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Comparison of Clinical, Laboratory, and Radiological Symptoms of Patients Hospitalized in the COVID-19 Wards of Imam Reza Hospital in Mashhad During the First, Second, and Third Peaks of COVID-19

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Abstract

Background: Considering that few studies have investigated the differences in clinical, laboratory, and imaging symptoms of patients with coronavirus disease 2019 (COVID-19) during different peaks of the disease in Iran, the present study compares the patients who were admitted to the COVID-19 departments of Imam Reza Hospital during the first, second, and third peaks of the disease.

Methods: In this cross-sectional study, data were collected by reviewing the files of patients with a definite diagnosis of COVID-19 based on the RT-PCR test in Imam Reza Hospital in Mashhad. The patients were divided into three groups based on the time of admission: The first peak from March 2020 to June 2020, the second peak from July to September 2020, and the third peak from October to December 2020. The variables evaluated in this study included demographic information, clinical signs and symptoms, and laboratory and radiological findings. Descriptive qualitative data were reported using frequency tables, while quantitative descriptive data were reported using measures of central tendency and dispersion. A comparison of qualitative data among the three peaks was conducted using the chi-square test, while for quantitative data, the ANOVA test was used followed by appropriate post-hoc tests.

Results: A total of 561 patients with an average age of 58.90 ± 16.80 years were included in the study, of which 336 (59.9%) were male. Regarding underlying diseases, significant differences were found in age ($P < 0.001$), smoking ($P < 0.001$), diabetes ($P = 0.003$), high blood pressure ($P < 0.001$), asthma ($P = 0.025$), and ischemic heart disease ($P < 0.001$). For vital signs, significant differences were observed in heart rate ($P < 0.001$), respiration rate ($P < 0.001$), diastolic blood pressure ($P = 0.010$), and SPO_2 ($P < 0.001$). In clinical characteristics, significant differences were found in fever ($P < 0.001$), nausea ($P = 0.011$), vomiting ($P = 0.031$), headache ($P < 0.001$), weakness ($P < 0.001$), and sore throat ($P < 0.001$). In laboratory characteristics, significant differences were observed in white blood cell (WBC) count ($P = 0.024$), neutrophil percentage ($P < 0.001$), lymphocyte percentage ($P < 0.001$), and C-reactive protein (CRP) ($P = 0.001$). The CT score values of the patients were significantly different between the three peaks. Patient mortality was significantly different across the three peaks. Less than 15% of hospitalized patients died in the first peak, while over 24% died in the second peak and nearly 40% of inpatients died in the third peak. In our study, the first and third surges and the second and third surges had different mortalities.

Conclusions: The third and first peaks had the highest and lowest mortality rates, respectively. Underlying diseases and unstable vital signs were more common in the second and third peaks. Patients in the second peak had significantly higher CT scores compared to the other peaks.

Keywords: Covid-19, Outcome, Laboratory Findings, Clinical Symptoms

1. Background

Coronaviruses are important pathogens in humans and animals. In December 2019, the severe acute respiratory syndrome (SARS-CoV-2) virus, the cause of coronavirus disease 2019 (COVID-19), spread in Wuhan, a city in Hubei province, China (1-3). SARS-CoV-2 has a lower mortality rate than its two predecessors, SARS-CoV and MERS-CoV, but it spreads faster than both. The World Health Organization (WHO) was forced to declare it a pandemic in March 2020 due to the virus's highly contagious nature and worldwide infection (4).

Genome analyses showed that SARS-CoV-2 is a betacoronavirus, same as SARS-CoV and MERS-CoV, but in different clades (5). Angiotensin-converting enzyme 2 (ACE2) is the host cell receptor for SARS-CoV and SARS-CoV-2 entry (6). Due to the various expressions of this receptor in different organs, virus particles can cause a vast spectrum of clinical manifestations and complications (4). Atypical or organized pneumonia is the first radiological finding in COVID-19 patients. Nearly 18% of patients have normal chest X-rays and CT scans at the beginning of the disease (7). Ground-glass opacification with or without mixed consolidation, adjacent pleural thickening, intralobular septal thickening, and air bronchograms are the most frequent chest CT findings (8). Lymphopenia, increased levels of aminotransferases, increased levels of lactate dehydrogenase, and elevated inflammatory markers such as ferritin, C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR) are common laboratory findings in hospitalized patients (9).

