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Risk Factors for Coronavirus disease 2019 (COVID-19)-Related Mortality among Hospitalized Patients in Southeastern Iran: A Case-Control Study

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Abstract

Background & Objectives: The Coronavirus disease 2019 (COVID-19) pandemic has posed a devastating global impact, with millions of cases which vary widely in the disease severity. Southeastern Iran has been particularly hard hit, with a high number of patients requiring hospitalization. This study aimed to identify risk factors associated with mortality from COVID-19 among hospitalized patients in this region.

Materials & Methods: A case-control study compared hospitalized COVID-19 patients who succumbed to the disease (confirmed by death certificates and positive polymerase chain reaction or PCR tests) with those who recovered, from February 27, 2020, to June 30, 2021. Researchers analyzed data using t-tests and chi-square tests to identify significant factors associated with mortality ($p < 0.05$). Variables significant at a less stringent level ($p < 0.2$) were then included in a backward logistic regression model to explore independent predictors of mortality.

Results: This retrospective study examined data from 473 patients, of whom 158 were in the case group and 315 were in the control group. Among the case group, 80.4% were elderly, compared to 41% in the control group. A significantly higher proportion of patients in the case group (12.7%) experienced critical symptoms leading to the ICU hospitalization, compared to the control group (7.3%). Multivariable regression analysis identified several factors significantly associated with increased mortality risk. These included ICU hospitalization (OR=5.27, CI: 3.09-8.98), advanced age (OR=4.06, CI: 2.43-6.80), hypertension (OR=4.44, CI: 1.52-12.93), cardiovascular diseases (OR=2.56, CI: 1.1-5.98), and critical symptoms (OR=2.74, CI: 1.92-8.04). Diabetes, pregnancy, nationality, and gender did not statistically increase mortality risk (p-value ≥ 0.05).

Conclusion: Advanced age, severe symptoms requiring ICU care, hypertension, and cardiovascular diseases are all critical mortality risk factors in hospitalized COVID-19 patients.

Keywords: Coronavirus disease 2019, Mortality, Hospitalized patients, Risk factors, Iran

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Introduction

Coronavirus disease 2019 (COVID-19) is a highly infectious respiratory illness caused by the novel coronavirus known as severe acute respiratory syndrome (SARS)-CoV-2. The disease can present with a wide range of symptoms, from none at all (asymptomatic) to severe and life-threatening acute

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respiratory distress syndrome (ARDS) (1). The average incubation period for COVID-19 is estimated to be around three days, with a range of 0-24 days (2, 3). COVID-19 typically begins with non-specific symptoms such as fever, dry cough, and fatigue. However, as the disease progresses, it can affect multiple body systems, including the respiratory, nervous, musculoskeletal, and digestive systems. COVID-19 can spread rapidly in some individuals, and acute respiratory distress syndrome (ARDS) is a common and severe complication that can develop rapidly, particularly in patients with underlying health conditions. ARDS is a significant risk factor for mortality in COVID-19 patients (4). Hypertension is recognized as the most common cardiovascular comorbidity in COVID-19 patients, significantly raising the risk of hospitalization and death (5). Furthermore, experimental studies have suggested that key patho-physiological mechanisms of hypertension, such as the activation of the renin-angiotensin system (RAS), may be involved in COVID-19 development (6).

Studies have shown that pre-existing health conditions, including diabetes, hypertension, obesity, and smoking, are linked to an increased risk of death from COVID-19. In fact, these conditions are estimated to contribute to nearly 30% of COVID-19 fatalities (7). This association is further supported by data from Tehran, where analysis of 16,000 COVID-19 cases revealed a high Case Fatality Rate (CFR). The data also identified significant risk factors for mortality, including age, gender, underlying non-communicable diseases, and admission to the intensive care unit (ICU) (8).

