Research Paper

Epidemiological Characteristics, Clinical Features, and Mortality Predictors of Iranian COVID-19 Patients

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ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) created a global public health emergency, impacting countries worldwide, including Iran. This study investigated the epidemiological characteristics, clinical features, and mortality predictors of Iranian COVID-19 patients admitted to Bohlool Hospital in Gonabad, Iran.

Methods: This retrospective cross-sectional study involved 1596 COVID-19 patients admitted to Bohlool Hospital in Gonabad, Iran, from February 2020 to November 2021. Data on demographic factors, clinical features, and hospitalization outcomes were gathered from patients' medical records at the medical care monitoring center (MCMC) and analyzed using the logistic regression model.

Results: The median age of the patients was 61.0 years (interquartile range: 32.0). Respiratory distress (57.1%), fever (37.3%), and cough (32.5%) were the most common symptoms reported. Comorbidities, including hypertension (28.8), cardiovascular disease (CVD) (15.4%), and diabetes (15.2%), were prevalent among the patients. The overall mortality rate was 12.8%. The findings of the logistic regression model indicated that patients aged 15-44 and 45-64 had lower mortality odds compared to older age groups (odds ratio [OR]=0.14 (95% confidence interval [CI]; 0.08%, 0.27%); OR= 0.32 (95% CI; 0.21%, 0.50%), respectively%). The respiratory distress (OR=1.87, 95% CI; 1.29%, 2.70%), impaired consciousness (OR=9.27, 95% CI; 5.48%, 15.67%), cancer (OR=3.53, 95% CI; 1.40%, 8.92%), diabetes (OR=1.61, 95% CI; 1.04%, 2.49%), and chronic kidney disease (CKD) (OR=5.00, 95% CI; 1.92%, 13.02%) were significantly associated with higher mortality rates.

Conclusion: COVID-19 patients with older age, respiratory distress, impaired consciousness, cancer, diabetes, or CKD face significantly higher mortality rates, underscoring the need for increased attention and care for them to prevent serious outcomes.

Keywords: COVID-19, Coronavirus, Epidemiology, Mortality, Public health, Iran

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Introduction

On March 11, 2020, the World Health Organization (WHO) declared a public health emergency due to the rapid spread of a novel coronavirus known as coronavirus 2019 [1]. Originating in Wuhan, China, the virus quickly disseminated across the globe, causing widespread disruption and placing immense strain on healthcare systems [1, 2]. Iran was among the first countries severely impacted outside of China, experiencing an outbreak of coronavirus disease 2019 (COVID-19) in late February 2020 [3]. The swift transmission of the virus throughout Iran resulted in a significant surge in cases, overwhelming the country's healthcare infrastructure. As of August 2, 2023, WHO reports indicate a staggering 768,983,095 confirmed cases of COVID-19 worldwide, with 6,953,743 deaths recorded, including 7,612,935 confirmed cases and 146,311 deaths attributed to Iran [4].

Throughout the pandemic, the virus has undergone mutations, resulting in the emergence of numerous variants. WHO has classified five of these variants—alpha, beta, gamma, delta, and omicron—as variants of concern [5]. Despite the WHO's declaration on May 5, 2023, that the COVID-19 pandemic is no longer a global health emergency [6], it remains essential to stay vigilant due to the ongoing risk of new variants emerging. The potential for new waves of cases and deaths underscores the importance of preparedness and the need to maintain the gains achieved in national healthcare capacity [7].

Research on the epidemiological and clinical features of COVID-19 is vital for enhancing response strategies and minimizing the impact of future pandemics [5, 8]. Tailoring evidence-based strategies to address COVID-19 at local and national levels relies heavily on local epidemiology [9]. During public health emergencies, resources, such as intensive care beds, ventilators, continuous oxygen, CT scanners, and basic testing kits are often in short supply [10]. Therefore, understanding the unique characteristics of patients requiring critical care is crucial for effectively allocating these limited resources and developing targeted strategies to manage COVID-19. This understanding facilitates the efficient allocation of available resources, assessment of risk levels, and anticipation of future needs [10, 11].

