Received: 14 February 2023 | Revised: 23 May 2023 | Accepted: 29 May 2023

DOI: 10.1002/hsr2.1329

ORIGINAL RESEARCH

Health Science Reports Open Access WILEY

Predictors of hospital length of stay and mortality among COVID-19 inpatients during 2020–2021 in Hormozgan Province of Iran: A retrospective cohort study

Zahra Mastaneh[1] | Ali Mouseli[2] | Shokrollah Mohseni[2] | Sara Dadipoor[2]

[1]Department of Health Information Management and Technology, School of Allied Medical Sciences, Infectious and Tropical Diseases Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

[2]Department of Public Health, School of Health, Social Determinants in Health Promotion Research Center, Hormozgan Health Institute, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

Correspondence
Sara Dadipoor, Department of Public Health, Social Determinants in Health Promotion Research Center, Hormozgan Health Institute, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.
Email: dadipoorsara@gmail.com and mdadipoor@yahoo.com

Funding information
Hormozgan University of Medical Sciences, Grant/Award Number: 1399.036

Abstract

Background and Aims: About one-fifth of patients with COVID-19 need to be hospitalized. Predicting factors affecting the hospital length of stay (LOS) can be effective in prioritizing patients, planning for services, and preventing the increase in LOS and death of patients. The present study aimed to identify the factors that predict LOS and mortality in COVID-19 patients in a retrospective cohort study.

Methods: A total of 27,859 patients were admitted to 22 hospitals from February 20, 2020 to June 21, 2021. The data collected from 12,454 patients were screened according to the inclusion and exclusion criteria. The data were captured from the MCMC (Medical Care Monitoring Center) database. The study tracked patients until their hospital discharge or death. Hospital LOS and mortality were assessed as the study outcomes.

Results: As the results revealed, 50.8% of patients were male and 49.2% were female. The mean hospital LOS of the discharged patients was 4.94. Yet, 9.1% of the patients ($n = 1133$) died. Among the predictors of mortality and long hospital LOS were the age above 60, admission to the ICU, coughs, respiratory distress, intubation, oxygen level less than 93%, cigarette and drug abuse, and a history of chronic diseases. Masculinity, gastrointestinal symptoms, and cancer were the effective variables in mortality, and positive CT was a factor significantly affecting the hospital LOS.

Conclusion: Paying special attention to high-risk patients and modifiable risk factors such as heart disease, liver disease, and other chronic diseases can diminish the complications and mortality rate of COVID-19. Providing training, especially for those who care for patients experiencing respiratory distress such as nurses and operating room personnel can improve the qualifications and skills of medical staff. Also, ensuring the availability of sufficient supply of medical equipment is strongly recommended.

Abbreviations: COVID-19, Coronavirus disease 2019; LOS, hospital length of stay.

KEYWORDS
COVID-19, Iran, length of stay, mortality rate, predictors, SARS-CoV-2

1 | INTRODUCTION

In December 2019, a new kind of respiratory distress disorder emerged in Wuhan, China, which the World Health Organization (WHO) designated COVID-19 on January 11, 2020.[1] It has been one of the greatest challenges of the world in the past century. COVID-19 has had the greatest global uncertainty index in recent years.[2] Statistical evidence confirms that COVID-19 has been the most serious pandemic since the emergence of Spanish flu in 1918, when between 40 and 50 million people died worldwide.[3] From the time the disease was proclaimed to be a global threat by WHO, to date (February 13, 2023) more than 755,703,002 people have been infected in the world and more than 6,836,825 people have died. In Iran at the time of the study, 7,224,701 were infected with COVID-19 among whom 141,165 died.[4]

Patients with COVID-19 infection frequently report fever, coughing, fatigue, anorexia, myalgia, and diarrhea; however, in severe cases, dyspnea is typically the most prominent symptom, frequently accompanied by hypoxemia.[5] Patients with severe respiratory failure brought on by interstitial pneumonia and acute respiratory distress syndrome have a higher fatality rate.[6] Furthermore, older age, male gender, pre-existing cardiovascular conditions, asthma, hypertension, uncontrolled diabetes, chronic lung disease, and a d-dimer larger than 1 g/mL at admission were all linked to a higher mortality rate.[7]

In a meta-analysis study, patients with a history of chronic diseases, smoking, being female, and aging had increased mortality rates. The most likely independent predictor of mortality among hospitalized patients was acute respiratory distress syndrome.[8]

There was no consistent cutoff point for prolonged LOS. However, it was described as the total number of bed days a patient spent in the hospital when their stay lasted longer than anticipated for a particular procedure.[9] The COVID-19 hospital LOS is dependent on the clinical condition of the patients, but it is also influenced by guidelines within the institution or local healthcare authority, as well as the capacity of hospitals.[5]

