Original Article

Hospitalized COVID-19 Patients Characteristics, Comorbidities, and Outcomes: A Retrospective Study

Farooq Ahmed Wani[1*], Ashokkumar Thirunavukkarasu[2], Nawaf Abdulaziz Alzarea[3], Waleed Abdullah Alzarea[3], Omar Mohammed Alshaya[3], Abdulkarim Fihat B Alanazi[3], Abdelazeez Mefreh Aldeghmani[3], Layth Dhumayri Alruwaili[3], Muhannad Aldayri Yatim Alruwaili[3], Abdulsalam Hail Fandi Alruwaili[3]

[1]Department of Pathology, College of Medicine, Jouf University, Sakaka, Saudi Arabia. [2]Department of Community Medicine, College of Medicine, Jouf University, Sakaka, Saudi Arabia. [3]College of Medicine, Jouf University, Sakaka, Saudi Arabia.

Abstract

The current research aimed to evaluate the hospitalized COVID-19 Patients' characteristics, comorbidities, and outcomes. The present hospital-based study was executed in the COVID-19 units of Aljouf province. A simple random sampling method was applied to include the 400 patients' files and all the relevant data was collected. The association between the COVID-19 outcome with sociodemographic characteristics, comorbidities, and immune status was assessed using the chi-square test. A p-value <0.05 was taken as statistically significant. The common symptoms were fever (54.5%), followed by cough (47.8%), and shortness of breath (47.3%). The commonest comorbidity was diabetes mellitus (43.5%). Of the 400 patients, 77.3% had recovered without any complications, 4.5% had one or more complications, and mortality was 18.3%. The COVID-19 outcome (complete recovery, recovery with complications, and death) were significantly associated with age (p<0.001), immune status (p=0.001), diabetes (p=0.001), hypertension (p=0.001), IHD (p=0.025), CKD (p=0.001), and cardiac failure (p=0.008). Most of the patients (77.3%) recovered completely and a mortality rate of 18.3% was observed in our study. This study confirms that patients afflicted with co-morbid conditions like diabetes, hypertension, IHD, CKD, and cardiac failure are highly susceptible to poor outcomes.

Keywords: Coronavirus, Disease, Infections, Vaccination

Introduction

In 2019, the emergence of the coronavirus disease (COVID-19) in China resulted in millions of infections and prompted immediate measures to save lives [1]. The causative agent responsible for damaging the respiratory system and causing severe acute respiratory syndrome was identified as the SARS-CoV-2 virus [2]. The Chinese government collaborated with the Health Commission of Wuhan to monitor the discovery of coronaviruses in patients with respiratory diseases. Over time, different variants of COVID-19 emerged, including the Middle East respiratory syndrome (MERS), coronavirus, and the seventh variant, which was particularly harmful to humans and classified as a variant of concern (VOC) [3]. The coronavirus manifests through a variety of heterogeneous symptoms, including dyspnea, fever, cough, fatigue, bilateral pulmonary infiltrates, headache, and increased shortness of breath [4]. Critically ill patients suffering from COVID-19 may develop cardiac injury, multiple organ failure, septic shock, and metabolic acidosis, leading to significant distress. Additionally, COVID-19 infections can complicate underlying medical conditions, such as hypertension, diabetes, and other respiratory diseases, thereby increasing the mortality rate [5]. It is reported that patients with COVID-19 who require admission to the intensive care unit have a higher risk of chronic diseases and adverse clinical outcomes [5]. A study conducted in America found that diabetes was one of the most common comorbidity among COVID-19 patients, with approximately 33.8% of in-house patients having diabetes [6]. The severity of COVID-19 ranges from mild to severe, with the latter often resulting in death [7]. The World Health Organization has classified patients based on disease severity, oxygen dependency, and mortality [8]. The severity of COVID-19 can be predicted by laboratory parameters, abnormalities in chest radiographs, and comorbidities related to oxygen dependency, which can complicate the clinical course of the disease [9].

