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RESEARCH ARTICLE **OPEN ACCESS**

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.

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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 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. MATERIALS AND METHODS

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 indicate that symptoms such as fever (25.1%), cough (24%), chest pain (22.6%), and respiratory distress (20.4%) were the most frequent and stomach ache and diarrhea were the lowest 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.

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

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

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

Table 3. Prevalence of underlying disease in patients with COVID-19.

Variable	Frequency	Percent
Cardiovascular diseases	50	28.1
Blood pressure	50	28.1
Diabetes	25	14.1
Chronic lung diseases	13	37.3
Chronic neurological disorders	4	2.2
Chronic liver diseases	3	1.7
Chronic kidney diseases	3	1.7
Chronic blood diseases	2	1.1
Immunodeficiency	1	0.6
Other chronic diseases	27	15.1

Table 4. The frequency of hospitalization in patients with COVID-19.

Number of Days of Hospitalization	Frequency	Percentage
1-5 days	226	42.7
5-10 days	179	33.8
10-15 days	57	10.7
15-20 days	32	6.1
Over 20 days	35	6.7

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

Variables	Mean	Standard Deviation	Minimum	Maximum
WBC	10.9	19.8	2	409
Cr	1.2	3.6	0.37	76
CRP	57.2	39.1	0.94	161
ESR	36.3	29.2	1	140

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 57.2 mg/l, which was not in the normal range (less than 10 mg/l). The average duration of red blood cell sedimentation rate was 36.3 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, cardiovascular diseases, 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.

AUTHORS' CONTRIBUTIONS

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to itssubmission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

ICU	=	Intensive Care Unit
CPK	=	Ceatine Phosphokinase

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This research was approved by the ethics committee of the Jiroft University of Medical Sciences 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 from the participants.

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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REFERENCES

[1] Bittar C, Machado RRG, Comelis MT, *et al*. Alphacoronavirus detection in lungs, liver, and intestines of bats from Brazil. Microb Ecol 2020; 79(1): 203-12. http://dx.doi.org/10.1007/s00248-019-01391-x PMID: 31144002

[2] Raesi R, Khalesi N, Safavi M, Mirzaei A, Alimohammadzadeh K. Identifying the outcomes of healthy lifestyles in the post-COVID-19 era. Arch Adv Biosci 2023; 14(1): 1-14.

[3] Suganthan N. Covid-19. Jaffna Med J 2019; 31(2): 3.

[4] Liu P, Jiang JZ, Wan XF, *et al*. Are pangolins the intermediate host of the 2019 novel coronavirus (SARS-CoV-2)? PLoS Pathog 2020; 16(5): e1008421. http://dx.doi.org/10.1371/journal.ppat.1008421 PMID: 32407364

[5] Sungsuwan S, Jongkaewwattana A, Jaru-Ampornpan P. Nucleocapsid proteins from other swine enteric coronaviruses differentially modulate PEDV replication. Virology 2020; 540: 45-56. http://dx.doi.org/10.1016/j.virol.2019.11.007 PMID: 31756532

[6] Xiao W, Wang X, Wang J, Fang P, Xiao S, Fang L. Replicative capacity of four porcine enteric coronaviruses in LLC-PK1 cells. Arch Virol 2021; 166(3): 935-41. http://dx.doi.org/10.1007/s00705-020-04947-2 PMID: 33492525

[7] Moghadaci A, Saghari S, Abbasi Z, Zandieh MA, Gholami MH, Hushmandi K. A study of how the serum levels of inflammatory markers correlate with hemoglobin oxygen saturation percentage and the type of respiratory support received by COVID-19 patients hospitalized in intensive care units. Open Public Health J 2023; 16(1) http://dx.doi.org/10.2174/0118749445260299231205041315

[8] Esmaeily M, Momeni S, Barahman G, Sarrafshahri N, Ahmadsimab S. Evaluation of the prevalence of heart problems in patients with COVID-19 with high blood pressure and diabetes in patients admitted to ICU. J Pharm Negat Results 2022; •••: 3254-65.