Despite the extensive body of literature on COVID-19, there remains a significant gap in epidemiological studies, specifically from Iran. Furthermore, much of the existing evidence is derived from studies with limited sample sizes or from research conducted during the early stages of the pandemic [12-16]. To address this gap, the present study aimed to investigate the epidemiological characteristics and clinical features of COVID-19 patients admitted to Bohlool Hospital in Gonabad, Iran, throughout various phases of the pandemic. Additionally, we sought to identify factors that predict mortality among COVID-19 patients. By exploring these dimensions, we aimed to enhance the understanding of COVID-19 in the Iranian context and provide valuable insights that can inform response strategies and optimize resource allocation in similar settings.

Methods

Study design

The study included a total of 1596 COVID-19 patients (with a confirmed diagnosis of coronavirus infection via RT-PCR method) admitted to Bohlool Hospital in Gonabad, Razavi-Khorasan province, Iran, from February 19, 2020 to November 17, 2021.

Data source and study population

The data were extracted from the medical care monitoring center (MCMC) of Gonabad University of Medical Sciences. The inclusion criteria were as follows: Hospitalization with a confirmed diagnosis of coronavirus infection via the reverse transcriptase-polymerase chain reaction (RT-PCR) method, the age of 15 years or older (noting a 0% COVID-19 mortality rate in our dataset for younger individuals), and Iranian nationality. Patients with incomplete data were excluded from the study.

Following the extraction of patients' reports from the MCMC system, the recorded information in the MCMC was cross-referenced with the patient's information in the disease management portal of the Deputy of Health and the hospital information system (HIS) at Gonabad University of Medical Sciences. Before analyzing data, the researchers conducted data quality control and eliminated duplicate reports.

The following demographic and clinical data were collected: Age, sex, history of COVID-19, smoking history, opium history, pregnancy, presenting symptoms and signs (fever, cough, respiratory distress, chest pain, myalgia, impaired consciousness, headache, convulsion, paresis, paralysis, olfactory disorder, taste disorder, abdominal pain, nausea, vomiting, diarrhea, anorexia, vertigo, and skin lesions), baseline comorbidity (cancer, diabetes, hypertension, cardiovascular disease (CVD),

chronic liver disease, chronic kidney disease (CKD), asthma, chronic lung disease except for asthma, hematological diseases, immunodeficiency, and neurological disorders), and hospitalization outcomes (length of stay in hospital, intubation, ICU admission, and death).

Statistical analysis

The normality of the quantitative variables (age and length of hospital stay) was assessed using the Kolmogorov-Smirnov test. Given the non-normal distribution of these variables, they were presented as medians accompanied by interquartile ranges (1st quartile, 3rd quartile). Categorical variables were reported as counts and percentages.

In this study, we conducted a focused analysis on four distinct age groups: 15–44, 45–64, 65–74, and ≥75 years. These age intervals were strategically selected to ensure a sufficient data set for modeling purposes. Additionally, we systematically recorded the signs and symptoms of COVID-19, as well as comorbidities, by coding each as a binary variable (1=yes, 0=no) for each patient. This approach enabled us to accurately capture the presence or absence of various signs, symptoms, and comorbidities.

We utilized a multiple binary logistic regression model to identify predictors of mortality among COVID-19 patients. Initially, each demographic and clinical variable was analyzed using simple binary logistic regression. Variables that demonstrated a P<0.2 were subsequently included in the final multiple logistic regression analysis to ascertain independent predictors of mortality. Before conducting the logistic regression, we evaluated the explanatory variables for potential multicollinearity, given the presence of several independent categorical variables. This assessment was performed using Cramer's V, with a threshold of >0.50 indicating multicollinearity [17]. The data analysis was carried out using SPSS software, version 21, and statistical significance was defined as a P<0.05.

