Examining the Clinical and Laboratory Findings of Patients with COVID-19 Hospitalized in the ICU (A Cross-sectional Study)

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Abstract:
Background: The clinical care for patients suffering from COVID-19 requires knowledge of clinical and laboratory findings.
Aim: This study aims to investigate the clinical and laboratory findings related to patients with COVID-19 who were hospitalized in the Intensive Care Unit (ICU).
Methods: The cross-sectional study was conducted on 529 patients with COVID-19 who were hospitalized in the ICU department of Imam Khomeini Hospital in Jiroft. The information is based on the researcher's checklist and was collected from the patient files by referring to the hospital archives. Data were analyzed using SPSS-26 statistical software.
Results: The average age of the patients was 68.7 ± 27.9 years, and the average total hospitalization time was 7.8 days. The rate of hospitalization was higher in men than in women. The most common clinical symptoms of the patients on arrival were cough, fever, and chest pain. Cardiovascular diseases, blood pressure, and diabetes were among the factors related to the hospitalization of patients with COVID-19. The mortality rate in the present study was 30.6%. An increase beyond the normal range was observed in the mean white blood cell count, red blood cell sedimentation time, and blood creatinine.
Conclusion: The results of this research showed that elderly men with at least one underlying disease are among the factors related to the hospitalization of patients in the ICU, which requires special attention in how to treat and follow them because of the increase in hospitalization time in this group and consequently its financial burden is imposed on the health system.

Keywords: Clinical symptoms, COVID-19, Hospitalization, Underlying diseases, ICU, Patient, Disease.
1. INTRODUCTION

Coronaviruses are widely distributed among humans and animals, causing respiratory and gastrointestinal diseases [1, 2]. Human coronaviruses were identified for the first time in the mid-1960s, and so far, seven human coronaviruses have been identified that can affect humans [3]. Coronavirus is a family of enveloped viruses that have a large positive-sense single-stranded RNA genome [4].

Sometimes, coronaviruses that normally infect animals can evolve and make humans sick. Many deaths are typically a result of coronaviruses transferred from animals to humans, which cross the species barrier and cause high morbidity and mortality in human populations, for example, SARS-CoV, which caused SARS, a severe acute respiratory syndrome that broke out in China in 2002 and in 2003, MERS-CoV spread, which caused severe respiratory disease. In 2012, there was an outbreak in the Middle East of SARS-CoV-2 was the seventh member of human coronavirus family [5, 6].

The initial tests of blood indicators related to the coronavirus include C-reactive protein, complete blood cell count test, measurement of lactate dehydrogenase, the amount and speed of red blood cell sedimentation, which are used to check the patient's condition and how the body responds to the virus [3, 7]. The red blood cell sedimentation rate test is used in coronavirus tests to check the presence of inflammation in the body, which increases significantly in colon patients. Of course, this test is not specific to diagnose the disease [8, 9]. The C-reactive protein test, like red blood cell sedimentation, increases rapidly in inflammatory conditions, and it can also be used to check inflammatory conditions in the body. The complete blood cell count test is a blood test that is used to check blood cells [10, 11]. A group of blood cells are white blood cells. The number of these cells increases in case of an infectious disease and as a result of the body's immune response. Especially lymphocytes and granulocytes are a group of white blood cells that are used to diagnose viral diseases. Testing for creatine phosphokinase (CPK), which is an intracellular enzyme, and its concentration is high in skeletal muscle, myocardium, and brain, and damage to any of these tissues increases its serum level [12, 13].

Considering that the clinical condition of patients with COVID-19 has a wide range and varies from asymptomatic to coma and death, therefore, one of the most vital measures in the correct management of the said disease is to conduct epidemiological studies regarding the factors affecting hospitalization and the severity of the occurrence. The results of such studies can be used to design and implement targeted preventive and treatment programs and subsequently adjust the resulting human, financial, and social damages. Considering that few studies have been conducted in Iran regarding factors related to the hospitalization of patients with COVID-19, therefore, the present study was designed and implemented to identify the factors related to hospitalization and the laboratory and clinical features of this disease.

2. METHODS AND MATERIALS

This descriptive, analytical, cross-sectional study was conducted using the census method on the medical records of patients admitted to the ICU department of Imam Khomeini (RA) Jiroft Hospital in 2021. Finally, according to the entry and exit criteria, 529 medical records of patients admitted to the ICU were evaluated. Hospitalization in the ICU and access to different parts of patient medical records (experiments, diagnostic and paraclinical tests, history sheet, clinical course, etc.), as well as a positive PCR test as an inclusion criterion and incompleteness of medical record information, were considered as an exit criterion.

