestations of the illness might be asymptomatic, mild, or severe, and several cases end in death.[16]

On March 2, 2020, the Kingdom of Saudi Arabia (KSA) reported the first case of COVID-19.[17] COVID-19 is a worldwide threat to people's health. More detailed and specific characteristics are required to better understand this disease pandemic.[18]

Table 4 Comparison Between Survivors and Non-Survivors from COVID-19 Infection

Variables	Survivors (N=540)	Non-Survivors (N=90)	p-value
Categorical variables (N, %)			
Gender (No %)			
Female	196 (36.3%)	30 (33.3%)	0.587
Male	344 (63.7%)	60 (66.7%)	
Nationality			
Saudi	422 (78.1%)	70 (77.8%)	0.937
Non-Saudi	118 (21.9%)	20 (22.2%)	
Smoking			
Yes	6 (1.1%)	3 (3.3%)	0.125
No	534 (98.9%)	87 (96.7%)	
ICU admission			
Yes	31 (5.7%)	70 (77.8%)	< 0.001*
No	509 (94.3%)	20 (22.2%)	
Mechanical ventilation			
Yes	6 (1.1%)	71 (78.9%)	< 0.001*
No	534 (98.9%)	19 (21.1%)	
DM			
Yes	146 (27%)	59 (65.6%)	< 0.001*
No	394 (73%)	31 (34.4%)	
HTN			
Yes	115 (21.3%)	53 (58.9%)	< 0.001*
No	425 (78.7%)	37 (41.1%)	
CKD			
Yes	12 (2.2%)	13 (14.4)	< 0.001*
No	528 (97.8%)	77 (85.6%)	
Respiratory diseases			
Yes	17 (3.1%)	12 (13.3%)	< 0.001*
No	523 (96.9%)	78 (86.7%)	
CVD			
Yes	29 (5.4%)	15 (16.7%)	< 0.001*
No	511 (94.6%)	75 (83.3%)	
Hepatic diseases			
Yes	0 (0%)	2 (2.2%)	0.001*
No	540 (100%)	88 (97.8%)	
Disease severity			
Mild to moderate	513 (95%)	12 (13.3%)	< 0.001*
Severe	27 (5%)	78 (86.7%)	
Continuous variables [Median (interquartile range)]			
Age	53 (19–94)	62 (28–86)	< 0.001*
Duration of hospital admission	7 (1–155)	13 (1–86)	< 0.001*
Hb	13.2 (5.3–18.2)	12.9 (5.2–19.8)	0.123
Platelets	241 (53–907)	249.5 (11–522)	0.773
TLC	6.04 (1.7–91.6)	7.8 (1.7–108)	< 0.001*
ALT	37.3 (3–475)	38.5 (7–1673)	0.478
AST	35.4 (2.01–926)	53 (5–869)	< 0.001*
Total Bilirubin	9 (0.5–756)	9.6 (1.6–44.3)	0.406
Albumin	34 (14–64.3)	26.9 (2.15–42.7)	< 0.001*
INR	0.9 (0.7–3.9)	1 (0.8–6.5)	< 0.001*
Urea	4.9 (1.7–61)	8.3 (1.3–44.3)	< 0.001*

(*Continued*)

Table 4 (Continued).

Variables	Survivors (N=540)	Non-Survivors (N=90)	p-value
Creatinine	87 (24–1062)	115 (31–973)	< 0.001*
RBS	7.5 (3–72)	9.8 (2.1–51)	< 0.001*
LDH	316 (109–4667)	430.5 (108–5280)	< 0.001*

Note: *Significant at p<0.05.