Results

Characteristics of COVID-19 patients

The study included a total of 1596 COVID-19 patients (with a confirmed diagnosis of coronavirus infection via RT-PCR method) admitted to Bohlool Hospital. The median age of the patients was 61.0 years, with a range from 44.0 to 76.0 years. Among the study participants, 48.4% were male. Additionally, 26.0% had a history of COVID-19, 2.4% had a smoking history, and 4.8% had a history of opium use. Regarding the clinical features, the most common symptoms and signs reported by the patients were respiratory distress (57.1%), fever (37.3%), and cough (32.5%). In terms of comorbidities, 52.3% of the patients had at least one underlying condition. The most prevalent comorbidities among COVID-19 patients were hypertension (28.8%), CVD (15.4%), and diabetes (15.2%). Other comorbidities included CKD (10.4%), asthma (5.1%), and cancer (1.8%). The study also investigated the outcomes of COVID-19 patients. The median length of hospital stay was 6.0 (Interquartile range: 5.0) days. Intubation was required for 4.2% of the patients, while 8.8% were admitted to the intensive care unit. The overall mortality rate among the patients was 12.8% (Table 1).

Risk factors for mortality of COVID-19 patients

Table 2 provides information on the characteristics of COVID-19 patients who died. The majority of them were 65 years or older, comprising 74.5% of the sample. Also, 57.8% were male. Only 0.5% had a history of COVID-19. A small percentage of patients (2.9% and 5.4%, respectively) reported a history of smoking or opium use. The most common symptoms and signs among died patients were respiratory distress (70.1%), followed by fever (34.3%), impaired consciousness (25.0%), and cough (21.1%). The most prevalent comorbidities were hypertension (35.8%), CVD (25.5%), and diabetes (22.1%).

The regression results are shown in Table 2. The odds of mortality for COVID-19 patients aged 15-44 years was significantly lower compared to those aged 75 and older, with an adjusted odds ratio (AOR) of 0.14 (95% CI; 0.08%, 0.27%), indicating that individuals aged 15-44 had about 86% lower odds of dying from COVID-19 than those aged 75 and older (P<0.001), holding other variables constant. For patients aged 45-64 years, the AOR was 0.33 (95% CI; 0.21%, 0.50%), suggesting that individuals in this age group had approximately 67% lower odds of dying compared to those aged 75 and older (P<0.001), holding other variables constant. In the 65-74 years age group, the AOR was 0.68 (95% CI; 0.45%, 1.02%), indicating a trend toward lower odds of mortality compared to those aged 75 and older, but this result was not statistically significant (P=0.081), holding other variables constant.

The odds of mortality for females compared to males was 0.72 (95% CI; 0.51%, 1.00%), suggesting that females may had 28% lower odds of mortality compared to males, but this was marginally significant (P=0.051), holding other variables constant.

Table 1. Characteristics of COVID-19 patients (n=1596)

	Variables	No. (%)/Values
Age (y)	Median (1st quartile and 3rd quartile)	61.0 (44.0, 76,0)
	15-44	413(25.8)
	45-64	494(31.0)
	65-74	260(16.3)
	≥75	429(26.9)
	Sex (Male)	772(48.4)
	History of COVID-19	415(26.0)
	Smoking history	38(2.4)
	Opium history	77(4.8)
	Pregnancy	7(0.4)
Signs and symptoms	Fever	595(37.3)
	Cough	519(32.5)
	Respiratory distress	911(57.1)
	Chest pain	57(3.6)
	Myalgia	134(8.4)
	Impaired consciousness	87(5.5)
	Headache	106(6.6)
	Convulsion	6(0.4)
	Paresis	8(0.5)
	Paralysis	3(0.2)
	Olfactory disorder	3(0.2)
	Taste disorder	3(0.2)
	Abdominal pain	69(4.3)
	Nausea	166(10.4)
	Vomiting	82(5.1)
	Diarrhea (yes)	61(3.8)
	Anorexia	130(8.1)
	Vertigo	50(3.1)
	Skin lesions	1(0.1)

	Variables	No. (%)/Values
Comorbidity	At least one	835(52.3)
	Cancer	28(1.8)
	Diabetes	243(15.2)
	Hypertension	460(28.8)
	CVD	246(15.4)
	Chronic liver disease	10(0.6)
	CKD	27(1.7)
	Asthma	48(3.0)
	Chronic lung disease except for asthma	74(4.6)
	Hematological diseases	10(0.6)
	Immunodeficiency	4(0.3)
	Neurological disorders	36(2.3)
Outcomes	Length of stay in hospital, median (1st quartile and 3rd quartile)	6.0 (4.0, 9.0)
	Intubation	67(4.2)
	ICU admission	140(8.8)
	Death	204(12.8)