The collected data showed that 5%–20% of COVID-19-infected patients need to be hospitalized and of these patients, 14%–20% require admission to the intensive care unit (ICU).[10] According to a study, the health system, which only has 3.2 hospital beds for every 1000 people, reached the breaking point due to the rapid rise in COVID-19 infection cases and the associated requirement for hospitalization.[11] Hospital LOS is a crucial predictor for healthcare planning. According to reports, shorter hospital stays are linked to lower mortality rates, fewer nosocomial infections, lower patient financial burden, and higher hospital bed turnover rates.[9,12]

Predicting LOS-related factors and mortality rate in COVID-19 patients can help better prioritize patients, make emergent decisions, provide healthcare services, and seek useful and necessary solutions to reduce mortality and hospital LOS. Although the predictors of mortality and hospital LOS have been previously reported in studies,[1,13,14] according to the epidemiological characteristics of patients and the specific socioeconomic features of each region, it is necessary to examine the correlates of hospital LOS and mortality in each region separately. It was recommended in an investigation that these factors be repeated in several studies to ensure comprehensive literature coverage.[15] Therefore, the present study was conducted to identify the predictors of mortality and hospital LOS in COVID-19-infected patients in Hormozgan Province in the south of Iran.

2 | METHODOLOGY

2.1 | Study setting and design

The present retrospective study was conducted between February 20, 2020 and June 21, 2021 among patients in Hormozgan Province in the south of Iran. The patients were definitely diagnosed with COVID-19 according to the "Diagnosis and Treatment Scheme for Novel Coronavirus Pneumonia (Trial), 6th Edition" adopted by the People's Republic of China's National Health Commission on February 19, 2021.[16]

Hormozgan Province lies between the coordinates of 25°24′ to 28°57′N latitude and 53°41′ to 59°15′E longitude. With an area of about 68,000 square kilometers (about the size of Georgia), Hormozgan is the eighth largest province in Iran.

2.2 | Research population and eligibility criteria

The research population consisted of all COVID-19-infected inpatients (with confirmed test results) who were either discharged from hospital (actually survived) or deceased. These patients were sampled from 22 active hospitals throughout the province that admitted COVID-19 patients. Patients diagnosed with confirmed COVID-19, discharged patients, and the deceased were included in this study. The exclusion criteria were incomplete information and outpatients.

2.3 | Research variables

2.3.1 | Dependent variables

Within-hospital mortality and hospital length of stay (LOS)

LOS: This variable was measured as the average length of hospitalization. Patients who remained in the hospital longer than the median length of stay were categorized as "long-term LOS" and those who remained below the median LOS were referred to as "short-term LOS."

2.3.2 | Independent variables

The demographic variables included: age, gender, ward, history of cigarette, or drug abuse

Clinical symptoms: fever, coughs, sore muscles, respiratory distress, headache or dizziness, sore throat, respiratory distress, gastrointestinal symptoms (vomiting, diarrhea, anorexia, abdominal pain, nausea), sore muscles, coughs, fever, CT result, PO2 level, intubation

History: diabetes, heart disease, hypertension, renal disease, asthma or chronic pulmonary disease, chronic liver disease, chronic neurological disorder, cancer

2.3.3 | Sample size estimation and sampling procedure

The required data were collected from patients' information recorded in the MCMC (Medical Care Monitoring Center) database. This national system covers the information of all patients admitted to the country's hospitals by province, city, and hospital name. This study was conducted on 12,454 patients who were admitted to 22 hospitals in Hormozgan Province from February 20, 2020 to June 21, 2021 with a definitive diagnosis of COVID-19.

2.3.4 | Data collection instrument, process, and management

The data were obtained from the electronic health records of the patients using a distinct medical record number (MRN) for each patient. A medical team, including medical residents and a consultant pulmonologist, evaluated and double-checked all the data.

In the MCMC system of Hormozgan Province from February 20, 2020 to the June 21, 2021, a total number of 28,759 people were diagnosed with the acute respiratory syndrome, out of which 15,405 were excluded for certain reasons. For instance, 10,761 patients tested negative for COVID-19, 4045 received outpatient care, and 599 had missing data. Finally, the data from 12,454 patients who tested positive for COVID-19 and had complete information about all the variables were included in the final analysis (Figure 1).

2.3.5 | Outcomes

The expected outcome was identifying the predictors of hospital LOS and mortality.