The data collection tool was a checklist made by the researcher. This checklist was designed according to the criteria in the patients’ medical records to check the laboratory and clinical results of the patients. This checklist consisted of two parts. The first part was related to the demographic information of the patients (age, gender, place of residence, duration of hospitalization, history of contact with a person infected with COVID-19, and history of underlying disease), and the second part was related to clinical and paraclinical findings (the result of treatment, clinical symptoms, tests, and signs of lung involvement in CT scan). To take ethical considerations into account, the researchers obtained the approval code of ethics from the research assistant at Jiroft University of Medical Sciences. After making necessary arrangements with the managers and officials of the research environment hospital, they proceeded to the medical records unit of Imam Khomeini Hospital in Jiroft to gather the required information from the files. The medical data of the patients were collected using a checklist created by the researcher. The data were collected without including the names and specific characteristics of the patients, ensuring confidentiality both during and after the study. The results were reported in a general manner to maintain patient privacy. The collected data were analyzed using SPSS version 26 statistical software and descriptive analysis tests, including frequency, frequency percent, mean, and standard deviation. A P-value of less than 0.05 was considered statistically significant.

3. RESULTS

In the current study, 529 patients with COVID-19 admitted to the ICU of Imam Jiroft Hospital in 2021 were examined. Table 1 shows the frequency related to demographic information in patients, 273 (51.6%) patients were Male, and the Mean age of hospitalized patients was 68.7 ± 27.9 years (range of 1-99 years), with the highest frequency in the age group of 50-80 years (40.4%). and the lowest frequency was observed in the age group of 20 to 35 years (9.6%). 90.3% were urban dwellers, and 489 (92.4%) had a history of contact with a person infected with COVID-19.

Table 2 shows the information related to the symptoms of COVID-19 in hospitalized patients, and the results
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indicate that symptoms such as fever (25.1%), cough (24%), chest pain (22.1%), and respiratory distress (20.4%) were the most frequent and stomach ache and diarrhea were the least reported symptoms.

Table 3 shows the information related to the underlying diseases of hospitalized patients with COVID-19, and of the 529 investigated people, 178 people (33.6%) had an underlying disease, and the highest frequency of underlying diseases was related to Cardiovascular diseases (28.1%), blood pressure (28.1%), and diabetes (14.1%).

Moreover, in the present study, 162 people (30.6%) of the hospitalized patients with COVID-19 died, and 367 people (69.4%) recovered. The mortality rate was 30.6%. Regarding the examination of lung involvement, 230 patients were scanned; 191 (83.1%) showed lung involvement, and 39 (16.9%) were without lung involvement.

Table 1. The frequency of demographic information of patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Classification</th>
<th>Absolute Frequency</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>≤20</td>
<td>101</td>
<td>19.1</td>
</tr>
<tr>
<td></td>
<td>20-35</td>
<td>51</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>35-50</td>
<td>87</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>50-80</td>
<td>214</td>
<td>40.4</td>
</tr>
<tr>
<td></td>
<td>&gt;80</td>
<td>76</td>
<td>14.5</td>
</tr>
<tr>
<td>Sex</td>
<td>Man</td>
<td>273</td>
<td>51.6</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>256</td>
<td>48.4</td>
</tr>
<tr>
<td>Residence</td>
<td>City</td>
<td>478</td>
<td>90.3</td>
</tr>
<tr>
<td></td>
<td>Village</td>
<td>51</td>
<td>9.7</td>
</tr>
<tr>
<td>History of contact with a person infected with COVID-19</td>
<td>Yes</td>
<td>489</td>
<td>92.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>40</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Table 2. The frequency of symptoms of COVID-19 in patients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Absolute Frequency</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>133</td>
<td>25.1</td>
</tr>
<tr>
<td>Cough</td>
<td>127</td>
<td>24</td>
</tr>
<tr>
<td>Chest pain</td>
<td>120</td>
<td>22.6</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>108</td>
<td>20.4</td>
</tr>
<tr>
<td>Muscular pain</td>
<td>44</td>
<td>8.3</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>33</td>
<td>6.2</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td>20</td>
<td>3.7</td>
</tr>
<tr>
<td>Anorexia</td>
<td>19</td>
<td>3.5</td>
</tr>
<tr>
<td>Headache</td>
<td>13</td>
<td>2.4</td>
</tr>
<tr>
<td>Convulsions</td>
<td>11</td>
<td>2.1</td>
</tr>
<tr>
<td>Stomach ache</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>3</td>
<td>0.5</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td>50</td>
<td>28.1</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>50</td>
<td>28.1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>25</td>
<td>14.1</td>
</tr>
<tr>
<td>Chronic lung diseases</td>
<td>13</td>
<td>37.3</td>
</tr>
<tr>
<td>Chronic neurological disorders</td>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>Chronic liver diseases</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td>Chronic kidney diseases</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td>Chronic blood diseases</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>Immunodeficiency</td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>Other chronic diseases</td>
<td>27</td>
<td>15.1</td>
</tr>
</tbody>
</table>
Table 4. The frequency of hospitalization in patients with COVID-19.

