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ORIGINAL RESEARCH

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The epidemiology and treatment outcomes of COVID-19 patients admitted to an intensive care unit in an Iranian hospital in Neyshabur city

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Abstract

Background and Aims: The COVID-19 pandemic and the infection of numerous individuals from diverse societies have emerged as major global challenges. Given the limited resources in intensive care units, effective bed management and resource allocation require a deep understanding of the disease. This study aimed to assess the epidemiology and treatment outcomes of COVID-19 patients admitted to an intensive care unit in an Iranian hospital in Neyshabur city.

Methods: This cross-sectional study was conducted on COVID-19 patients hospitalized in intensive care units in Razavi Khorasan, Iran in 2021. Census sampling was used to include all intensive care units. Of the initial 480 cases, 54 cases were excluded based on the exclusion criteria, leaving 426 cases for the study. Data were collected with the help of a data collection form that was designed by the researcher and its content validity and reliability were measured with Cronbach's alpha coefficient ($\alpha = 89\%$.). Data were analyzed with SPSS version 20 software. Descriptive and inferential statistics were used to analyze the data. Mean, standard deviation, and interquartile range indicators were used for descriptive statistics, and absolute frequency and relative frequency (percentage) were used to show numbers and ratios.

Results: The mean (*SD*) age of the patients was 66.33 (15.05) years, and 49.3% were female. The results showed that arterial blood oxygen saturation, respiratory rate, and Alzheimer's disease were significant variables for predicting mortality. Furthermore, arterial blood oxygen saturation, respiratory rate, and the need for transfusion of blood products were significant variables in predicting hospitalization and the risk of acute respiratory distress syndrome (ARDS).

Conclusion: This study demonstrated that arterial blood oxygen saturation, respiratory rate, and Alzheimer's disease are crucial variables for predicting death. Furthermore, arterial blood oxygen saturation and respiratory rate are significant factors in predicting the risk of ARDS.

KEYWORDS
clinical symptoms, COVID-19, demographic characteristics, intensive care unit, Iran, treatment outcome

1 | INTRODUCTION

The COVID-19 pandemic, which began spreading in late 2019, has become one of the significant crises of the twenty-first century.[1] The occurrence of acute complications and the rapid increase in critically ill patients with this disease cause a significant increase in the demand for specialized care and intensive care unit (ICU) beds or other facilities,[2] but the supply of these services is insufficient compared to the demand. The limited resources, increased demand, and heavy workload of the treatment team generate numerous conflicts in the allocation of resources and delivery of services.[3,4]

The importance of demographic characteristics such as age, income, education, and even marital status as determining factors of country-specific mortality rates is well recognized.[5] Additionally, demographic characteristics influence the health status and needs of a population. For example, the age composition of a population will be reflected in the prevalence of various diseases, as the healthcare needs of young individuals differ significantly from those of the elderly.[6]

Due to epidemiology's focus on various aspects and levels of prevention and prognosis, it helps determine the size and burden of disease in society accurately. This enables the proper allocation of resources for disease control and prevention. Epidemiology also provides crucial information for making informed decisions about patient care and treatment.[7]

Understanding the characteristics and outcomes of critical patients is vital for healthcare professionals and government officials involved in disease control planning. Recording basic information about departments, such as demographic data, is essential for triage, prioritization of care, and training skilled personnel.[6]

Healthcare planners and policymakers should be able to identify and address the population's needs and the characteristics of different patient groups by understanding the demographic profiles of individuals. This knowledge can inform the allocation of human resources, facilities, and equipment.[8] Therefore, basic information about these specialized care departments should be documented for triage and prioritization of care, as well as for the training of skilled healthcare personnel in these areas. Based on the recorded data, requests for equipment and human resources can be made accordingly.[9]

Prior studies have described the epidemiological and clinical characteristics of COVID-19 in Wuhan, but this information has been reported infrequently in other cities. The clinical manifestations are comparable, but the epidemiology may vary from country to country.[10,11] Consequently, these studies must be conducted in other nations, specifically in ICUs, to accurately understand epidemiologic characteristics and clinical outcomes, to aid decision-making at various levels, and to precisely control disease and hospital resources.

