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Original Article

Comparison of Individual, Clinical, and Paraclinical Factors in the Survivors and Deceased of COVID-19

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Abstract

Background and aims: COVID-19 prevention, diagnosis, and treatment require the identification of high-risk variables. Thus, this study compared the personal, clinical, and paraclinical characteristics of deceased and surviving COVID-19 patients.

Methods: This cross-sectional descriptive-analytical study was conducted on COVID-19 patients in the University of Medical Sciences Hamadan hospitals from September 2021 to June 2022. A total of 1948 COVID-19 patients were included in the census. Personal, clinical, and paraclinical data were collected from the medical record. Chi-square, independent t-test, and logistic regression were used to analyze the data in SPSS, version 24.

Results: Individual, clinical, and paraclinical variables differed significantly between deceased and surviving COVID-19 patients ($P<0.05$). Age (over 60 years), complications after COVID-19, frequent cardiopulmonary resuscitation (CPR), use of antifungal drugs, oxygen therapy, underlying disease, insulin, diabetes mellitus, hyperlipidemia, angiotensin II receptor blocker, acidosis, cancer, hypertension, antibiotic use, C-reactive protein, creatinine, bilateral lung involvement, and high levels of potassium were the strongest abnormal predictors of death in COVID-19 patients.

Conclusion: Identifying the differences between the deceased and the survivors of COVID-19 in terms of individual, clinical, and paraclinical variables and comparing them with each other in terms of these variables can help in the diagnosis, monitoring, risk assessment, treatment, and prevention of COVID-19.

Keywords: COVID-19, Survivors, Deceased, Individual factors, Clinical factors, Paraclinical factors

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Introduction

COVID-19 is a virulent disease that has spread rapidly worldwide.[1] It caused many deaths. While parts of this significant challenge have been explored, its nature remains unknown.[2] Understanding the characteristics and aspects of COVID-19 is essential since it is widespread and potentially dangerous. Currently, prevention is the most effective approach. Distancing from conditions and social distancing with close surveillance can help prevent them.[4] Nonetheless, it is crucial to formulate and implement comprehensive infrastructure plans to prevent future COVID-19 invasions and cope with them. Furthermore, patients who survive COVID-19 also face numerous complications.[5]

In COVID-19, high-risk factors can result in death, aggravate this disease's course, or influence its progression.[6] This issue has undergone investigation. Pan et al found that gender, saturation of peripheral oxygen (SPO_2), respiratory rate, diastolic blood pressure, neutrophils, lymphocytes, C-reactive protein, procalcitonin, lactate dehydrogenase, and D-dimer were associated with death.[7] In a study in Brazil, people with hypertension (HTN) and diabetes over 65 had a 1.5-fold higher risk of COVID-19-related mortality. Furthermore, infectious, kidney, and heart diseases were predictors of in-hospital mortality.[8] Another study in China demonstrated that discharged and deceased patients had different clinical and laboratory factors. In-hospital mortality was related to lymphocyte count and age. White blood cell counts among older men and women were similar risk factors for in-hospital death.[9] In Iran, COVID-19 patients over 65 treated in the intensive care unit/cardiac care unit (ICU/CCU) had the highest mortality rate. Moreover, in all cases, the mortality rate was the highest in patients with a history of diabetes, cardiovascular disease, or cancer.[10] Further, persistent cough and fever were typical symptoms of COVID-19. In addition, age, body mass index (BMI), and affected family members have been reported to correlate with disease severity.[11]

COVID-19 is a complex disease with many unknowns.

Several factors, such as individual (e.g., age and gender), clinical (e.g., symptoms, signs, and laboratory findings in this disease), and paraclinical (e.g., computed tomography scan results) factors, are effective in determining its prevalence, incidence, and mortality in different people. It seems that the investigation and identification of the mentioned factors, as well as their comparison between the deceased and the survivors of this disease, can be effective in the prevention, diagnosis, monitoring, risk assessment, treatment, and management of mortality caused by this disease. Therefore, the present study was performed to compare individual, clinical, and paraclinical factors in the survivors and deceased of COVID-19.

Materials and Methods

Study Design and Setting

The present cross-sectional descriptive-analytical study was conducted in Besat, Sina Farshchian, Beheshti, Fatemieh, and Farshchian cardiovascular center hospitals of medical education affiliated with Hamadan University of Medical Sciences, Hamadan, Iran, from September 2021 to June 2022.

Sample and Sampling

In this study, 1948 survivors and deceased cases of COVID-19 (974 people in each group) were selected by the census method. The inclusion criteria included hospitalization or death, solely due to COVID-19.

On the other hand, the exclusion criteria were defects in the medical records of the patients and the death of the patient for any reason, except for COVID-19.

Data Collection

Data were collected from the medical record using the researcher's checklist. This checklist included personal, clinical, and paraclinical characteristics. The individual variables consisted of age, gender, marital status, education, place of residence, occupation, and time of year. Clinical data were days of hospitalization, COVID-19 infection frequency, concurrent infections in the family, 14-day past travel/contact with a sick person, ward, type of hospitalization, underlying diseases, BMI, and comorbid conditions. The other data included signs and symptoms, hospitalization complications, average vital signs and SPO_2, oxygen therapy, medications, treatment outcomes, frequency of cardiopulmonary resuscitation (CPR), date of hospitalization/discharge/death, and death time and work shift. Laboratory and radiological results are paraclinical data. The validity checklists were confirmed through ten academics in nursing and epidemiology.

Data Analysis

The data were analyzed using means, standard deviations, frequencies, and percentages. A chi-square and independent samples t-test were applied to compare the two groups. Logistic regression was used to examine mortality factors and adjust for confounding variables. Data analysis was performed with SPSS (version 24) at a significance level of 0.05.