In April 2020, an analysis of 19 studies by Rodriguez-Morales et al. showed that rapid progression of fever, cough, and dyspnea are common symptoms of COVID-19, and rapid progression to acute respiratory distress syndrome (ARDS) is among the more specific manifestations of the disease. In terms of imaging, bilateral pneumonia and ground-glass opacification were the most common findings (10). Another study conducted in November 2020 by Allameh et al. reported fever, dry cough, and dyspnea as the most common signs, similar to previous studies. However, the proportion of these symptoms in the patients of this study was higher than in other studies. For example, 93.5% of patients had a fever, which was less frequently reported in previous studies. Additionally, laboratory findings showed increased levels of LDH or CRP in more than 90% of patients, but lymphopenia was reported in only 42.9% of patients (11).

Finally, although it seems the symptoms of patients with COVID-19 have been similar since the beginning, different studies have shown varying manifestations over time. These changes in symptoms could be the result of genomic changes in the virus, temperature changes, or racial differences in infected people at different times. As far as we know, few reliable studies with access to a large sample size of patients have compared the symptoms during different peaks of this disease in Iran. Evaluating these changes can help public health decision-makers and clinicians to manage the disease in society and individuals more effectively.

2. Methods

We conducted this cross-sectional study on hospitalized COVID-19 cases at Imam Reza Hospital, Mashhad, Iran, in 2021. This study was approved by the Mashhad University of Medical Sciences Ethics Committee (code of ethics: IR.MUMS.REC.1399.572). We included all patients older than 18 years with confirmed COVID-19 infection based on clinical features, CT scan findings, and positive COVID PCR test from February 20, 2020, until December 20, 2020. We excluded pregnant and pediatric cases. Based on the number of hospitalized patients meeting the study criteria at our center and the prevalence of this disease in the community, patients were divided into three separate groups: The first peak from February 2020 to June 2020, the second peak from June 2020 to September 2020, and the third peak from September 2020 to December 2020 (12).

We used a pre-prepared checklist for gathering data on our variables. Our variables were divided into three categories: (1) Demographic information, including age, gender, and comorbidities (e.g., diabetes, hypertension, cardiovascular, pulmonary, hepatic, renal disease, malignancies, and HIV); (2) physical examination and clinical manifestations, including fever, cough, fatigue, headache, hemoptysis, diarrhea, vomiting, nausea, dyspnea, hypertension, tachypnea (respiratory rate > 24), and abdominal pain. These signs and symptoms were assessed using first admission data.; (3) disease severity was based on O_2 saturation at the time of admission, complete blood count (CBC), ESR and CRP values, CT scan score (measured by the amount of lung involvement from 0 to 5 in each of the 5 lobes of the lung and then summed up to give a score of 0 to 25, based on the study by Pan et al. (13), ICU admission, and outcome. The obtained data were analyzed using SPSS software version 25. The comparison of qualitative data between the three peaks was done using the chi-square test, and quantitative data were analyzed with the ANOVA test. The estimated number of patients in each of the three peaks was 150.

3. Results

In total, we included 561 patients in this study with a mean age of 58.9 ± 16.8 years. Our study population consisted of 336 males (59.9%) and 225 females. The second peak had the most admitted patients (218 patients, 38.6%), while the lowest number of patients was in the third peak (138 patients, 24.6%) (Figure 1).