Address for correspondence: Farooq Ahmed Wani, Department of Pathology, College of Medicine, Jouf University, Sakaka, Saudi Arabia.
fawani@ju.edu.sa

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Integrating clinical and preclinical symptoms and variables can help develop prognostic scores for managing COVID-19 patients. Multivariable machine learning has been explored for the predictive modeling of disease prognosis based on disease severity and patient admission [10, 11]. Several studies have identified biomarkers and physiological mechanisms, such as hematological, inflammatory, and biochemical factors, including lactate dehydrogenase (LDH), lymphocyte count, white blood cell count, and creatine kinase, as strong indicators of disease severity and mortality in COVID-19 patients [12]. Elevated levels of inflammatory markers are associated with higher rates of admission to the intensive care unit and increased mortality in the hospital [12].

The primary mode of transmission of the SARS-CoV-2 virus appears to be through droplet infection during close contact [13]. The virus has had a significant impact on most countries worldwide, with evidence showing that the majority of patients present with either mild symptoms or are asymptomatic [14]. Within the first four months of the pandemic, the virus has resulted in 2 million cases and 120,000 deaths [15]. Meta-analyses have shown that patients with pre-existing conditions, such as cardiovascular disease, obesity, and diabetes, are at a higher risk of developing chronic obstructive pulmonary disease (COPD), cancer, and chronic kidney disease due to COVID-19. Both hospitalized and isolated patients with a history of COVID-19 have an increased risk of comorbidities and continued complications, which can lead to death [16].

The SARS-CoV-2 virus causing COVID-19 is now a pandemic affecting millions of people worldwide. The incubation period ranges from 2 to 14 days, and symptomatic cases may present with various symptoms, including pyrexia, cough, chills, difficulty in breathing, fatigue, headache, body aches, sore throat, loss of sense of taste or smell, stuffy or runny nose, nausea, vomiting, and diarrhea [17]. Unfortunately, no cure for COVID-19 is currently available, and antibiotics are not effective against it [18]. However, the recent development of COVID-19 vaccines has substantially altered the course of the pandemic. Nonetheless, the global distribution of vaccines, particularly in low-income countries, is a concern that may affect outcomes and undermine the importance of global vaccine equity [19].

In Europe, France was one of the first countries to report COVID-19 cases, with Italy following closely behind [20, 21]. During the first wave of COVID-19, Brazil, the UK, and Spain also reported a large number of cases in Europe. Subsequently, flight cancellations and border restrictions were imposed [22]. In the United States, the first COVID-19 case was reported in 2020 after traveling from China. By the end of the year, the number of reported cases had reached 20 million, with a mortality rate of up to 350,000 [23]. Similarly, the pandemic has greatly affected the populations of Latin America and Asia, with confirmed cases reaching 1 million in 2020 [24]. By September 2020, India had become the second-highest country in terms of the number of affected cases [25]. African countries have also experienced COVID-19 cases, with community transmission occurring after the virus was imported from Europe and the United States. Limited healthcare resources and capacities in Africa are a challenge [26].

The objective of this study is to evaluate the clinical outcomes of patients hospitalized with COVID-19. The findings of this study will have important implications for patients with pre-existing conditions, who may be at higher risk for severe complications from COVID-19. Understanding the severity and nature of complications associated with COVID-19 will help these individuals take necessary precautions to prevent infection and seek prompt medical attention if they become ill. Furthermore, the results of this study will contribute to the ongoing efforts to improve the diagnosis and treatment of COVID-19. This will not only enhance the quality of care for patients with COVID-19 but will also assist healthcare professionals in devising more effective strategies to manage the disease. In addition, this study will inform the development of guidelines and protocols for the management of COVID-19 in public places and hospitals. The information derived from this study will be invaluable for the authorities to make informed decisions about public health policies and resource allocation. By improving our understanding of the disease and its impact on public health, this study will ultimately contribute to efforts to control the spread of COVID-19 globally.

Materials and Methods

Major Clinical Trials Failure

The present study is a retrospective hospital-based research that was conducted in the Aljouf province of Saudi Arabia from August to December 2021. The study was conducted in the main national hospital of the province, which is equipped with modern technologies and facilities and has a well-organized COVID-19 unit with different patient classifications based on their physical conditions. The study was conducted with the ethical approval of the hospital management and the Saudi Arabian Government, and informed consent forms were designed to ensure proper handling of the pandemic situation [27].