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Table 2. Characteristics of deceived COVID-19 patients and risk factors for mortality of COVID-19 patients based on the logistic regression model

Variables			No. (%)		Logistic Regression			
			Deceived (n=204)	Ref	Unadjusted		Adjusted	
					OR (95% CI)	P	OR (95% CI)	P
Age (y)		15-44	1(6.4)	≥75	0.09 (0.06, 0.18)	<0.001	0.14 (0.08, 0.27)	<0.001
		45-64	39(19.1)		0.26 (0.06, 0.18)	<0.001	0.33 (0.21, 0.50)	<0.001
		65-74	46(22.5)		0.66 (0.18, 0.39)	<0.001	0.68 (0.44, 1.05)	0.081
		≥75	106(52.0)		-	-	-	-
Sex		Male	118(57.8)	Female	0.65 (0.48, 0.87)	0.004	0.72 (0.51, 1.00)	0.051
History of COVID-19		Yes	1(0.5)	No	1.42 (0.18, 11.24)	0.743	-	-
Smoking history		Yes	6(2.9)	No	1.29 (0.53, 3.12)	0.575	-	-
Opium history		Yes	11(5.4)	No	1.15 (0.59, 2.21)	0.686	-	-
General symptoms	Fever	Yes	70(34.3)	No	0.86 (0.63, 1.18)	0.348	-	-
	Myalgia	Yes	9(4.4)	No	0.47 (0.23, 0.94)	0.032	0.90 (0.43, 1.87)	0.777

Variables			No. (%)		Logistic Regression			
			Deceived (n=204)	Ref	Unadjusted		Adjusted	
					OR (95% CI)	P	OR (95% CI)	P
Respiratory symptoms	Cough	Yes	43(21.1)	No	0.51 (0.36, 0.73)	<0.001	0.80 (0.54, 1.18)	0.257
	Respiratory distress	Yes	143(70.1)	No	1.91 (1.39, 2.62)	<0.001	1.87 (1.29, 2.70)	0.001
	Chest pain	Yes	5(2.5)	No	0.65 (0.26, 1.64)	0.359	-	-
Neurological symptoms	Headache	Yes	3(1.5)	No	0.19 (0.06, 0.59)	0.004	0.37 (0.11, 1.21)	0.099
	Impaired consciousness	Yes	51(25.0)	No	12.56 (7.94, 19.85)	<0.001	9.27 (5.48, 15.67)	<0.001
	Others[a]	Yes	7(3.4)	No	0.82 (0.37, 1.82)	0.620	-	-
Gastrointestinal symptoms	Abdominal pain	Yes	7(3.4)	No	0.76 (0.34, 1.69)	0.504	-	-
	Nausea	Yes	10(4.9)	No	0.41 (0.21, 0.79)	0.008	0.69 (0.31, 1.53)	0.361
	Vomiting	Yes	5(2.5)	No	0.43 (0.17, 1.07)	0.070	0.83 (0.28, 2.43)	0.734
	Diarrhea	Yes	6(2.9)	No	0.74 (0.31, 1.73)	0.484	-	-
	Anorexia	Yes	15(7.4)	No	0.88 (0.50, 1.54)	0.658	-	-
Comorbidity	Cancer	Yes	10(4.9)	No	3.94 (1.79, 8.65)	0.001	3.53 (1.40, 8.92)	0.008
	Diabetes	Yes	45(22.1)	No	1.71 (1.19, 2.46)	0.004	1.61 (1.04, 2.49)	0.031
	Hypertension	Yes	73(35.8)	No	1.45 (1.06, 1.97)	0.019	0.73 (0.50, 1.07)	0.108
	CVD	Yes	52(25.5)	No	2.11 (1.49, 3.00)	<0.001	1.50 (1.00, 2.26)	0.050
	CKD	Yes	11(5.4)	No	4.90 (2.24, 10.72)	<0.001	5.00 (1.92, 13.02)	0.001
	Asthma	Yes	6(2.9)	No	0.97 (0.41, 2.32)	0.953	-	-
	Chronic lung disease except for asthma	Yes	19(9.3)	No	2.50 (1.45, 4.30)	0.001	1.48 (0.80, 2.72)	0.214
	Immunodeficiency	Yes	1(0.5)	No	0.29 (0.04, 2.18)	0.293	-	-
	Neurological disorders	Yes	5(2.5)	No	1.10 (0.42, 2.87)	0.841	-	-

[a]Other neurological symptoms comprised of convulsion, paresis, paralysis, and vertigo.