This study was conducted in the intensive care departments of hospitals in the city of Neyshabur. The city of Neyshabur has an average of 30 intensive care beds and is of great importance in terms of patient admission and disease prevalence. Iranian and non-Iranian patients (Afghan nationals) reside in this city, which is known for its migrant population. Therefore, examining disease indicators and epidemiology holds great importance in disease management. This hospital is also significant in other aspects. Many hospitals in the surrounding rural areas of Mashhad do not have access to any other hospital except Neyshabur Hospital, making it the sole healthcare facility for patients from surrounding villages. Additionally, due to the high volume of patients from neighboring cities and the filling of capacity in this hospital, a desert hospital was established under the supervision of this medical unit, indicating that this center serves patients with diverse epidemiology and demographic characteristics. This study aims to assess the epidemiology and treatment outcomes of COVID-19 patients admitted to an ICU in an Iranian hospital in Neyshabur city.

2 | METHOD

2.1 | Study design

This study was a cross-sectional study aimed at determining the epidemiological and demographic characteristics as well as treatment results in patients with COVID-19 who were hospitalized in the “ICU” from March 20, 2020, to March 20, 2021.

2.2 | The study context of the study population

Sampling was conducted through a census in Neyshabur city, 22 Bahman and Hakim hospitals affiliated with Neyshabur University of Medical Sciences, were included in the study. 22 Bahman Hospital a care center for COVID-19 patients had 3 ICUs with a total of 30 beds. The sample size consisted of all patients with COVID-19 who were hospitalized in these departments during 2020–2021.

Data were extracted from the patients' medical records and the hospital's information system (HIS) and recorded on a self-administered data collection form by the researcher. Data collection took place during in the discharge stage of the patients.

2.3 | Data collection tools

The researcher developed a custom data collection form after conducting tests to ensure validity and reliability to gather information. This form

consisted of three parts: the first part focused on demographic information, the second part included epidemiological details (such as disease diagnosis, symptom onset, etc.), and the third part covered treatment-related variables. The information collected encompassed demographic data (age, gender, nationality, occupation, education), clinical symptoms, signs, accompanying disorders or underlying diseases (including diabetes, chronic kidney disease, chronic cardiovascular disease, hypertension, chronic respiratory disease, obesity, addiction, malignancies, chronic blood disorders, chronic neurological disorders, chronic liver diseases, congenital diseases, AIDS), laboratory results (complete blood count, coagulation tests, liver enzymes, serum creatinine, troponin levels, PCR test results), radiological evidence of pneumonia, epidemiological risk factors (like healthcare personnel status, travel to endemic areas, or contact with a confirmed patient), symptom onset time and location, hospitalization outcomes, medications used (especially corticosteroids, immunosuppressive agents, vasoconstrictors, antiviral agents, antibacterial agents, immunoglobulins), high-flow nasal cannula oxygen therapy, mechanical ventilation (invasive or non-invasive), extracorporeal membrane oxygenation, renal replacement therapy, vaccination history, and residence location. The definitive diagnosis criteria were a positive PCR test and lung involvement on chest radiography.

Initially, the collection form was developed through literature review. Then, this form was provided to 10 members of the faculty at Tehran University of Medical Sciences to determine its face and content validity (including two epidemiologists, five resident physicians in the ICU for COVID-19, and three faculty members). Their potential opinions were finalized after discussion and review by the research team. After that, 20 cases that were not included in the study samples were evaluated using this form, and its Cronbach's alpha coefficient was determined to be "89%."

2.4 | Sample collection

The study population consisted of patients with COVID-19 who were admitted to ICUs with a confirmed diagnosis of COVID-19. The minimum sample size was calculated using the formula: $N = Z\alpha/22 \times P \times (1 - P)/d^2$. In this formula, α was set to 0.05, P represented the prevalence (considered as 50%, the maximum sample size), and d represented the desired precision (set at 5%). However, since COVID-19 patients were only admitted to two academic hospitals in Neyshabour, all cases admitted to these hospitals were included in the study. Ultimately, a total of 426 cases met the inclusion criteria.