Sample Size and Sampling Method

The sample size of the current study has been measured utilizing the formula $n=z^2$ pq / ^{d2}, where z is the standard normal distribution, p is the anticipated proportion of the population, q is the proportion of the population that does not have the characteristic being studied, and d is the margin of error. With an anticipated proportion of 50%, a margin of error of 5%, and a 95% confidence interval, the estimated sample size was calculated as 384, which was rounded up to 400 [28]. The study aimed to examine the influence of various comorbidities and factors, including age, immune status, diabetes, hypertension, chronic kidney disease, ischemic

heart disease, cardiac failure, cancer, emphysema, cytotoxic chemotherapy, and steroid usage, on the outcome of hospitalized COVID-19 cases. A simple random sampling method was used to select the required number of files from all available files from the COVID-19 units [27].

Data Collection Method

The research team obtained administrative and ethical approval (wide approval no: 12-08-42) from the Ethical Committee of Jouf University, KSA, before initiating data collection from selected COVID-19 patient files. The data collection form was prepared by a team of experts in internal medicine and infectious diseases and included patient age, gender, and immune status, as defined in the operational definition. The research team recorded the disease diagnosis as noted in the patient's files. The present study involved analyzing COVID-19 patient files, and the data collectors extracted secondary data from the files. The study did not involve direct contact with patients; hence, the local committee of bioethics, at Jouf University, waived the need for informed consent. However, the hospital routinely obtained informed consent from all admitted patients or their relatives before undergoing any procedure.

Data Analysis

The details collected from patients' files were entered into the Statistical Package for Social Sciences version 21.0. The present study's continuous data were presented as mean and standard deviation (SD), while qualitative data were presented as frequency and proportion. The chi-square ($\chi 2$) analysis was used to determine the correlation between COVID-19 outcomes and sociodemographic characteristics, comorbidities, and immune status. Additionally, multivariate logistic regression analyses were conducted to identify the predictors of COVID-19 complications and mortality. A p-value of less than 0.05 was considered statistically significant.

Results and Discussion

The study included a total of 400 COVID-19 patients, with 265 (65.5%) being males and 138 (34.5%) being females. The clinical features of the patients are presented in **Table 1**. The most common symptoms reported by the patients were fever (54.5%), followed by cough (47.8%), and shortness of breath (47.3%).

Table 1. Pattern of clinical picture in hospital admissions (n=400)

Symptoms	Yes No (%)	No (%)
Fever	218 (54.5%)	182 (45.5%)
Cough	191 (47.8%)	209 (52.3%)
Chills	0 (0%)	400 (100%)
Shortness of breath	189 (47.3%)	211 (52.8%)
Headache	43 (10.8%)	357(89.3%)
Muscle or body aches	4 (1%)	396 (99%)
Loss of taste	53 (13.3%)	347 (86.7%)
Loss of smell	60 (15%)	340 (85%)
Sore throat	27 (6.8%)	373 (93.3%)
Congested or runny nose	3 (0.8%)	397 (99.3%)
Nausea	17 (4.3%)	383 (95.8%)
Vomiting	21 (5.3%)	379 (94.8%)
Diarrhea	25 (6.3%)	375 (93.8%)
Asymptomatic	23 (5.8%)	377 (94.3%)

Table 2 presents the prevalence of comorbidities among the COVID-19 patients admitted to the hospital. The most frequently observed comorbidity was diabetes mellitus (43.5%), followed by hypertension (16.8%), cardiac failure (8.5%), and ischemic heart disease (7.8%).

Table 2. Basic demographic characteristics and co-morbidities in COVID-19 patients (n=400)

Variables	N (%)
Total Cases	400
Age, years	
<30	60 (15%)
30-49	140 (35%)
50-69	140 (35%)
≥ 70	60 (15)
Gender	
Male	265 (65.5%)
Female	138 (34.5%)
Co-morbid conditions	
Diabetes mellitus	174 (43.5)
Hypertension	67 (16.8)
IHD	31 (7.8)
Cardiac failure	34 (8.5)
Chronic Kidney Disease	21 (5.3)
Emphysema	4 (1)
Cancer	2 (0.5)
Cytotoxic chemotherapy	2 (0.5)
Steroids	1 (0.3)

The study included 400 COVID-19 patients, among whom 77.3% recovered without any COVID-19-related complications, 4.5% experienced one or more complications, and the mortality rate was 18.3%. The recovery rate was found to be higher among females (81.2%) compared to males (75.2%), as depicted in **Figure 1**.