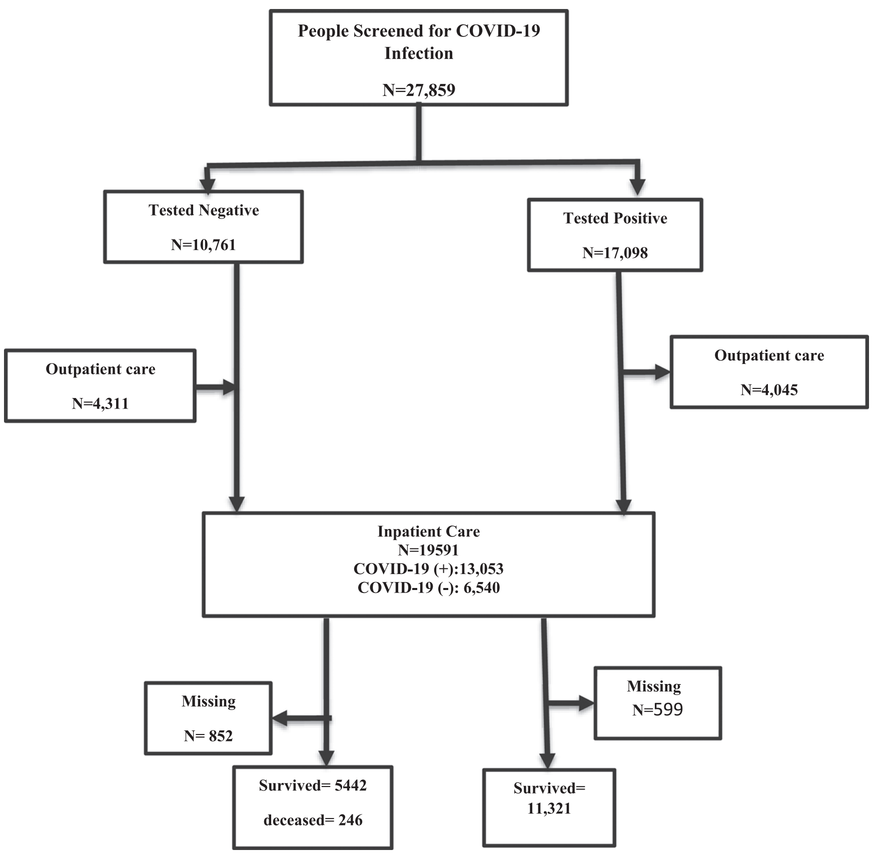

FIGURE 1 Sampling procedure.

TABLE 1 Research participants' sociodemographic features ($N = 12{,}454$).

Characteristics	Level	Discharged (survived the disease) f.	%	Deceased f.	%	Total
Age groups	≥60	3217	28.42	737	65.05	3954
	20–59	7938	70.12	393	34.69	8331
	0–19	166	1.47	3	0.26	169
Gender	Male	5645	49.86	676	59.66	6321
	Female	5676	50.14	457	40.34	6133
Ward	ICU	276	2.44	852	75.20	1128
	Ordinary or isolated	11,045	97.56	281	24.80	11,326
Fever	Yes	4579	40.45	445	39.28	5024
	No	6742	59.55	688	60.72	7430
Coughs	Yes	6299	55.64	564	49.78	6863
	No	5022	44.36	569	50.22	5591
Sore muscles	Yes	4796	42.36	344	30.36	5140
	No	6525	57.64	789	69.64	7314
Respiratory distress	Yes	4408	38.94	763	67.34	5171
	No	6913	61.06	370	32.66	7283
Gastrointestinal symptoms	Yes	2923	25.82	233	20.56	3156
	No	8398	74.18	900	79.44	9298
Headache/dizziness	Yes	2100	18.55	145	12.80	2245
	No	9221	81.45	988	87.20	10,209
Sore throat	Yes	585	5.17	63	5.56	648
	No	10,736	94.83	1070	94.44	11,806
Intubated	Yes	231	2.04	681	60.11	912
	No	11,090	97.96	452	39.89	11,542
PO2	<93	2124	18.76	769	67.87	2893
	>93	9197	81.24	364	32.13	9561
CT	Positive	11,073	97.81	1117	98.59	12,190
	Negative	248	2.19	16	1.41	264
Cigarette or drug abuse	Yes	215	1.90	56	4.94	271
	No	11,106	98.10	1077	95.06	12,183
Cancer	Yes	94	0.83	31	2.74	125
	No	11,227	99.17	1102	97.26	12,329
Chronic liver disease	Yes	26	0.23	7	0.62	33
	No	11295	99.77	1126	99.38	12,421
Diabetes	Yes	1715	15.15	362	31.95	2077
	No	9606	84.85	771	68.05	10,377
Cardiac disease	Yes	1042	9.20	324	28.60	1366
	No	10,279	90.80	809	71.40	11,088
Renal disease	Yes	169	1.49	88	7.77	257
	No	11,152	98.51	1045	92.23	12,197

TABLE 1 (Continued)

Characteristics	Level	Discharged (survived the disease) f.	%	Deceased f.	%	Total
Asthma/chronic pulmonary disease	Yes	356	3.14	70	6.18	426
	No	10,965	96.86	1063	93.82	12,028
Chronic neurological disease	Yes	88	0.78	17	1.50	105
	No	11,233	99.22	1116	98.50	12,349
Hypertension	Yes	2033	17.96	467	41.22	2500
	No	9288	82.04	666	58.78	9954

2.4 | Statistical analysis

The data recorded in MCMC system were punched into SPSS16. Descriptive statistics, including frequency, percentage, mean with SD, and median with interquartile range (IQR) were used to describe the participants. Chi-square assumption was tested before the statistical analysis. For each predictor variable, bivariate binary logistic regressions were fitted. The variables with p values less than 0.25 were candidate for multivariable logistic regression models to test their effects after adjusting for the potential confounders. In the multivariable logistic regressions, predictor variables were provided using adjusted odds ratios (AORs) at 95% confidence intervals (CIs). Finally, the statistical significance was substantiated at a p value lower than 0.05.

