Received: 8 September 2023 | Revised: 28 November 2023 | Accepted: 8 December 2023

DOI: 10.1002/hsr2.1845

ORIGINAL RESEARCH

Health Science Reports Open Access WILEY

# Demographic study of patients' mortality rate before and after the COVID-19 outbreak: A cross-sectional study

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## Abstract

**Background and Aim:** To better guide the health policies, it is essential to clarify the socio-demographic and clinical risk factors affecting the mortality rate of patients with coronavirus disease 2019 (COVID-19).

**Objective:** The purpose of this project is to separate hospital mortality statistics into different groups, which will definitely help in planning to reduce the mortality rate. As well, we aimed to compare factors involved in COVID-19 death between the period before and after its outbreak.

**Methods:** This cross-sectional study was performed based on all death certificates of archived records in Rasool Akram Hospital during the years 2018 and the first half of 2019. A checklist was completed based on the variables, including death cases by time, gender, age, duration of hospitalization, department of place and time of death, cause of death, cases referred to forensic medicine, information of the patient, including educational and occupational level and birth certificate issuing city, neonatal death, and IUFD, classification of diseases according to the provided version of ICD 10 (international classification of diseases 10th edition).

**Results:** A number of 2632 deceased patients were included in this study, 1511 (57.4%) patients who died before the start of the COVID-19 outbreak, and 1121 (42.6%) patients died in the hospital after the start of this pandemic. There were statistically significant differences in gender (higher prevalence of males), increased average age, lower occupational status, decreased number of infants, increased cause of death due to COVID-19 and increased hospitalization in Royal ICU in dead patients ($p < 0.05$).

**Conclusion:** The findings show that the elderly cases are more at risk of COVID-19 mortality than other age groups, which needs more attention to this group of society and clarifies other epidemiological factors, as well as clinicopathological and public healthcare practices.

KEYWORDS

COVID-19, demographics, hospitalization, mortality, SARS-COV2

## 1 | BACKGROUND

The acute respiratory infection syndrome is the major world health concern caused by the coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), with 214,468,60 established cases and a total of 4,470,969 deaths universally.[1-3] The mortality rate of COVID-19 was 5.9% globally and 4.99% in Iran.[4] According to WHO statistics, the prevalence and mortality rate of COVID-19 are considered as the crucial indicators of disease severity, which implies the need for preventive planning.[5]

Some of the significant clinical signs are attributed to COVID-19 at its early stages and onset, including fever, fatigue, dry cough, shortness of breath, lymphocytopenia, myalgia, and atypical lung computerized tomography (CT) scan causing respiratory tract infections in acute cases with multiorgan failure.[2,6,7]

Differences in COVID-19 morbidity and mortality rate are caused by several factors, including sociodemographic, clinicopathologic, therapeutic interventions, and laboratory findings.[8] Among the sociodemographic features involved in COVID-19 severity, aging has been considered as one of the main risk factors as reported in numerous patients over 85 years of age with a percentage of 31% and 45% in hospitalized, 53% in intensive care unit (ICU) admitted, and 80% in died cases.[9,10]

It has been demonstrated that the COVID-19 incidence, prevalence and mortality rate varied with other demographic factors such as gender, regional differences, civil status, educational and occupational level in a broad population-based cohort studies.[11] As well, the inequalities in death due to COVID-19 might be geographical and varied between developed and developing countries.[4] It has been recorded that most of COVID-19 deaths befallen in patients with 50–70 years of age in developing countries including Iran than in developed countries with older people which are more likely to die.[12-16]

Of the clinicopathological factors, existing of underlying diseases or comorbidities, including cardiovascular, and chronic pulmonary disease, diabetes, and hypertension have been related to the incidence and mortality rate of COVID-19.[4] It has been reported that about 48% of COVID-19 patients showed one or more comorbidities, and 23%–67% of them died from COVID-19.[8,17,18] Therefore, Iran, as one of the developing countries, has been challenged with a number of concerns, including fragility, socioeconomic, demographic, and clinical risk factors of mobility, which impacted the COVID-19 outbreak.

In general, the other factors affecting the hospital's mortality rate include treatment facilities, the ability of the medical staff, the overall health status of the community, and the prevalence of certain diseases in the community.[19] In the current conditions, there is a need for accurate and reliable studies and statistics to manage and reduce COVID-19 mortality rate and burden through the financial dimensions and facilities.[19]

### 1.1 | Objective

In this study, we aimed to prepare the hospital mortality statistics into different based on the socio-demographic and clinical characteristics of patients to manage the mortality rate and improve the quality of medical services in hospitalized Iranian society as well as cause of death.

