

FULL PAPER

Risk factors determining severity in COVID-19 positive patients admitted to the intensive care unit (ICU) at NGHA

Asma Alanazi^{a,b,*} | Abdulaziz Alturki^a | Mohammed Alosaimi^a | Nawaf Alnajmi^a | Mohammed Alrajeh^a | Abdullah Kentab^a | Farida Habib^c

^aCollege of Medicine, King Saud bin Abdulaziz University for Health Sciences (KSAU-HS), Riyadh, Saudi Arabia

^bKing Abdullah International Medical Research Center, Riyadh, Saudi Arabia

^cCollege of Health Sciences, University of Fujairah, UEA

Although a wealth of research exists on the typical traits of ICU patients suffering from COVID-19, targeted studies focusing on Saudi Arabia are relatively scarce. We executed a detailed cross-sectional investigation to pinpoint frequent comorbidities and risk variables in critically sick individuals diagnosed with COVID-19 at the National Guard Hospital. The timeframe for the study spanned from March 2, 2020, to March 20, 2021. Information was culled from King Abdulaziz Medical City's BEST care database and statistically analyzed using SPSS software. Our study comprised 385 ICU-admitted COVID-19 patients. The mean age was 60.85 years with a standard deviation of 20.46 years; 60.85% were men and 39.2% were women. A notable positive correlation was observed between the severity of symptoms and age, validated by a p-value of 0.002. Patients, on average, stayed in the hospital for 21.85 days with a standard deviation of 28.47 days. The mortality rate was roughly 37.4%, whereas around 62.6% recovered and were released from the hospital. In the context of the National Guard Health Affairs in Riyadh, Saudi Arabia, 75.3% had respiratory issues. Among the patients, 55.1% (or 212 individuals) had diabetes mellitus and 52.7% (or 203 individuals) suffered from high blood pressure. A significant link was found between individuals with gastrointestinal tract (GIT) complications and increased symptom severity, confirmed by a p-value of 0.000. In addition, hypertension was strongly associated with worsening COVID-19 symptoms, substantiated by a p-value of 0.017. Patients who have COVID-19 in conjunction with gastrointestinal problems or hypertension are at a greater risk for developing severe symptoms. Moreover, advancing age stands out as an additional risk factor contributing to heightened symptom severity.

***Corresponding Author:**

Asma Alanazi

Email: Anazia@Ksau-hs.edu.sa

KEYWORDS

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Introduction

COVID-19 is a viral respiratory illness triggered by a new strain of coronavirus, first discovered in Wuhan, China, in late 2019. On March 11, 2020, the World Health

Organization (WHO) officially designated it as a global pandemic [1]. The virus chiefly spreads via airborne particles from the respiratory system of infected persons, making it highly infectious in populated environments. While a majority of individuals

infected with COVID-19 display mild to moderate respiratory issues that often do not necessitate medical treatment, seniors and people with pre-existing health conditions are more susceptible to severe complications [2].

The risk factors associated with COVID-19 and its potential complications are still being actively studied due to the disease novelty. However, several factors have emerged as potential contributors to severe disease outcomes. Obesity, for instance, has been linked to worsened respiratory effects of COVID-19, with individuals with a high body mass index (BMI) more likely to require interventions like intermittent mandatory ventilation (IMV) [3]. In addition, older individuals, especially those above the age of 70 are at an increased risk of COVID-19 infection and subsequent admission to intensive care units (ICUs) [4]. Other risk factors include heart failure, male gender, and chronic kidney disease.

Understanding the common risk factors associated with ICU admission in patients who test positive for COVID-19 is crucial for predicting, preventing, and managing complications, ultimately improving patient outcomes. This study aims to provide insights into the epidemiology and clinical characteristics of COVID-19 patients admitted to the ICU at the Ministry of National Guard-Health Affairs (NGHA) in Riyadh, Saudi Arabia.

This study is designed to achieve the following research objectives: To identify and analyze the demographic characteristics, comorbidities, and risk factors in COVID-19 patients admitted to the to examine the relationships between demographic factors, comorbidities, and the severity of COVID-19 symptoms in this patient population and to contribute valuable data on COVID-19 patients.