Several studies have shown that older individuals, those with underlying health conditions, and patients experiencing shortness of breath are more likely to develop severe illness and require intensive care for COVID-19, and they are at a higher risk of death than others (9-12). Also, pregnant patients with SARS-CoV-2 infection are at increased risk for severe disease, including hospitalization, intensive care admission, ventilatory support, and death (13). The results of some studies show that older age, male gender, longer time from onset to death (measured in days), the development of acute respiratory distress syndrome or shock, pre-existing diabetes, and pre-existing cardiovascular diseases (CVD) are some of the main risk factors associated with a high CFR (12).

Although approximately 80% of clinical cases of COVID-19 are mild or asymptomatic, the disease is highly contagious and has raised concerns among healthcare professionals worldwide (1). It is estimated that approximately 20 to 30% of COVID-19 cases progress to severe disease, with some patients requiring admission to the ICU for further intervention (14, 15). Treatment for severe cases typically involves oxygen therapy, mechanical ventilation, intravenous antibiotics, and antiviral therapy (2, 15).

Therefore, given the strategic importance of the region (involving land and sea border interactions with Pakistan and other nations via maritime boundaries), along with the diverse cultural perspectives of certain ethnic groups and the availability of medical facilities in the southeastern part of the country compared to other areas of Iran, the study aims to investigate the clinical characteristics and factors related to COVID-19-related deaths in patients admitted to hospitals in the southeastern region of Iran between February 27, 2020, and June 30, 2021.

By identifying the risk factors associated with COVID-19-related mortality, healthcare professionals in the region can better understand which patients are at higher risk of severe illness and death. This knowledge can lead to earlier interventions and potentially improve patient outcomes. This study aimed to identify risk factors associated with mortality from COVID-19 among hospitalized patients in southeastern region of Iran during 2020-2021.

Materials and Methods

Study design

In this retrospective case-control study, we analyzed data from patients hospitalized for COVID-

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19 at five selected hospitals affiliated with Iranshahr University of Medical Sciences and Health Services in southeastern Iran. The study period spanned from February 27, 2020, to June 30, 2021. Informed by a study by Seong Su Moon et al. (16) investigating risk factors for death among hospitalized patients, we examined the prevalence of high blood pressure in both the case and control groups. The prevalence was $p_1 = 0.16$ in the case group and $p_2 = 0.84$ in the control group. To achieve adequate statistical power, this study aimed to recruit 143 cases and two controls for each case (resulting in a total of 286 controls) with a power of 90% and a type I error of 5%. Anticipating a potential 10% loss due to incomplete data, the final sample size was set at 473 participants (158 cases and 315 controls) (Figure 1).

