



Risk factors associated with mortality in COVID-19 patients with pulmonary involvement in Behbahan County, Southwestern Iran

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ABSTRACT

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Coronavirus disease 2019 (COVID-19) pandemic and its rising death toll have become a global issue. To address the disease's evolving nature, it is crucial to identify factors influencing its severity. The purpose of this study was to look at the risk factors for death in COVID-19 patients with pulmonary involvement. A total of 340 patients with confirmed COVID-19 who were admitted to Shahidzadeh Hospital in Behbahan, Iran, participated in this retrospective cohort study. Between March 20, 2020, and January 20, 2021, patient data was gathered from medical records. The Cox proportional hazards regression model was used for the statistical analysis. The mean age of patients was 58.3 ± 16.71 years (range: 13–96 years) at diagnosis. Among the study population, 63 patients (18.5%) died, whereas 277 patients (81.5%) achieved clinical recovery. Dyspnea (64.1%), cough (45%), and chills (42.4%) were the most commonly reported symptoms during hospitalization. Both lungs (50%), the upper zone (16.2%), and the left lung (7.9%) were the most affected lung areas. Age (Hazard Ratio=1.03; 95% CI 1.02-1.05; $P<0.001$) and cardiovascular disorders (Hazard Ratio=2.71; 95% CI: 1.59-4.62; $P<0.001$) were associated with COVID-19 patient death, according to multivariate regression analysis. The study found a significant link between increased mortality in COVID-19 patients and factors such as old age and cardiovascular disease. These findings implement a self-care program for elderly and cardiovascular patients to help reduce mortality rates.

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1. Introduction

Since its emergence in Wuhan, China, in 2019, the coronavirus disease (COVID-19) has evolved into a critical global health challenge. On March 11, 2020, it was declared a pandemic by the World Health Organization (WHO).

This condition can manifest clinically as anything from an infection with no symptoms to severe respiratory distress syndrome that necessitates intensive care unit hospitalization [1,2]. Considering that approximately more than 80% of COVID-19 patients experience mild clinical symptoms, early identification of risks associated with adverse outcomes can significantly contribute to improving patient outcomes and increasing survival rates. Research has demonstrated that the advancement of disease and the existence of pre-existing ailments (including cardiovascular diseases, diabetes, and hypertension) are risk factors linked to patient death [3–6].

Given the above and the variability in clinical manifestations, imaging findings, and the rapid progression and severity of the disease, identifying prognostic factors for COVID-19 is of particular importance [7–9]. Since no research has been done in Behbahan County on the risk factors related with death in COVID-19 patients with pulmonary involvement, this study aims to examine prognostic variables associated with mortality risk.

2. Materials and Methods

2.1 Study design

A total of 340 patients with a confirmed diagnosis of COVID-19 based on positive RT-PCR results who were admitted to Shahidzadeh Hospital in Behbahan, southwest Iran, between March 20, 2020, and January 20, 2021, were included in this retrospective cohort study. The presence and pattern of pulmonary involvement were determined based on chest computed tomography (CT) findings. Medical records containing insufficient or incomplete information were excluded from the final analysis. Demographic attributes, clinical symptoms, and underlying conditions were gathered and noted from their health records.

2.2 Data collection

Information retrieved from the medical records was organized into five main categories: demographic characteristics, clinical manifestations at admission, vital signs, underlying conditions and medical history, and pulmonary imaging findings.

Demographic information consisted of age and gender. When assessing the clinical profile at admission, factors such as cough, pain and bruising, chills, fatigue and lethargy, loss of smell, headache, sore throat, chest pain, dyspnea, abdominal pain, anorexia, nausea and

vomiting, diarrhea, loss of consciousness, vertigo, and orthopnea were taken into account. Heart rate, breathing rate, SpO₂, body temperature, and systolic and diastolic blood pressure were all considered vital signs. The medical history was examined for cardiovascular conditions, diabetes, hypertension, stroke, and smoking. Chest CT data were reviewed to assess pulmonary involvement, including the imaging pattern and anatomical site of lung involvement. The response variable was defined as the duration, in days, between hospital admission and the final recorded outcome of either death or recovery.

2.3 Statistical analysis

Descriptive statistics were used to summarize the research variables; continuous data were presented as mean $\pm$ standard deviation, while categorical characteristics were reported as frequency distributions and percentages. The chi-square test or Fisher's exact test for categorical variables and the Mann-Whitney U test for continuous variables were employed to compare patients with varying outcomes (survival versus death). The Cox proportional hazards regression model was used for survival analysis in order to identify the factors linked to the risk of death.

First, univariate Cox regression analysis was used to look at each variable independently. The multivariable Cox regression analysis was then applied to variables with a P-value less than 0.20. In order to find independent predictors of mortality, the final model was optimized using a backward elimination technique. A two-sided P-value of less than 0.05 was used to determine statistical significance. R software (version 4.2.1) and SPSS (version 26) were used for all statistical techniques. Survival analyses were conducted using the R survival package.