By explicitly stating the research objectives and the significance of the study, this revised introduction provides a clearer focus for the

reader and highlights the knowledge gap that the study aims to address.

Method

A detailed cross-sectional analysis was carried out to explore prevalent risk elements among critically sick patients diagnosed with COVID-19. These individuals were admitted to the Intensive Care Units (ICU) of the National Guard Hospital (NGHA) at King Abdulaziz Medical City (KAMC) in Riyadh, Saudi Arabia, between March 2, 2020, and March 20, 2021 [5]. Situated in the eastern region of Riyadh, KAMC was founded in May 1983 and has broadened its healthcare offerings to meet the needs of an expanding patient base. With a total of 1501 beds, it not only ranks as one of the leading medical facilities not just in Saudi Arabia, but also in the broader Middle East, mainly catering to National Guard personnel and their families, as well as employees and their dependents.

Data was sourced from an array of ICUs at NGHA, including but not limited to General ICU, Neurological ICU, Burns ICU, Trauma/Surgical ICU, ICU Step-down, and Liver Transplant Step-down units. Units specialized in Transplantation, Oncology, and Hematology were in the developmental phase when the study was conducted. The pool of study participants consisted of around 5000 men and women across all age groups who were non-smokers and had confirmed cases of COVID-19. The severity of their respiratory distress-necessitating heightened levels of oxygen support, high-flow nasal cannula, or non-invasive positive pressure ventilation-was the main reason for their ICU admission. [6, 7] This study was granted approval by the King Abdullah International Medical Research Center (KAIMRC) (No. SP21R-249-05).

For the study, we used convenience sampling, incorporating all the accessible records that fit the established guidelines. The sample size was ascertained using the Raosoft sample size calculator, aiming for a 95%

confidence level and a 5% margin of error. This resulted in a final sample size of 385 patients. The sample size for this study was determined through a systematic calculation to ensure that the findings are statistically robust and representative of the patient population at the National Guard Hospital (NGHA). To achieve a 95% confidence level with a 5% margin of error, we utilized the Raosoft sample size calculator. Data was extracted from KAMC's BEST care system, with a total of over 1600 patient records provided by the research center as of August 11, 2021. The data was bifurcated into demographic aspects like gender and age, and risk variables such as respiratory, cardiac, kidney, and liver diseases, diabetes mellitus, gastrointestinal issues, hypertension, and tumors. A "non-category" was established for samples without identifiable risk factors.

The statistical scrutiny was executed using SPSS version 22.0. Descriptive statistics like frequency, percentage, mean, and standard deviation helped outline demographic features. Chi-square tests were utilized for non-parametric variables linked to risk factors such as gender and symptoms. A one-sample t-test was deployed for gauging the significance of the mean concerning interval and ratio variables like age and temperature.

Results

In Table 1, the distribution of demographic characteristics among the 385 participants is detailed. Males comprised 60.85% of the sample, whereas females accounted for 39.2%. The average age of the study participants was 60.85 years with a standard deviation of 20.46 years. A significant majority, roughly two-thirds of the sample, were 61 years or older. A very small fraction, only 6.4%, were 20 years old or younger. Interestingly, the vast majority of the sample, 86.2%, showed no symptoms of COVID-19, while a smaller segment, 13.8%, did exhibit symptoms of the virus.

In Table 2, the focus is on the duration of the hospital stays among the 385 patients in the study.

In Table 2, the data highlights the length of hospital stays for the 385 participants. The average duration was recorded as 21.85 days, with a standard deviation of 28.47 days. A relatively small portion, 17.7%, had short hospital stays of 5 days or fewer. Conversely, a significant 30.8% of the patients stayed in the hospital for more than 20 days.

TABLE 1 Distribution of demographic features across the study sample (N = 385)

Variable	Number	Percent (%)
Gender		
Male	234	60.8
Female	151	39.2
Age		
20 or less	25	6.4
21-40	13	3.4
41-60	90	23.4
61 and up	257	66.8
Mean /SD		60.85 ± 20.46
Presence of COVID symptoms		
No	332	86.2
Yes	53	13.8

TABLE 2 Duration of hospital stays among the 385 patients

Symptoms	Number	Percent (%)
Duration of Stay		
5 days or less	68	17.7
6-10	73	19.0
11-15	73	19.0
16-20	54	14.0
21-25	34	8.8
26-30	30	7.8
More than 30	53	13.8
Mean/ SD		21.85 ± 28.47

In Table 2, we present the duration of hospital stays among the 385 patients included in this study. The mean duration was 21.85 days, with a notable standard deviation of 28.47 days. This high standard deviation indicates a considerable level of variability in the length of hospital stays among COVID-19 patients admitted to the ICU at the National Guard Hospital.