Results

In this study, the mean age of patients in the deceased and survivor groups was 65.57 ± 15.13 and 55.43 ± 15.44, respectively ($P < 0.001$). Patients were predominantly males (76.6%) and had a university degree (76.5%). Approximately 50.3% of the deceased patients had high-risk conditions associated with COVID-19, including hyperlipidemia, alcohol consumption, organ transplantation, chemotherapy, specific or immunosuppressive drugs, pregnancy, obesity, and smoking (Table 1). In general, the personal factors and baseline conditions of deceased patients differed significantly from those of survivors, except for gender, occupation, place of residence, marital status, and season ($P < 0.05$, Table 1).

The clinical characteristics of the survivors and deceased of COVID-19 differed significantly except for diuretics, corticosteroids, intravenous immunoglobulin (IVIg), non-steroidal anti-inflammatory drugs (NSAIDs), and vitamin D ($P < 0.05$, Table 2). Deceased patients had more symptoms, signs, and complications after infection with COVID-19, except for dry cough, diarrhea, and hyperglycemia ($P < 0.05$). Dyspnea was the most common symptom, followed by fever and a dry cough. ICU admission and respiratory failure were the most common among deceased patients (Table 3). The paraclinical and radiological findings of dead and surviving patients differed significantly, except for calcium and magnesium levels ($P < 0.05$). In the survivor group, 67.1% had unilateral lung involvement, whereas the deceased group had bilateral lung involvement (69.1%). The surviving group had fewer white blood cells and monocytes than the dead group; however, the surviving group had more neutrophils (Table 4).

The logistic regression of factors affecting death in COVID-19 patients indicated that age (over 60 years), complications after COVID-19, frequent CPR, antifungal medications, oxygen therapy, underlying diseases, insulin, diabetes mellitus (DM), hyperlipidemia, angiotensin II receptor blockers, acidosis, cancer, HTN, antibiotic use, C-reactive protein, creatinine (Cr), bilateral lung involvement, and potassium were the strongest abnormal predictors of death in COVID-19 patients (Table 5).

Discussion

The present study compared the personal, clinical, and paraclinical characteristics of deceased and surviving COVID-19 patients. Based on this comparison, the severity and extent were higher in the deceased group than in the survivors. Studies may vary in frequency and proportion due to the unpredictable nature of epidemic waves.

The findings revealed that COVID-19 survivors and deceased patients differed significantly in age and education. In most cases, the deceased group included

Table 1. Baseline Characteristics of Patients Infected With COVID-19

Epidemiological Data		Total (N = 1948) Mean ± SD or n (%)	Survived (N = 974) Mean ± SD or n (%)	Deceased (N = 974) Mean ± SD or n (%)	*P* Value
Age (y)		60.50 ± 16.10	55.43 ± 15.44	65.57 ± 15.13	<0.001[a]
	<40 y	268 (13.8%)	193 (19.8%)	75 (7.7%)	
	40–60 y	667 (34.2%)	413 (42.4%)	254 (26.1%)	<0.001[b]
	>60 y	1013 (52.0%)	368 (37.8%)	645 (66.2%)	
Gender	Male	1491 (76.5%)	740 (76.0%)	751 (77.1%)	0.556[b]
	Female	457 (23.5%)	234 (24.0%)	223 (22.9%)	
Occupation	Unemployed	516 (26.5%)	249 (25.6%)	267 (27.4%)	
	Employee	188 (9.7%)	82 (8.4%)	106 (10.9%)	
	Self-employment	750 (38.5%)	391 (40.1%)	359 (36.9%)	0.261[b]
	Farmer	175 (9.0%)	89 (9.1%)	86 (8.8%)	
	Housekeeper	319 (16.4%)	163 (16.7%)	156 (16.0%)	
Residence	Urban	1469 (75.4%)	731 (75.1%)	738 (75.8%)	0.713[b]
	Rural	479 (24.9%)	243 (24.9%)	236 (24.2%)	
Marriage status	Married	1487 (76.3%)	761 (78.1%)	726 (74.5%)	0.062[b]
	Single	461 (23.7%)	213 (21.9%)	248 (25.5%)	
Education	Under diploma	1492 (76.6%)	727 (74.6%)	765 (78.5%)	
	Undergraduate	433 (22.2%)	239 (24.5%)	194 (19.9%)	0.020[b]
	Postgraduate	23 (1.2%)	8 (0.80%)	15 (1.5%)	
Season	Spring	498 (25.6%)	253 (26.0%)	245 (25.2%)	
	Summer	430 (22.1%)	217 (22.3%)	213 (21.9%)	0.524[b]
	Autumn	589 (30.2%)	302 (31.0%)	287 (29.5%)	
	Winter	431 (22.1%)	202 (20.7%)	229 (23.5%)	
BMI (kg/m^2)	<25	1137 (58.4%)	612 (62.8%)	525 (53.9%)	
	26–30	389 (20.0%)	196 (20.1%)	193 (19.8%)	<0.001[b]
	>30	422 (21.7%)	166 (17.0%)	256 (26.3%)	
High-risk conditions	Yes	736 (37.8%)	246 (25.3%)	490 (50.3%)	<0.001[b]
Hyperlipidemia	Yes	388 (19.9%)	72 (7.4%)	316 (32.4%)	<0.001[b]
Alcohol	Yes	31 (1.6%)	0 (0.0%)	31 (3.2%)	<0.001[b]
Transplantation	Yes	39 (2.0%)	9 (0.9%)	30 (3.1%)	0.001[b]
Chemotropic	Yes	28 (1.4%)	6 (0.6%)	22 (2.3%)	0.002[b]
Special drugs	Yes	16 (0.8%)	0 (0.0%)	16 (1.6%)	<0.001[b]
Immunosuppressive drugs	Yes	78 (4.0%)	19 (2.0%)	59 (6.1%)	<0.001[b]
Pregnancy	Yes	14 (0.7%)	4 (0.4%)	10 (1.0%)	0.108[b]
Fatty	Yes	425 (21.8%)	169 (17.4%)	256 (26.3%)	<0.001[b]
Smoking	Recently	689 (35.4%)	223 (22.9%)	466 (47.8%)	
	Before	328 (16.8%)	171 (17.6%)	157 (16.1%)	<0.001[b]
	Never	931 (47.8%)	580 (59.5%)	351 (36.0%)	