The sample size was proportional to the number of ICU beds, and sampling was conducted from all COVID-19 patients based on the bed number. The study was conducted in the ICUs of hospitals affiliated with Neyshabur University of Medical Sciences. Sampling was conducted from all eligible ICUs.

Inclusion criteria:

1. Patients with a definite diagnosis of COVID-19
2. Hospitalization in ICUs

Exclusion criteria:

1. Deficiency of information in the patient record (failure to record at least 50% of the information specified in the data collection form)

It should be noted that 54 people (11.25%) were excluded from this study due to missing information in their records.

2.5 | Statistical analysis

Data was analyzed using SPSS version 20 software. Descriptive and inferential statistics were utilized for data analysis. Descriptive statistics included mean, standard deviation, and interquartile range indicators, while absolute frequency and relative frequency (percentage) were used to display numbers and ratios.

2.6 | Ethical considerations

Ethical clearance (ID IR.TUMS.FNM.REC.1399.109) was obtained from Tehran University of Medical Sciences and Neyshabur University of Medical Sciences, Iran, to access hospital files. Patients provided informed consent and were asked to share their contact information with the researcher. The researcher assured them that their names would remain confidential and that their demographic information would be presented in a general manner.

3 | RESULT

3.1 | Demographic data

The mean age of the patients was 66.33 ± 15.05 years. The minimum and maximum age of the participants were 20 and 95 years, respectively. The majority of patients had a diploma education (32.40%), while the lowest frequency was observed among patients with a university education (13.7%). Three patients (0.7%) did not provide information about their education. Most of the patients were married (73.5%). Other demographic characteristics are presented in Table 1.

3.2 | Epidemiological information

The most common comorbidity among the patients was high blood pressure (37.3%). Upon admission, the arterial blood oxygen saturation of most patients (36.2%) ranged between 80 and 89. The majority of patients (62.9%) had a respiratory rate of less than 23 breaths per minute at the time of admission. It should be noted that 1.2% of patients were admitted with cardiorespiratory arrest.

TABLE 1 Demographic characteristics of participants.

Variables	N	%
Education		
Illiterate	106	25
High school	122	28.9
Diploma	137	32.40
University degree	58	13.7
Total	423	100
Marital statue		
Single	113	26.5
Married	313	73.5
Total	426	100
Gender		
Male	216	50.7
Female	210	49.3
Total	426	100
Job		
Worker	17	4
Unemployment	113	26.5
Housewife	183	43
Other	83	19.5
Total	426	100
Location		
Urban	274	64.3
Rural	152	35.7
Total	426	100
BMI		
Normal	136	31.9
Overweight	247	57
Obesity	43	10.1
Total	426	100
Oxygen saturation		
>95	25	5.9
90–94	64	15
80–89	154	36.2
60–79	135	31.7
40–59	37	8.7
20–39	11	2.6
Total	426	100
Respiratory rate/min		
<23	268	62.9
24–29	132	31
>30	26	6.1
Total	268	100
Heart rate/min		
<59	14	3.3
60–99	267	62.7
>100	145	34
Age		
Mean ± *SD*	66.33 + 15.05	

Abbreviation: BMI, body mass index.

3.3 | Clinical symptoms

Regarding treatment variables, the results indicated that 30.8% of the patients received oxygen therapy via nasal cannula. According to the radiologist's report, most patients exhibited lung involvement in all lobes of both lungs. In the initial computed tomography (CT) scan, 40 individuals (9.2%) showed no pulmonary involvement, while in the last CT scan, this number decreased to 13 patients (3%). The majority of patients were hospitalized in the ICU for a duration of 1–10 days (81.5%). Furthermore, the majority of patients (92.5%) were admitted to the ICU only once during their hospital stay.

The findings revealed a significant relationship between age and the mortality rate in the context of the epidemiological, demographic characteristics, and treatment outcomes of COVID-19 patients hospitalized in the ICU (Table 2).

