Archives of Academic Emergency Medicine. 2022; 10(1): e42

ORIGINAL RESEARCH

An 18-Month Epidemiologic Survey of 3364 Deceased COVID-19 Cases; a Retrospective Cross-sectional Study

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Received: February 2022; Accepted: March 2022; Published online: 31 May 2022

Abstract: **Introduction:** The COVID-19 pandemic has been considered an international problem. This study aimed to survey the demographic and clinical characteristics of the deceased COVID-19 patients. **Methods:** The present cross-sectional study was performed on all deceased COVID-19 patients who died in Imam Reza Hospital, Mashhad, Iran, from March 20, 2020, to September 23, 2021. Their data, including age, gender, complaints, and clinical symptoms at the time of admission, as well as information at the time of death (hour, shift, holiday/non-holiday) were analyzed and reported. **Results:** 3364 deaths due to COVID-19 have been registered during the study period (60.46% male). The patients' mean age was 66.99±16.97 (range: 1-101) years (92.7% of them were Iranian). The mortality at night shifts was less than day shifts (1643 vs. 1721). The average amount of deaths/day on holidays and workdays was (5.63 vs. 6.24). The number of deaths varied during the various hours of the day and night. Diabetes and cardiovascular diseases were the most common confounding factors, which were observed in 22.44% and 15.36% of the cases, respectively. **Conclusion:** Based on the findings of this series, COVID-19 mortality was frequently observed in male patients, those with the mean age of 66.99 years, morning shifts, and workdays.

Keywords: COVID-19; Hospital Mortality; Diabetes Mellitus; Cardiovascular Diseases

Cite this article as: Tavakolian A, Ashrafi Shahri SH, Jafari MA, Pishbin E, Zamani Moghaddam H, Foroughian M, Reihani H. An 18-Month Epidemiologic Survey of 3364 Deceased COVID-19 Cases; a Retrospective Cross-sectional Study. Arch Acad Emerg Med. 2022; 10(1): e42. https://doi.org/10.22037/aaem.v10i1.1568.

1. Introduction

SARS-COV-2, a member of the Coronaviridae family, caused a disease named COVID-19 in the late 2019, which became a widespread infection in world (1, 2). SARS-COV-2 can cause various ranges of the clinical symptoms from mild manifestations to severe forms of disease requiring intensive care unit (ICU) admission (3-7).

Acute respiratory distress syndrome (ARDS) is the main cause of death from COVID-19 (8, 9). Pooled analyses of mortality rates have demonstrated extensively higher rates of mortality among ICU admitted patients (40.5%) compared to ward admitted ones (11.5%) (10). Various studies are conducted to predict mortality rate and distinguish indices related to severity of COVID-19 and its mortality, as well as to investigate biochemical, laboratory, clinical, and imaging characteristic of patients (11, 12). Additionally, some astounding findings have pointed to the significant effects of the spatiotemporal factors as well (13, 14). Zhang et al. reported that shift work at night was linked to a higher risk of mortality (14). But Morales et al. showed that being admitted to ICU at night does not correlate to higher mortality rate of COVID-19 patients (15). Understanding the impact of different times of the day on the quality of care, and finding other potentially influential factors would provide the opportunity for applying proper policies. So, this study aimed to evaluate the demographic and clinical findings of deceased COVID-19 cases, stratified by death time in a referral hospital in North-East of Iran.

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2. Methods

2.1. Study design and setting

In the present retrospective cross-sectional study, characteristics of 3364 deceased COVID-19 patients in Imam Reza Hospital, Mashhad, as one of the referral centers for COVID-19 patients in North-East of Iran, from March 20, 2020, until September 23, 2021 (about 18 months), were reviewed. After obtaining approval from Mashhad University of Medical Sciences Ethics Committee (code: IR.MUMS.REC.1399.242), information about all deceased patients with confirmed COVID-19 diagnosis based on international guidelines was collected from the archives of the hospital using census method. Researchers adhered to confidentiality of patients' information and ethical considerations stated in declaration of Helsinki.

2.2. Participants

The present study includes all cases of hospital mortalities due to COVID-19 during the study period. All cases of mortalities attributed to COVID-19 by an infectious disease specialist was considered in this study, even cases with underlying health conditions. Records of patients who were transferred from other centers were also included. Patients who did not meet the ICD-10 criteria for COVID-19 diagnosis were excluded. Patients who had died after being transmitted to other hospitals were not included. Ethnicity was not considered when gathering data and refugees were also included.