3. Results

This study comprised 340 COVID-19 individuals whose ages ranged from 13 to 96 years at diagnosis, with a mean age of 58.3 ± 16.71 years. In the research sample, 203 patients were male (59.7%) and 137 patients were female (40.3%). Of all the patients, 277 (81.5%) made a clinical recovery and 63 (18.5%) died from the condition. At the time of admission, chills (42.4%), cough (45%), and dyspnea (64.1%) were the most prevalent clinical symptoms. Diabetes (25.9%) and hypertension (24.4%) were the most common underlying diseases.

The upper zone (16.2%), the left lung (7.9%), and both lungs (50%) were the most common locations of lung involvement (Table 1).

Variables with a P-value <0.2 in the univariate analysis, including age, cardiovascular diseases, and a history of stroke, were selected for inclusion in the final multivariate Cox regression model. The final model demonstrated that age and cardiovascular diseases were

significantly associated with mortality among COVID-19 patients. Each additional year of age was associated with a 3% increase in the hazard of death (hazard ratio=1.03; 95% CI 1.02-1.05; P<0.001). Moreover, patients with

cardiovascular diseases had a 2.71-fold higher hazard of death compared with those without cardiovascular diseases (HR=2.71; 95% CI: 1.59–4.62; P <0.001) (Table 2).

Table 1. Demographic profile, clinical manifestations, and comorbidities of patients with COVID-19

Variables	Total (n=340)	Survival n (%)	Death n (%)	P-value
Overall	340	277 (81.5)	63 (18.5)	-
Demographic Characteristics				
Age (Mean ± SD)	58.3 ± 16.71	56.31 ± 16.32	67.05 ± 15.71	<0.001
Gender				0.411
Female	137 (40.3)	112 (81.8)	25 (18.2)	
Male	203 (59.7)	165 (81.3)	38 (18.7)	
Clinical manifestations at admission				
Chills	144 (42.4)	112 (77.8)	32 (22.2)	0.582
Pain and bruising	60 (17.6)	51 (85.0)	9 (15.0)	0.061
Weakness and lethargy	115 (33.8)	90 (78.3)	25 (21.7)	0.276
Loss of smell	19 (5.6)	16 (84.2)	3 (15.8)	0.752
Headache	28 (8.2)	24 (85.7)	4 (14.3)	0.546
Sore throat	12 (3.5)	12 (100)	0 (0)	0.093
Cough	153 (45.0)	129 (84.3)	24 (15.7)	0.222
Chest pain	18 (5.3)	15 (83.3)	3 (16.7)	0.834
Dyspnea	218 (64.1)	174 (79.8)	44 (20.2)	0.294
Anorexia	42 (12.4)	36 (85.7)	6 (14.3)	0.499
Abdominal pain	10 (2.9)	9 (90.0)	1 (10.0)	0.481
Nausea and vomiting	31 (9.1)	29 (93.5)	2 (6.5)	0.069
Diarrhea	10 (2.9)	9 (90.0)	1 (10.0)	0.481
Loss of consciousness	24 (7.1)	6 (25.0)	18 (75.0)	<0.001
Vertigo	12 (3.5)	9 (75.0)	3 (25.0)	0.557
Orthopnea	25 (7.4)	23 (92.0)	2 (8.0)	0.159
Vital signs at admission				
Fever (body temperature >37.5°C)	108 (31.8)	85 (78.7)	23 (21.3)	0.370
SpO ₂ < 93%	169 (49.7)	120 (71.0)	49 (29.0)	<0.001
Respiratory Rate (Mean ± SD)	21.24 ± 3.05	21.11 ± 2.52	21.85 ± 4.81	0.086
Systolic blood pressure (Mean ± SD)	117.18 ± 17.88	116.01 ± 18.70	119.04 ± 25.10	0.564
Diastolic blood pressure (Mean ± SD)	74.33 ± 14.01	74.54 ± 15.01	73.41 ± 13.43	0.843
Heart Rate (Mean ± SD)	90.33 ± 17.75	89.52 ± 17.20	93.89 ± 19.74	0.078
Underlying diseases				
Hypertension	83 (24.4)	66 (79.5)	17 (20.5)	0.598
Diabetes	88 (25.9)	66 (75.9)	22 (24.1)	0.060
Cardiovascular disease	49 (14.4)	27 (55.1)	22 (44.9)	<0.001
History of stroke	15 (4.4)	10 (66.7)	5 (33.3)	0.131
Smoking	47 (13.8)	32 (68.1)	15 (31.9)	0.011
Length of hospital stay (Mean ± SD)	7.62 ± 5.17	7.41 ± 4.77	8.54 ± 6.61	-
Lung involvement				<0.001
Right lung	22 (6.5)	21 (95.5)	1 (4.5)	
Left lung	27 (7.9)	26 (96.3)	1 (3.7)	
Both lungs	170 (50.0)	114 (67.1)	56 (32.9)	
Upper zone	55 (16.2)	55 (100)	0 (0)	
Middle zone	13 (3.8)	13 (100)	0 (0)	
Lower zone	14 (4.1)	14 (100)	0 (0)	
Central	11 (3.2)	9 (81.8)	2 (18.2)	
Posterior lobar involvement	10 (2.9)	10 (100)	0 (0)	
Other (Subpleural + lower & middle zones)	18 (5.3)	15 (83.3)	3 (16.7)	