For respiratory symptoms, the AOR for respiratory distress was 1.87 (95% CI; 1.30%, 2.70%), indicating that patients with respiratory distress had nearly twice the odds of dying compared to those without this symptom (P=0.001), holding other variables constant.

Regarding neurological symptoms, impaired consciousness was associated with significantly higher odds of mortality, with an AOR of 9.27 (95% CI; 5.50%, 15.40%), meaning patients with impaired consciousness had over nine times the odds of dying compared to those without this symptom (P<0.001), holding other variables constant.

In terms of comorbidities, patients with a history of cancer had an AOR of 3.53 (95% CI: 1.45%, 8.60%), indicating they had more than three times the odds of dying compared to those without cancer (P=0.008), holding other variables constant. The AOR for diabetes was 1.61 (95% CI; 1.10%, 2.36%), suggesting that patients with diabetes had 61% higher odds of mortality compared to those without diabetes (P=0.031), holding other variables constant. For hypertension, the AOR was 0.73 (95% CI; 0.48%, 1.10%), indicating a trend toward lower odds of mortality compared to those without hypertension, but this was not statistically significant (P=0.108), holding other variables constant. The AOR

for CVD was 1.50 (95% CI; 1.00%, 2.25%), suggesting 50% higher odds of mortality compared to those without CVD (P=0.050), holding other variables constant. Finally, CKD was associated with significantly higher odds of mortality, with an AOR of 5.00 (95% CI; 2.50%, 10.00%), indicating patients with CKD had five times the odds of dying compared to those without this condition (P=0.001), holding other variables constant.

Discussion

The current study investigated the epidemiological characteristics, clinical features, and mortality predictors of COVID-19 patients admitted to Bohlool Hospital in Gonabad, Iran.

This study identified that the majority (74.5%) of the patients who died in the hospital were over the age of 65, confirming a significant correlation between advanced age and elevated mortality among COVID-19 patients, which is consistent with prior research findings [18-20]. For example, a cohort study conducted in South Khorasan province, Iran, from February to August 2020, found that being over 60 years old was a significant independent prognostic factor for mortality associated with COVID-19 [19]. Similarly, another study conducted in Arak, Iran, indicated that patients over 60 had a 10.87 times higher likelihood of dying from COVID-19 compared to those less than 45 years old [20]. These studies, conducted in different regions of Iran during the early months of the pandemic, share similarities with our findings regarding age as a risk factor for COVID-19 mortality. Several factors may contribute to older individuals being more likely to experience severe outcomes from COVID-19, including immune system alterations, comorbidities, physiological changes, and reduced regenerative capacity [21].

In the present study, a higher proportion of males were among those who died. However, when controlling for other variables, the study did not find a statistically significant difference in mortality risk between males and females. Similar studies have produced mixed results regarding gender-based differences in COVID-19 mortality. Some studies have indicated a greater likelihood of mortality in males, while other studies have reported no significant differences. For instance, a multicenter cross-sectional study conducted across 55 hospitals in the Tehran metropolitan area from February 20 to June 8, 2020, found that the impact of sex on COVID-19 mortality varied significantly among different age groups [22]. Conversely, another study conducted in India between July and November 2020 demonstrated that both genders exhibited equal susceptibility to the infection [23]. Additionally, a study conducted in Germany from February 4, 2020, to March 22, 2021, revealed that while mortality rates increased with age, there was no substantial difference between sexes until the age of 60. Beyond this age, the likelihood of mortality increased more significantly in males than in females [24]. These mixed findings may be influenced by several factors, including the emergence of different COVID-19 variants and the demographic characteristics of the populations studied. Variants of the virus may exhibit different pathogenicity and transmissibility, potentially affecting mortality rates across genders. Furthermore, population-specific factors, such as healthcare access, comorbidities, and public health responses can also contribute to these discrepancies. Further research is necessary to fully understand the complex interplay between gender, COVID-19 variants, and population characteristics in determining outcomes.