BMI: Body mass index; SD: Standard deviation.
Note. [a] *P* value of an independent t-test. [b] *P* value of a Chi-square test.

older than 60-year-old and less educated individuals, which conforms to the findings of some studies.[11-14]As age increases, the immune system deteriorates, causing disease and infection; therefore, immunity declines with age. This reduces the effectiveness of vaccinations or the ability to fight respiratory infections.[15] According to this study, men had a higher mortality rate than women, which is in line with the results of Chen et al[16] and Lian et al[17] but contradicts those of Yue et al.[18] There might be a discrepancy due to the fewer samples and shorter sampling time in the study by Yue et al. Men are more likely than women to die from COVID-19 in most countries. Robust innate immune systems probably reduce COVID-19 disease in females.[19] Research shows that women are more likely than men to take preventive and health measures.[20,21]

According to this study, deceased patients were found to have more high-risk conditions and underlying diseases. Previous studies support these conclusions.[22-26] Cueto-Manzano et al and Soto et al reported no differences between deceased and surviving patients in terms of

Table 2. Clinical Characteristics of Patients Infected With COVID-19

Clinical Data		Total (N = 1948) Mean ± SD or n (%)	Survived (N = 974) Mean ± SD or n (%)	Deceased (N = 974) Mean ± SD or n (%)	*P* Value
Hospitalization (day)		3.11 ± 2.62	2.19 ± 1.62	4.04 ± 3.07	**< 0.001**[a]
Hospitalization ward	ICU	1153 (59.2%)	437 (44.9%)	716 (73.5%)	**< 0.001**[b]
	COVID	717 (36.8%)	514 (52.8%)	203 (20.8%)	
	CCU	78 (4.0%)	23 (2.4%)	55 (5.6%)	
Admit type	Emergency	1024 (52.6%)	414 (42.5%)	610 (62.6%)	**< 0.001**[b]
	Urgent	794 (40.8%)	450 (46.2%)	344 (35.3%)	
	Elective	130 (6.7%)	110 (11.3%)	20 (2.1%)	
Infection frequency	Once	1394 (71.6%)	703 (72.2%)	691 (70.9%)	**0.031**[b]
	Twice	440 (22.6%)	216 (22.2%)	224 (23.0%)	
	Three or more	114 (5.8%)	55 (5.6%)	59 (6.1%)	
Family history	Yes	1471 (75.5%)	738 (75.8%)	733 (75.3%)	0.792[b]
Travel history	Yes	792 (40.7%)	414 (42.5%)	378 (38.8%)	0.097[b]
Communication history	14 days ago	1457 (74.8%)	731 (75.1%)	726 (74.5%)	0.794[b]
Underlying disease	Yes	1016 (52.2%)	276 (28.3%)	740 (76.0%)	**< 0.001**[b]
HTN	Yes	254 (13.0%)	54 (5.5%)	200 (20.5%)	**< 0.001**[b]
DM	Yes	253 (13.0%)	40 (4.1%)	213 (21.9%)	**< 0.001**[b]
CVD	Yes	87 (4.5%)	0 (0.0%)	87 (8.9%)	**< 0.001**[b]
CKD	Yes	74 (3.8%)	19 (2.0%)	55 (5.6%)	**< 0.001**[b]
COPD	Yes	33 (1.7%)	0 (0.0%)	33 (3.4%)	**< 0.001**[b]
HIV	Yes	5 (0.3%)	0 (0.0%)	5 (0.5%)	**< 0.001**[b]
HBV	Yes	10 (0.5%)	0 (0.0%)	10 (1.0%)	**0.002**[b]
Cancer	Yes	34 (1.7%)	6 (0.6%)	28 (2.9%)	**< 0.001**[b]
Respiratory	Yes	56 (2.9%)	0 (0.0%)	56 (5.7%)	**< 0.001**[b]
GI	Yes	74 (3.8%)	74 (7.6%)	0 (0.0%)	**< 0.001**[b]
Neurology	Yes	14 (0.7%)	14 (1.4%)	0 (0.0%)	**< 0.001**[b]
Endocrine	Yes	36 (1.8%)	0 (0.0%)	36 (3.7%)	**< 0.001**[b]
Liver	Yes	61 (3.1%)	16 (1.6%)	45 (4.6%)	**< 0.001**[b]
Hematology	Yes	8 (0.4%)	0 (0.0%)	8 (0.08%)	**0.005**
Dermatology	Yes	25 (1.3%)	25 (2.6%)	0 (0.0%)	**< 0.001**[b]
Psychology	Yes	10 (0.5%)	10 (1.0%)	0 (0.0%)	**0.002**[b]
Other diseases	Yes	20 (1.0%)	20 (2.1%)	0 (0.0%)	**< 0.001**[b]
Antibiotic	Yes	840 (43.1%)	253 (26.0%)	587 (60.3%)	**< 0.001**[b]
Remdesivir	Yes	850 (43.6%)	559 (57.4%)	291 (29.9%)	**< 0.001**[b]
Favipiravir	Yes	1029 (52.8%)	603 (61.9%)	426 (43.7%)	**< 0.001**[b]
Hydroxychloroquine	Yes	445 (22.8%)	195 (20.0%)	250 (25.7%)	**0.003**[b]
Heparin	Yes	319 (16.4%)	86 (8.8%)	233 (23.9%)	**< 0.001**[b]
Atrovent	Yes	97 (5.0%)	36 (3.7%)	61 (6.3%)	**0.009**[b]
Insulin	Yes	226 (11.6%)	34 (3.5%)	192 (19.7%)	**< 0.001**[b]
Diuretic	Yes	173 (8.9%)	95 (9.8%)	78 (8.0%)	0.176
Antifungal	Yes	506 (26.0%)	41 (4.2%)	465 (47.7%)	**< 0.001**[b]
Corticosteroid	Yes	1702 (87.4%)	851 (87.4%)	851 (87.4%)	1.0[b]
IVIg	Yes	140 (7.2%)	62 (6.4%)	78 (8.0%)	0.160[b]
NSAID	Yes	1516 (77.8%)	764 (78.4%)	752 (77.2%)	0.513[b]
ACEI	Yes	254 (13.0%)	54 (5.5%)	200 (20.5%)	**< 0.001**[b]
ARB	Yes	74 (3.8%)	12 (1.2%)	62 (6.4%)	**< 0.001**[b]
VIT C	Yes	547 (28.1%)	302 (31.0%)	245 (25.2%)	**0.004**[b]
VIT D	Yes	795 (40.8%)	394 (40.5%)	401 (41.2%)	0.747[b]
Zn	Yes	703 (36.1%)	430 (44.1%)	273 (28.0%)	**< 0.001**[b]