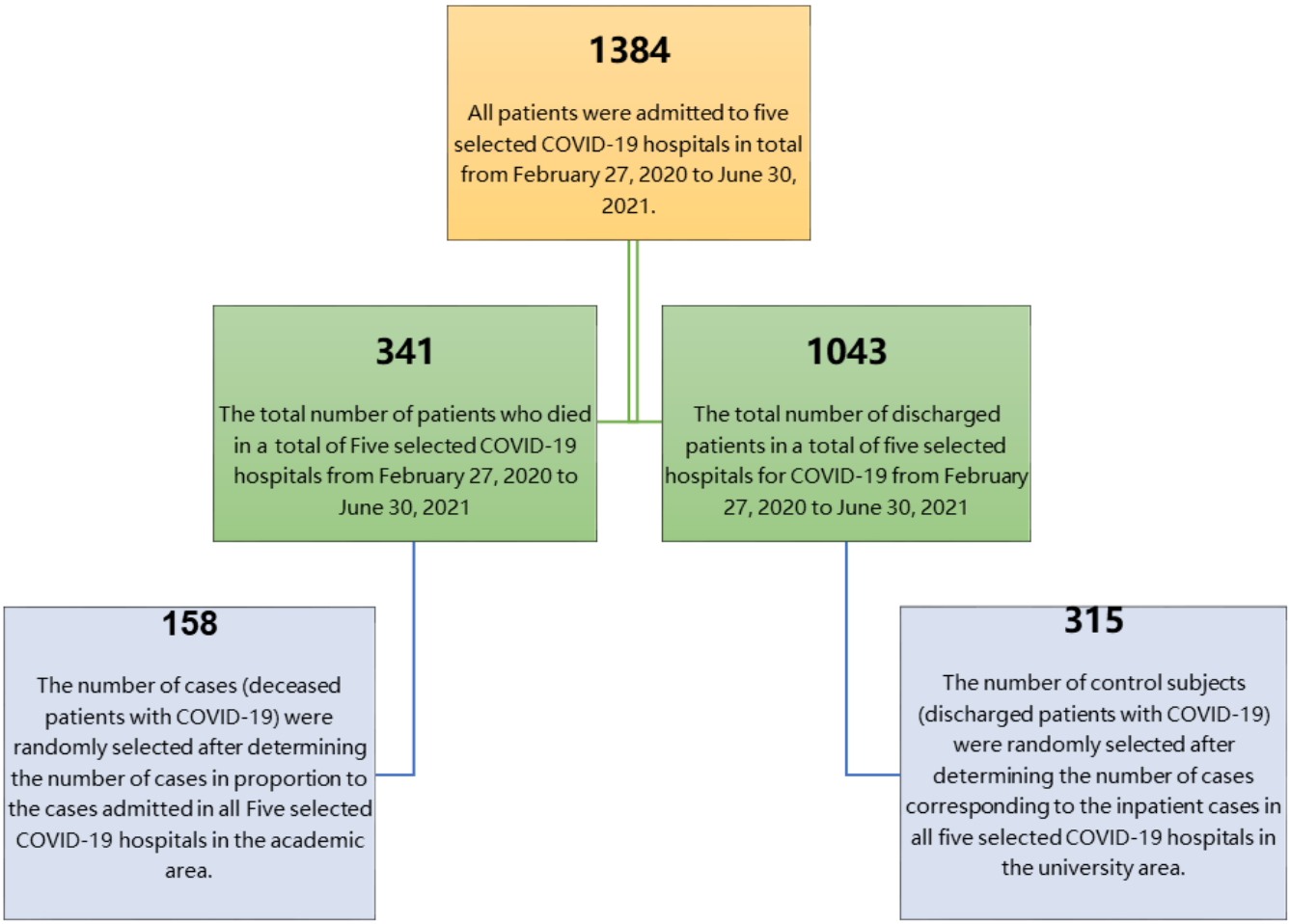


Figure 1. Process of Selecting Cases and Controls

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The patients included in this study had been identified through referrals from the comprehensive health centers of 19 cities (across 12 cities) or directly referred to the covered hospitals (the five selected hospitals affiliated with the academic institution). Only patients who required hospitalization were included in the study, in accordance with the protocols of the Ministry of Health of Iran. The database was created across all five selected hospitals for COVID-19, and data were extracted and recorded manually by reviewing the patients' medical records. The medical and demographic information of the patients was examined using a predetermined set of variables based on the research questions. Data collection was completed in July 2021 to ensure that all necessary information was obtained comprehensively. The study evaluated the factors associated with death in COVID-19 patients with severe disease who required hospitalization.

Participants

The case group in this study included hospitalized patients with confirmed COVID-19 via polymerase chain reaction (PCR) testing who died from the disease, as documented on their death certificates. The control group consisted of hospitalized patients who also tested positive for COVID-19 via PCR test with improved conditions, and subsequently discharged from the hospitals. Prior to sampling, all medical records were reviewed and checked for the accuracy. This data verification process was completed in July 2021. Initially, we identified all hospitalized patients within the five designated COVID-19 hospitals who either recovered or succumbed to the disease. Subsequently, patients were stratified into case and control groups based on discharge and mortality rates, respectively. A simple random sampling technique was then employed to determine the final sample size within each group. It is important to note that no data points required exclusion or replacement throughout the study. Furthermore, to ensure patient confidentiality and adhere to research ethics, no specific hospital names or individual patient information are disclosed within this report.