## 2 | METHODS

### 2.1 | Study design

This is a retrospective cross-sectional study.

### 2.2 | Setting

The study was performed on patients who died in a university-based Hazrat Rasul Akram Hospital in Tehran, Iran, during the years 2018 and the first half of 2019.

### 2.3 | Participants

All death certificates and medical records of 3040 patients who died in the hospital were extracted and reviewed.

### 2.4 | Measurement

The prepared checklist includes the variables of age, sex, cause of death, length of hospitalization, medical unit of death, referred cases to forensic medicine, time of death, and personal and identity information of the patient (occupation and city where the birth certificate was issued) and Neonatal death and intrauterine fetal demise (IUFD). Classification of death causes was based on the International Classification of Diseases, Tenth Revision (ICD-10).

### 2.5 | Ethical approval

Ethical approval was achieved by the Ethics Committee of the Iran University of Medical Sciences (IR.IUMS.REC.1399.352), and an assertion was made to preserve the patients' data confidential. All the ethical principles of Helsinki were fully followed, and no personal information of the patients, such as name and surname, was used, and there was no access to this information. There were contradictions between religious and cultural standards and society. Informed consent was obtained from relatives of the subjects.

### 2.6 | Data analysis

The data was analyzed using SPSS statistical software (version 24; SPSS). The results for quantitative variables were expressed as mean ± SD and for qualitative variables as the frequency and

percentage. The normality of the distribution of the variables was checked based on the Kolmogorov–Smirnov (K-S) test of the SPSS software, and according to whether the desired variable was quantitative or qualitative, it was explored using the Mann–Whitney *U* test, student *t*-test or chi-square in three groups. One-way ANOVA and post hoc test were used to check quantitative data in the investigated groups (blood, sputum, and urine). The Spearman's nonparametric test was used to analyze the relationship between two quantitative variables. A statistical level of less than 0.05 was considered as significant.

## 3 | RESULTS

### 3.1 | Demographic features of patients mortality rate before and after the COVID-19 outbreak

To evaluate the death of patients, out of 2632 patients, 1511 (57.4%) cases died before the start of the COVID-19 pandemic, and 1121 (42.6%) patients died after the pandemic. Of which, 1086 (41.3%) cases were male and 1546 were female (58.7%). Also, the gender incidence of patients was done according to the study periods (before and after COVID-19), which is summarized in Table 1. The prevalence of death in males and females before COVID-19 was 56.7% and 43.3%, respectively. This prevalence after COVID-19 was 61.5% in males and 38.5% in females, respectively. Moreover, the number of deaths in males was significantly higher than in females, and after COVID-19, the ratio of male to female deaths was higher than in COVID-19 ($p = 0.01$). The average age of the patients was 63.3 ± 21.8 years (ranged 0–99), and the average age of patients who died in hospital before the COVID-19 pandemic was 61.5 ± 22.9 years, and after the onset of the disease was 65.8 ± 19.9 years. There was a statistically significant difference in this average before and after COVID-19 ($p < 0.001$). Most of the patients were between 60 and 80 years old in the groups of 60–69 (517/19.6%), 70–79 (547/20.8%), and 8–89 (515/19.6%). The prevalence of deaths in the age groups of 50–99 years increased after the COVID-19 period. As well, the prevalence of mortality decreased in other cases or increased in the age group of 40-49 years. There was a statistically significant difference in the prevalence of deaths between the age groups before and after the COVID-19 ($p = 0.001$). Twenty-five infants (0.9%) who died during the mentioned time period were examined in this study, of which 1 infant (4%) was a case of IUFD. As well, 1.3% of infant deaths occurred before COVID-19% and 0.4% after COVID-19. There was a significant decrease in infant mortality after the COVID-19 pandemic in hospitals ($p = 0.02$). The 20.1% of patients were born in Tehran, and the place of birth in 17.4% of cases was unknown.