Table 5 Risk Factors for in-Hospital Death Due to COVID-19 Infection

Variable	Univariable Analysis		Multivariable Analysis	
	OR (95% CI)	P value	AOR (95% CI)	P value
Age	0.959 (1.020–1.053)	<0.001*	0.951 (0.91–0.99)	0.023*
Sex (male)	1.140 (0.711–1.827)	0.58		
Nationality (Saudi)	1.022 (0.597–1.75)	0.937		
Smoking (Yes)	3.069 (0.75–12.49)	0.118		
Length of hospital stay	0.94 (0.922–0.959)	<0.001*	0.97 (0.94–0.99)	0.25
DM (Yes)	5.136 (3.196–8.254)	<0.001*	4.849 (1.440–16.332)	0.011*
HTN (Yes)	5.294 (3.316–8.451)	<0.001*	1.185 (0.331–4.250)	0.794
Respiratory diseases (Yes)	4.733 (2.178–10.287)	<0.001*	7.464 (1.411–39.468)	0.018*
CVD (Yes)	3.524 (1.805–6.879)	<0.001*	0.513 (0.108–2.440)	0.401
CKD (Yes)	7.429 (3.271–16.871)	<0.001*	1.062 (0.161–7.028)	0.950
ICU admission (Yes)	57.468 (31.065–106.31)	<0.001*	59.7 (20.213–176.487)	0.0001*
Mechanical ventilation (Yes)	1.14 (1.02–1.28)	0.018*	4.165 (0.856–20.4)	0.075
Disease severity	123.5 (60.08–253.9)	<0.001*	1.99 (0.247–16.04)	0.518
Hb	1.091 (0.99–1.21)	0.088		
TLC	0.939 (0.9–0.98)	0.003*	0.924 (0.854–1)	0.049*
Platelets	1 (0.99–1.002)	0.941		
ALT	0.997 (0.99–1)	0.026*	1.001 (0.98–1.02))	0.871
AST	0.996 (0.993–0.998)	0.002*	1.003 (0.99–1.02)	0.705
Total bilirubin	1.001 (0.992–1.009)	0.890		
Albumin	1.163 (1.12–1.21)	0.0001*	1.170 (1.080–1.267)	0.001*
Urea	0.94 (0.91–0.97)	0.0001*	0.924 (0.85–1.01)	0.077
Creatinine	0.998 (0.997–1)	0.007*	1.002 (0.998–1.01)	0.346
RBS	0.952 (0.92–0.98)	0.001*	1.036 (0.96–1.12)	0.375
LDH	0.998 (0.997–0.999)	0.0001*	0.998 (0.996–1)	0.10

Note: *Significant at p<0.05.

The purpose of this study was to identify various factors that influence the duration of hospital admission and in-hospital death and to report the epidemiological features and characteristics of COVID-19 among patients who were admitted at King Fahad Hospital in Al-Ahsa, Eastern Province, Saudi Arabia, during the period from August to October 2020. This is very important for the understanding and management of COVID-19.

The study included 630 hospitalized patients diagnosed with COVID-19. The COVID-19 infection was more prevalent among those in the middle age group. This is consistent with another previous study that mentioned that, although the virus can infect any age group, the middle-aged group (40 to 60 years) was the most commonly infected group.[19] This finding is not in accordance with some previous non-Saudi studies that mentioned ages above 60 as high-risk factors.[20–22] This discrepancy could be explained by the fact that the population of Saudi Arabia is younger than that of European and Asian countries.

Our findings revealed that the infection affected more men than women. This was consistent with other studies' findings that found similar results.[5,23,24] But this contradicts other studies, which showed that females were more infected by SARS-CoV-2.[25,26] The predominance of infection among males can be attributed to the higher number of men than women in the Saudi population. On the other hand, males are more involved in daily activities than females, which means they are more exposed to COVID-19 cases and more susceptible to infection. Another explanation for the higher rate of infection among males is that the X chromosome in females encodes some immune regulatory genes that cause lower viral load levels.[27]

In our study, most of the patients were Saudi (78.1%), while non-Saudi patients made up 21.9%. This contradicts a previous early study that found non-Saudi patients to be more affected, representing around 80% of the cases.[28] The high rate of infection among non-Saudi patients was explained by higher exposure to infection due to sharing housing units.[29] Our finding here is similar to other studies by Al Dossary et al and Al Mutair et al, who found more cases among the Saudi population.[30,31] This can be explained by the fact that the number of Saudis in Saudi Arabia is at least double that of non-Saudis.