<table>
<thead>
<tr>
<th>Number of Days of Hospitalization</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 days</td>
<td>226</td>
<td>42.7</td>
</tr>
<tr>
<td>5-10 days</td>
<td>179</td>
<td>33.8</td>
</tr>
<tr>
<td>10-15 days</td>
<td>57</td>
<td>10.7</td>
</tr>
<tr>
<td>15-20 days</td>
<td>32</td>
<td>6.1</td>
</tr>
<tr>
<td>Over 20 days</td>
<td>35</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Table 5. The average number of blood indices in patients with COVID-19.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>10.9</td>
<td>19.8</td>
<td>2</td>
<td>409</td>
</tr>
<tr>
<td>Cr</td>
<td>1.2</td>
<td>3.6</td>
<td>0.37</td>
<td>76</td>
</tr>
<tr>
<td>CRP</td>
<td>57.2</td>
<td>39.1</td>
<td>0.94</td>
<td>161</td>
</tr>
<tr>
<td>ESR</td>
<td>36.3</td>
<td>29.2</td>
<td>1</td>
<td>140</td>
</tr>
</tbody>
</table>

Table 4 shows information about the duration of hospitalization in patients with COVID-19. The average number of days of hospitalization was 7.8 ± 7.2 days, and most cases (42.7%) were hospitalized for a period of 1 to 5 days.

Table 5 shows several blood indicators tested in patients with COVID-19. The average number of white blood cells (μ/l × 103) was 10.9±19.8, which was not in the normal range (3.9 to 9.9 × 103/μ/l). The average C-reactive protein was 36.36 mg/l, which was not in the normal range (less than 10 mg/l). The average duration of red blood cell sedimentation rate was 57.2 mm/hr. The average creatinine in the present study was 1.2 mg/dl, which was in the normal range (0.5-1.2 mg/dl).

The relationship between the laboratory indicators and the age of the subjects showed that the highest mean white blood cells, C-reactive protein, and red blood cell sedimentation rate were seen in the age group of 20 to 35 years. The highest mean creatinine was observed in the age group above 80 years, and no significant correlation was found between laboratory results and the age of people. Moreover, the relationship between the laboratory indicators performed with the gender of the studied subjects showed that the highest average number of white blood cells and creatinine in men and the highest average C-reactive protein and red blood cell sedimentation rates were observed in women, and only the average red blood cell sedimentation rate among women and men had a statistically significant difference (P<0.05).

4. DISCUSSION

Several coronaviruses can infect humans. Two major epidemics in recent years caused by the Middle East respiratory syndrome coronavirus and the acute respiratory syndrome coronavirus have caused extensive complications and even death [14]. Knowing the factors related to the hospitalization of patients with COVID-19 is effective in planning for the treatment of COVID-19 and the spread of the disease, therefore, the present study aims to determine the factors related to hospitalization in patients with COVID-19 and the laboratory and clinical aspects of this.