The findings of this study have revealed that respiratory distress was the third most commonly reported symptom among patients, with a prevalence rate of 57.1%. It was also the most prevalent symptom observed in 70.1% of deceased cases. This result is consistent with a previous study conducted in Iran, which analyzed 7,222 eligible patients admitted to hospitals in Sirjan from March 2020 to June 2021, and identified respiratory distress as a significant clinical feature in COVID-19 patients. Furthermore, that study demonstrated that patients experiencing respiratory distress had a higher likelihood of mortality compared to those without this symptom [25]. In severe cases of COVID-19, there is a rapid progression toward acute respiratory distress syndrome (ARDS) [26]. A systematic review and meta-analysis encompassing 109 published articles up to May 8, 2020, confirmed that ARDS is strongly associated with an increased risk of mortality in COVID-19 patients [27]. The link between respiratory distress and mortality can be attributed to the SARS-CoV-2 infection, which triggers inflammation through the JAK/STAT pathway. This inflammatory response leads to the recruitment of various immune cells, such as lung cells, endothelial cells, macrophages, monocytes, lymphocytes, natural killer cells, and dendritic cells, resulting in a cytokine storm and the eventual development of ARDS or death [28].

The findings revealed that impaired consciousness was strongly associated with an increased mortality risk. This result aligns with previous research, including a retrospective study involving confirmed COVID-19 cases from 44 hospitals in Wuhan and Sichuan, China, conducted between January 18 and March 30, 2020, as well as a retrospective cohort study of patients from 575 hos-

pitals across 31 provincial administrative regions as of January 31, 2020. Both studies identified impaired consciousness as a significant predictor of poor outcomes in COVID-19 patients [29, 30]. Impaired consciousness can manifest in various ways among COVID-19 patients, such as altered mental status, confusion, disorientation, or even loss of consciousness. The underlying mechanisms that connect impaired consciousness to mortality in COVID-19 are intricate and multifaceted and have not been fully comprehended. However, it is likely that these changes are linked to either hypoxemia (low oxygen levels) or brain viremia (presence of the virus in the brain), both of which can lead to toxic encephalopathy [29, 31].

The present study results showed that COVID-19 patients with cancer had odds of mortality higher than those without cancer. This finding highlights the increased vulnerability of individuals with cancer to severe outcomes from COVID-19 infection. The association between cancer and increased mortality in COVID-19 patients has been documented in several studies. For example, a retrospective case-control study conducted in Sabzevar, Razavi Khorasan, Iran, from February 19 to May 17, 2020, found that COVID-19 mortality was significantly higher in cancer patients compared to non-cancer patients (41.7% vs 6.8%) [32]. Similarly, another retrospective study across multiple centers in Louisiana, United States, from March 1 to April 30, 2020, reported comparable results, with death rates of 21.2% in cancer patients versus 8.7% in non-cancer patients [33]. Additionally, a systematic review and meta-analysis examining the impact of pre-existing comorbidities on COVID-19 mortality indicated that cancer is associated with a significantly higher risk of mortality from COVID-19, with a risk ratio of 1.47 (95% CI; 1.01%, 2.14%) [34]. One of the potential mechanisms of death in cancer patients is microvascular COVID-19 lung vessels obstructive thromboinflammatory syndrome (MicroCLOTS), which is a progressive endothelial thromboinflammatory syndrome that can involve the microvascular bed of the brain and other vital organs, leading to multiple organ failure and death. Cancer patients are at an increased risk of developing venous thromboembolism, which makes them more vulnerable to MicroCLOTS. This syndrome occurs when the complement cascade activates, leading to endothelial damage and the release of pro-inflammatory cytokines [35].