Table 2. Continued

Clinical Data		Total (N = 1948) Mean ± SD or n (%)	Survived (N = 974) Mean ± SD or n (%)	Deceased (N = 974) Mean ± SD or n (%)	*P* Value
CPR	Number	1.04 ± 1.02	0.322 ± 0.54	1.76 ± 0.86	**< 0.001**[a]
Shift work	Morning	754 (38.2%)	452 (46.4%)	293 (30.1%)	**< 0.001**[b]
	Evening	622 (31.9%)	265 (27.2%)	357 (36.7%)	
	Night	581 (29.8%)	257 (26.4%)	324 (33.3%)	
HR	Bpm	76.62 ± 30.43	76.16 ± 18.55	83.09 ± 38.54	**< 0.001**[a]
RR	Bpm	13.84 ± 4.88	16.27 ± 3.95	11.42 ± 4.51	**< 0.001**[a]
T	°C	37.18 ± 1.09	36.92 ± 0.71	37.43 ± 1.32	**< 0.001**[a]
SBP	mmHg	125.58 ± 21.06	123.22 ± 18.45	127.93 ± 23.16	**< 0.001**[a]
DBP	mmHg	84.38 ± 18.08	83.34 ± 15.38	85.43 ± 20.37	**< 0.001**[a]
MAP	mmHg	97.57 ± 19.16	95.98 ± 16.58	99.16 ± 21.33	**< 0.001**[a]
O_2 therapy	Non-invasive	1065 (54.7%)	787 (80.8%)	278 (28.5%)	**< 0.001**[b]
	Invasive	883 (45.3%)	187 (19.2%)	696 (71.5%)	
O_2 with mask	L/m	3.93 ± 3.87	5.43 ± 3.19	2.43 ± 3.91	**< 0.001**[a]
Ventilator mode	SIMV	360 (18.5%)	40 (4.1%)	320 (32.9%)	**< 0.001**[b]
	SPONT	144 (7.4%)	46 (4.7%)	98 (10.1%)	
	CPAP	186 (9.5%)	61 (6.3%)	125 (12.8%)	
	BIPAP	184 (9.4%)	40 (4.1%)	144 (14.8%)	
	No	1074 (55.1%)	787 (80.8%)	287 (29.5%)	
PEEP	cmH_2O	3.30 ± 4.16	0.7 ± 1.45	5.91 ± 4.36	**< 0.001**[b]
FiO_2	%	30.48 ± 38.34	8.98 ± 18.71	51.98 ± 40.81	**< 0.001**[b]

Note. HTN: Hypertension; DM: Diabetes mellitus; CVD: Cardiovascular disease; CKD: Chronic kidney disease; COPD: Chronic obstructive pulmonary disease; HIV: Human immunodeficiency virus; HBV: Hepatitis B virus; GI: Gastrointestinal; IVIg: Intravenous immunoglobulin; NSAID: Non-steroidal anti-inflammatory drug; ACEI: Angiotensin-converting enzyme inhibitors; ARB: Angiotensin II receptor blockers; CPR: Cardiopulmonary resuscitation; HR: Heart rate; BPM: Beats per minute; RR: Respiratory rate; T: Temperatures; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure; FiO_2: Fraction of inspired oxygen; VIT C: Vitamin C; VIT D: Vitamin D: Zn: Zinc; SIMV: Synchronized intermittent mandatory ventilation; SPONT: Biphasic positive airway pressure; CPAP: Continuous positive airway pressure; BIPAP: Biphasic positive airway pressure; PEEP: Positive end-expiratory pressure; ICU: Intensive care unit; CCU: Cardiac care unit; Zn: Zinc.
[a] Independent t-test. [b] Chi-square test.