The average age of the studied patients was 68.7 years, which, according to the results of the present study, people over 75 years old and people over 50 years old had a significantly higher chance of being hospitalized, which was reported by two studies [15, 16]. In the study of Price-Haywood et al. [17] and Fried et al. [18], increasing age was mentioned as one of the factors associated with hospitalization in patients with COVID-19. In their review study, Rodriguez-Morales et al. stated that the average age of hospitalized patients in 18 articles was over 60 years [19]. In another review study that was conducted on 29 articles in 2020, the average age of the patients was 65 years, which is consistent with the results of our studies [20]. In the study conducted by Grasselli et al., in the investigation of risk factors related to mortality in patients with COVID-19 in ICU in Italy, age was also introduced as a risk factor for the disease [21]. In the study conducted in England, more than 90% of deaths were reported in people over 60 years of age, which is consistent with the global pattern and reports in this field [22]. According to the Centers for Disease Control and Prevention, a high percentage of deaths caused by the coronavirus occurred in people over 65 years of age in the United States, and the risk of infection is higher in the elderly. In the study of Soares et al., they reported age and seniority as factors related to the hospitalization of patients with COVID-19 [23]. Many physiological changes occur in body tissues with aging such as, muscle atrophy, decreased endurance capacity and muscle weakness, increased susceptibility to infectious agents, decreased immune system function, hormonal changes, decreased ratio of anabolic to catabolic hormones, increased risk of infection in old age due to disorders in the function of cellular and humoral immunity. Furthermore, other physiological changes with aging are nutritional deficiencies, bacterial colonization in some mucosal surfaces, a decrease in the body's physiological defense reflexes such as cough, wound healing, and an increase in the prevalence of chronic diseases with...
infections. Therefore, older age and suffering from several diseases at the same time can cause defects in the body’s immune response to pathogens, dysfunction of body organs as a result of the highest mortality rates, hospitalizations, hospitalization stays in the ICU, and resulting complications of this disease in the elderly [24].

The results show that the rate of hospitalization in men is higher than in women, and gender is known as one of the risk factors that is mentioned in most studies. In some research, it was reported that the reason for the increase in death in men compared to women is more smoking and, subsequently, the increase in the presence of underlying diseases in men [25]. In line with the results of our study, Galbadage et al. reported in their systematic review that men are more likely than women to experience severe clinical symptoms due to COVID-19, and the mortality rate is higher in men than in women [26]. In the study by Chen et al., among the 249 patients studied, 176 were men [27]. In the study of Long et al., with an epidemiological and clinical study of corona patients in the city of Shihan, China, 58% of the examined patients were men [28]. In the report of the World Health Organization in 2020 on the impact of various factors on the mortality rate of COVID-19 patients, it was determined that 51.1% of the deceased were men [19]. In the meta-analysis published in 2020, which examined the results of 656 patients, the rate of infection was higher in men, and their results are consistent with our studies [29]. In general, most of the studies that have been conducted so far have shown a higher percentage of men. This gender disparity may be attributed to biological differences, such as stronger immune responses in women, as well as behavioral and socioeconomic factors that increase men’s vulnerability to COVID-19. Overall, these findings highlight the importance of tailoring prevention and treatment strategies to address men’s unique needs and risk factors during the COVID-19 pandemic.

The most common clinical symptoms of the patients on arrival were cough, fever, and chest pain. Initially, the symptoms of patients with COVID-19 were fever, muscle pain, cough, and fatigue, but with the passage of time and further research, symptoms such as shortness of breath, anorexia, and impaired sense of taste were also reported. In Yang et al.’s study, the most common symptoms in patients with COVID-19 were fever, cough, fatigue, and shortness of breath [30]. In Haung et al.’s study, the most common complaints were fever, cough, and then fatigue [31]. In the study of Zayet and his colleagues, they mentioned that the most common symptoms of the disease in patients were cough, fever, and diarrhea [32], and these studies are in line with our study and indicate that the most important symptom in patients with COVID-19 is cough. These symptoms are consistent with the typical respiratory manifestations of the disease and are crucial indicators for early diagnosis and management. The similarities in symptom presentation across various studies underscore the characteristic clinical profile of COVID-19 and highlight the importance of recognizing these key symptoms for prompt identification and treatment of the virus. Additionally, the consistency in findings among different research works enhances the reliability and generalizability of these clinical characteristics in hospitalized COVID-19 patients.

Moreover, the results show that underlying cardiovascular diseases, blood pressure, and diabetes are among the factors related to the hospitalization of patients with COVID-19. Other studies also confirm this finding. High blood pressure is usually associated with other risk factors, such as cardiovascular diseases and diabetes, which increase the risk of death due to COVID-19 [33]. Moreover, diabetes can be considered a risk factor for the severity and progression of COVID-19. Past studies have also shown that diabetes and cardiovascular diseases increase the rate of contracting SARS and MERS, which, like COVID-19, are a type of acute respiratory syndrome [34, 35]. The similarities in findings across various studies underscore the critical role of cardiovascular health in determining the severity of COVID-19 infection and highlight the importance of targeted interventions for individuals with underlying cardiovascular conditions to mitigate the risks associated with COVID-19.