2.5 | Ethical statement

The ethics board at Hormozgan University of Medical Sciences approved this study (Ref. no. IR.HUMS.REC.1399.036). Informed consent was obtained from patients and they were assured that their personal information would be kept confidential and used for research purposes. The ethical principles of the Declaration of Helsinki were followed during the collection, handling, and storage of data, and all care was taken to protect patient confidentiality.

3 | RESULTS

3.1 | Sociodemographic features

The data from 12,454 patients were analyzed. In all, 50.8% of these patients ($n = 6321$) were male and 49.2% of patients ($n = 6133$) were female. The mean and SD of age were 50.25 ± 17.20 years for men and 50.97 ± 16.46 years for women. Out of the 12,454 patients, 1133 (9.1%) died. Of the deceased, 676 (59.7%) were male and 457 (40.3%) were female. Of the deaths, 737 (65.05%) occurred in patients aged 60 years or older. The details of participants' features and the clinical symptoms were compared between two groups of "survived" and "deceased" as indicated in Table 1.

3.2 | Predictors of mortality

In the multivariate regression analysis, the adjusted odds ratio of mortality for those at or above 60 compared to those in the 0–19 age group was OR = 10.02 (CI 95%: 1.61, 62.47). For patients admitted to the ICU in comparison to those admitted to the ordinary or isolated ward, the odds ratio was OR = 47.47 (CI 95%: 37.54, 60.03). The same value for intubated patients was OR = 31.73 (CI 95%: 24.03, 41. 89). For individuals with PO2 less than 93, the odds ratio was OR = 3.29 (CI 95%: 2. 63, 4.12). The other mortality predictors are listed in Table 2.

Overall, the mean and SD of hospital LOS was 4.94 ± 3.72 with a median of 4 days. In the "survived" group, the mean and SD of hospital LOS was 3.86 ± 5.03. In women, the mean and SD of LOS was 4.85 ± 3.57 with a median of 4 days.

3.3 | Predictors of hospital LOS

In the multivariate regression analysis, the adjusted odds ratio of long-term LOS for those aged 60 or more compared to the 0–19 age group was OR = 2.29 (CI 95%: 1.55, 3.39). In Mitella patients with asthma or chronic lung disease, the odds ratio was OR = 1.24 (CI 95%: 1.09, 1.49), and in patients with hypertension it was OR = 1.43 (CI 95%: 1.03, 1.98) (Tables 3 and 4).

4 | DISCUSSION

The present study aimed to identify the predictors of mortality and hospital LOS in COVID-19-infected patients. The factors that independently affected mortality and hospital LOS were age over 60, admission to ICU, coughs, respiratory distress, intubation, oxygen level below 93%, cigarette or drug abuse, diabetes, cardiovascular disease, renal disease, asthma or chronic pulmonary disease and hypertension. Masculinity, gastrointestinal symptoms and cancer specifically affected mortality, and positive CT specifically affected the LOS.

In Hormozgan Province, there were 215,847 infected cases up to May 8, 2022 of whom 2614 died. In the present study, the

TABLE 2 Predictors of patient mortality ($N = 12{,}454$).