2.3. Data gathering

The collected data include age, gender, postal address, complaints and clinical symptoms, O2 saturation at the time of admission, as well as information on the time of death (hour, shift, holiday/workdays). A checklist of the mentioned factors was provided by researchers and filled out, retrospectively, by reviewing hospital records. Only records containing a positive PCR result for COVID-19 were recruited.

2.4. Statistical analysis

The collected data were analyzed using SPSS software version 26. Descriptive statistics for qualitative variables were reported in the form of frequency and frequency distribution and those of quantitative variables were reported as mean and standard deviation. The normality of quantitative variables was confirmed using the Kolmogorov-Smirnov test.

3. Results

3364 deaths due to COVID-19 were recorded during the study period (2034 (60.46%) male and 1330 (39.54%) female). The mean age was 66.99 ± 16.97 (range: 1 -101; median: 68) years with normal distribution (50% > 67 and 25% < 56 years). Table 1 shows the baseline characteristics of studied patients. The most common complaint was shortness of breath (74.23%) followed by cough (34.0%). 88.59% of patients had a decrease in O2 saturation at the time of admission to the hospital. 1321/2015 (65.56%) patients with complete clinical information had at least one underlying disease. (15.36% heart disease and 22.44% diabetes mellitus).

3.1. Mortality peaks

Figure 1 shows a comparison of the total number of COVID-19-associated deaths during each peak. During the study period, five mortality peaks was observed. During the first one (from March 20, 2020, up to June 3, 2020), which occurred in the first month of the COVID-19 pandemic, a total of 309 people died and the average daily death rate was 4.07±2.91 deaths/day. In the second peak (June 11 up to August 26, 2020), during which 911 COVID-19 deaths was recorded, the average daily number of deaths was 11.99±8.06 deaths/day. The third and fourth waves of death due to coronavirus occurred at the end of 2020 and the first half of 2021. The fifth wave occurred from July 7, 2021, until September 20, 2021, in which 1042 COVID-19 deaths were recorded with a daily average number of 13.71± 8.28. At the same time, the highest mortality rate was recorded, with 34 deaths in one day. This peak was larger than the other peaks in terms of intensity and extent. The second and fifth peaks were more severe and there were a higher number of patients with worse conditions compared to the other waves.

3.2. Age distribution

Figure 2 shows the age distribution of deceased cases stratifying study periods to 3-month parts. Least deaths were reported in individuals less than 20 years old with 59 (1.75%) cases, followed by twenty- to forty-year-old subjects with 281 (8.35%) cases. The highest number of death reports, 1516 (45.07%) cases, belonged to those 60 to 80 years old followed by those 40 to 60 years old and over 80 years old with 732 (21.76%) and 776 (23.07%) cases, respectively ($p < 0.001$).

3.3. Time distribution

The lowest death rate is recorded in the early hours of the morning with 103(3.06%) deaths and the highest death rate is recorded in 11-12 AM with 170 (5.05%) deaths (figure 3). In the morning shift, 884 patients died with an average of 1.61 ± 2.41 deaths/day, and in the evening shift, 837 people died with an average of 1.52±2.25 deaths/day. By a division of the night shift into two shifts from 19 in the evening till 1 in the morning and the other shift from 1 AM till 7 AM an average death rate of 1.58 ±2.38/day and 1.41± 2.08/day were recorded, respectively (figure 4).

3.4. Day Distribution

The present study period covers a total of 115 holidays and 435 workdays. The average COVID-19 mortality rate was 5.58 deaths/day (642 cases) on holidays and 6.27 deaths/day (2722 deaths) on workdays.

4. Discussion

Based on the findings of this series, the COVID-19 mortalities were frequently observed in males, patients with the mean age of 66.99 years, morning shifts, and workdays.

Preliminary reports of COVID-19 epidemiology in China show that the mortality rate of males (2.8%) is higher than females (1.7%) (16). Mir Jalili et al. reviewed the risk factors of COVID-19 patients' mortality in a case-cohort study and reported that 56.1% of the deceased patients are male, and their mean age is 71 years (17).

Another study on COVID-19 mortality in ten major European countries reported that men had a higher death rate than women. COVID-19-related death risk ranged from RR = 1.11 in Portugal to RR = 1.54 in France (18).

Hannah et al., in a large meta-analysis of more than three million COVID-19 patients in 44 countries, indicate that gender does not play a role in COVID-19 infection, but in the case of COVID-19, male patients have three times more chance of ICU admission and death (OR = 1.39,95% CL = 1.31,1.47) (19). In the present study, similar to most studies, males accounted for more deaths (60.46%) than females.

Ghasemian et al. reviewed the medical files of deceased COVID-19 cases and found that their mean age was 63.36 years with a standard deviation of 15.26 years. 43% of patients were under 60 years old and 42.3% of patients were in the age group of 60-80 years (20).