[9] Yanai H. A significance of high prevalence of diabetes and hypertension in severe COVID-19 patients. J Clin Med Res 2020; 12(6): 389-92. http://dx.doi.org/10.14740/jocmr4218 PMID: 32587655

[10] Raesi R, Saleki S, Heydari S, Behzadi G, Mehralizade A, Daneshi S. Risk Factors of Acute Coronary Syndrome: The Experience from Iran. Open Public Health J 2023; 16(1): e187494452309110. http://dx.doi.org/10.2174/18749445-v16-e230913-2023-131

[11] Zaki N, Alashwal H, Ibrahim S. Association of hypertension, diabetes, stroke, cancer, kidney disease, and high-cholesterol with COVID-19 disease severity and fatality: A systematic review. Diabetes Metab Syndr 2020; 14(5): 1133-42. http://dx.doi.org/10.1016/j.dsx.2020.07.005 PMID: 32663789

[12] Lippi G, Henry BM, Sanchis-Gomar F, Mattiuzzi C. Updates on laboratory investigations in coronavirus disease 2019 (COVID-19). Acta Biomed 2020; 91(3): e2020030. PMID: 32921725

[13] Abbasi Z, Moghadaci A, Mohammadnahal L, *et al*. Investigating how interleukin 6 serum level, blood group type, and underlying diseases are associated in patients admitted to the covid-19 intensive care unit: A retrospective study. Open Public Health J 2023; 16(1): e187494452309191. http://dx.doi.org/10.2174/0118749445258188230922115257

[14] Zainol Rashid Z, Othman SN, Abdul Samat MN, Ali UK, Wong KK. Diagnostic performance of COVID-19 serology assays. Malays J Pathol 2020; 42(1): 13-21. PMID: 32342927

[15] Hamer M, Kivimäki M, Gale CR, Batty GD. Lifestyle risk factors, inflammatory mechanisms, and COVID-19 hospitalization: A community-based cohort study of 387,109 adults in UK. Brain Behav Immun 2020; 87: 184-7. http://dx.doi.org/10.1016/j.bbi.2020.05.059 PMID: 32454138

[16] Bhasin A, Nam H, Yeh C, Lee J, Liebovitz D, Achenbach C. Is BMI higher in younger patients with COVID-19? Association between BMI and COVID-19 hospitalization by age. Obesity 2020; 28(10): 1811-4. http://dx.doi.org/10.1002/oby.22947 PMID: 32610371

[17] Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and mortality among black patients and white patients with COVID-19. N Engl J Med 2020; 382(26): 2534-43. http://dx.doi.org/10.1056/NEJMsa2011686 PMID: 32459916

[18] Fried MW, Crawford JM, Mospan AR, *et al*. Patient characteristics and outcomes of 11 721 patients with coronavirus disease 2019 (COVID-19) hospitalized across the United States. Clin Infect Dis 2021; 72(10): e558-65. http://dx.doi.org/10.1093/cid/ciaa1268 PMID: 32856034

[19] Rodriguez-Morales AJ, Cardona-Ospina JA, Gutiérrez-Ocampo E, *et al*. Clinical, laboratory and imaging features of COVID-19: A systematic review and meta-analysis. Travel Med Infect Dis 2020; 34: 101623. http://dx.doi.org/10.1016/j.tmaid.2020.101623 PMID: 32179124

[20] Alsofayan YM, Althunayyan SM, Khan AA, Hakawi AM, Assiri AM. Clinical characteristics of COVID-19 in Saudi Arabia: A national retrospective study. J Infect Public Health 2020; 13(7): 920-5. http://dx.doi.org/10.1016/j.jiph.2020.05.026 PMID: 32534945

[21] Grasselli G, Greco M, Zanella A, *et al*. Risk factors associated with mortality among patients with COVID-19 in intensive care units in Lombardy, Italy. JAMA Intern Med 2020; 180(10): 1345-55. http://dx.doi.org/10.1001/jamainternmed.2020.3539 PMID: 32667669

[22] England N. Patient initiated follow up: giving patients greater control over their hospital follow-up care. London: NHS England 2020.