In addition, more than 50% of people with MERS had diabetes and high blood pressure, and more than 30% had cardiovascular disease. Diabetes can increase the risk of immune system disorders, as many studies have shown that diabetes can interfere with the immune system by reducing the function of the immune system through the disruption of chemotaxis of neutrophils and the antibacterial activity of monocytes and phagocytosis, and lead to an increase in infection [36]. In terms of the prevalence of underlying diseases, all the reviewed studies were consistent with our study. In examining the relationship between high blood pressure and hospitalization of patients with COVID-19, studies reported that the rate of hospitalization due to COVID-19 has a direct relationship with high blood pressure [15]. Based on the study of the estimation of risk factors for mortality caused by COVID-19 in China, regarding co-morbidities, it seems that cardiovascular disease along with chronic respiratory disease are the most dangerous underlying diseases [37]. In the study conducted in Iran, the mortality was higher in heart patients (38.46%) and lung patients (35.79%) [38]. Risk factors related to mortality in patients with COVID-19 in the ICU in Lombardy, Italy, were also introduced to underlying diseases such as diabetes, heart disease, kidney disease, and hypercholesterolemia [21]. The immune response is less efficient in people with underlying diseases. Therefore, the risk of contracting COVID-19 is higher in these people, and in case of infection, it leads to a severe type of disease with hospitalization and the risk of death [39].

In the present study, the mortality rate was 30.6%, which has been reported differently in different centers. In a study by Baud et al., the death rate of the disease in China was estimated at 5.6%, and outside of China was up to 25.2% [40]. The mortality rates in countries such as China, 3.5%, South Korea 0.5%, Italy 2%, Japan 2.3%,
France 1.5%, and Hong Kong 2% have been reported [41]. Undoubtedly, according to the type of studies conducted, the sample size, and the type of centers examined in terms of the number of referrals and the number of corona patients evaluated, we observed a large difference in the death rate in different centers in the world.

In this study, the average total hospitalization time of patients with COVID-19 was 7.8 days. Blitz et al. reported the average length of stay in the emergency department and the ICU as 13 and 8 days, respectively [42]. Liu and his colleagues reported the average length of hospital stay to be 8.33 days [43]. Zayet and his colleagues also reported the average length of hospitalization of patients in the hospital and the average length of hospitalization of patients in the ICU as 6.9 and 7.9 days, respectively [32]. All these reviewed studies showed a relatively high duration of hospitalization in the inpatient and ICUs of the hospital in patients with COVID-19, which shows that these patients have very high hospitalization costs due to hospitalization, and especially in the special care department for patients and their families.

The findings of the study showed that the average of white blood cells, C-reactive protein, and the sedimentation rate of red blood cells were in the higher-than-normal range, Zhu et al., who had a higher WBC had a much higher probability of death, and also their results showed that there is a significant relationship between the number of WBC and death [44]. Reports indicate that the degree of CRP increase indicates the systemic release of cytokines, and the increase of CRP>41 indicates the worsening of the disease [45]. Liu et al. conducted research to describe the clinical manifestations and laboratory results of COVID-19 disease in 15 pregnant women. Their results showed that the most common abnormal laboratory findings were a decrease in blood lymphocytes (12.15 patients) and an increase in CRP (10.15 patients) [46]. Qin et al. [47] and Shi et al. [48] showed that the WBC count increased in patients with severe forms of COVID-19. Studies have shown that in the early stages of the disease of COVID-19, when patients did not have any exclusive symptoms, the number of white blood cells and lymphocytes in the peripheral blood is normal or slightly reduced, while these indicators may change as the disease progresses [49]. ESR is one of the laboratory indicators of inflammation that normally increases moderately in viral infections, but this index is widely increased in patients with COVID-19 [50]. Various studies have confirmed the relationship between ESR values and the severity of the disease of COVID-19. These studies emphasize that the amount of ESR physicochemical phenomenon caused by the response of the acute stage is higher in patients with COVID-19 who show a severe form of the disease [51]. Lapić et al. believed that although ESR does not have analytical and diagnostic properties, its determination may help in the management of COVID-19 patients and provide more information about disease progression [52]. These laboratory abnormalities are consistent with the heightened inflammatory response associated with severe COVID-19 infections. The elevated white blood cell count, CRP, and ESR are common markers of systemic inflammation and have been consistently reported in other studies examining the clinical characteristics of hospitalized COVID-19 patients. This inflammatory profile is thought to contribute to the development of cardiovascular complications, such as myocardial injury, arrhythmias, and thromboembolism, that have been observed in COVID-19 cases. The similarities in these laboratory findings across various studies underscore the characteristic inflammatory state associated with severe COVID-19 illness, which has important implications for disease monitoring and management.