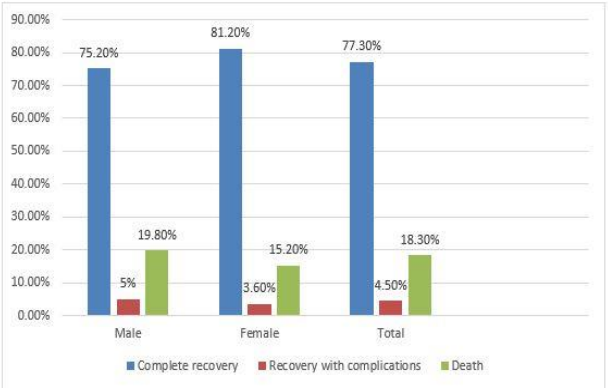

Figure 1. The outcome of COVID-19 patients

The immune status of the COVID-19 patients in this study was classified according to the guidelines provided by the Centers for Disease Control and Prevention (CDC). The study found that COVID-19 outcome, which included complete recovery, recovery with complications, and death, was significantly associated with various factors. These factors included age (p<0.001), immune status (p=0.001), diabetes (p=0.001), hypertension (p=0.001), chronic kidney disease (p=0.001), Ischemic Heart disease (p=0.025), and cardiac failure patients (p=0.008). However, the study did not find any significant association between the COVID-19 outcome and Cancer (p=0.498), Emphysema (p=0.867), Cytotoxic chemotherapy (p=0.744), and steroid use (p=0.106). The details of the statistical analysis and significance are presented in **Table 3**.

Table 3. Association between Outcome with background characteristics and Comorbid conditions (statistical test applied: Chi-square test) (n=400)

		Outcome			
		Complete recovery	**Recovery with complications**	**Death**	**P value**
Age (mean ± SD)		49.25 ± 15.7	56.83 ± 18.2	65.12 ± 14.8	<0.001*
Gender	Male	197 (49.3)	13 (3.3)	52(13.0)	0.399
	Female	112 (28.0)	5 (1.3)	21 (5.3)	
Immune status	Immunocompromised	130 (32.5)	11 (2.8)	59 (14.8)	0.001*
	Immunocompetent	179 (44.8)	7 (1.8)	14 (3.5)	
Diabetes	No	190 (47.5)	10 (2.5)	26 (6.5)	0.001*
	Yes	119 (29.8)	8 (2.0)	47 (11.8)	
Hypertension	No	95 (23.7)	15 (3.7)	60 (15.0)	0.001*
	Yes	153 (38.2)	30 (7.5)	47 (11.7)	
Ischemic Heart Disease	No	288 (72.0)	15 (3.8)	50 (12.5)	0.025*
	Yes	19 (4.8)	3 (0.8)	24 (6.0)	
Chronic Kidney Disease	No	91 (22.7)	16 (4.0)	60 (15.0)	0.001*
	Yes	153 (38.2)	32 (8.0)	48 (12.0)	
Cardiac failure	No	290 (72.5)	15 (3.8)	61 (15.3)	0.008*
	Yes	19 (4.8)	3 (0.8)	12 (3.0)	
Cancer	No	308 (77.0)	18 (4.5)	72 (18.0)	0.498
	Yes	1 (0.3)	0	1 (0.3)	
Emphysema	No	306 (76.5)	18 (4.5)	72 (18.0)	0.867
	Yes	3 (0.7)	0.0)	1 (0.3)	
Cytotoxic chemotherapy	No	307 (76.8)	18 (4.5)	73 (18.2)	0.744
	Yes	2 (0.5)	0	0	
Steroids	No	308 (77.0)	18 (4.5)	72 (18.0)	0.106
	Yes	(0.0)	0.0)	2 (0.5)	

*Significant p-value.

The study conducted a multivariate regression analysis to identify the significant indicators of COVID-19 recovery, recovery with complications, and mortality. The analysis included factors such as gender and types of comorbidities **(Table 4)**. Results showed that gender had no association with clinical outcomes and complications. However, comorbidities were significantly associated with clinical outcomes. Specifically, diabetes (p<0.001) and cardiac failure (p<0.001) were significantly associated with both incomplete recovery and mortality. On the other hand, ischemic heart disease (p=0.06) and chronic kidney disease (p=0.08) were associated with non-significant complete recovery, while ischemic heart disease (p=0.03) and chronic kidney disease (p=0.05) were significantly associated with incomplete recovery **(Table 4)**.