[23] Soares RCM, Mattos LR, Raposo LM. Risk factors for hospitalization and mortality due to COVID-19 in Espírito Santo State, Brazil. Am J Trop Med Hyg 2020; 103(3): 1184-90. http://dx.doi.org/10.4269/ajtmh.20-0483 PMID: 32682453

[24] Alavi-Moghaddam M. A novel coronavirus outbreak from Wuhan City in China, rapid need for emergency departments preparedness and response; A letter to editor. Arch Acad Emerg Med 2020; 8(1): e12. PMID: 32185368

[25] Jiang S, Shi Z, Shu Y, *et al*. A distinct name is needed for the new coronavirus. Lancet 2020; 395(10228): 949. http://dx.doi.org/10.1016/S0140-6736(20)30419-0 PMID: 32087125

[26] Galbadage T, Peterson BM, Awada J, *et al*. Systematic review and meta-analysis of sex-specific COVID-19 clinical outcomes. Front Med 2020; 7: 348. http://dx.doi.org/10.3389/fmed.2020.00348 PMID: 32671082

[27] Chen N, Zhou M, Dong X, *et al*. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. Lancet 2020; 395(10223): 507-13. http://dx.doi.org/10.1016/S0140-6736(20)30211-7 PMID: 32007143

[28] Liu L, Lei X, Xiao X, *et al*. Epidemiological and clinical characteristics of patients with coronavirus disease-2019 in Shiyan City, China. Front Cell Infect Microbiol 2020; 10: 284. http://dx.doi.org/10.3389/fcimb.2020.00284 PMID: 32574282

[29] Li X, Wang L, Yan S, *et al*. Clinical characteristics of 25 death cases with COVID-19: A retrospective review of medical records in a single medical center, Wuhan, China. Int J Infect Dis 2020; 94: 128-32. http://dx.doi.org/10.1016/j.ijid.2020.03.053 PMID: 32251805

[30] Yang X, Yu Y, Xu J, *et al*. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. Lancet Respir Med 2020; 8(5): 475-81. http://dx.doi.org/10.1016/S2213-2600(20)30079-5 PMID: 32105632

[31] Huang C, Wang Y, Li X, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395(10223): 497-506. http://dx.doi.org/10.1016/S0140-6736(20)30183-5 PMID:

31986264

[32] Zayet S, Gendrin V, Klopfenstein T. Natural history of COVID-19: Back to basics. New Microbes New Infect 2020; 38: 100815. http://dx.doi.org/10.1016/j.nmni.2020.100815 PMID: 33204429

[33] Papadokostaki E, Tentolouris N, Liberopoulos E. COVID-19 and diabetes: What does the clinician need to know? Prim Care Diabetes 2020; 14(5): 558-63. http://dx.doi.org/10.1016/j.pcd.2020.06.010 PMID: 32654982

[34] Arumugam VA, Thangavelu S, Fathah Z, *et al*. COVID-19 and the world with co-morbidities of heart disease, hypertension and diabetes. J Pure Appl Microbiol 2020; 14(3): 1623-38. http://dx.doi.org/10.22207/JPAM.14.3.01

[35] Luk AOY, Ng SSS, Holt RIG. Impact of diabetes on COVID-19 and other infection: Report from the 22nd Hong Kong diabetes and cardiovascular risk factors—east meets west symposium. Diabet Med 2021; 38(5): e14547. http://dx.doi.org/10.1111/dme.14547 PMID: 33615546

[36] Pickup JC, Crook MA. Is Type II diabetes mellitus a disease of the innate immune system? Diabetologia 1998; 41(10): 1241-8. http://dx.doi.org/10.1007/s001250051058 PMID: 9794114

[37] Caramelo F, Ferreira N, Oliveiros B. Estimation of risk factors for COVID-19 mortality-preliminary results. MedRxiv 2020; 2020.02. http://dx.doi.org/10.1101/2020.02.24.20027268

[38] Lu H, Ai J, Shen Y, Li Y, Li T, Zhou X. A descriptive study of the impact of diseases control and prevention on the epidemics dynamics and clinical features of SARS-CoV-2 outbreak in Shanghai, lessons learned for metropolis epidemics prevention. MedRxiv 2020; 2020.02. http://dx.doi.org/10.1101/2020.02.19.20025031

[39] Jannat Alipoor Z, Fotokian Z. COVID-19 and the elderly with chronic diseases: Narrative review. Journal Mil Med 2022; 22(6): 632-40.