Based on the results obtained from regression analysis using backward elimination, independent variables with a $p < 0.1$ were eliminated. Consequently, arterial blood oxygen saturation, respiratory rate, and Alzheimer's disease were identified as significant variables for predicting mortality ($p < 0.05$). The remaining variables are listed in Table 3.

4 | DISCUSSION

This study aimed to assess the epidemiology and treatment outcomes of COVID-19 patients admitted to an ICU in an Iranian hospital in Neyshabur city. This study found that the majority of patients (36.2%) had arterial blood oxygen saturation levels between 80 and 89 at the time of admission. In this regard, a study conducted Kumar et al.'s study in Mexico and Samuel's study revealed that the majority of patients hospitalized in ICUs required oxygen due to a drop in arterial blood oxygen (below 90).[12,13]

The most important reason could be that the majority of the patients were in critical condition and were admitted to the ICU. According to studies, patients with severe diseases have a lower percentage of arterial oxygen. Furthermore, the current study found that the majority of the patients were admitted with a respiratory rate of less than 23 breaths per minute, and the most common

TABLE 2 Association of dead as dependent variable with other factors in the multiple logistic regression.

Variables	Odds ratio (OR)	95% Confidence interval of OR	*p* value
Age (each year increased)	1.02	1.003–1.04	0.01
Education			
Illiterate	Reference group		
High school	1.39	3.16–0.61	0.42
Diploma	1.33	2.94–0.6	0.47
Academic	0.36	0.81–0.16	0.01
Job			
Gov employee	Reference group		
Labor	1.2	0.33–4.36	0.78
Self-employed	3.27	8.8–1.21	0.01
Unemployed	4.2	11.06–1.6	0.004
Housewife	4.07	9.92–1.67	0.002
Blood group			
A	Reference group		
B	0.85	0.31–2.33	0.76
AB	2.2	0.24–19.52	0.47
O	3.85	1–14.82	0.05
Body mass index			
Normal	Reference group		
Overweight	0.64	0.34–1.19	0.16
Fat	0.64	0.19–2.09	0.46
O2 saturation (each percent increased)	0.96	0.93–0.98	0.003
Respiratory rate (each one increased per minute)	1.05	1.004–1.109	0.03
Temperature on hospitalization	1.005	0.96–1.04	0.77

TABLE 3 The relationship between the variables of death, ARDS, and the number of hospitalization days with demographic factors (multivariable model).

Variable	Odd's ratio	*p* value	CI95%
Death			
Age	1.01	0.14	1.04–0.99
BMI			
Overweight	0.57	0.09	1.1–0.29
Fat	0.6	0.42	2.07–0.17
Arterial blood oxygen saturation on admission	0.96	0.002	0.98–0.93
Respiratory rate on admission	1.08	0.01	1.15–1.01
Alzhmire	0.25	0.03	0.9–0.07
ARDS			
Age	0.99	0.57	0.97–1.01
Arterial blood oxygen saturation on admission	0.97	0.003	0.96–0.99
Respiratory rate on admission	1.06	0.004	1.02–1.1
Number of days of hospitalization			
Blood group			
B	0.41	0.06	0.16–1.04
AB	0.28	0.1	0.06–1.3
O	0.42	0.06	0.17–1.04
No registered	0.21	0.00	0.1–0.42
Arterial blood oxygen saturation on admission	1.02	0.00	1.01–1.04
Headache	2.25	0.056	0.98–5.16
Low conciseness	0.51	0.058	0.25–1.02
Death	0.84	0.59	0.45–1.56

Abbreviations: ARDS, acute respiratory distress syndrome; BMI, body mass index; CI, confidence interval.

COVID-19 symptoms in the first 5 days of the disease were dyspnea (70.4%). In our study, all patients were hospitalized in the ICU and experienced unstable hemodynamic conditions. Also, most studies mentioned that dyspnea is one of the most common symptoms of patients, and according to the guidelines of the World Health Organization and Iran's Health Department, dyspnea is one of the most common symptoms of COVID-19 patients. Therefore, the results of this study are consistent with the findings of the mentioned studies.