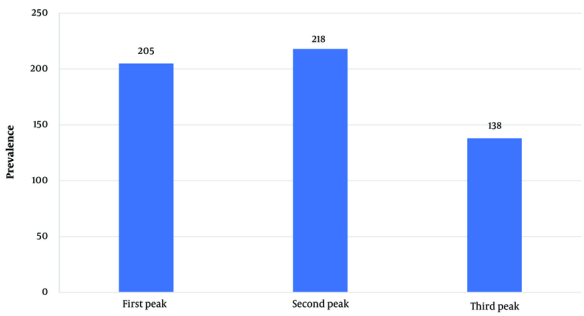

Figure 1. Details of mortality rate and ICU admission

Hypertension and diabetes were the most common comorbidities, with 293 (52.2%) and 226 (40.3%) cases respectively. Dyspnea was the most frequent symptom, present in 462 (75.4%) patients at the time of admission, followed by fever in 423 (75.4%) patients. The average time elapsed since the onset of symptoms was 7.12 ± 2.37 days. Among the patients included in the study, the average CT score was 12.26 ± 4.95. As seen in Table 1, ground glass opacity was the most common finding on CT scans, present in 537 patients (96.6%).

Table 1. Demographic, Comorbidities Details, Patients' Signs and Symptoms, and Imaging Findings

Data	No. (%)
Gender	
Male	336 (59.9)
Female	225 (40.1)
Cigarette smoking	144 (25.7)
Drug addiction	56 (10)
Alcohol consumption	3 (0.5)
Underlying disease	
Diabetes	226 (40.3)
Hypertension	293 (52.2)
Asthma	13 (2.3)
Ischemic heart disease	171 (30.4)
Chronic kidney disease	42 (7.5)
Transplantation	13 (2.3) [a]
Malignancy	26 (4.6)
COPD	67 (11.9)
CVD	15 (2.7)
Other conditions [b]	41 (7.3)
Drugs	
Anti hypertension (except ACE, ARB)	311 (55.4)
ACE I or ARB	240 (42.8)
Anti diabetes	220 (39.2)
Chemotherapy	12 (2.1)
Corticostroides	18 (3.2)
Aspirine	15 (2.7)
Nonsteroidal immunosuppresives	12 (2.1)
Clinical features	
Fever	423 (75.4)
Cough	333 (59.4)
Dyspnea	462 (82.4)
Phlegm	53 (9.4)
Chest discomfort	302 (53.8)
Nausea	118 (**21**)
Vomiting	109 (**19.4**)
Diarrhea	50 (**8.9**)
Rhinorrhea	4 (**0.7**)
Abdominal pain	34 (**6.1**)
Conjunctivitis	3 (**0.5**)
Headache	300 (**53.5**)
Myalgia	219 (**39**)
Arthralgia	73 (**13**)
Weakness	386 (**68**)
Fatigue	156 (**27.8**)
Sore throat	31 (**5.5**)
Shaking	46 (**8.2**)
Confusion	90 (**16**)
Anosmia	21 (**3.7**)
Taste disorder	4 (**0.7**)
CT scan findings	
Ground glass	537 (**96.6**)
Consalidation	394 (**70.9**)
Crazy paving	120 (**21.6**)

Abbreviations: COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; ACE, angiotensin converting enzyme; ARB, angiotensin-II receptor blocker.

[a] 4 patients' transplant had been rejected.

[b] Includes: Alport (1), goodpasture (1), TTP (1), psoriasis (1), necrotizing fasciitis (1), hepatitis (1), morbid obesity (5), tuberculosis (3), emboli (4), cystic colitis (4), rheumatoid arthritis (2), lupus (2), seizure (1), multiple sclerosis (2), mitral valve replacement (3), hypothyroidism (7).

Demographic details, comorbidities, patients' signs and symptoms, and imaging findings are shown in Table 1. Table 2 shows the details of patients' vital signs and laboratory findings.