Table 4. Multivariate analysis of the association of gender and comorbidities between complication and clinical outcomes of patients with COVID-19.

	Complete recovery OR (95% CI)	p-value	Recovery with complication OR (95% CI)	p-value	Mortality OR (95% CI)	p-value
Gender (male vs female)	0.8 (0.8-1.3)	0.7	1.0 (0.9-1.5)	0.65	1.0 (0.8-1.3)	0.4
Comorbidities (yes/no)						
Diabetes	2.3 (2.0-5.0)	<0.001	1.8 (1.4-2.5)	<0.001	2.0 (1.5-2.8)	<0.001
Ischemic heart disease	1.3 (1.0-2.0)	0.06	2.6 (1.1-6.0)	0.03	6.2 (1.5-26.0)	<0.001
Chronic kidney disease	1.5 (1.8-2.9)	0.08	1.3 (1.0-1.8)	0.05	8.5 (3.0-21.0)	<0.001
Cardiac failure	2.6 (1.1-6.2)	0.03	3 (1.3- 7.5)	0.005	3.2 (1.9-5.5)	<0.001

The findings of this study suggest that there is no significant association between gender and COVID-19 outcomes, including complete recovery, recovery with complications, and mortality. However, comorbidities such as diabetes, ischemic heart disease, chronic kidney disease, and cardiac failure were identified as significant predictors of COVID-19 recovery with complications and mortality. These results highlight the importance of managing these comorbidities in COVID-19 patients to improve their clinical outcomes. The study provides valuable insights into the factors that influence COVID-19 outcomes and can inform clinical decision-making for the management of COVID-19 patients.

The global COVID-19 situation as of 02/07/2022 was characterized by 553,770,544 reported cases and 6,360,339 deaths [29]. Co-morbidities have been shown to increase the risk of COVID-19 complications and mortality. The severity of COVID-19 is impacted by the presence of comorbid conditions, which are associated with increased morbidity [30].

The study included 400 admitted COVID-19 patients, of which 265 (65.5%) were males and 138 (34.5%) were females. The most prevalent symptoms noted were fever (54.5%), cough (47.8%), and shortness of breath (47.3%). These findings are consistent with previous reviews by Jiang *et al*. [31] and Wu *et al*. [32], which also reported fever, cough, and dyspnea as the primary clinical features. Another study conducted by Lounis *et al*. [33] also found coughs, fever, and asthenia to be the common clinical presentations of COVID-19.

The study investigated 400 COVID-19 patients, and the findings indicate that 77.3% recovered without complications, 4.5% experienced one or more complications, and 18.3% died. The recovery rate for males was 75.2%, while for females, it was 81.2%. In a study conducted in the Kingdom of Saudi Arabia (KSA), the mortality rate was reported to be 30% for hospitalized COVID-19 patients, with higher mortality rates in the northern and western regions [34]. Christanto *et al*. [35] reported that 66.7% of their patients had severe disease, with a mortality rate of 30%, which increased to 37.8% in patients with comorbidities. These findings are consistent with previous studies that have shown fever, cough, and shortness of breath as the most common COVID-19 symptoms. The present study highlights the significance of gender-independent predictors of COVID-19 outcomes, including comorbidities such as diabetes, ischemic heart disease, chronic kidney disease, and cardiac failure.

In this study, a significant association was observed between COVID-19 outcomes (complete recovery, recovery with complications, and death) and various factors such as age (p<0.001), immune status (p=0.001), comorbidities including diabetes (p=0.001), hypertension (p=0.001), Ischemic Heart Disease (IHD) (p=0.025), Chronic Kidney Disease (CKD) (p=0.001), and cardiac failure (p=0.008) **(Table 1)**. These findings suggest that these factors may contribute to the severity of COVID-19 and increase the risk of adverse outcomes. Choi *et al*. [36] similarly observed that underlying chronic diseases led to poor outcomes and increased patient management expenditure. They found a significant association between chronic diseases (such as Cardiovascular Disease (CVD), diabetes, kidney disease, dementia, malignancy, and death. In addition, Christanto *et al*. [35] reported that comorbidities were associated with significant worsening of the disease and increased mortality in hospitalized patients. Du *et al*. [37] also identified risk factors such as old age, the presence of CVD or cerebrovascular diseases, levels of certain types of T-cells, and levels of troponin I that significantly increased mortality rates in their study.