overweight, obesity, or smoking. Nonetheless, most deceased patients were obese and had underlying diseases such as cardiovascular, renal, and pulmonary diseases.[23,24] Smaller sample sizes and shorter study durations may explain this discrepancy. SARS-CoV-2 infection is strongly associated with chronic obstructive pulmonary disease (COPD) and smoking, and COPD patients and smokers fare worse than others. Thus, smoking causes COVID-19 complications and mortality.[27] COVID-19 is especially deadly for cancer patients due to chemotherapy and surgery suppressing their immune systems[28] and those patients who have rheumatoid arthritis, pneumonia, organ transplantation and graft versus host disease. A poor immune response may accelerate COVID-19 in these patients.[29] Therefore, the treatment of underlying diseases must be continued during the treatment of COVID-19.[30,31] A significant difference was found in clinical variables between the deceased group and the surviving group, except for diuretics, corticosteroids, IVIG, NSAIDs, and vitamin D, which matches the results of previous studies.[13,18,26,32,33] However, in the study by He et al, severe patients received more corticosteroid medications.[13] Compared to our study, the mentioned researchers found many times more non-severe patients in their study than patients in both groups. Remdesivir and favipiravir were used more frequently in the survivor group. Studies by Kumar et al and Sheehan et al showed the most promising effect against COVID-19.[34,35] Additionally, the survivor's group took more vitamin C. Vitamin C positively affects T lymphocytes and natural killer cells, which are involved in the immunological response to viral pathogens. It inhibits the formation of reactive oxygen species and alters the cytokine network of the systemic inflammatory syndrome.[36]

The present study revealed that symptoms, signs, and complications after COVID-19 infection differed significantly between the deceased and surviving groups, except for dry cough, diarrhea, and hyperglycemia. Hence, the deceased group suffered from more severe and extensive illnesses. Several studies have reached the same conclusion.[16,26,30,37] Of course, the results of Tu et al[38] contradict those of our results. This discrepancy can be explained by the small sample sizes in these studies and the unequal patient numbers. The findings of the current study also represented that the most common COVID-19 complications were respiratory failure and hospitalization in the ICU, which occurred more frequently in deceased patients. The most common signs and symptoms were dyspnea, fever, and a dry cough. These findings are consistent with the results of the study by Hasabo et al.[37]

Table 3. Signs and Symptoms of Patients Infected With COVID-19

Signs and Symptoms Data	Total (N = 1948) Mean ± SD or n (%)	Survived (N = 974) Mean ± SD or n (%)	Deceased (N = 974) Mean ± SD or n (%)	*P* value
Dry cough	544 (27.9%)	272 (27.9%)	272 (27.9%)	1.0[b]
Phlegmatic cough	99 (5.1%)	0 (0.0%)	99 (10.2%)	**< 0.001**[b]
Fever	640 (32.9%)	397 (40.8%)	243 (24.9%)	**< 0.001**[b]
Chills	497 (25.5%)	397 (40.8%)	100 (10.3%)	**< 0.001**[b]
Anorexia	119 (6.1%)	119 (12.2%)	0 (0.0%)	**< 0.001**[b]
Myalgia	512 (26.3%)	195 (20.0%)	317 (32.5%)	**< 0.001**[b]
Dyspnea	817 (41.9%)	272 (27.9%)	545 (55.6%)	**< 0.001**[b]
Sore throat	127 (6.5%)	0 (0.0%)	127 (13.0%)	**< 0.001**[b]
Headache	247 (12.7%)	0 (0.0%)	247 (25.4%)	**< 0.001**[b]
Vertigo	150 (7.7%)	0 (0.0%)	150 (15.4%)	**< 0.001**[b]
Confusing	150 (7.7%)	0 (0.0%)	150 (15.4%)	**< 0.001**[b]
Rhinorrhea	78 (4.0%)	0 (0.0%)	78 (8.0%)	**< 0.001**[b]
Congested nose	120 (6.2%)	0 (0.0%)	120 (12.3%)	**< 0.001**[b]
Parosmia	524 (26.9%)	397 (40.8%)	127 (13.0%)	**< 0.001**[b]
Dyspepsia	524 (26.9%)	397 (40.8%)	127 (13.0%)	**< 0.001**[b]
Nausea	371 (19.0%)	272 (27.9%)	99 (10.2%)	**< 0.001**[b]
Vomiting	371 (19.0%)	272 (27.9%)	99 (10.2%)	**< 0.001**[b]
Diarrhea	226 (11.6%)	119 (12.2%)	107 (11.0%)	0.396[b]
Chest pain	120 (6.2%)	0 (0.0%)	120 (12.3%)	**< 0.001**[b]
LOC	150 (7.7%)	0 (0.0%)	150 (15.4%)	**< 0.001**[b]
COVID-19 complication	926 (47.5%)	22 (2.3%)	904 (92.8%)	**< 0.001**[b]
Sepsis	165 (8.5%)	0 (0.0%)	165 (16.9%)	**< 0.001**[b]
Respiratory frailer	340 (17.5%)	0 (0.0%)	340 (34.9%)	**< 0.001**[b]
Heart frailer	216 (11.1%)	0 (0.0%)	216 (22.2%)	**< 0.001**[b]
MODS	288 (14.8%)	0 (0.0%)	288 (29.6%)	**< 0.001**[b]
Coagulopathy	114 (5.9%)	0 (0.0%)	114 (11.7%)	**< 0.001**[b]
Secondary infection	265 (13.6%)	0 (0.0%)	265 (27.2%)	**< 0.001**[b]
Stroke	67 (3.4%)	0 (0.0%)	67 (6.9%)	**< 0.001**[b]
Hyperglycemia	30 (1.5%)	12 (1.2%)	18 (1.8%)	0.270[b]
Acidosis	60 (3.1%)	10 (1.0%)	50 (5.1%)	**< 0.001**[b]
ICU admission	1153 (59.2%)	437 (44.9%)	716 (73.5%)	**< 0.001**[b]
ICU hospitalization (day)	1.99 ± 2.68	1.02 ± 1.61	2.96 ± 3.15	**< 0.001**[a]

Note. LOC: Level of consciousness; MODS: Multiple organ dysfunction syndrome; ICU: Intensive care unit; SD: Standard deviation; MODS: Multiple organ dysfunction syndrome.
[a] Independent t-test. [b] Chi-square test.