In the present study, the mean age of the patients was 67 and their median age was 68 years. 71.7% of patients were over 60 years old. In the age range of 60-69 years, total death count equaled 25.6%.

During our study, the top five mortality peaks occurred. The fifth peak occurred from July 7, 2021 until September 20, 2021, in which 1042 COVID-19 patients died (a daily average mortality rate of 17.31 patients/day). In the twenty-third epidemiological report of COVID-19 disease in Fars province, published by Shiraz University of Medical Sciences, five peaks in mortality rate due to coronavirus were reported. The second and fifth peaks were more extensive, which conform with our study (21).

The results of a study conducted in Canada indicated that in the case of some medical emergencies, the mortality rate of patients admitted to the emergency room on holidays is significantly higher (22). Also, based on the results of a study conducted in Japan on 1134 patients, it was found that if the patient is admitted on workdays of the week, the prognosis of the disease will be better (23). In the present study, the mortality rate reported in the morning shifts was significantly higher compared to other shifts.

In our study, COVID-19 death counts varied at various times during the day and night.

According to our study, 2722 COVID-19 deaths were reported on workdays (mean 6.27 ± 6.5), while 642 deaths were confirmed on holidays (mean 5.58 ± 6.05). This result was in contrast to other studies and needs further investigation.

According to our study, the most common patient complaint was shortness of breath.

5. Limitations

Our study was a retrospective review of hospital records, in some of which data were missing, and we could not examine more detailed hypotheses. Also, the records were registered by different persons, each of which might have their own definition for the different concepts used in the study as well as symptoms.

6. Conclusion

Based on the findings of this series, the COVID-19 mortalities were frequently observed in males, patients with mean age of 66.99 years, morning shifts, and workdays.

7. Declarations

7.1. Acknowledgments

The present review is a portion of Dr. Seyed Hassan Ashrafi Shahri's thesis, with an approved code of ethics IR.MUMS.REC.1399.242. The financial support, guidance, and advice of the Clinical Research Development Unit of Imam Reza Hospital are appreciated.

7.2. Authors' contributions

This study was designed and registered by SHAS, MJ, and MF. EP, HZM, MF, and HR participated in data collection. Data preprocess was performed by HZM and SHAS. Data analysis was performed by MF and SHAS. All authors contributed to literature review and manuscript writing as well as the revisions.

7.3. Funding and supports

This study was supported by Mashhad University of Medical Sciences.

7.4. Conflict of interest

The researchers claim no conflicts of interest.

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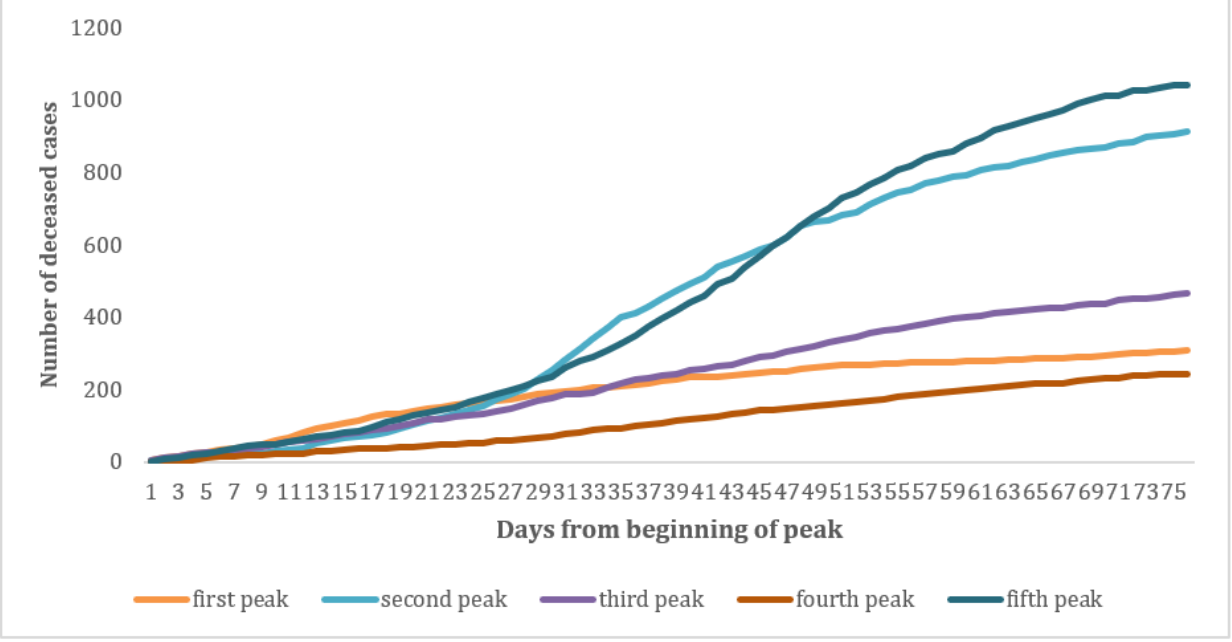

Figure 1: The frequency of death per day during the five peaks of COVID-19 referrals in the studied hospital.