CONCLUSION

The results of this research showed that old age, male gender, heart disease, blood pressure, and diabetes, and an increase in laboratory indicators of CRP, ESR, and WBC were among the factors related to the hospitalization of patients with COVID-19 in the ICU. These results suggest that individuals with these risk factors may be more susceptible to severe COVID-19 illness and complications, potentially requiring more intensive medical care and monitoring. Understanding these risk factors can help healthcare providers identify high-risk patients and implement targeted interventions to prevent or mitigate the severity of COVID-19 infections in these populations. Furthermore, the findings highlight the importance of closely monitoring and managing underlying health conditions, as well as the potential value of using laboratory markers as early indicators of disease severity in COVID-19 patients. These insights can inform clinical decision-making and resource allocation to ensure that the most vulnerable patients receive appropriate care and support.

Health policymakers should consider these research findings when developing and implementing COVID-19 response strategies. Firstly, they should prioritize the allocation of resources and targeted interventions to address the needs of high-risk populations, such as older adults and individuals with cardiovascular diseases, hypertension, and diabetes. This may include increased access to vaccination, early treatment options, and specialized healthcare services for these groups. Secondly, policymakers should invest in public health education campaigns to raise awareness about the increased vulnerability of individuals with these risk factors. This information can empower people to take proactive measures to protect their health, such as adhering to preventive measures, seeking timely medical care, and closely monitoring their underlying conditions. Additionally, policymakers should consider incorporating laboratory markers, such as CRP, ESR, and WBC, as part of the COVID-19 risk assessment and triage process. This can help healthcare providers identify high-risk patients early and ensure they receive the appropriate level of care and monitoring, potentially preventing or mitigating the severity of their illness.
LIMITATIONS OF THE STUDY
This study was hampered by several limitations. The first restriction was the incapacity to compute body mass index because the patient’s height and weight were not recorded in the files. Another restriction was the exclusion of some patients from the study because the files did not contain all of the necessary information. Additionally, this study only included patients hospitalized in the Imam Khomeini Hospital in Jiroft ICU. As a result, caution should be exercised when extrapolating the findings. The study was limited by the ICU’s restricted medical resources and inability to accommodate all critically ill patients, resulting in the exclusion of this patient population from the study.

The study’s limitations, including the inability to calculate body mass index (BMI) due to missing height and weight data, the exclusion of patients with incomplete files, and the restriction to patients hospitalized in the Imam Khomeini Hospital in Jiroft ICU, highlight the need for future research to address these gaps. Specifically, future studies should aim to include BMI calculation, and should ensure that BMI is calculated by including patient height and weight data in their files. This will allow for a more comprehensive understanding of the relationship between BMI and the risk of ICU admission for COVID-19 patients.

To improve data collection and inclusion criteria, the researchers should strive to collect complete and accurate data on all patients, including those with incomplete files. This can be achieved by implementing more rigorous data collection protocols and ensuring that all patients meet the inclusion criteria for the study. Future studies should aim to include patients from multiple hospitals and ICUs to increase the generalizability of the findings and expand the study population. This will allow for a better understanding of the factors associated with ICU admission for COVID-19 patients across different healthcare settings. By addressing these limitations, future research can provide a more complete and accurate understanding of the factors associated with ICU admission for COVID-19 patients, ultimately informing more effective strategies for managing this disease.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE
This research was approved by the ethics committee of the university and the code of ethics (IR.JMU.REC.1401.052) was received.

HUMAN AND ANIMAL RIGHTS
All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1975 Helsinki Declaration and its later amendments or comparable ethical standards.

CONSENT FOR PUBLICATION
Informed consent was obtained.

STANDARDS OF REPORTING
STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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CONFLICT OF INTEREST
The authors declare no conflict of interest financial or otherwise.

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