Smoking ($P < 0.001$), diabetes ($P = 0.003$), hypertension ($P < 0.001$), asthma ($P = 0.025$), ischemic heart disease ($P < 0.001$), chronic kidney disease ($P =$

Table 2. Patients' Vital Signs and Laboratory Findings Details

Variables	Mean ± Standard Deviation	Highest	Lowest
Heart rate	109.66 ± 17.49	150	29
Respiratory rate	30.02 ± 6.54	100	15
Systolic blood pressure	128.34 ± 20.44	200	70
Diastolic blood pressure	82.04 ± 11.39	130	50
SPO_2	82.72 ± 7.66	98	60
Hemoglobin (gr/dL)	12.96 ± 2.75	45.8	4.5
WBC (10^9/L)	9.93 ± 11.65	0.3	240
Neutrophile (%)	79.58 ± 11.33	99	8
Lymphocytes (%)	14.66 ± 9.42	76	1
Platelets (10^3/μL)	213.33 ± 104.09	917	2.3
ESR	52.75 ± 30.76	196	1
CRP	107.9 ± 84.4	554	0.1

Abbreviations: WBC, white blood cell; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein.

Table 3. Comparison of Patients' Demographic and Underlying Diseases in First, Second, and Third Peaks [a]

Variables	P-Value	First Peak	Second Peak	Third Peak
Gender	0.995 [b]			
Male		123 (60)	130 (59.6)	83 (60.1)
Female		82 (40)	88 (40.4)	55 (39.9)
Cigarette smoking	< 0.001 [b]	30 (14.6)	68 (31.2)	46 (33.3)
Drug addiction	0.283 [b]	16 (7.8)	22 (10.1)	18 (13)
Alcohol consumption	0.939 [b]	1 (0.5)	1 (0.5)	1 (0.7)
Underlying disease				
Diabetes	0.003 [b]	65 (31.7)	93 (42.7)	68 (49.3)
Hypertension	< 0.001 [b]	65 (31.7)	140 (64.2)	88 (63.8)
Asthma	0.025 [b]	9 (4.4)	4 (1.8)	0 (0)
Ischemic heart disease	< 0.001 [b]	39 (19)	90 (41.3)	42 (30.4)
Chronic kidney disease	0.003 [b]	5 (2.4)	23 (10.6)	14 (10.1)
Transplantation	0.007 [b]	3 (1.5)	2 (0.9)	8 (5.8)
Malignancy	0.442 [b]	12 (5.9)	10 (4.6)	4 (2.9)
COPD	0.111 [b]	17 (8.3)	29 (13.3)	21 (15.2)
CVD	0.392 [b]	3 (1.5)	7 (3.2)	5 (3.6)
Age	< 0.001 [c]	56.26 ± 16.18	62.56 ± 17.01	57.01 ± 166.44

Abbreviation: COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease.

[a] Values are expressed as No (%) or mean ± SD.

[b] We used chi-square test for compare.

[c] We used ANOVA test for compare.

third peaks. Gender, opioid usage, alcohol consumption, malignancy, chronic obstructive pulmonary disease (COPD) and cardiovascular disease (CVD) did not show significant differences across different peaks (Table 3).

The mean age during the first, second, and third peaks was 56.26 ± 16.18, 62.56 ± 17.01, and 57.01 ± 16.44 years, respectively. An ANOVA test showed significant differences in these ages ($P < 0.001$) (Table 4). However, post hoc analysis using the LSD test showed significant

Table 4. Comparison of Patients' Sign and Symptoms in First, Second, and Third Peaks [a]