The substantial variability in the duration of stay can be attributed to several factors, including the diverse clinical presentations of COVID-19, variations in treatment responses, and individual patient characteristics. While a portion of patients experienced relatively short stays of five days or less (17.7%), a significant number required more extended hospitalization, with 30.8% of patients staying for more than 20 days. The reasons for this wide range of hospital stays warrant further investigation and may have implications for healthcare resource allocation and patient management.

Figure 1 displays the mortality rate among the 385 COVID-19 patients admitted to the hospital. Notably, more than a third-37.4% to be precise-of the admitted cases resulted in death. On the other hand, roughly two-thirds of the patients managed to fully recover and were subsequently discharged from the hospital.

As summarized in Table 3, the lion's share of patients admitted to the National Guard Hospital (NGHA)-75.3% or 290 individuals-had respiratory diseases. Diabetes mellitus was also a common comorbidity, present in 55.1% (212 patients) of the sample. Hypertension was another notable risk factor, seen in 52.7% (203 patients) of those admitted. Intriguingly, a minuscule portion, just 2.9% or 11 patients, were admitted without any identifiable risk factors. Additional distributions of risk factors are elaborated upon in the table.

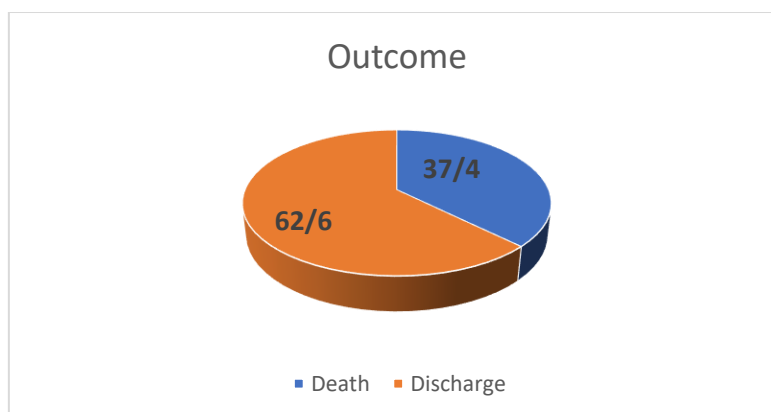
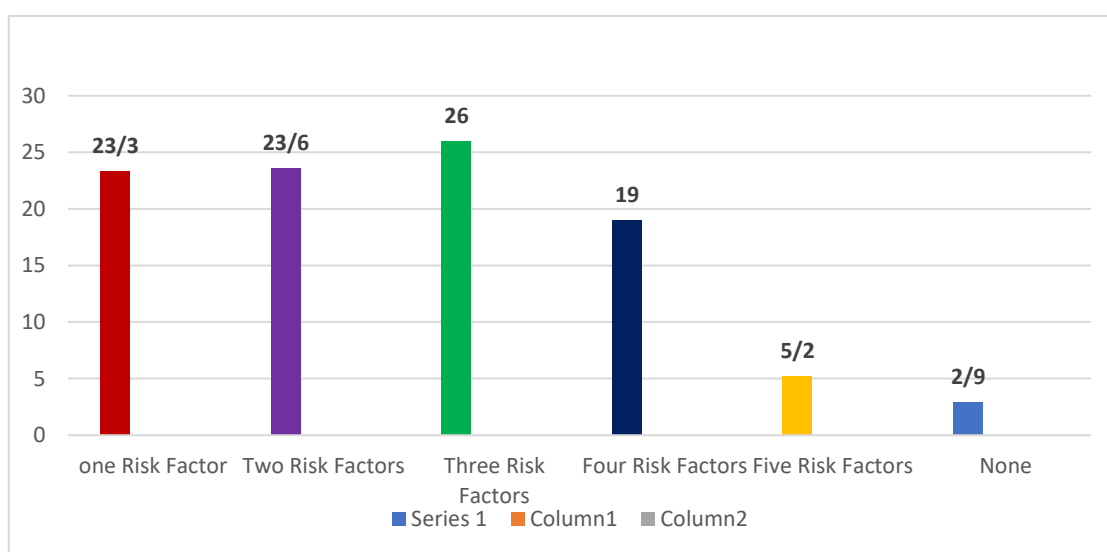
**FIGURE 1** Visualizes the proportion of COVID-19 related fatalities among the 385 patients who were admitted to the hospital