The place of issuing the birth certificates of the patients according to the examined period is summarized in the table below. There was no statistically significant association between the birth certificate issuing place and pre- or post-COVID-19 phases ($p = 0.20$). As shown in Table 1, most of the patients were housewives (21.4%) or self-employed (19.3%). There was a significant association between the patient's occupation and COVID-19, and the prevalence of deaths in unemployed cases, students and housewives decreased significantly while increasing in other occupational groups ($p < 0.001$). Patients were hospitalized for an average of 10.4 ± 20.3 days. The minimum hospitalization period was 0 days, and the maximum was 477 days.

### 3.2 | Hospitalization length, referral, and death cause of patients before and after the COVID-19 outbreak

The average of hospitalization length of patients in pre- and post-COVID-19 pandemic was 24.7 ± 12.2 and 11.6 ± 8.1 days before and after the pandemic, respectively. The average hospitalization time of patients before and after COVID-19 did not show a statistically significant difference ($p = 0.09$). The most common cause of death during the COVID-19 pandemic was cardiovascular disease (19.8%). As shown in Table 2, the second most common cause of death was COVID-19, with 491 (18.7%) deaths. The mortality rate due to all causes of death decreased, while 43.8% of patients died due to COVID-19. Moreover, there was no significant difference in the patients' causes of death before and after COVID-19 ($p < 0.001$). For detailed examination of the cause of death, 338 (12.8%) deceased cases were referred to forensic medicine for detailed examination of the cause of death. As well, 13.8% and 11.6% of patients were referred to forensic medicine before and after the pandemic, respectively. There was no statistically significant difference in the prevalence of referring patients to forensic medicine according to the COVID-19 phases ($p = 0.10$).

Approximately a thousand patients died in the ICU units, and 820 (31.2%) patients also died in the emergency department. While 162 (6.2%) cases died in the ICU or COVID-19 units. The mortality rate of patients hospitalized in several medical departments decreased except ICU, surgery, and operating room, while it showed a higher rate after the COVID-19 pandemic in the Royal ICU. There was a significant difference in the prevalence of deaths in different departments of the hospital before and after the COVID-19 pandemic ($p < 0.001$).

The average time of death in COVID-19 patients was 12:03:46 (hr:min:s) with a standard deviation of 6:53:08) during the day. Also, the average time of death in pre-COVID-19 phase was 6:5345 ± 12:12:08, and in post-COVID-19 was 11:53:22 ± 6:52:20. There was no statistical difference in the time of death before and after the pandemic ($p$-value = 0.20). Moreover, the evaluation of the cause of death based on the gender of patients showed a statistically significant association, and the most common causes of death in males were COVID-19 (20.3%), cardiovascular disease (17.9%), and cancer (12.2%), respectively. However, in females, cardiovascular disease (22.4%), COVID-19 (16.3%), and cancer (15.5%) were the most prevalent complications ($p < 0.001$).

**TABLE 1** Demographic changes of patients before and after the COVID-19 outbreak.

| | | Pre-COVID19 | | Post- COVID19 | | |
|---|---|---|---|---|---|---|
| **Variables** | **Subgroups** | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Total no (%)** |
| Gender | Male | 857 | 56.7 | 689 | 61.5 | 1546 (58.7) |
| | Female | 654 | 43.3 | 432 | 38.5 | 1086 (41.3) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |
| Age groups | 0–9 | 77 | 5.1 | 30 | 2.7 | 107 (4.1) |
| | 10–19 | 35 | 2.3 | 15 | 1.3 | 50 (1.9) |
| | 20–29 | 51 | 3.4 | 26 | 2.3 | 77 (2.9) |
| | 30–39 | 82 | 5.4 | 42 | 3.7 | 124 (4.7) |
| | 40–49 | 108 | 7.1 | 83 | 7.4 | 191 (7.3) |
| | 50–59 | 220 | 14.6 | 135 | 12 | 355 (13.5) |
| | 60–69 | 283 | 18.7 | 234 | 20.9 | 517 (19.6) |
| | 70–79 | 294 | 19.5 | 253 | 22.6 | 547 (20.8) |
| | 80–89 | 286 | 18.9 | 229 | 20.4 | 515 (19.6) |
| | 90–99 | 74 | 4.9 | 74 | 6.6 | 148 (5.6) |
| | Total | 1150 | 100 | 1121 | 100 | 2631 (100) |
| Infant | Yes | 20 | 1.3 | 5 | 0.4 | – |
| | No | 1491 | 98.7 | 1116 | 99.6 | – |
| | Total | 1511 | 100 | 1121 | 100 | – |
| Birth certificate issuing place | Tehran | 312 | 20.6 | 217 | 19.4 | 529 (20.1) |
| | Other | 925 | 61.2 | 720 | 64.2 | 1654 (62.5) |
| | Unknown | 274 | 18.1 | 184 | 16.4 | 458 (17.4) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |
| Occupation | Unknown | 402 | 26.6 | 361 | 32.2 | 763 (29.0) |
| | Self-employed | 281 | 18.6 | 226 | 20.2 | 507 (19.3) |
| | Retired | 216 | 14.3 | 245 | 21.9 | 461 (17.5) |
| | Unemployed | 166 | 11.0 | 30 | 2.70 | 196 (7.40) |
| | Medical or paramedical | 6.0 | 0.40 | 7.0 | 0.60 | 13 (0.50) |
| | University or school student | 22 | 1.50 | 7.0 | 0.60 | 29 (1.10) |
| | Employee | 42 | 2.80 | 42 | 3.70 | 84 (3.20) |
| | Housewife | 363 | 24.0 | 199 | 17.8 | 562 (21.4) |
| | Workman | 13 | 0.90 | 4.0 | 0.40 | 17 (0.60) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |

Abbreviation: COVID-19, coronavirus disease 2019.

## 4 | DISCUSSION

The COVID-19 outbreak is a universal catastrophe, and its incurred fatalities are affected by various socioeconomic and demographic factors.[2,19] As well, the COVID-19 pandemic did not impressed different regions of the world equally.[2,20,21] It has been reported that the differences in COVID-19 outcomes might be triggered by several economic, demographic, genetic aptitudes, policy maker's restrictions, population attitudes, and environmental factors.[2,22-26] One of the most imperative policy issues regarding COVID-19 in the world has

**TABLE 2** The frequency of patients' hospitalization length and cause of death in pre- and post-COVID-19 phases.

| | | Pre-COVID19 | | Post- COVID19 | | |
|---|---|---|---|---|---|---|
| **Variables** | **Subgroups** | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Total no (%)** |
| Cause of death | No cause | 157 | 10.4 | 28 | 2.5 | 185 (7.00) |
| | non-COVID-19 infectious | 151 | 10 | 65 | 5.8 | 216 (8.20) |
| | COVID-19 | 0 | 0 | 491 | 43.8 | 491 (18.7) |
| | Cancer | 251 | 16.6 | 106 | 9.5 | 357 (13.6) |
| | Cardiovascular disease | 361 | 23.9 | 159 | 14.2 | 520 (19.8) |
| | Pulmonary disease | 153 | 10.1 | 72 | 6.4 | 225 (8.50) |
| | Unknown | 96 | 6.4 | 58 | 5.2 | 154 (5.90) |
| | Accidents | 41 | 2.7 | 21 | 1.9 | 62 (2.40) |
| | Other | 301 | 19.9 | 121 | 10.8 | 422 (16.0) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |
| Referral | Yes | 208 | 13.8 | 130 | 11.6 | 338 (12.8) |
| | No | 1303 | 86.2 | 991 | 88.4 | 2294 (87.2) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |
| Death unit | Other | 118 | 7.80 | 64 | 5.70 | 182 (6.90) |
| | Internal | 171 | 11.3 | 90 | 8.00 | 261 (9.90) |
| | CCU & PCCU | 40 | 2.60 | 22 | 2.00 | 62 (2.40) |
| | Surgery & operating room | 41 | 2.70 | 36 | 3.20 | 77 (2.90) |
| | Before arrival | 17 | 1.10 | 9.0 | 0.80 | 26 (1.00) |
| | ICU | 568 | 37.6 | 427 | 38.1 | 995 (37.8) |
| | Unknown | 28 | 1.90 | 19 | 1.70 | 47 (1.80) |
| | Royal ICU (COVID) | 0.0 | 0.0 | 162 | 14.5 | 162 (6.20) |
| | Emergency | 528 | 34.9 | 292 | 26 | 820 (31.2) |
| | Total | 1511 | 100 | 1121 | 100 | 2632 (100) |

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit.