Variables	First Peak	Second Peak	Third Peak	P- Value [b] Total	P-Value [c] 1 & 2 Peak	P- Value [c] 1 & 3 Peak	P- Value [c] Peak 2 & 3
Fever	140 (68.3)	153 (70.2)	130 (94.2)	0.001 <	0.675	< 0.001	< 0.001
Cough	124 (60.5)	125 (57.3)	84 (60.9)	0.738	0.533	> 0.999	0.581
Dyspnea	166 (81)	185 (80.3)	121 (87.7)	0.164	0.902	0.104	0.081
Phlegm	34 (16.6)	10 (4.6)	9 (6.5)	0.001 <	< 0.001	0.007	0.472
Chest discomfort	61 (19.8)	156 (71.6)	85 (61.6)	< 0.001	< 0.001	< 0.001	0.063
Nausea	34 (16.6)	60 (27.5)	24 (17.4)	0.011	0.007	0.884	0.030
Vomiting	29 (14.1)	53 (24.3)	27 (19.6)	0.031	0.010	0.233	0.362
Diarrhea	19 (9.3)	25 (11.5)	6 (4.3)	0.070	0.525	0.094	0.021
Rhinorrhea	3 (1.5)	1 (0.5)	0 (0)	0.244	0.358	0.277	> 0.999
Abdominal pain	8 (3.9)	17 (7.8)	9 (6.5)	0.236	0.102	0.315	0.835
Headache	72 (35.1)	136 (62.4)	92 (66.7)	0.001 <	< 0.001	< 0.001	0.430
Myalgia	86 (42)	92 (42.2)	41 (29.7)	0.035	> 0.999	0.023	0.019
Arthralgia	24 (11.7)	31 (14.2)	18 (13)	0.745	0.472	0.739	0.875
Weakness	117 (57.1)	170 (78)	99 (71.7)	0.001 <	< 0.001	0.006	0.206
Fatigue	56 (27.3)	60 (27.5)	40 (29)	0.938	> 0.999	0.806	0.809
Sore throat	22 (10.7)	3 (1.4)	6 (4.3)	0.001 >	< 0.001	0.043	0.095
Chills	35 (17.1)	3 (1.4)	8 (5.8)	< 0.001	< 0.001	0.002	0.026
Confusion	12 (5.9)	53 (24.3)	25 (18.1)	< 0.001	< 0.001	0.001	0.190
Anosmia	2 (1)	15 (6.8)	4 (2.9)	0.005	0.002	0.225	0.146
Ageusia	2 (1)	1 (0.5)	1 (0.7)	0.819	0.613	> 0.999	> 0.999
ICU admission	28 (13.9)	40 (18.5)	78 (56.5)	< 0.001	0.233	< 0.001	< 0.001
Mortality	30 (14.7)	52 (24.8)	54 (39.7)	< 0.001	0.013	< 0.001	0.004
Mean age	56.26 ± 16.18 [d]	62.56 ± 17.01 [d]	57.01 ± 16.44 [d]	< 0.001 [e]	< 0.001 [f]	0.685 [f]	0.002 [f]
Ct score	10.76 ± 3.98	11.86 ± 4.8	5.3 ± 15.17	0.001 < [g]	0.029 [h]	< 0.001 [h]	< 0.001 [h]

[a] Values are expressed as No (%) or mean ± SD.
[b] We used chi-square test for comparison.
[c] We used Fisher's exact test for comparison.
[d] Calculation unit is based on years.
[e] We used ANOVA test for compare.
[f] Post hoc analysis using LSD test.
[g] We used Welch's analysis for comparison.
[h] Post hoc analysis using Games-Howell test.

differences between the mean ages at the first and second peaks (P < 0.001) and between the second and third peaks (P = 0.002), but no significant difference between the first and third peaks (P = 0.685) (Table 4).

Patients' signs and symptoms, including fever (P < 0.001), phlegm (P < 0.001), chest discomfort (P < 0.001), nausea (P = 0.011), vomiting (P = 0.031), headache (P < 0.001), myalgia (P = 0.035), weakness (P < 0.001), sore throat (P < 0.001), shaking (P < 0.001), confusion (P < 0.001), and anosmia (P = 0.005), showed significant differences across different peaks (Table 4).

Table 4 also compares the location of the hospitalization ward and patients' outcomes at different peaks. Both variables had significant differences between different peaks (P < 0.001).