TABLE 3 Focuses on the distribution of various risk factors among the 385 patients who were admitted to the National Guard Hospital (NGHA)

Risk Factors	Number	Percent
Respiratory problem	290	75.3
Cardiac	144	37.4
Kidney	52	13.5
Liver	3	0.8
Diabetes	212	55.1
GIT	7	1.8
Hypertension	203	52.7
Cancer	34	8.8
No risk factor	11	2.9

Figure 2 illustrates an intriguing pattern in the distribution of risk factors among the 385 patients admitted to NGHA. Patients with three risk factors account for the largest share, making up 26% of the admitted cases. Those with two risk factors follow closely, comprising 23.6% of patients. Surprisingly, individuals with four or five risk factors are

less common, with percentages of 19% and 5.2%, respectively. This finding suggests that a higher number of risk factors doesn't necessarily correlate with a larger percentage of admissions. Similarly, having fewer risk factors does not guarantee a lower percentage of hospital admissions.

**FIGURE 2** Visual breakdown of the prevalence of various risk factors among the 385 patients admitted to NGHA**TABLE 4** The connection between COVID-19 symptoms and various demographic variables among the patients

Variables	Symptoms Chi-square	P-value
Gender	1.354	0.245
Age	18.14	0.002
Outcome	7.149	0.007

TABLE 5 The relationships between COVID-19 symptoms and various risk factors among the patient population

Risk Factors	Symptoms Chi-square	P-value
Respiratory problem	1.777	0.229
Cardiac	1.589	0.203
Kidney	2.710	0.617
Liver	0.484	0.487
Diabetes	0.359	0.549
GIT	13.643	0.000
Hypertension	5.648	0.017
Cancer	2.967	0.085

The analysis revealed some noteworthy correlations concerning the severity of COVID-19 symptoms. Specifically, there was a statistically significant positive relationship between symptom severity and age, supported by a p-value of 0.002. In other words, older individuals are more likely to experience severe symptoms. Similarly, a significant correlation was found between symptom severity and patient outcomes, evidenced by a p-value of 0.007 (Table 4). This suggests that the more severe the symptoms, the worse the medical outcome is likely to be. Interestingly, no significant correlation was observed between symptom severity and gender, indicating that both men and women are equally likely to experience varying levels of symptom severity.

The analysis presented in Table 5 sheds light on some significant correlations between COVID-19 symptom severity and specific risk factors. A particularly strong association was found between gastrointestinal tract (GIT) risk factors and symptom severity, underscored by a p-value of 0.000. This suggests that patients with GIT-related issues are highly likely to experience severe COVID-19 symptoms. Another compelling correlation was observed between hypertensive patients and symptom severity, substantiated by a p-value of 0.017. This indicates that individuals with hypertension also face a higher likelihood of severe symptoms. Conversely, the data showed no statistically significant

relationships between symptom severity and other listed risk factors such as kidney disease, diabetes mellitus, and liver disease, with respective P-values of 0.617, 0.549, and 0.487.

Discussion

In this study conducted at NGHHA in Riyadh, Saudi Arabia, focused on analyzing the risk factors and comorbidities associated with ICU admissions in patients with COVID-19.

Among the 385 patients admitted to the ICU with confirmed COVID-19, 60.8% were males, which aligns with findings from similar studies [8]. The majority of patients admitted to the ICU, accounting for 66.8%, were aged above 61, making age and male gender the most common characteristics among ICU-admitted COVID-19 patients, a trend observed in other studies as well [9].

The risk factors and comorbidities identified in this study were as follows:

1. Respiratory diseases: Respiratory problems were the most prevalent risk factor, with 75.3% of patients presenting with conditions such as COPD, pneumonia, or asthma.