		Univariate				Multivariate			
			95% CI for OR				95% CI for OR		
Covariates	Level	OR	Lower	Upper	*p* Value	OR	Lower	Upper	*p* Value
Age groups	≥60	12.68	4.04	39.82	<0.001	10.02	1.61	62.47	0.014
	20–59	2.74	0.87	8.62	0.085	3.75	0.60	23.28	0.157
	0–19	Reference				Reference			
Gender	Male	1.49	1.31	1.68	<0.001	1.58	1.26	1.99	<0.001
	Female	Reference				Reference			
Ward	ICU	121.34	101.34	145.28	<0.001	47.47	37.54	60.03	<0.001
	Ordinary or isolated	Reference				Reference			
Fever	Yes	0.95	0.84	1.08	0.444				
	No	Reference				Reference			
Coughs	Yes	0.79	0.70	0.89	<0.001	1.05	0.84	1.31	0.677
	No								
Sore muscles	Yes	0.59	0.52	0.68	<0.001	0.85	0.67	1.09	0.199
	No	Reference				Reference			
Respiratory distress	Yes	3.23	2.84	3.68	<0.001	1.87	1.50	2.37	<0.001
	No	Reference				Reference			
Gastrointestinal disorder	Yes	0.74	0.64	0.86	<0.001	0.75	0.57	0.98	0.036
	No	Reference				Reference			
Headache/dizziness	Yes	0.644	0.54	0.77	<0.001	0.82	0.58	1.14	0.241
	No	Reference				Reference			
Sore throat	Yes	1.081	0.83	1.41	0.570				
	No	Reference				Reference			
Intubated	Yes	72.33	60.63	86.28	<0.001	31.73	24.03	41.89	<0.001
	No	Reference				Reference			
PO2	<93	9.15	8.00	10.45	<0.001	3.29	2.63	4.12	<0.001
	>93	Reference				Reference			
CT	Positive	1.56	0.94	2.60	0.085	1.19	0.53	2.68	0.673
	Negative	Reference				Reference			
Cigarette or drug abuse	Yes	2.67	1.99	3.63	<0.001	2.31	1.37	3.89	0.002
	No	Reference				Reference			
Cancer	Yes	3.36	2.23	5.07	<0.001	2.69	1.27	5.70	0.010
	No	Reference				Reference			
Chronic liver disease	Yes	2.70	1.17	6.24	0.020	1.04	0.14	7.66	0.969
	No	Reference				Reference			
Diabetes	Yes	2.63	2.30	3.01	<0.001	1.37	1.05	1.78	0.020
	No	Reference				Reference			
Cardiac disease	Yes	3.95	3.42	4.56	<0.001	2.53	1.93	3.32	<0.001
	No	Reference				Reference			

TABLE 2 (Continued)

		Univariate				Multivariate			
			95% CI for OR				95% CI for OR		
Covariates	Level	OR	Lower	Upper	*p* Value	OR	Lower	Upper	*p* Value
Renal disease	Yes	5.56	4.26	7.24	<0.001	3.08	1.83	5.18	<0.001
	No	Reference				Reference			
Asthma/chronic pulmonary disease	Yes	2.03	1.56	2.64	<0.001	1.93	1.18	3.15	0.008
	No	Reference				Reference			
Chronic neurological disease	Yes	1.94	1.15	3.28	0.013	1.02	0.35	2.95	0.978
	No	Reference				Reference			
Hypertension	Yes	3.20	2.82	3.64	<0.001	1.55	1.20	2.00	0.001
	No	Reference				Reference			

within-hospital mortality rate was 9,097. A study reported that the increasing incidence and mortality of COVID-19 worldwide is a significant issue.[17] Sadeghifar et al.[13] reported a mortality rate of 3.9% among COVID-19 patients in Ilam. Shahriarirad et al. carried out a retrospective multicenter study to assess the clinical characteristics of COVID-19 patients in Fars Province. The findings revealed that individuals with COVID-19 had an overall mortality rate of 8%,[18] which was lower than the mortality rate of the present study. In addition, a meta-analysis of mortality in COVID-19 patients was reported to be 15%.[8] These divergent findings can be explained by different demographic features of patients, different geographies, time and setting of research and the severity of disease.

As the present findings showed, the mean days of hospital stay for survivors were 4.72 ± 3.72 with a median of 4 days and a range of 1–68 days. For the deceased patients, the mean duration was 8.342 ± 9.56 with a median of 7 days and a range of 1–64. In a number of studies, the mean days of hospital stay were 12 and 13 days.[19,20] However, in Saudi Arabia, the mean duration was 6 days,[5] while patients not admitted to the ICU in the United States had a mean duration of 6 days.[21] In France, Peru, the Mediterranean, London, and Tehran, the mean hospital LOS was respectively 9,[22] 7,[22] 8.5,[23] 6,[24] and 7.5 days[25] These variations in hospital stay could be attributed to differences in countries, geographical regions, health facilities, and the severity of patients' conditions.[26] Other demographic factors, such as age, may also contribute to these differences.

According to the present findings, old age was associated with higher mortality rates and longer hospital stays. This is consistent with other studies that have identified age as a significant predictor of both mortality and hospital length of stay.[7,19,25] In a retrospective, multicenter cohort study conducted in China, patients who died from COVID-19 had a mean age of approximately 69 years, which was significantly higher than those who survived.[7] It appears that as age increases, the probability of death induced by COVID-19 and the LOS increases too. This could be attributed to weakened immune systems in older patients, as well as various behavioral reactions to treatments.[27]

In the present study, admission to the ICU was identified as a predictor of both mortality and longer hospital stay. A meta-analysis found a high mortality rate among ICU patients.[8,28] In another study, ICU patients had a high probability of mortality.[21] This result was quite expected since patients with acute medical conditions often require critical care. Therefore, they have a higher risk of mortality compared to those in regular hospital wards.