The present study observed a significant relationship between COVID-19 outcomes and diabetes (p=0.001), with diabetic patients having a poorer prognosis. This is consistent with the findings of Alguwaihes *et al*. [27], who reported significantly higher mortality rates in COVID-19 patients with diabetes than in non-diabetics. Other significant predictors of mortality identified by Alguwaihes *et al*. [27] included age, congestive heart failure, smoking, and bilateral lung infiltrates. A meta-analysis conducted by Ezeokpoa *et al*. [38] showed a moderate association between diabetes mellitus and hypertension with the severity of the disease and mortality rates in COVID-19 patients, with a stronger association found for cardiovascular disease. Pathogenic mechanisms contributing to poor outcomes in diabetic patients include impaired immunity, microangiopathy, impaired glycemic

control, effects of glucocorticoids and catecholamines, and drugs [34].

The outcome of COVID-19 was significantly associated with IHD and cardiac failure in the present study, which is consistent with the findings of Yang *et al*. [39], Mehra *et al*. [40], and Kong *et al*. [41]. The underlying pathophysiological mechanisms for poor COVID-19 outcomes in IHD patients include a mismatch between raised metabolic requirements due to the infection and reduced cardiac reserves in these patients, which makes them more prone to plaque rupture due to systemic inflammation and pro-coagulant effects induced by COVID-19. Additionally, SARS-CoV down-regulates ACE2 pathways in the heart and lungs, leading to inflammation in these organs [42]. Cardiac failure patients have higher hospitalization and death rates in COVID-19, which may be attributed to decreased circulatory and physiological reserves as well as the presence of other co-morbidities [43].

The study found a significant association between COVID-19 outcomes and chronic kidney disease (CKD). According to Jdiaa *et al*. [43], CKD adversely affects the incidence, severity, and mortality rates of COVID-19, as well as the frequency of hospitalization and ICU admissions, leading to worse outcomes in CKD patients as compared to those without CKD. CKD patients exhibit alterations in both the innate and adaptive immune systems, including changes in pattern recognition receptors and lymphocyte function, which makes them more susceptible to infections, atherosclerosis, and cardiovascular diseases. The presence of COVID-19 exacerbates these alterations and complications in CKD patients [44].

The multivariate analysis of results showed that there were no significant gender-based differences observed regarding the likelihood of complete recovery, recovery with complications, and mortality in COVID-19 patients. However, the study did find that all of the examined comorbidities had relatively higher odds ratios (ORs) for recovery with complications and mortality. These findings highlight the importance of taking into account comorbidities when developing treatment protocols for COVID-19 patients.

The present study did not find a significant association between gender and COVID-19 outcome, nor did it find a significant relationship between certain co-morbidities (such as immunosuppressive conditions, steroid usage, and emphysema) and COVID-19 outcome. However, it should be noted that the number of COVID-19 patients with these conditions was very low in the study, which may have limited the ability to detect significant associations. The study was conducted in one hospital with a specific demographic, so further research is needed in different healthcare centers in Saudi Arabia to explore COVID-19 cases and their association with comorbidities. A prospective study with well-defined laboratory markers and a larger sample size is needed to provide further insight [1].

Conclusion

The majority (77.3%) of patients in the present study recovered from COVID-19 without complications, while the mortality rate was 18.3%. Patients with diabetes, hypertension, ischemic heart disease (IHD), chronic kidney disease (CKD), and cardiac failure had significantly poorer outcomes, indicating a strong association between COVID-19 and these comorbidities. The immune status of individuals significantly affected the outcome, with immunocompromised individuals more prone to poorer outcomes and more likely to die from COVID-19. While the present study found partial associations between some comorbidities and complete or incomplete recovery, all comorbidities were significant in terms of mortality. As the world is still experiencing a pandemic and cases are not subsiding, it is recommended to continue monitoring COVID-19 cases in the Kingdom, with a special focus on high-risk groups. Additionally, preventive activities should continue, with a greater focus on high-risk groups. However, it should be noted that the present study was conducted in only one hospital, and further research in other healthcare centers in Saudi Arabia is needed to confirm these findings. Moreover, a prospective study with a larger sample size and well-defined laboratory markers is needed to better understand the impact of COVID-19 on different comorbidities and immune status.

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