2. Cardiac diseases: Cardiovascular risk factors like smoking, obesity, and physical inactivity were associated with a higher risk of COVID-19 development in 37.4% of patients. However, there was no significant relationship between cardiovascular problems and the severity of COVID-19 symptoms, though some

studies in other countries have suggested such an association [10].

3. Kidney diseases: Only 13.5% of patients had kidney diseases, and no direct relationship between kidney diseases and more severe COVID-19 symptoms was found in this analysis. However, other studies have indicated that COVID-19 may increase the risk of acute kidney injury, eGFR decline, end-stage kidney disease, and major adverse kidney events [11].

4. Liver diseases: Chronic liver disease (CLD) was present in only 0.8% of patients in this study, suggesting that it is not a major risk factor for ICU admission due to COVID-19. Other studies have also indicated that CLD patients did not have an increased risk of developing severe COVID-19 [12].

5. Diabetes mellitus: Diabetes was one of the most common comorbidities among COVID-19 patients and is considered a risk factor for severe and fatal COVID-19 cases [13]. Previous studies have supported this association [14,15], which is consistent with the findings in this study.

6. Hypertension: Hypertension was observed more frequently in severe COVID-19 patients compared to non-severe cases[16,17], and a strong relationship between hypertension and COVID-19 severity was found in this study ($P = 0.017$). The CDC also suggests that individuals with hypertension may be at increased risk for severe illness from COVID-19 [18]

7. Gastrointestinal diseases: Gastrointestinal tract risk factors were present in only 1.8% of patients admitted to NGH. However, there was a very strong significant positive relationship between these risk factors and the severity of COVID-19 symptoms ($P = 0.000$).

8. Cancer: Patients with cancer, especially hematologic malignancies, were found to be

vulnerable to SARS-CoV-2 infection due to compromised immunity[19]. The study data indicated that cancer was an independent risk factor for COVID-19, with 8.8% of patients having cancer (34 patients), consistent with research from Wuhan, China [20]

This study provides valuable insights into the risk factors and comorbidities associated with severe COVID-19 cases in NGH, Riyadh, Saudi Arabia, contributing to our understanding of the disease's impact on different patient populations.

Conclusion

In conclusion, this study sheds light on critical aspects of COVID-19 patient admissions to the Intensive Care Unit at the National Guard Hospital (NGH) in Riyadh, Saudi Arabia. The findings reveal the importance of age and gender as indicators for severe COVID-19 outcomes, consistent with international trends. Respiratory diseases play a substantial role in the severity of COVID-19 symptoms, reinforcing the respiratory implications of the virus.

Interestingly, the study underscores that while certain comorbidities like diabetes and hypertension are prevalent among the patient population, only hypertension displayed a statistically significant association with COVID-19 severity ($p\text{-value} = 0.017$). Furthermore, the unexpected and strong correlation between gastrointestinal tract (GIT) risk factors and severe COVID-19 symptoms ($p\text{-value} = 0.000$) suggests a potential area for further exploration.

Moreover, this study contributes valuable localized insights into COVID-19 in Saudi Arabia, a region often underrepresented in existing literature. The methodological rigor employed, including robust sampling techniques and statistical analysis, bolsters the credibility of the findings.

The findings of this study can inform healthcare practitioners and policymakers in

Saudi Arabia in making more informed decisions for patient management, resource allocation, and preventive measures.

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Conflict of interest

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Authors' contributions

All authors contributed to data analysis, drafting, and revising of the manuscript and agreed to be responsible for all the aspects of this work.

Orcid:

Asma Alanazi:

<https://orcid.org/0000-0002-6401-9347>

Abdulaziz Alturki:

<https://orcid.org/0009-0001-3161-086X>

Mohammed Alosaimi:

<https://orcid.org/0009-0006-2259-477X>

Nawaf Najmi:

<https://orcid.org/0009-0001-1486-2811>

Mohammed Alrajeh:

<https://orcid.org/0009-0006-3038-2849>

Abdullah Kentab:

<https://orcid.org/0009-0002-5699-9637>

Farida Habib:

<https://orcid.org/0000-0001-9051-6155>

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