Chen et al noted that acute respiratory distress syndrome and respiratory failure are common after COVID-19 infection.[16] The paraclinical and radiological findings of the deceased patients in the current study were significantly different from those of the surviving patients, except for calcium and magnesium. These variables were higher or worse in the deceased patients. Most of those who died had bilateral lung involvement, whereas those who survived often had unilateral lung involvement. Previous studies have confirmed this issue.[7,39,40] During the COVID-19 epidemic, patient assessment is critical. The results of this study demonstrated the importance of simple, rapid, and inexpensive laboratory biomarkers for COVID-19 patients.

The real-time polymerase chain reaction (RT-PCR) is used to diagnose new COVID-19 infections. The sensitivity (70%) and availability of this test are limited.[41,42]Some COVID-19 patients had false-negative RT-PCR results.[43] When RT-PCR is false-negative or unavailable, computed tomography can diagnose COVID-19.[44] It is important to note that the symptoms and development of COVID-19 can range from mild to severe. Clinical signs likely determine the laboratory results in these patients. For example, in our study, the survivors had fewer leukocytes and monocytes than the deceased but more neutrophils. The findings of the study by Ibrahim et al indicated a decrease in lymphocytes and an upper limit for neutrophils, but an average leukocyte

Table 4. Laboratory Features of Patients Infected With COVID-19

Laboratory Data		Total (N = 1948) Mean ± SD or n (%)	Survived (N = 974) Mean ± SD or n (%)	Deceased (N = 974) Mean ± SD or n (%)	*P* Value
SPO_2	%	86.61 ± 7.84	91.91 ± 4.18	81.30 ± 7.02	**< 0.001**[a]
PaO_2	mmHg	86.63 ± 6.07	90.81 ± 2.51	82.45 ± 5.70	**< 0.001**[a]
RBC ($\times 10^6$)	$\times 10^6$/μL	4.38 ± 1.69	4.99 ± 1.71	3.78 ± 1.42	**< 0.001**[a]
WBC ($\times 10^3$)	$\times 10^3$/μL	8.73 ± 5.47	8.48 ± 4.75	8.97 ± 6.10	**0.047**[a]
Neutrophil	%	64.05 ± 13.33	65.53 ± 10.09	62.56 ± 15.79	**< 0.001**[a]
Lymphocyte	%	29.91 ± 14.69	29.68 ± 13.77	30.14 ± 15.57	0.495[a]
Monocyte	%	4.14 ± 1.64	3.92 ± 1.66	4.35 ± 1.60	**< 0.001**[a]
Eosinophil	%	2.38 ± 1.36	2.36 ± 1.42	2.41 ± 1.30	0.475[a]
Basophil	%	0.49 ± 0.50	0.50 ± 0.50	0.48 ± 0.50	0.415[a]
Hemoglobin	g/dL	12.66 ± 2.79	14.10 ± 2.02	11.21 ± 2.71	**< 0.001**[a]
Hematocrit	%	38.27 ± 7.99	42.46 ± 5.49	34.08 ± 7.90	**< 0.001**[a]
Albumin	g/dL	3.64 ± 1.15	3.55 ± 1.10	3.72 ± 1.18	**0.001**[a]
LDL	mg/dL	120.96 ± 30.73	110.15 ± 26.25	131.77 ± 31.09	**< 0.001**[a]
HDL	mg/dL	54.99 ± 21.45	58.74 ± 21.94	51.25 ± 20.28	**< 0.001**[a]
PT	S (Second)	12.15 ± 2.25	12.58 ± 1.93	11.73 ± 2.46	**< 0.001**[a]
PTT	S (Second)	31.61 ± 8.11	32.87 ± 7.11	30.35 ± 8.82	**< 0.001**[a]
INR	No unit	0.98 ± 0.18	1.01 ± 0.15	0.94 ± 0.20	**< 0.001**[a]
ESR	mm/h	13.78 ± 7.35	8.35 ± 5.24	19.21 ± 4.65	**< 0.001**[a]
CRP	+	584 (30.0%)	408 (41.9%)	176 (18.1%)	**< 0.001**[b]
	++	553 (28.4%)	202 (20.7%)	351 (36.0%)	
	+++	405 (20.8%)	75 (7.7%)	330 (33.9%)	
	No	406 (20.8%)	289 (29.7%)	117 (12.0%)	
D-dimer	n/mL	374.87 ± 329.18	77.50 ± 26.08	672.25 ± 197.73	**< 0.001**[a]
LDH	IU/L	149.27 ± 40.71	124.04 ± 28.01	174.51 ± 35.46	**< 0.001**[a]
AST	U/L	66.90 ± 48.85	40.89 ± 25.89	92.90 ± 52.45	**< 0.001**[a]
ALT	U/L	51.16 ± 41.51	28.15 ± 17.53	74.16 ± 45.62	**< 0.001**[a]
ALK	U/L	97.31 ± 122.96	76.06 ± 74.67	118.56 ± 154.19	**< 0.001**[a]
CPK-MB	U/L	3.99 ± 3.08	3.33 ± 2.89	4.64 ± 3.13	**< 0.001**[a]
TNI	Positive	824 (42.3%)	316 (32.4%)	508 (52.2%)	**< 0.001**[b]
	Negative	1124 (57.7%)	658 (67.6%)	466 (47.8%)	
BUN	mg/dL	24.25 ± 12.59	17.22 ± 6.39	31.28 ± 13.33	**< 0.001**[a]
Cr	mg/dL	1.67 ± 1.36	0.98 ± 0.34	2.37 ± 1.62	**< 0.001**[a]
Na	mEq/L	140.35 ± 7.43	139.27 ± 5.98	141.44 ± 8.50	**< 0.001**[a]
K	mEq/L	4.60 ± 0.90	4.25 ± 0.67	4.95 ± 0.96	**< 0.001**[a]
Ca	mg/dL	9.04 ± 0.76	9.02 ± 0.73	9.06 ± 0.79	0.203[a]
P	mg/dL	3.47 ± 0.97	3.25 ± 0.90	3.69 ± 0.99	**< 0.001**[a]
Mg	mg/dL	2.15 ± 0.57	2.16 ± 0.54	2.15 ± 0.60	0.721[a]
PLT ($\times 10^5$)	$\times 10^5$/μL	11.99 ± 12.68	2.77 ± 1.13	2.27 ± 1.21	**< 0.001**[a]
TSH	mIU/L	2.20 ± 1.19	1.82 ± 0.81	2.58 ± 1.39	**< 0.001**[a]
T3	ng/dL	153.36 ± 27.07	157.30 ± 20.93	149.43 ± 31.58	**< 0.001**[a]
T4	ng/dL	7.88 ± 2.30	8.28 ± 1.93	7.47 ± 2.55	**< 0.001**[a]
Radiography	One tail	955 (49.0%)	654 (67.1%)	301 (30.9%)	**< 0.001**[b]
	Two tails	993 (51.0%)	320 (23.9%)	673 (69.1%)	