The most common comorbidities seen in our patients were diabetes mellitus (32.5%), hypertension (26.7%), cardiovascular diseases (7%), respiratory diseases (4.6%), chronic kidney diseases (4%), and liver diseases (0.3%). Similarly, Alahmari et al found diabetes to be their patients' most prevalent comorbid condition, followed by hypertension.[32] Also, Alwafi et al mentioned that the most common comorbidities were diabetes mellitus, hypertension, and heart diseases.[33] Patients with chronic liver disorders (CLD) were also more likely to experience fatal outcomes, such as death or a longer hospital stay. The confirmed test results emphasize COVID-19's detrimental effects on liver functions.[34]

The median duration of hospital admission for COVID-19 patients in this study was 7 days, whereas the average duration was 10.4 days. The average duration of hospital admission was longer in patients who died when compared to discharged patients (8.94 versus 19.24 days). The fact that patients who died spent more time in the hospital could be due to complications from underlying conditions or the severity of their illness. Our findings were similar to those of many other studies in Saudi Arabia. Alwafi et al reported that the median length of hospital stays among COVID-19 patients was 6 days (range 0–55 days).[33] According to Alghamdi, the length of hospital stays of COVID-19 patients ranged from 4 to 15.6 days,[35] while Alahmari et al found that the median length of hospital stays among COVID-19 patients was 7 days.[32]

In a systemic review done by Rees et al, they discovered that the median length of hospital stays in China is 14 days, compared to 5 days outside of China. The summary distributions for ICU are more similar (a median of 8 days in China and 7 days outside of China).[36] Wang et al as well as Zhao et al reported the duration of hospital admission in patients with COVID-19 to be 10 and 13 days, respectively.[4,18] The length of hospital stay for COVID-19 patients varies widely from one country to another and depends on the clinical situation of the patients, the local guidelines, and the capacity of hospitals.[37,38]

The results of our study showed that older age, severe disease, the need for mechanical ventilation, and admission to the ICU were all associated with a longer duration of hospital stay. Also, increased total leucocyte count, ALT, LDH, blood glucose, blood urea, and decreased serum albumin were associated with a prolonged duration of hospital admission. These findings suggest a correlation between prolonged hospitalization and significant physiological changes. It is important to understand these relationships to improve patient outcomes.

Age and the severity of the disease were found to be substantially correlated with the length of the hospital stay by Wang et al.[39] In a different trial, patients with severe illness, mechanical ventilation, diabetes, or chronic kidney disease stayed in the hospital for noticeably longer.[32] Higher creatinine levels and chronic liver or renal disease prior to admission, according to Guo et al, were linked to COVID-19 patients' extended length of hospital stay (LoHS).[40] In a separate study conducted in Saudi Arabia, leukocytosis, elevated LDH, elevated creatinine, and other comorbidities such as congestive heart failure and COPD were all linked to an increased risk of a longer hospital stay.[33] Older age, diabetes mellitus, sickness severity, CRP, D-dimer, serum ferritin, serum Lactate Dehydrogenase (LDH), blood urea, and SGOT were all linked to a longer length of stay among COVID-19 patients who were hospitalized, according to Khatal et al.[41]

In a study conducted in India, oxygen saturation, the presence of more than two comorbidities, and specific laboratory indicators including LDH, ferritin, and D-dimer were found to be the most significant influences on LoHS.[42] Alqassieh et al observed that patients with increased WBC had a shorter LoHS,[43] which is contrary to our findings.

We did a multivariable analysis to find out what made COVID-19 patients stay in the hospital longer. We found that being admitted to the ICU, having a lower serum albumin level, and having a higher serum LDH level were all independent factors.

COVID-19 is distinguished by an inflammatory-related cytokine storm, which may enhance vascular permeability and allow albumin to escape from the interstitial space, leading to hypoalbuminemia.[44] LDH production is triggered by viral infections or lung injuries, such as pneumonia associated with COVID-19. In cases of tissue damage, LDH levels are reportedly much higher, and these higher levels of LDH are reportedly correlated with the severity of inflammation.[45,46] Furthermore, studies show that critically sick ICU patients also had much higher LDH levels than non-critical non-ICU patients.[47,48] And patients in the intensive care units are more likely to get prolonged medical care.[7]