Variables

The primary outcome measure for this study was mortality due to COVID-19, confirmed by death certificate. We collected baseline demographic data, including age group (categorized as elderly (>60 years old) or non-elderly (≤60 years old)), gender, and nationality. Additionally, information regarding pre-infection and in-infection COVID-19 symptoms was obtained using a standardized 0-2-point scale. Patients were then classified based on disease severity: mild-to-moderate (no symptoms or mild pneumonia without oxygen requirement), severe (symptoms requiring oxygen), and critical (requiring mechanical ventilation). The length of hospital stay was also documented, along with any underlying medical conditions such as diabetes, hypertension, pregnancy, heart disease, and other comorbidities.

Statistical analysis

Following data extraction, analysis was conducted using Statistical Package for the Social Sciences (SPSS)-19 software. Prior to the study commencement, all participant identifiers were anonymized through a coding system. A random sampling technique was then employed to select participants, both cases and controls, from the pool of COVID-19 patients hospitalized across the five designated hospitals. Sample size calculations were considered during this selection process. Data normality was assessed to determine the appropriate statistical tests for evaluating associations between variables ($\alpha = 0.05$). Based on normality testing, t-test, chi-square test, or analysis of variance (ANOVA) test were employed. Variables demonstrating statistically significant associations at a level of $\alpha = 0.2$ were identified as potential predictors and entered into a logistic regression model. The final model was built using a backward elimination approach.

Results

Descriptive Statistics

This retrospective case-control study included 473 hospitalized COVID-19 patients in southeastern Iran.

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The case group comprised 158 patients, while the control group included 315 participants (supplementary Table 1). Notably, 19.6% (31 individuals) in the case group were classified as non-elderly (<60 years old), compared to 59.0% (186 individuals) in the control group. Conversely, the case group had a higher proportion of elderly patients (80.3%, 127 individuals) compared to the control group (41.0%, 129 individuals). Regarding symptom severity, 80.3% (127 individuals) of the case group presented with severe symptoms, while only 57.5% (181 individuals) in the control group experienced severe symptoms. The average length of hospitalization was also longer in the case group (6.74 ± 7.06 days) compared to the control group (5.65 ± 5.90 days).

In the diabetes variable, 96.2% (303 individuals) in the control group did not have diabetes, and only 3.8% (12 individuals in the control group) had diabetes. On the other hand, 8.9% (14 individuals) of those in the case group had concurrent diabetes. In the blood pressure variable, 95.1% of all the patients (450 individuals) did not have high blood pressure, while 4.9% (23 individuals) had high blood pressure. In the control group, 98.1% (309 individuals) did not have high blood pressure, and only 1.9% (6 individuals) in the control group had high blood pressure. In the CVD variable, 93% of those in the case group (147 individuals) did not have CVD, while 7% (7 individuals in the case group) had CVD. In the control group, 98.7% (311 individuals) did not have CVD, while 1.3% (4 individuals in the control group) had CVD (Table 1).

Table1. Frequency and Association of Variables between Hospitalized COVID-19 Patients and Controls in the Southeastern Region of Iran