Table 2. Univariate and multivariable Cox regression models for predictors of mortality among COVID-19 patients

Variable	Univariate Hazard Ratio (95% CI)	P-value	Multivariable Hazard Ratio (95% CI)	P-value
Age	1.03 (1.01 – 1.05)	<0.001	1.03 (1.02 – 1.05)	<0.001
Gender (ref: Male)	1.18 (0.70 – 1.96)	0.51	—	—
Cardiovascular disease (ref: No)	3.28 (1.95 – 5.53)	<0.001	2.71 (1.59 – 4.62)	<0.001
Hypertension (ref: No)	0.78 (0.44 – 1.38)	0.40	—	—
Diabetes (ref: No)	1.40 (0.83 – 2.36)	0.21	—	—
History of stroke (ref: No)	2.96 (1.17 – 4.48)	0.030	—	—
Smoking (ref: No)	1.39 (0.76 – 2.52)	0.28	—	—

4. Discussion

In line with other research, the results of this study showed that dyspnea and cough were the most often reported symptoms among COVID-19 patients [10,11]. Furthermore, it was shown that pulmonary involvement was common among hospitalized patients, and bilateral involvement was more frequent among those who died. 50% of patients in the current research had bilateral lung involvement, with an overall mortality rate of 18.5%. By comparison, a study conducted in France among 247 individuals with COVID-19 reported pulmonary involvement in 56% of patients [12]. Another investigation from the United States indicated that among patients with lung involvement, each 1% increase in the affected lung area was associated with a 3.6% rise in mortality and an increased probability of hospital-related complications by up to 2.5% [13]. The current research showed that age and cardiovascular comorbidities had a substantial impact on the mortality risk of COVID-19 individuals with pulmonary involvement. The findings showed that increasing age was associated with poorer outcomes; for each additional year of age, the risk of death increased by 3%. This observation is consistent with the results reported by Zandkarimi et al. in Iran [14]. Similarly, Sun et al. demonstrated that older age was an independent determinant of mortality among elderly patients with COVID-19 [15].

Furthermore, a large retrospective cohort study including more than 5,600 COVID-19 cases confirmed that increasing age was associated with higher mortality and adverse clinical outcomes [16]. The increased vulnerability of elderly patients may be explained by age-related changes in immune function, which reduce the ability to effectively respond to infectious agents and increase the likelihood of severe disease progression. Moreover, the coexistence of chronic medical conditions in older individuals can further contribute to poor outcomes, including death [17,18]. In the current study, cardiovascular disease was identified as another major factor associated with increased mortality among patients with COVID-19.

Patients with cardiovascular comorbidities had a significantly higher hazard of death than those without such conditions (HR = 2.71), which is in line with earlier findings from a study carried out in Colombia and a study involving over 13,400 patients in the United States [19,20]. Cardiovascular disorders may increase susceptibility to severe COVID-19 outcomes through the development of complications such as myocardial infarction, cardiac injury, arrhythmias, myocarditis, shock, heart failure, and venous thromboembolic events, which can ultimately contribute to fatal outcomes [21–23].

This study was limited in a number of ways. First, the study's single-center methodology may restrict how broadly the results may be applied; as a result, additional multicenter research is advised. Another drawback of

this study was the absence of therapy and medication data; these variables should be taken into account and adjusted for in future analyses. Another drawback was the small sample size, which could be addressed by future research using larger sample sizes.

The study's findings showed an association between advanced age, cardiovascular conditions, and pulmonary involvement and COVID-19-related death. It is advised that radiological results be taken into account in addition to clinical complaints because of the significance of age in this study. Additionally, giving patients with cardiovascular disorders the knowledge they need to exercise self-care should be given top priority since it is essential to improving patient outcomes and lowering death rates.

Declaration of artificial intelligence (AI) in the writing process

The authors declare whether AI or AI-assisted technologies were used during the preparation of this manuscript. If used, AI tools were employed solely to improve language quality, grammar, readability, and organizational structure. The authors carefully reviewed and edited all AI-generated content and take full responsibility for the accuracy, integrity, and originality of the final manuscript. No AI tool was used to generate, analyze, or interpret scientific data or images, or to draw scientific conclusions. The use of AI-assisted technologies complies with current publication ethics recommendations and journal policies.

Authors' contributions

TN and JFA: conceptualized and designed the study and supervised the research process. VRN, SA, AA, and AP: contributed to data acquisition and data collection. TN and JFA: performed the statistical analysis and interpreted the results. TN and JFA: drafted the initial manuscript and critically revised the manuscript for important intellectual content. All authors contributed to the interpretation of the findings, reviewed and approved the final manuscript, and agreed to be accountable for all aspects of the work.

Conflict of interest

No potential conflict of interest was reported by the authors.

Ethical declarations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Behbahan Faculty of Medical Sciences (Approval No. IR.BHN.REC.1400.030). Since this study involved a retrospective analysis of existing medical records and did not require direct contact with patients, the requirement for written informed consent was waived by the ethics committee.

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