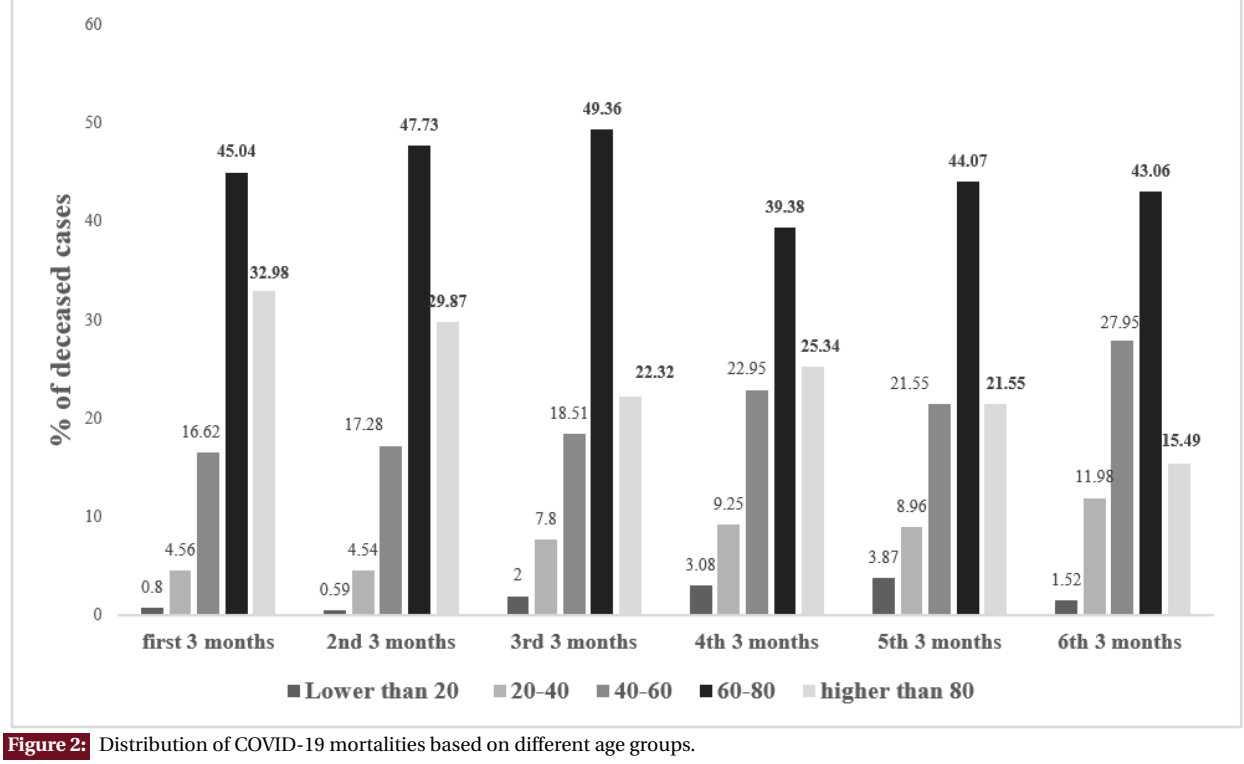

Figure 2: Distribution of COVID-19 mortalities based on different age groups.