Variables	Categories	Case: 158 patients	Control: 315 patients	*p* value
Age category, Frequency (%)	Non-elderly (60<)	31 (19.6)	186 (59)	0.0001*
	Elder (60≥)	127 (80.4)	129 (41)	
Gender, Frequency (%)	Male	89 (56.3)	177 (56.2)	0.977*
	Female	69 (43.7)	138 (43.8)	
Nationality, Frequency (%)	Iranian	157 (99.4)	305 (96.8)	0.084*
	Non-Iranian	1 (0.6)	10 (3.2)	
Inpatient department	Isolated section	71 (44.9)	268(85.1)	0.0001*
	COVID-19 intensive care unit	87 (55.1)	47 (14.9)	
The severity of symptoms, Frequency (%)	Mild to moderate	11 (7)	111 (35.2)	0.0001*
	Severe	127 (80.3)	181 (57.5)	
	Critical	20 (12.7)	23 (7.3)	
Diabetes, Frequency (%)	NO	144 (91.1)	303 (96.2)	0.023*
	Yes	14 (8.9)	12 (3.8)	
Pregnancy, Frequency (%)	NO	155 (98.1)	314 (99.7)	0.077*
	Yes	3 (1.9)	1 (0.3)	
Blood Pressure, Frequency (%)	NO	141 (89.2)	309 (98.1)	0.0001*
	Yes	17 (10.8)	6 (1.9)	
Heart disease, Frequency (%)	NO	147 (93)	311 (98.7)	0.001*
	Yes	11 (7)	4 (1.3)	
Length of Hospital Stay, mean ± SD	-	7.06 ± 6.74	5.90 ± 5.65	0.049**

SD: standard deviation,"-"Not Applicable
* Chi-square Test
** Independent Samples T-test

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Univariate logistic regression for predicting COVID-19 patients mortality

After conducting a univariate logistic regression analysis, the study found that patients with high blood pressure had an almost four times higher odds of death compared to non-hypertensive patients (OR 4.2, CI 1.32-12.23), which was statistically significant (p-value ≤ 0.05). Additionally, older adults had an almost four times higher odds of death than the non-elderly group, which was also statistically significant (OR 4.01, CI 2.38-6.73). Patients with critical symptoms (requiring mechanical ventilation) were more likely to die compared to patients with mild to moderate symptoms (OR 2.55, CI 1.05-6.17). In addition, patients admitted to the ICU had a higher risk of mortality than patients admitted to the isolation ward (OR 5.17, CI 3.00-8.93). Finally, the variables of gender, diabetes, pregnancy, nationality, and the average length of hospitalization did not show a significant difference in the risk of death between the studied groups (p ≥ 0.05), as shown in Table 2.

Table 2. Univariate Analysis of Risk Factors Associated with COVID-19-Related Mortality in the Southeastern Region of Iran

Variables	Categories	Odds Ratio (95% confidence interval) **	*p* value*
Age Group	Non-elderly (60<)	Ref	Ref
	Elder (60≥)	4.01 (2.38 – 6.73)	0.0001
Blood Pressure	NO	Ref	Ref
	Yes	4.02 (1.32-12.23)	0.014
Heart disease	NO	Ref	Ref
	Yes	4.67 (1.21-18.07)	0.025
Severity of symptoms	Mild to moderate	Ref	Ref
	Severe	0.55 (0.18 – 1.64)	0.284
	Critical	2.55 (1.05 – 6.17)	0.038
Inpatient department	Isolated section	Ref	Ref
	COVID-19 intensive care unit	5.17 (3.00 – 8.93)	0.0001
Diabetes	NO	Ref	Ref
	Yes	1.31 (0.45-3.81)	0.614
Pregnancy	NO	Ref	Ref
	Yes	16.10 (0.90 – 286.56)	0.059
Sex	Male	Ref	Ref
	Female	1.24 (0.75 – 2.03)	0.388
Nationality	Iranian	Ref	Ref
	Non-Iranian	0.23 (0.028 – 2.51)	0.226
Length of Hospital Stay	-	1.01 (0.97 – 1.05)	0.602

SD: standard deviation,"-"Not applicable

*Univariate logistic regression

**Ref: Reference group, Significant level<0.05

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Multivariable logistic regression for predicting COVID-19 patient mortality

To consider potential confounding variables such as age groups, gender, nationality, and comorbidities, this study performed a multivariable logistic regression analysis. The results revealed several important risk factors for the mortality from COVID-19 in hospitalized patients. The highest probability of death was observed in patients admitted to the ICU ward compared with those admitted to the isolated ward (OR 5.07, CI 1.32-19.43). Older patients were almost four times more likely to die compared with non-elderly individuals, with a statistically significant adjusted association (OR 4.06, CI 2.43–6.80). Patients with high blood pressure were almost four times more likely to die than those without high blood pressure (OR 4.44, CI 1.52-12.93). Patients with critical symptoms were more likely to die than patients with mild to moderate symptoms (OR 2.56, CI 1.10-5.98). Finally, the adjusted final model showed a five times higher chance of death in hospitalized patients with CVD compared with those without CVD (OR 5.07, CI 1.32-19.43). The only variable without any statistically significant association after adjusting for the variables was pregnancy (p-value ≥ 0.05) (Table 3).