The comparison of patients' vital signs at different peaks showed that pulse rate, respiratory rate, diastolic blood pressure, and SPO_2 had significant differences. Post hoc analysis conducted for pairwise comparisons of these variables revealed significant differences in blood O_2 saturation, diastolic blood pressure, respiratory rate, and heart rate between the first and second peaks; blood O_2 saturation, respiratory rate, and heart rate between the first and third peaks; and blood O_2 saturation between the second and third peaks.

Fever (P < 0.001), phlegm (P < 0.001), chest discomfort (P < 0.001), nausea (P = 0.011), vomiting (P = 0.031), headache (P < 0.001), myalgia (P = 0.035), weakness (P < 0.001), sore throat (P < 0.001), shaking (P

< 0.001), confusion (P < 0.001), and anosmia (P = 0.005) were patients' signs and symptoms that had significant differences across different peaks.

The average CT scan scores in the first, second, and third peaks were 10.76 ± 3.98, 11.86 ± 4.8, and 5.3 ± 15.17, respectively. Welch's analysis test showed that these scores had significant differences (P < 0.001).

Post hoc analysis using the Games-Howell test for CT scores showed significant differences between the first and second peaks (P = 0.029), the first and third peaks (P < 0.001), and the second and third peaks (P < 0.001). CT scan findings indicated that the prevalence of consolidation and crazy paving showed significant differences across different peaks. Table 4 compares the location of the hospitalization ward and patients' outcomes at different peaks, showing significant differences between these variables (P < 0.001). Table 4 also compares patients' signs and symptoms across different peaks.

A comparison of laboratory findings showed that patients' white blood cell (WBC) count, neutrophil percentage, lymphocyte percentage, and CRP levels had significant differences at different peaks. Post-hoc analysis revealed significant differences in neutrophil (P < 0.001) and lymphocyte (P < 0.001) percentages between the first and second peaks; WBC count (P = 0.006), neutrophil (P < 0.001) and lymphocyte (P < 0.001) percentages, and CRP (P < 0.001) between the first and third peaks; and neutrophil percentage (P = 0.035) and CRP (P = 0.039) between the second and third peaks.

4. Discussion

After the spread of COVID-19 around the world, new variants of SARS-CoV-2 emerged, sometimes presenting different symptoms and disease severity compared to the original virus (14). This study was conducted to compare the clinical symptoms, laboratory findings, CT scans, and outcomes of patients with COVID-19 during the first three peaks of the disease in Iran, which occurred in the spring, summer, and autumn of 2020.

Our study results showed that the second peak in summer 2020 had the highest mortality rate, while the first peak during spring had the lowest mortality rate. In all three peaks, approximately 60% of hospitalized patients were male and 40% were female, with no significant difference between genders across all peaks. In terms of age, patients in the second peak were significantly older than those in the other peaks.

Cigarette smoking showed significant differences across the peaks, while alcohol consumption and opioid usage did not vary significantly in all three peaks. Except for COPD and CVD, all other comorbidities showed significant differences across the three peaks. Overall, these results indicate that patients with underlying diseases were less affected during the first peak. This may be due to the stricter adherence to health protocols by these patients during the first peak. However, in the second and third peaks, after the widespread transmission of the virus at the community level, these individuals were eventually infected.

An inquiry into patients' vital signs at admission showed a deterioration in their clinical condition over time. The deterioration of patients' vital signs in the second and third peaks is likely directly related to their comorbidities. By studying 7,000 patients, Brojakowska et al. showed that obesity, hypertension, diabetes, and coronary artery disease were the most frequent comorbidities (15). In another article published by Osibogun et al., with the same gender ratio as ours, hypertension and diabetes were more frequent than other comorbidities. Contrary to Osibogun et al.'s article, mortality was higher in our study, which can be attributed to the examination of outpatients in their study (16).