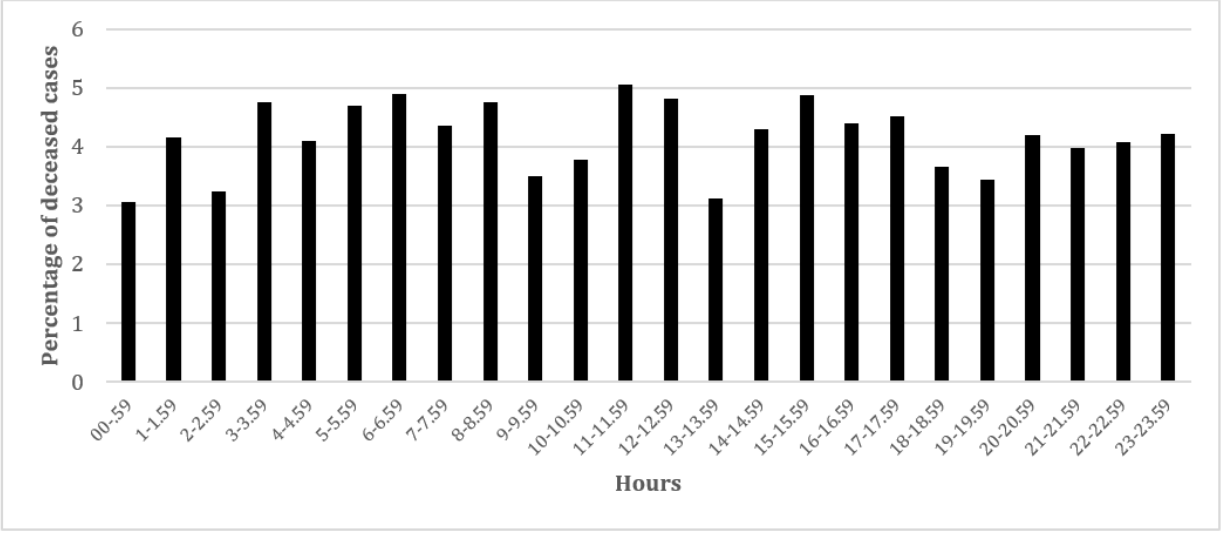

Figure 3: Distribution of COVID-19 mortalities based on the different hours of the day.

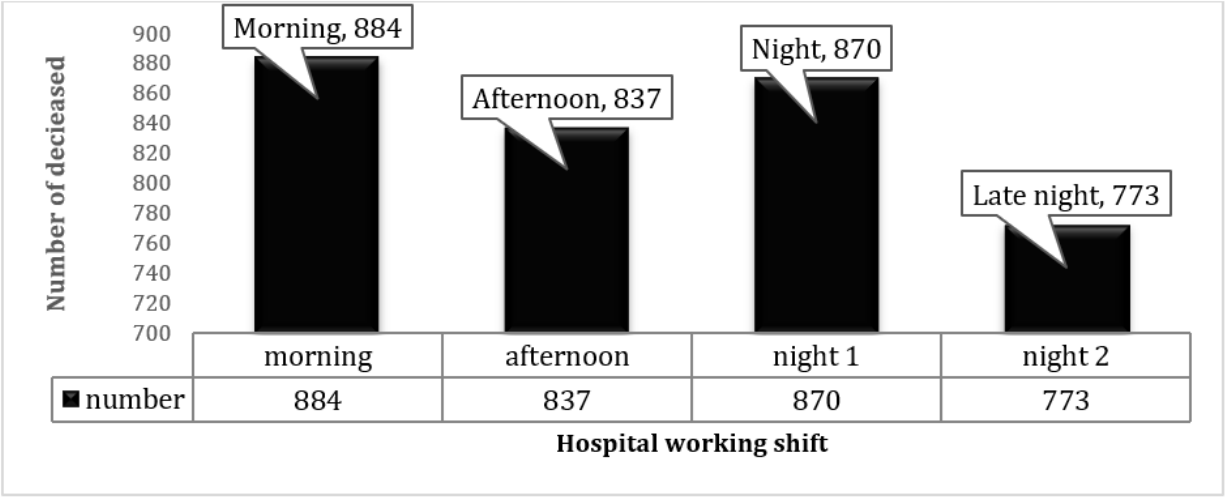

Figure 4: Distribution of COVID-19 mortalities based on different working shifts.

Table 1: Baseline characteristics of deceased COVID-19 cases

Variables	Number *	Value
Age (year)		
Mean ± SD	3364	66.99 ± 16.97
Gender	3364	
male	2034	2034 (60.46)
Female	1330	1330 (39.54)
Presenting sign/symptoms		
Fever	2340	530 (22.65)
Chills	2340	212 (9.06)
Cough	2340	796 (34.02)
Sore throat	2340	19 (0.81)
Dyspnea	2340	1737 (74.23)
General weakness	2340	666 (28.46)
Diarrhea	2340	26 (1.11)
Nausea/vomiting	1725	61 (3.54)
Headache	1725	63 (3.65)
Abdominal pain	1725	37 (2.14)
Smell disorder	1725	10 (0.58)
Taste disorder	1725	10 (0.58)
Saturation O2 < 93%	1954	1731 (88.59)
Respiratory rate >23/minutes	1827	344 (18.83)

Data are presented as mean ± standard deviation (SD) or frequency (%). *: number of available data.