Respiratory distress and intubation were the other predictors of increased mortality and longer hospital LOS. Patients who experience respiratory problems face a higher risk of complications that can lead to death or prolonged hospitalization. This study supports previous findings that respiratory distress was a significant factor in COVID-19 patients' mortality.[19] Additionally, Zhang et al.[29] reported a 100% increase in mortality rates for patients with damaged lungs.[29] A study in Iran found that patients with shortness of breath, sore throat, and abnormal chest radiographic test results were at greater risk of dying compared to other patients.[13] In another study, patients with respiratory distress had an eight times higher mortality rate than those without respiratory issues.[8] Moreover, studies on patients with respiratory problems consistently showed longer hospital stays.[21,30]

Low oxygen levels (below 93%) have been identified as a predictor of mortality and length of hospital stay in COVID-19 patients. Several studies have found that lower O_2 levels are linked to an increased risk of death.[30–34] This may be due to alveolar damage, which can interfere with the exchange of oxygen and carbon dioxide, ultimately leading to early mortality in COVID-19 patients.[35]

The current study found that patients with comorbidities had higher rates of mortality and longer hospital stays. These findings are supported by other research studies.[20,36,37] In contrast, Yuriy Pya[31] reported no association between comorbidities and mortality in their study. However, they suggested that this may have been due to certain comorbidities going undiagnosed or incomplete data, indicating a need for further research in this area.

The correlation found between comorbidities and mortality rate in the present study could be due to the fact that the coexistence of COVID-19 infection with other diseases could have an

TABLE 3 Research participants' socio-demographic features (associated with LOS) (N = 11,321).

Characteristics	Level	Long term stay		Short term stay		Total
		f.	%	f.	%	
Age groups	≥60	1545	31.95	1672	25.78	3217
	20–59	3237	66.94	4701	72.49	7938
	0–19	54	1.12	112	1.73	166
	Total	4836	100.00	6485	100.00	11,321
Gender	Male	2449	50.64	3196	49.28	5645
	Female	2387	49.36	3289	50.72	5676
	Total	4836	100.00	6485	100.00	11,321
Ward	ICU	166	3.43	110	1.70	276
	Ordinary or isolated	4670	96.57	6375	98.30	11,045
	Total	4836	100.00	6485	100.00	11,321
Fever	Yes	1941	40.14	2638	40.68	4579
	No	2895	59.86	3847	59.32	6742
	Total	4836	100.00	6485	100.00	11,321
Coughs	Yes	2762	57.11	3537	54.54	6299
	No	2074	42.89	2948	45.46	5022
	Total	4836	100.00	6485	100.00	11,321
Sore muscles	Yes	2051	42.41	2745	42.33	4796
	No	2785	57.59	3740	57.67	6525
	Total	4836	100.00	6485	100.00	11,321
Respiratory distress	Yes	2070	42.80	2338	36.05	4408
	No	2766	57.20	4147	63.95	6913
	Total	4836	100.00	6485	100.00	11,321
Gastrointestinal symptoms	Yes	1293	26.74	1630	25.13	2923
	No	3543	73.26	4855	74.87	8398
	Total	4836	100.00	6485	100.00	11,321
Headache/dizziness	Yes	893	18.47	1207	18.61	2100
	No	3943	81.53	5278	81.39	9221
	Total	4836	100.00	6485	100.00	11,321
Sore throat	Yes	286	5.91	299	4.61	585
	No	4550	94.09	6186	95.39	10,736
	Total	4836	100.00	6485	100.00	11,321
Intubated	Yes	130	2.69	101	1.56	231
	No	4706	97.31	6384	98.44	11,090
	Total	4836	100.00	6485	100.00	11,321
PO2	<93	1261	26.08	863	13.31	2124
	>93	3575	73.92	5622	86.69	9197
	Total	4836	100.00	6485	100.00	11,321
CT	Positive	4758	98.39	6315	97.38	11073
	Negative	78	1.61	170	2.62	248
	Total	4836	100.00	6485	100.00	11,321

TABLE 3 (Continued)

Characteristics	Level	Long term stay		Short term stay		Total
		f.	%	f.	%	
Cigarette or drug abuse	Yes	80	1.65	135	2.08	215
	No	4756	98.35	6350	97.92	11,106
	Total	4836	100.00	6485	100.00	11,321
Cancer	Yes	45	0.93	49	0.76	94
	No	4791	99.07	6436	99.24	11,227
	Total	4836	100.00	6485	100.00	11,321
Chronic liver disease	Yes	16	0.33	10	0.15	26
	No	4820	99.67	6475	99.85	11,295
	Total	4836	100.00	6485	100.00	11,321
Diabetes	Yes	811	16.77	904	13.94	1715
	No	4025	83.23	5581	86.06	9606
	Total	4836	100.00	6485	100.00	11,321
Cardiac disease	Yes	542	11.21	500	7.71	1042
	No	4294	88.79	5985	92.29	10,279
	Total	4836	100.00	6485	100.00	11,321
Renal disease	Yes	87	1.80	82	1.26	169
	No	4749	98.20	6403	98.74	11,152
	Total	4836	100.00	6485	100.00	11,321
Asthma/chronic pulmonary disease	Yes	171	3.54	185	2.85	356
	No	4665	96.46	6300	97.15	10,965
	Total	4836	100.00	6485	100.00	11,321
Chronic neurological disease	Yes	41	0.85	47	0.72	88
	No	4795	99.15	6438	99.28	11,233
	Total	4836	100.00	6485	100.00	11,321
Hypertension	Yes	921	19.04	1112	17.15	2033
	No	3915	80.96	5373	82.85	9288
	Total	4836	100.00	6485	100.00	11,321