Table 3. Multivariable Analysis of Risk Factors Associated with COVID-19-Related Mortality in the Southeastern Region of Iran

Variables	Categories	Adjusted odds ratio (95% confidence interval) ***	*p* value*
Age Group	Non-elderly(60<)	Ref	0.0001
	Elder(60≥)	4.06 (2.43 – 6.80)	
Blood Pressure	NO	Ref	Ref
	Yes	4.44 (1.52-12.93)	0.006
Heart disease	NO	Ref	Ref
	Yes	5.07 (1.32-19.43)	0.018
Pregnancy	NO	Ref	Ref
	Yes	9.94 (0.86 – 114.10)	0.065
Severity of symptoms	Mild to moderate	Ref	Ref
	Severe	0.56 (0.19 – 1.63)	0.290
	Critical	2.56 (1.10 – 5.98)	0.029
Inpatient department	Isolated section	Ref	0.0001
	COVID 19 intensive care unit	5.27 (3.09 – 8.98)	

*Multivariable logistic regression using backward Technique

***Ref: Reference group, Significant level<0.05

Variable entered in the model: Age Group, Blood Pressure, Heart disease, Severity of symptoms, Pregnancy, Inpatient department, Wave of COVID-19 Epidemic

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Discussion

The results of this case-control study provide valuable insights into the risk factors for death due to COVID-19 in hospitalized patients in southeastern Iran. The study identified several important risk factors, including older age, high blood pressure, CVD, and other factors related to the hospitalization that increase the likelihood of death from COVID-19. These findings underscore the importance of identifying and managing comorbidities in COVID-19 patients to improve outcomes. Additionally, the study found that patients with critical symptoms had a higher risk of dying than those with mild and moderate symptoms. This finding may be due to the fact that patients with critical symptoms may have delayed seeking hospital care or had more severe underlying conditions, leading to decreased chances of survival. Overall, this study contributes to the growing body of literature on risk factors for COVID-19 and underscores the importance of identifying and managing comorbidities in COVID-19 patients. These findings can inform clinical decision-making and help healthcare providers develop more effective strategies for managing COVID-19 patients, especially those with comorbidities.

In this study, we found the presence of acute symptoms upon admission to be one of the significant predictors of mortality. As the COVID-19 pandemic continues to present significant challenges to healthcare systems globally, there may be a resurgence in the number of infected patients and deaths in certain areas. It is well-established that older adults and individuals with comorbidities are at a higher risk of hospitalization or death if infected with COVID-19. Therefore, identifying predictors of mortality, such as the presence of acute symptoms upon admission, can aid in early intervention and potentially improve patient outcomes (17). Older patients with COVID-19 are more likely to develop severe illness and face a higher risk of mortality, significantly influenced by pneumonia severity, respiratory dysfunction, weakness, and vulnerability. These factors can be used to predict the prognosis of the disease and guide healthcare providers in making critical decisions regarding patient management. Identifying and addressing these risk factors can help develop effective treatment strategies and improve patient outcomes (18). Indeed, older patients are at a higher risk of developing severe COVID-19 due to age-related factors and multiple comorbidities. Hence, it is essential to identify and manage these risk factors in older patients to reduce the severity of the disease and improve outcomes. Healthcare providers should prioritize the care of elderly patients with COVID-19 and take extra precautions to prevent the spread of the virus among this vulnerable population (10, 19-21). Several studies have revealed that individuals over 85 years of age face the risk of death more than double that of younger individuals when infected with COVID-19. This highlights the increased vulnerability of this age group to severe illness and mortality from COVID-19. Therefore, it is crucial to implement targeted interventions and prioritize the care of older adults to reduce the risk of severe disease and improve patient outcomes (22).