A comparison of patients' signs and symptoms showed that dyspnea was the most common symptom in the first and second peaks, but in the third peak, fever was the most common symptom and dyspnea was the second. In the third peak, nearly 95% of patients had a fever, while this rate was nearly 70% in the first and second peaks. During our first peak, Guan et al. showed that fever, non-productive coughs, and fatigue were the most frequent symptoms, respectively (17). In another study conducted by Popov et al. at the same time as our first peak, they examined the clinical features of COVID-19 patients. Similar to our study, they found that fever, cough, and headache were the most frequent symptoms, except for dyspnea (18). In another study, Valladares-Garrido et al. showed that patient symptoms such as respiratory and gastrointestinal issues, dyspnea, and ageusia were higher in the second COVID-19 wave than in the first one (19).

Among the laboratory findings, the average number of leukocytes and neutrophil percentage were highest in the third peak and lowest in the first peak. Conversely, lymphopenia was highest in the third peak and lowest in the first peak. The average CRP also increased from the first to third peaks, but there was no significant change in average ESR. The highest CT score was in the third peak and the lowest was in the first. Ground-glass opacity was the most common CT scan pathological finding. Guan et al. found pathological findings in 71% of their participants (17).

In terms of hospitalization location, ICU admissions increased from 14% in the first peak to 18% in the second peak and over 56% in the third peak. Regarding patient outcomes, less than 15% of hospitalized patients died in the first peak, over 24% died in the second peak, and nearly 40% of inpatients died in the third peak. Our study showed different mortalities between the first and third surges and the second and third surges. In contrast, Hadadi et al.'s study did not show significant differences in disease severity, ICU admission, and mortality between peaks (12).

However, a study by Jarrett et al. found that clinical outcomes such as the need for renal replacement therapy, intubation, and inpatient mortality remained unchanged between the first and second peaks (20). In another study conducted by Gray et al. in England, there was a decrease in mortality rates during both the first and second peaks (21). Similar to our study, Kumar et al. found that mortality rates were higher during the second peak than the first; however, this increase occurred mainly among younger people without underlying diseases (22).

Based on these findings, it appears that disease severity among hospitalized individuals was higher during the third peak than in previous peaks and higher during the second peak than in the first. Various factors could contribute to this situation. For example, more potent variants of the virus could lead to increased patient deaths. Another possible explanation is that due to a sharp increase in patient numbers during the second and third peaks, only critically ill patients were admitted, resulting in higher mortality rates among those hospitalized during these periods.

4.1. Limitations

The cross-sectional nature of the study and the lack of patient follow-up were the most significant limitations. However, the large sample size and the examination of patients' symptoms and findings across different peaks, which can be considered an innovation, were the strengths of our study. We suggest that future researchers examine symptoms, laboratory findings, and patient imaging during subsequent peaks of COVID-19 spread.

4.2. Conclusions

Patients' gender showed no differences across the three peaks, although the mean age of patients was higher in the second peak than in the other two. Comorbidities were more prevalent in the second and third peaks compared to the first one. The reason for the higher mean age of patients in the second peak remains unknown. Patients' vital signs were more unstable in the second and third peaks than in the first one. Since the patients hospitalized in the second and third peaks had more underlying diseases, the instability of their vital signs was expected. The highest patient mortality was observed in the third peak, while the lowest was in the first one.

Footnotes

Authors' Contribution: Mahnaz Mozdorian and Lida Jarahi, conceived and designed the evaluation and drafted the manuscript; Ali Shamshirian and Hamed Ferdowsi Moghadam, participated in designing the evaluation, performed parts of the statistical analysis and helped to draft the manuscript; Mahnaz Mozdorian, re-evaluated the clinical data, revised the manuscript and performed the statistical analysis and revised the manuscript; Hamed Ferdowsi Moghadam, collected the clinical data, interpreted them and revised the manuscript; Mostafa Mansouri, re-analyzed the clinical and statistical data and revised the manuscript. All authors read and approved the final manuscript.

Conflict of Interests Statement: There is no conflict of interests.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

Ethical Approval: The present study was approved by the Ethics Committee of the Mashhad University of Medical Sciences (IR.MUMS.REC.1399.572).

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