immunosuppressive effect and poor treatment response, which might adversely affect the treatment outcome of the infected patients.[38] Additionally, comorbidities can contribute to the development of an acute hyperinflammatory response known as a cytokine storm, which can further increase the risk of mortality in COVID-19 patients.[32]

In the present study, it was found that men had a higher mortality rate than women. This is consistent with the findings of a systematic review, which indicated that masculinity was one of the predictors of patient death.[39] One possible explanation for this disparity is the higher prevalence of COVID-19 among men as compared to women. The incidence of COVID-19 was higher in men than in women, as evidenced by the Sadeghifar et al.[13] It is thought that the natural immunity of women, which is bolstered by chromosome X protection and sex hormones, makes them less susceptible to viral infections.[40]

In the present study, the odds of mortality were higher in patients with cancer. Similar studies revealed that patients with cancer are at greater risk of mortality compared to the general population.[37–39] Williams et al.[41] reported that the mortality rate increased for at least 2.5-fold in patients with hematologic malignancy.[41] This increased risk is likely due to both the nature of cancer and the effects of antineoplastic medications, which compromise the immune system. As a result, these patients are more vulnerable to severe and potentially fatal COVID-19 infections. In addition, frequent clinical visits for follow-up and chemotherapy treatment may expose cancer patients to infection.[42]

TABLE 4 Predictors of hospital LOS.

Covariates	Level	Univariate				Multivariate			
			95% CI for OR				95% CI for OR		
		OR	Lower	Upper	*p* Value	OR	Lower	Upper	*p* Value
Age group	≥60	1.92	1.37	2.67	<0.001	2.29	1.55	3.39	<0.001
	20–59	1.43	1.03	1.98	0.033	1.45	0.98	2.13	0.062
	0–19	Reference				Reference			
Gender	Male	1.06	0.98	1.14	0.153	1.05	0.97	1.14	0.185
	Female	Reference				Reference			
Ward	ICU	2.06	1.61	2.63	<0.001	1.81	1.41	2.32	<0.001
	Ordinary or isolated	Reference				Reference			
Fever	Yes	0.98	0.91	1.06	0.561	Not included in the multivariate analysis			
	No	Reference							
Coughs	Yes	1.11	1.03	1.19	0.006	1.15	1.06	1.24	0.000
	No	Reference				Reference			
Sore muscles	Yes	1.00	0.93	1.08	0.930	Not included in the multivariate analysis			
	No	Reference							
Respiratory distress	Yes	1.33	1.23	1.43	<0.001	1.19	1.10	1.29	<0.001
	No	Reference				Reference			
Gastrointestinal symptoms	Yes	1.09	0.99	1.18	0.054	1.06	0.97	1.16	0.219
	No	Reference				Reference			
Headache/dizziness	Yes	0.99	0.90	1.09	0.843	Not included in the multivariate analysis			
	No	Reference							
Sore throat	Yes	1.30	1.10	1.54	0.001	1.30	0.97	1.72	0.076
	No	Reference				Reference			
Intubated	Yes	1.75	1.33	2.29	<0.001	1.74	1.35	2.25	<0.001
	No	Reference				Reference			
PO2	<93	2.30	2.09	2.53	<0.001	1.94	1.74	2.16	<0.001
	>93	Reference				Reference			
CT	Positive	1.64	1.25	2.15	<0.001	1.45	1.10	1.90	0.008
	Negative	Reference				Reference			
Cigarette or drug abuse	Yes	1.50	1.13	1.98	<0.001	1.58	1.38	2.29	0.003
	No	Reference				Reference			
Cancer	Yes	1.23	0.82	1.85	0.311	Not included in the multivariate analysis			
	No	Reference							
Chronic liver disease	yes	2.15	0.97	4.74	0.058	1.13	0.97	1.27	0.088
	No	Reference				Reference			
Diabetes	Yes	1.24	1.12	1.38	<0.001	1.16	1.04	1.30	0.007
	No	Reference				Reference			
Cardiac disease	Yes	1.51	1.33	1.72	<0.001	1.27	1.11	1.46	0.000
	No	Reference				Reference			
Renal disease	Yes	1.43	1.06	1.94	0.021	1.47	1.08	2.02	0.016
	No	Reference				Reference			