This study also revealed that older patients, with a median age of 60 years and above, and underlying conditions such as hypertension and CVD, are at a higher risk of developing severe COVID-19 and have an increased likelihood of death. This highlights the importance of identifying and managing comorbidities in older adults and implementing targeted interventions to reduce the risk of severe illness and improve patient outcomes. By doing so, we can help to mitigate the impact of COVID-19 on this vulnerable population and enhance the overall health outcomes of our communities (15, 23, 24).

Indeed, several studies have reported that older patients with cognitive and neurological disorders (CND) are more disabled and have a higher mortality rate when infected with COVID-19 than those with vascular risk factors and other comorbidities (25). This study revealed that comorbidities (such as high blood pressure and CVD) in hospitalized patients are among

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the most significant indicators of death from COVID-19. This result is consistent with the findings of a previous study conducted by Xiaolin Wei et al., which also identified comorbidities as a significant risk factor for mortality in COVID-19 patients (26); in many other studies, CVD problems were shown to be a risk factor for increased death in COVID-19 patients (19, 23). Some studies have demonstrated that the presence of hypertension in patients with COVID-19 is a risk factor for hospitalization and death of patients (21). The study by Ujué Fresán et al. (27) demonstrated that individuals with hypertension face an increased likelihood of experiencing severe COVID-19, requiring admission to the ICU, and mortality, which aligns with the findings of the current study (28).

Also, diabetes mellitus (type 2) had a significant effect on the mortality (10). Diabetic patients may be considered as predictors of death (28, 29). In this study, no significant association was found between diabetes and COVID-19, possibly due to the exacerbation of the disease in these patients or the limited number of people in this subgroup.

Several studies have identified gender as a risk factor for the progression of COVID-19 to a severe and critical stage (30). After reviewing the available literature, it appears that while some studies have found a significant association between male gender and mortality from COVID-19, gender was not identified as a factor predicting death in the current study, which is consistent with findings from other studies (10, 31). The impact of gender on COVID-19 outcomes may vary depending on other factors such as age and comorbidities (21).

A study by Monita Karmakar et al. found that various sociodemographic risk factors, including socio-economic status, racial/ethnic minority status, household composition, and environmental factors, were significantly associated with the incidence and mortality of COVID-19 (32).

The results of this study outlined no significant difference in the nationality of the patients between the two groups, with an odds ratio of 0.23 and a 95% confidence interval of 0.02-2.51. However, this may have been attributable to this study's small sample size of non-Iranian patients. It is possible that a larger sample size could reveal significant differences in COVID-19 outcomes between different nationalities, as observed in other studies. Systematic reviews have identified that the most common symptoms experienced by pregnant women with COVID-19 are fever, cough, shortness of breath, fatigue, and myalgia. Identifying and managing these symptoms in pregnant women is essential to reduce the risk of severe illness and adverse pregnancy outcomes.

Additionally, pregnant women should be closely monitored for COVID-19 to ensure timely diagnosis and appropriate management, which can help improve outcomes for both the mother and the infant. The rate of severe pneumonia in pregnant women with COVID-19 has been reported to range from 0% to 14% (33). Many of these cases required hospitalization in the ICU to manage respiratory failure and other complications associated with severe illness (33, 34). Studies have shown that pregnant women with COVID-19 symptoms are at a higher risk of developing complications than those without symptoms (35, 36). Pregnant women with COVID-19 are also at a higher risk of preterm delivery than those without COVID-19.