Note. RBC: Red blood cell; WBC: White blood cell; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; PT: Prothrombin time; PTT: Partial thromboplastin time; INR: International normalized ratio; ESR: Erythrocyte sedimentation rate; CRP: C-reactive protein; LDH: Lactate dehydrogenase; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; ALK: Alkaline phosphatase; CPK-MB: Creatine phosphokinase; TNI: Troponin I; BUN: Blood urea nitrogen; Cr: Creatinine; PLT: Platelet; TSH: Thyroid stimulating hormone; Na: Sodium; K: Potassium; Ca: Calcium; P: Phosphorus; Mg: Magnesium; T3: Triiodothyronine; T4: Thyroxine; SPO_2: Saturation of peripheral oxygen; PaO_2: Partial pressure of oxygen.

[a] Independent t-test; [b] Chi-square test.

Table 5. The Binary Logistic Regression of the Baseline, Clinical, and Paraclinical Characteristics Predicting Deceased

Baseline Characteristics		OR	SE	*P* Value	95% CI for OR
Age (year)	<40 Y	1.0	-	-	-
	40 – 60 Y	1.58	0.25	0.004	1.16 – 2.16
	>60 Y	4.51	0.68	<0.001	3.35 – 6.06
Clinical characteristics					
BMI (kg/m^2)	<25	1.0	-	-	-
	26 - 30	1.15	0.60	0.241	0.91 – 1.45
	>30	1.18	0.09	<0.001	1.43 – 2.26
High-risk conditions	Yes	3.0	0.29	<0.001	2.47 – 3.63
Hyperlipidemia	Yes	6.02	0.84	<0.001	0.66 – 0.81
Transplant	Yes	3.41	1.30	0.001	1.61 – 7.21
Chemotropic	Yes	3.73	1.72	0.004	1.51 – 9.24
Immunosuppressive drugs	Yes	3.24	0.87	<0.001	1.92 – 5.48
Smoking	Recently	1.0	-	-	-
	Before	0.44	0.06	<0.001	0.34 – 0.58
	Never	0.29	0.03	<0.001	0.23 – 0.36
Hospitalization ward	COVID-19	0.24	0.02	<0.001	0.20 – 0.29
Admit type	Emergency	1.0	-	-	-
	Urgent	0.52	0.05	<0.001	0.43 – 0.63
	Elective	0.12	0.03	<0.001	0.07 – 0.20
Underlying conditions	Yes	8.00	0.83	<0.001	6.53 – 9.79
Hypertension	Yes	4.40	0.71	<0.001	3.21 – 6.03
Diabetes mellitus	Yes	6.53	1.17	<0.001	4.60 – 9.28
Chronic kidney disease	Yes	3.00	0.81	<0.001	1.77 – 5.11
Cancer	Yes	4.78	2.16	0.001	1.97 – 11.58
Liver	Yes	2.90	0.85	<0.001	1.63 – 5.17
Antibiotic	Yes	4.32	0.42	<0.001	3.57 – 5.24
Remdesivir	Yes	0.32	0.03	<0.001	0.26 – 0.38
Favipiravir	Yes	0.48	0.04	<0.001	0.40 – 0.57
Heparin	Yes	3.25	0.44	<0.001	2.49 – 4.23
Insulin	Yes	6.79	1.30	<0.001	4.66 – 9.89
Antifungal	Yes	20.79	3.57	<0.001	14.84 – 29.12
Angiotensin-converting enzyme inhibitors	Yes	4.40	0.71	<0.001	3.21 – 6.03
Angiotensin II receptor blockers	Yes	5.45	1.74	<0.001	2.92 – 10.18
Zn	Yes	0.49	0.05	<0.001	0.41 – 0.59
Cardiopulmonary resuscitation		34.60	6.18	<0.001	24.38 – 49.10
Shift work	Morning	1.0	-	-	-
	Evening	2.08	0.23	<0.001	1.67 – 2.58
	Night	1.95	0.22	<0.001	1.56 – 2.42
Respiratory rate	Bpm	0.78	0.01	<0.001	0.76 – 0.80
Temperatures	˚C	1.59	0.07	<0.001	1.45 – 1.74
O_2 therapy	Invasive	10.54	1.14	<0.001	8.53 – 13.02
Ventilator mode	SIMV	1.0	-	-	-
	SPONT	0.27	0.06	<0.001	0.16 – 0.43
	CPAP	0.26	0.06	<0.001	0.16 – 0.40
	BIPAP	0.45	0.11	0.001	0.28 – 0.73
	No	0.05	0.01	<0.001	0.03 – 0.07
Fever	Yes	0.48	0.05	<0.001	0.40 – 0.59
Chills	Yes	0.17	0.02	<0.001	0.13 – 0.21