The results regarding underlying diseases showed that the most common underlying disease in the study was high blood pressure (37.3%). In this regard, Liu et al.[14] and In Nikpour Moghadam's[15] study showed that hypertension was the most common underlying disease among COVID-19 patients, and respiratory symptoms were the most common clinical complaints of patients. In the present study, most of the patients were elderly and had hypertension. Also, the risk of cardiovascular and respiratory problems increases with age, and in this sense, the results of the studies confirm the findings of the present study. Therefore, the results of the present study are in line with the results of this study.

The results showed that most patients had involvement in all lobes of both lungs. In Liu et al.'s[14] study regarding the CT scan findings of COVID-19 patients, it was found that 90% of patients had pulmonary involvement, and two-lobe involvement was seen in most of the patients, In Zhao et al.s[16] study, all patients had pulmonary involvement, and the most common types of involvement were multiple mottling and ground-glass opacity. In the present study, all

patients were hospitalized in the ICU and experienced severe disease conditions.

Therefore, the results of the present study are in line with the results of these studies. In Nikpour Moghadam's[15] study, the mortality rate was 239 people (8.06), while in the present study, 368 people have died. Mortality is one of the important indicators of hospital and epidemiology, which is related to various factors. Age, underlying disease, time of diagnosis, and transfer to the hospital, and therapeutic interventions are effective in reducing the mortality of patients. It seems that different factors should be evaluated to compare mortality.

The results of our study determined that there is a significant relationship between age and mortality rate. Sassoon et al.'s[17] study showed that age is a strong predictor of mortality in patients with COVID-19, and increasing age is considered an important risk factor. Bonanad et al.[18] conducted a meta-analysis study with the aim of investigating the effect of age on the mortality of COVID-19 patients. A total of 6,111,583 subjects were analyzed in this study, and 141,745 (23.2%) were over 80 years of age. Mortality in patients less than 50 years old was less than 1.1%.

The highest mortality rate was observed in patients over 80 years old. All age groups had higher mortality compared to the younger age group. The highest increase in the risk of mortality was observed in patients aged 60–69 compared to those aged 50–59.[19] In the current study, most of the patients were over 60 years old, and the mortality rate was almost 86%. One of the reasons for the high mortality rate in this study could be the highest mean age of the patients. In the study of Mari et al.[19] and Albitar et al.'s[20] study which was conducted with the aim of investigating factors affecting the mortality of COVID-19 patients, it was found that increasing age strongly and independently increases the risk of mortality in COVID-19 patients.

The risk of mortality in patients who had a university education was 64% lower than that of uneducated patients. Feldman and Bassett study showed that the level of education had a significant relationship with the mortality rate among COVID-19 patients.[21] The results of Ribeiro et al.'s[22] study showed that social discrimination such as a low education level, poverty, and unemployment increase the mortality rate in this vulnerable group.

The results of our study highlighted that there was a statistically significant relationship between arterial blood oxygen saturation at admission and the risk of mortality during acute respiratory distress syndrome (ARDS) hospitalization. Furthermore, with the increase of each SpO2 unit, the risk of ARDS in patients decreased by 3%, and the risk of mortality decreased by 4%. On the other hand, with the decrease of each SpO2 unit, the risk of staying in the hospital longer than 10 days increased by 3%. Gao et al.[23] also reported that blood oxygen saturation is an independent factor in the mortality of patients with COVID-19. The percentage of oxygen saturation is considered an important indicator for the recovery of the disease.

This study also showed that the risk of mortality was 2.05 times higher in patients with a history of high blood pressure. In this regard, Thakur et al.[24] in their study, which was conducted with the aim of reviewing underlying diseases and their relationship with mortality among COVID-19 patients, determined that out of 120 studies with 125,446 patients, the most common co-morbidities were hypertension (32%), obesity (25%), diabetes (18%), and cardiovascular disease (16%). Patients with cerebrovascular accidents and cardiovascular patients had higher severity and mortality rates of COVID-19, respectively.[24] In the present study, it was also found that it was not possible to determine the type of medication used for blood pressure. It seems that there is a significant relationship between the type of medication used to control high blood pressure and the mortality of patients, but there is a need for more studies in this field. Also, the study of Chao et al.[25] showed that the risk of mortality in patients with hypertension and low medication adherence is higher than in patients who take medicine to control their blood pressure.