The results demonstrated that diabetes is one of the significant predictors of mortality risk of COVID-19. This finding aligns with the results of a systematic review and meta-analysis that examined 186 observational studies conducted between December 2019 and November 14, 2020, across a broad geographical range, including Europe, North America, Asia, South America, and Africa [36]. Moreover, another retrospective cohort study using COVID-19 epidemiological registry data from Jakarta Province during the first six months of the pandemic supports our results [37]. People with diabetes are more susceptible to severe COVID-19 due to several factors, such as hyperglycemia side effects, secondary comorbidities, weakened immunity, chronic inflammation, and poor nutritional status. SARS-CoV-2 may have a high binding affinity for angiotensin-converting enzyme 2 (ACE-2) in diabetes mellitus, which could lead to accelerated viral uptake. It is complemented by the reduced clearance capacity, which means that the virus may not be eliminated as effectively in individuals with diabetes [38].

This study showed that COVID-19 patients with CVD had a 1.5 times higher mortality risk than those without CVD. Although the statistical significance was marginally significant (P=0.050), these findings suggest that CVD may be associated with slightly higher odds of mortality in individuals infected with COVID-19. The association between CVD and increased mortality risk in COVID-19 has been examined in several studies. For instance, a systematic review and meta-analysis that included 15 studies from Europe, Australia, and Asia up to January 2021, revealed a significantly higher risk of in-hospital mortality in individuals with CVD compared with periods outside the pandemic [39]. Additionally, a cohort study in England examining hospitalized adults for severe COVID-19 between March 1 and June 30, 2020, found that pre-existing CVD was associated with higher mortality in patients under 70 years of age, while this association was not observed in those aged 70 and older [40]. These findings collectively highlight the importance of considering cardiovascular health in the management and prognosis of COVID-19 patients. Viral toxicity, disruption of the renin-angiotensin-aldosterone system (RAAS), damage to endothelial cells and inflammation of blood vessels, cytokine storm, and an imbalance between the supply and demand of oxygen are the possible underlying mechanisms to cause cardiovascular complications or worsen existing CVD in COVID-19 patients [41].

The results of the present study showed a clear difference in the risk of death between COVID-19 patients with and without CKD. Patients with CKD had a 5.00 times higher risk of death compared to those without CKD. This finding aligns with some studies' results that have investigated the association between CKD and mortality in COVID-19 patients. For instance, a study involving 7,624 COVID-19 patients in New York, between March and April 2020, indicated the elevated risk

of death among individuals with CKD [42]. A systematic review and meta-analysis encompassing 348 studies conducted between November 2019 and February 2021 corroborated this association, as well [43]. This susceptibility is due to factors, such as altered immune cell function in the pre-uremic state, loss of antibodies and complement through damaged glomeruli, systemic inflammation, and immunosuppressive medications [44]. CKD is often associated with comorbidities, like hypertension, diabetes, and CVD, which are known risk factors for death from COVID-19 [34]. CKD patients have weakened immune systems, making them more prone to more severe infections of COVID-19, more complications, and a higher death rate compared to the general population [45]. Hospitalized COVID-19 patients are also more likely to experience acute kidney injury, which further increases the risk of death [46].

Conclusion

Older patients with respiratory distress, impaired consciousness, cancer, diabetes, and CKD were found to have a higher mortality rate from COVID-19. It is important to understand these factors to better manage the disease, particularly in areas with limited resources.

Strength and limitations

The study has several limitations. It employed a retrospective cross-sectional design, which may introduce certain biases and limitations in data collection. Additionally, it was conducted at a single hospital, which may restrict the generalizability of the findings. Some patients were excluded due to incomplete data, which could impact the results. Furthermore, important factors, such as socioeconomic status, access to healthcare, and treatment regimens were not considered due to the retrospective nature of the study and the lack of detailed data on these variables. However, the study provides valuable insights into COVID-19 in Iran, with large sample size and the use of regression analysis to identify predictors of mortality. The findings can inform healthcare providers and policymakers in Iran.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Gonabad University of Medical Sciences, Gonabad, Iran (Code: IR.GMU.REC.1402.126). The data for this study were obtained from the data registry project to record suspected, probable, and confirmed cases of COVID-19 in the health centers of Gonabad. The data were made anonymous and did not include any personal information.

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Authors' contributions

Conceptualization: Fatemeh Mohammadzadeh, Ali Alami, Abdoljavad Khajavi and Mitra Tavakolizadeh; Data collection: Fatemeh Mohammadzadehand Mitra Tavakolizadeh; Study design and final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

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