Table 5. Continued

Baseline Characteristics		OR	SE	*P* Value	95% CI for OR
Dyspnea	Yes	3.28	0.32	<0.001	2.71 – 3.96
Olfactory	Yes	0.22	0.02	<0.001	0.17 – 0.27
Dyspepsia	Yes	0.22	0.02	<0.001	0.17 – 0.27
Nausea	Yes	0.29	0.04	<0.001	0.23 – 0.38
Vomiting	Yes	0.29	0.04	<0.001	0.23 – 0.38
Complication	Yes	558.84	139.03	<0.001	343.17 – 910.03
Acidosis	Yes	5.22	1.82	<0.001	2.63 – 10.35
ICU admission	Yes	3.41	0.33	<0.001	2.82 – 4.12
Paraclinical characteristics					
SPO_2	%	0.75	0.01	<0.001	0.73 – 0.77
PaO_2	mmHg	0.67	0.01	<0.001	0.65 – 0.70
Hemoglobin	g/dL	0.64	0.01	<0.001	0.61 – 0.66
Hematocrit	%	0.85	0.01	<0.001	0.84 – 0.86
INR	No unit	0.09	0.02	<0.001	0.05 – 0.16
Cardiopulmonary resuscitation	+	1.0	-	-	-
	++	4.03	0.51	<0.001	3.14 – 5.16
	+++	10.20	1.60	<0.001	7.50 – 13.86
	-	0.94	0.36	0.655	0.71 – 1.24
TNI	Positive	1.0	-	-	-
	Negative	0.44	0.04	<0.001	0.37 – 0.53
Cr	mg/dL	9.64	1.28	<0.001	7.73 – 12.51
K	mEq/L	2.56	0.15	<0.001	2.29 – 2.87
Radiography	Two tails	4.56	0.44	<0.001	3.78 – 5.53

Note. OR: Odds ratio; SE: Standard error; CI: Confidence interval; BPM: Beats per minute. ORs equal to 1 represent the reference level. TNI: Troponin I; Cr: Creatinine; K: Potassium; SPO_2: Saturation of peripheral oxygen; PaO_2: Partial pressure of oxygen; ICU: Intensive care unit; INR: International normalized ratio; Zn: Zinc; BMI: Body mass index; SIMV: Synchronized intermittent mandatory ventilation; SPONT: Biphasic positive airway pressure; CPAP: Continuous positive airway pressure; BIPAP: Biphasic positive airway pressure.

count.[45] Other studies have found high neutrophil and low lymphocyte counts in elderly COVID-19 patients.[46,47] Older COVID-19 patients may be more susceptible to bacterial infections, causing high neutrophil counts.[46,48] In general, paraclinical findings help diagnose, treat, and follow up on COVID-19 patients.

Based on the results of the present study, the strongest abnormal predictors of death in COVID-19 patients were age (over 60 years), complications after COVID-19, frequent CPR, antifungal drug usage, and oxygen therapy. The other abnormal predictors included underlying disease, insulin, DM, hyperlipidemia, angiotensin II receptor blocker, acidosis, cancer, HTN, antibiotic use, C-reactive protein, Cr, bilateral lung involvement, and potassium. During acute respiratory distress syndrome, COVID-19 rapidly escalates in this setting, causing septic shock, metabolic acidosis, coagulopathy, and other complications leading to death, especially in the elderly with underlying disease. Consequently, identifying risk factors for COVID-19 mortality and severe infections may help develop preventive and therapeutic measures.

Limitations

The main limitation of this study was the insufficient information on the patient's underlying diseases in the file, which was resolved by attaching tests to the file. Several reports in the record were illegible but were determined by matching nursing reports with physicians' orders. Each study uncovers new limitations. These limitations will allow future researchers to conduct more generalizable studies. Future studies and COVID-19 patients will benefit from these study findings.

Conclusion

The findings demonstrated that the COVID-19 deceased and survivors had different personal, clinical, and paraclinical characteristics. COVID-19 patients can be difficult to diagnose and treat clinically and require a multidisciplinary approach. An interdisciplinary approach is needed to diagnose and treat COVID-19 patients. To improve the management of COVID-19, identifying private, clinical, and paraclinical variables can assist in analyzing, monitoring, and assessing the mortality risk of these patients.

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Competing Interests

All authors agree that there is no conflict of interests.

Ethical Approval

The Ethics Committee of Hamadan University of Medical Sciences, Hamadan, Iran, approved this study (ethics code: IR.UMSHA.REC.1400.347). All patient data were collected confidentially, and researchers did not interfere with admission, discharge, diagnostics, or treatment decisions.

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