TABLE 4 (Continued)

		Univariate				Multivariate			
			95% CI for OR				95% CI for OR		
Covariates	Level	OR	Lower	Upper	*p* Value	OR	Lower	Upper	*p* Value
Asthma/chronic pulmonary	Yes	1.32	1.07	1.64	0.008	1.24	1.09	1.49	0.010
	No	Reference				Reference			
Chronic neurological	Yes	1.17	0.77	1.78	0.461	Not included in the multivariate analysis			
	No	Reference							
Hypertension	Yes	1.14	1.03	1.25	0.009	1.43	1.03	1.98	0.034
	No	Reference				Reference			

According to Li et al.,[19] coughing and sputum production are common symptoms among patients with severe or acute COVID-19, and were found to be significant predictors of mortality in the present study. While coughing is a symptom often associated with pulmonary conditions such as asthma and lung cancer, it was also found to be prevalent in COVID-19 patients. In fact, a previous study showed that coughing was the most commonly reported symptom among patients with chronic pulmonary disease and lung cancer.[43]

According to the results of this study, cigarette and drug abuse were identified as significant predictors of mortality and longer hospital stay. Similarly, another study found that smoking was a major predictor of mortality among COVID-19 patients.[32,43] This may be due to the fact that smoking and drug abuse can lead to compromised lung function, which could exacerbate COVID-19 infections and ultimately lead to fatalities.[7]

4.1 | Conclusion

The present study confirmed the impact of effective demographic variables such as age, gender, cigarette smoking, and drug abuse along with clinical symptoms such as coughs, respiratory distress, intubation, oxygen level less than 93, and chronic comorbidities on mortality and hospital LOS. To reduce complications and mortality rates associated with COVID-19, it is essential to focus on high-risk patients and address modifiable risk factors, such as heart disease, liver disease, and other chronic illnesses. The medical team, notably nurses and operating room staff should receive proper training to improve their readiness and skills in dealing with patients experiencing respiratory distress, given the high hospitalization rate for these individuals.

To accelerate diagnosis and treatment processes, medical facilities must ensure an adequate supply of medical equipment like oxygen generators, ECMO devices, and portable digital imaging machines for respiratory ICU. Early classification of COVID-19 patients' risk factors upon admission can also facilitate more effective care delivery.

4.2 | Strengths and limitations

Retrospective studies have certain limitations including incorrect classification, low coding accuracy, and missing data. Additionally, lack of access to laboratory findings can be a challenge in such studies. The retrospective nature of the data necessitates careful interpretation of the current findings. Furthermore, the cross-sectional design of the study prevents the researcher from inferring causal relationships between the independent and dependent variables. However, using a secondary data set in the analyses can lead to a larger sample size, increasing the statistical power and external validity of the study.

4.3 | Implications

We believe that our results are somehow in line with the findings of similar studies, which can help to better classify the risk factors. By identifying high-risk patients more accurately, these findings have the potential to prevent healthcare facilities from becoming overcrowded and limit treatment to specialized centers where severe illness is more likely to occur. Additionally, healthcare professionals can utilize our findings to predict mortality rates associated with specific risk factors, enabling them to make informed decisions and provide better care for infected individuals. However, further large-scale research is needed to validate our findings.

AUTHOR CONTRIBUTIONS

Zahra Mastaneh: Conceptualization; data curation; investigation; methodology; writing—original draft. **Ali Mouseli**: Conceptualization; investigation; methodology; writing—original draft. **Shokrollah Mohseni**: Data curation; formal analysis; methodology. **Sara Dadipoor**: Conceptualization; investigation; methodology; supervision; writing—original draft.

ACKNOWLEDGMENTS

This work was supported by a grant from the Hormozgan University of Medical Sciences. The authors sincerely thank all the participants for their sincere cooperation in this study.

DATA AVAILABILITY STATEMENT

The corresponding author will provide the data supporting the study's finding on reasonable request. Sara Dadipoor had full access to all of the data in this study and took complete responsibility for the integrity of the data and the accuracy of the data analysis.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICS STATEMENT

All methods adhere to the Helsinki Declaration. The Hormozgan University of Medical Sciences ethics committee approved the study (ethical code ref. no. IR.HUMS.REC.1399.036). To participate in this study, all individuals completed an online consent form.

TRANSPARENCY STATEMENT

The lead author Sara Dadipoor affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Sara Dadipoor http://orcid.org/0000-0002-4205-6235

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How to cite this article: Mastaneh Z, Mouseli A, Mohseni S, Dadipoor S. Predictors of hospital length of stay and mortality among COVID-19 inpatients during 2020–2021 in Hormozgan Province of Iran: a retrospective cohort study. *Health Sci Rep*. 2023;6:e1329. doi:10.1002/hsr2.1329