The highest frequency among patients with a specific blood group was related to blood group A (12%). Liu et al.[14] conducted a study with the aim of reviewing the effect of ABO blood groups on the morbidity and mortality of COVID-19 patients. The results showed that, in general, people with blood group A had a 33% and blood group B, 7% higher risk of contracting the disease of COVID-19. But blood groups AB and O are not considered risk factors. Furthermore, Rh-positive patients are at a higher risk of contracting COVID-19.[26] In the current study, it was also found that the risk of mortality for patients with blood group O was 3.85 times higher than for patients with blood group A. The risk of being hospitalized for more than 10 days in patients whose blood type was not included in the file was 78% lower than in patients with blood type A due to a lack of need for transfusion of blood products.

4.1 | Implication of the study

The results of the present study can provide valuable information about the conditions of patients with various demographic and disease characteristics. This information can assist in monitoring and accurately measuring these indices, as well as in paying attention to them during patient treatment. Additionally, understanding risk factors enables nurses to identify and prioritize patients with severe conditions. The findings of the study also suggest that increasing knowledge and awareness can help prevent the occurrence of COVID-19 or its complications. Effective measures can be implemented at multiple levels of prevention.

4.2 | Limitation

According to the doctor's orders, different tests were performed for the patients, which were not the same for all patients, and as a result, the statistical information was not enough to check the specific tests. Additionally, most of the required information was not included in the medical record, and it was necessary to review nursing reports and other systems such as the HIS, which caused the study to take time.

4.3 | Recomndation

It is suggested to investigate the relationship between disease symptoms and prognosis. Furthermore, conducting outpatient examinations of COVID patients discharged from ICUs would be beneficial for a comprehensive understanding of their outcomes and recovery.

5 | CONCLUSION

The study demonstrated that arterial blood oxygen saturation, respiratory rate, and Alzheimer's disease are significant variables for predicting death. Additionally, arterial blood oxygen saturation and respiratory rate are significant variables for predicting the risk of ARDS, as estimated by logistic regression with backward elimination.

Furthermore, the oxygen saturation of arterial blood at the beginning of admission and the absence of blood product transfusion were significant variables in predicting the length of hospital stay. These findings have important implications for epidemiology, demographic characteristics, and treatment outcomes of COVID-19 patients admitted to ICUs, serving as a representative sample of the broader ICU community.

These results can aid in making more informed decisions in response to the ongoing crisis. Moreover, considering that Iran is susceptible to various natural and man-made disasters, understanding the consequences of emerging diseases like COVID-19 can help in resource allocation and improving hospital bed management.

Additionally, nurses, particularly community health nurses, can benefit from this research by providing more effective and accurate training in identifying and educating high-risk populations. This can be achieved by incorporating relevant information such as underlying diseases like hypertension, education level, and other related variables. Consequently, better quality care and education based on societal needs for preventing communicable diseases can be provided.

AUTHOR CONTRIBUTIONS

Farzaneh Yazdanpanah: data curation; formal analysis; investigation; writing—original draft; writing—review & editing. **Alun C. Jackson**: conceptualization; supervision; validation; writing—review & editing. **Neda Sanaie**: data curation; writing—original draft. **Farshad Sharifi**: conceptualization; supervision. **Seyed Morteza Shamshirgaran**: supervision; writing—original draft. **Fatemeh Bahramnezhad**: conceptualization; methodology; supervision; validation; visualization; writing—original draft; writing—review & editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Supporting data are available at Department of Critical Care Nursing, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran.

ETHICS STATEMENT

This study approved in the ethical Committee of Tehran University of Medical Sciences (ID IR.TUMS.FNM.REC.1399.109).

TRANSPARENCY STATEMENT

The lead author Fatemeh Bahramnezhad affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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