[40] Baud D, Qi X, Nielsen-Saines K, Musso D, Pomar L, Favre G. Real estimates of mortality following COVID-19 infection. Lancet Infect Dis 2020; 20(7): 773. http://dx.doi.org/10.1016/S1473-3099(20)30195-X PMID: 32171390

[41] Coronavirus E. 13,968 Cases and 223 Deaths. 2020. Available from: https://www. worldometers. info/coronavirus/country/ethiopia

[42] Blitz MJ, Rochelson B, Minkoff H, Meirowitz N, Prasannan L, London V. Maternal mortality among women with coronavirus disease 2019 admitted to the intensive care unit. Am J Obstet Gynecol 2020; 223(4): 595-9. http://dx.doi.org/10.1016/j.ajog.2020.06.020

[43] Liu J, Zheng X, Tong Q, *et al*. Overlapping and discrete aspects of the pathology and pathogenesis of the emerging human pathogenic coronaviruses SARS-CoV, MERS-CoV, and 2019-nCoV. J Med Virol 2020; 92(5): 491-4. http://dx.doi.org/10.1002/jmv.25709 PMID: 32056249

[44] Zhu N, Zhang D, Wang W, *et al*. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020; 382(8): 727-33. http://dx.doi.org/10.1056/NEJMoa2001017 PMID: 31978945

[45] Liu D, Li L, Wu X, *et al*. Pregnancy and perinatal outcomes of women with coronavirus disease (COVID-19) Pneumonia: A preliminary analysis. AJR Am J Roentgenol 2020; 215(1): 127-32. http://dx.doi.org/10.2214/AJR.20.23072 PMID: 32568580

[46] Liu Y, Sun W, Li J, Chen L, Wang Y, Zhang L. Clinical features and progression of acute respiratory distress syndrome in coronavirus disease 2019. medRxiv 2020.

[47] Qin C, Zhou L, Hu Z, *et al*. Dysregulation of immune response in patients with coronavirus 2019 (COVID-19) in Wuhan, China. Clin Infect Dis 2020; 71(15): 762-8. http://dx.doi.org/10.1093/cid/ciaa248 PMID: 32161940

[48] Shi S, Qin M, Shen B, *et al*. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. JAMA Cardiol 2020; 5(7): 802-10. http://dx.doi.org/10.1001/jamacardio.2020.0950 PMID: 32211816

[49] Fan BE, Chong VCL, Chan SSW, *et al*. Hematologic parameters in patients with COVID-19 infection. Am J Hematol 2020; 95(6): E131-4. http://dx.doi.org/10.1002/ajh.25774 PMID: 32129508

[50] Henry BM, de Oliveira MHS, Benoit S, Plebani M, Lippi G. Hematologic, biochemical and immune biomarker abnormalities associated with severe illness and mortality in coronavirus disease 2019 (COVID-19): A meta-analysis. Clin Chem Lab Med (CCLM) 2020; 58(7): 1021-8. http://dx.doi.org/10.1515/cclm-2020-0369 PMID: 32286245

[51] Karimi Shahri M, Niazkar HR, Rad F. COVID-19 and hematology findings based on the current evidences: A puzzle with many missing pieces. Int J Lab Hematol 2021; 43(2): 160-8. http://dx.doi.org/10.1111/ijlh.13412 PMID: 33264492

[52] Lapić I, Rogić D, Plebani M. Erythrocyte sedimentation rate is associated with severe coronavirus disease 2019 (COVID-19): A pooled analysis. Clin Chem Lab Med (CCLM) 2020; 58(7): 1146-8. http://dx.doi.org/10.1515/cclm-2020-0620 PMID: 32386190