Additionally, pregnant women with COVID-19 may be at an increased risk of maternal death and hospitalization in the ICU. It is important to note that the risk of adverse outcomes may be higher for pregnant women with underlying medical conditions or who experience severe illness from COVID-19 (37). It is reassuring to learn that Iran has prioritized maternity care during the COVID-19 pandemic, and medical centers have not faced ICU capacity limitations. This is particularly important given that pregnant women are a vulnerable population that require specialized care to ensure optimal maternal and fetal outcomes. For instance, at Iranshahr University of Medical Sciences, pregnant women with severe conditions have not been denied admission or transfer to the ICU (38). However,

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it is worth noting that the low sample size of pregnant women in the two subgroups studied in this study may have contributed to a lack of confirmation of pregnancy as a risk factor for increased mortality. Further research with larger sample sizes is required to better understand the impact of COVID-19 on pregnant women.

Limitations of the study

Limitations of the study included the fact that despite the inclusion of cases from diverse geographical areas, all subjects received care within the same healthcare system, which may not fully represent variations in hospitalization factors across different regions. The study primarily focused on hospitalized patients, potentially excluding less severe cases and leading to the underrepresentation of individuals without underlying health conditions or with unreported comorbidities. Additionally, due to the small sample sizes in certain subgroups such as pregnant women, non-Iranian patients, and those with concurrent diseases, separate analyses for these groups were not feasible. The study was conducted during a period of limited public acceptance and uneven prioritization of vaccination rollout, with inaccurate data recording further hindering comprehensive analysis. Furthermore, while multiple risk factors contribute to COVID-19 mortality, the study only examined a subset of these factors, suggesting the need for further investigation into chronic respiratory diseases, smoking history, vaccination status, and other relevant factors. Paraclinical factors such as lung involvement percentage and biomarker levels were not assessed, which could provide valuable insights into the disease severity. Moreover, the study did not examine treatment approaches, including the use of specific drugs and their alignment with national protocols. Lastly, factors like ethnicity and pregnancy were overlooked due to their small representation in the study population, highlighting the need for larger-scale research to explore their impact on COVID-19 outcomes.

Conclusion

Old age and underlying diseases such as high blood pressure and heart diseases have been identified as significant risk factors for the morbidity and mortality in patients hospitalized with COVID-19 in southeast Iran. This study highlights the importance of prioritizing the care and management of patients with comorbidities and critical symptoms to reduce adverse outcomes. Additionally, it emphasizes the need to prioritize vaccination for these high-risk groups and provide more attentive care for older individuals affected by the disease. The study also underscores the necessity for additional research to understand the effects of COVID-19 on various populations and to create effective prevention and management strategies to improve outcomes and reduce the disease burden on healthcare systems. Meanwhile, healthcare providers should focus on implementing preventive measures and providing specialized care and management for vulnerable populations, including elderly patients and those with comorbidities.

List of abbreviations

ARDS: Acute Respiratory Distress Syndrome, COVID-19: Coronavirus Disease 2019, PCR: Polymerase Chain Reaction, IQR: Interquartile Range, CND: Center for Neurological Diseases, SD: Standard Deviation, CVD: Cardiovascular Disease, RAS: Renin-Angiotensin System, ANOVA: Analysis of Variance, CFR: Case Fatality Rate, ICU: Intensive Care Unit

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Conflict of Interests

The authors declare that they have no conflicts of interest to disclose.

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Ethical Considerations

The study protocol was developed in accordance with the ethical principles of the Helsinki Declaration. To safeguard the confidentiality of patient data, all information was anonymized and handled exclusively by authorized personnel. Great importance was placed on the ethical considerations of the study, and every possible measure was taken to preserve the privacy and dignity of the participants.

Code of Ethics

Approval was obtained from the Research Ethics Committee of Iranshahr University of Medical Sciences (Ethics Code: IR.IRSHUMS.REC 1401.030).

Authors' Contributions

Study design and drafting of the manuscript: HKH, MJ, MA, HA, AB, and SA. Revision of the manuscript: VR, HKH. All authors have read and approved the final manuscript.

Data availability Statement

The authors confirm that this article contains all the necessary data to support the findings presented in this research.

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