In the present study, the fatality rate among hospitalized patients with COVID-19 was 14.3%. This is similar to the range of 12–15% reported by other authors.[49,50] Hospital mortality varies in different studies between 4.3% and 28%.[4,50,51] The low overall mortality of COVID-19 in Saudi Arabia is attributed to the younger age of the Saudi population and to previous exposure to MERS-CoV. Exposure to MERS-CoV may partially protect against serious illness.[52] In addition, the strict measures taken by the government and the high quality of the health care system played a major role in limiting disease spread and fatalities. Mortality in ICU-admitted patients is high (between 26% and 78%) in different countries.[50,51,53]

We found the mortality rate is higher in patients with chronic diseases, including diabetes mellitus, hypertension, respiratory diseases, cardiovascular diseases, chronic kidney diseases, and hepatic diseases. According to numerous studies, COVID-19 individuals with comorbidities were more likely to experience severe COVID-19 and frequently had a worse prognosis. Exacerbations of COVID-19 were more likely in patients with hypertension, diabetes, or chronic obstructive pulmonary disease (COPD).[54–57]

In the multivariable analysis, age, ICU admission, diabetes mellitus, respiratory diseases, total leukocyte count, and serum albumin were independent factors for in-hospital death in patients with COVID-19. Our findings are consistent with other research that has identified diabetes, heart disease, and hypertension as risk factors for fatalities.[58–60] Al Mutair et al research shows that COVID-19 patients who are older than 50 years and have a history of high blood pressure, diabetes, or both have a higher death rate than younger patients who do not have diabetes and have normal blood pressure.[61]

In a different study on COVID-19 patients conducted in Saudi Arabia by Alswaidi et al, they discovered a large correlation between mortality and elderly and cardiovascular diseases.[62] Ibrahim et al discovered a statistically significant link between ICU admission, cardiovascular disease, hypertension, renal failure, and COVID-19 death. The older population experienced a marked increase in COVID-19 deaths. The total leucocyte count and urea level were considerably greater in the COVID-19 death group compared to the recovered group.[63] In older patients and those with concomitant illnesses, COVID-19 infection quickly escalates to acute respiratory distress syndrome, septic shock, metabolic acidosis, and coagulation failure, resulting in mortality.[64]

In this study, an increased WBC count, serum AST, INR, blood urea, serum creatinine, blood glucose, LDH, and decreased serum albumin were associated with a bad prognosis and higher mortality. The WBC count at admission is significantly correlated with death in COVID-19 patients. A higher level of WBC count should be given more attention in the treatment of COVID-19.[65] Poor prognosis is associated with LDH levels, which represent tissue necrosis brought on by immunological hyperactivity in SARS.[66]

According to Pouw et al, severe patients had significantly higher levels of the neutrophil count, ALT, AST, lactate dehydrogenase (LDH), and serum creatinine than moderately ill individuals.[67] SARS-CoV-2 may harm the tissues of the liver and heart, raising AST levels to varying degrees in severe patients.[68] Acute kidney damage with elevated serum creatinine may be caused by the virus directly, as well as by hypoxia and shock.[4] Patients with severe disease may develop Systemic Inflammatory Response Syndrome (SIRS) and Multi-organ Dysfunction Syndrome (MODS) due to the organ damage they have.[57,69]

This study has some limitations. The study's retrospective design is the first factor. Second, given that this information was collected at the outbreak's outset, it's plausible that psychological and social variables may have played a role in the longer stays experienced by our patients. Third, the data was gathered prior to the availability of the COVID-19 vaccine and novel antiviral treatments, which significantly reduced illness severity and dissemination. Fourth, the data were acquired over a brief period of time from a single hospital, which restricted the experience to a specific location.

Conclusions

According to our findings, ICU admission, low serum albumin, and increased LDH upon hospital admission were found to be independent risk factors associated with a longer hospital stay in COVID-19 patients. Those patients continue to have a significant in-hospital mortality rate. The independent predictors of in-hospital mortality were ICU admission, diabetes, and respiratory illnesses as comorbidities, total leukocytic count, and serum albumin. This study's findings may be used as a foundation for further research into the disease's natural history, the creation of practical diagnostic tools for use in clinical practice, and the identification of persons at risk of presenting the disease's severe form.

Data Sharing Statement

The data underlying this study is available from the first author upon reasonable request.

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Disclosure

The authors report no conflicts of interest in this work.

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