been related to the diverse mortality patterns between populations and regions at the hospital level, which need to be intensively clarified. Therefore, the present study aimed to investigate the demographic factors affecting patients' mortality pre- and post-COVID-19 phases. One of the most constant risk factors of COVID-19, which has been pulled out by the WHO and Centers for Disease Control (CDC) is elder age which might be different based on the age patterns of several countries.[27] It has been reported that males had a higher risk for COVID-19 and were more often severely affected by COVID-19 than females even in different stages of the disease with intensive care admission.[28] While other studies reported that none of the socio-demographic features like age, gender, and comorbidities was associated with mortality rate of patients with COVID-19 which might be to the difference in the study population or therapy time.[29-33] As the COVID-19 pandemic has spread around the world, it is argued that countries with large numbers of elderly people have faced difficulties. As well, reports from Italy and China showed a higher mortality rate due to COVID-19 in males than females, with ratios of 72%–57% and 2.8%–1.7%, respectively.[27,34,35]

In the present study, 70.6% of all dead cases were over 60 years old, and 79.1% of patients were over 50 years old. Besides, the prevalence of deaths in the older age group has increased significantly after the COVID-19 pandemic. In other studies in Iran, the average age of patients who died with COVID-19 significantly increased after the start of the pandemic, which is in line with our aforementioned cases.[36-38] It has been reported that the weakness of the immune system along with comorbidities can be involved in the severity and complications in this age group.[39] In contrast, the lesser chance of mortality rate among the several societies may be due to the age patterns of the countries

which pave the way for prediction of the capacity of critical cases to manage the number of hospital beds and medical care systems in the early phase of disease.[2] As reported in a meta-analysis on 59 studies with 36.470 patients, there was a significant association with higher age and male gender as the main demographic features and higher risk for severe COVID-19 infection, ICU admission and mortality rate.[28] In other study, the distribution of age in COVID-19 cases was similar to worldwide statistics (64%) ranged 25–64.[40] While COVID-19 transmission has increased in all age groups, especially among the US young population.[41] In our study, the male-to-female ratio of COVID-19 mortality was 1.59, which was consistent with the global sex-mortality ratio and other Iranian study.[4,42] In contrast, the discrepancies between the gender ratios in the findings of other studies may be linked to differences in the healthcare systems, therapeutic possibilities, and the length of outbreaks in different geographical areas.[4]

According to our findings, having a history of comorbidities such as cardiovascular disease may be a robust risk factor for COVID-19 mortality which is higher in COVID-19 cases than in other people.[43] In our study, the main cause of death before the pandemic was related to cardiovascular disease with a prevalence of 24% which was decreased to 14% after the pandemic. In contrast to our findings, it has previously been testified that cardiovascular disease was introduced as the risk factor for COVID-19 mortality. Findings of most existing studies showed a robust association between cardiovascular disease and COVID-19 mortality.[10,44] In addition, evaluation of patients' causes of death based on gender showed that cardiovascular problems were the most common cause of death in males with COVID-19 than in females with cancer as the highest underlying disease.

In general, the mortality rate was higher in males than in females in both pre- and postpandemic periods. Similarly, deaths caused by COVID-19 have been more frequent in males than in females. However, the main reason for these differences in morbidity between both sexes has not been determined. It has been believed that immune-related genes on the X chromosome and sexual hormones could be powered by innate and acquired immune responses in males to be more susceptible to infection.[45] The prevalence of deaths due to all causes of death decreased during the COVID-19 period, and instead, based on the rate of deaths caused by COVID-19 was 43% in our hospitalized patients within 7 months from the onset of the disease. As well, there was a significant difference in the causes of death before and after the COVID-19 outbreak. One of the causes of this issue might be to increase in the number of patients hospitalized in COVID-19 unit, a decrease in the number of patients hospitalized for other reasons, and a decrease in the elective hospitalization of patients. We also observed a decrease in the death rate of patients hospitalized in other sections, which can be attributed to the reduction of elective other causes of hospitalizations. There was also a statistically significant increase in patients' mortality rate hospitalized in the Royal ICU the main COVID-19 unit. As found in the present study, the ICU-specific mortality rate was 14.5% in the post-COVID-19 phase, which was less than the ICU mortality rate of 83.6%, 49%, and 42% found by other studies.[1,46,47] The deterioration of the patient's condition at the time of admission and quick seeking of health care may be important factors of differences among the studies.

Meanwhile, according to the global statistics, the COVID-19 death rate has been recorded at 3.4% in the time setting of our study.[48] The COVID-19 death rate recorded by other studies was 21.9%, 15%, 28.2%, 13.7%, and 14.4% which may depend on the type of population, the prevalence of underlying diseases, rate of patients' referrals, nutrition, genetics, and the sample size.[49-51] As well, the average time of death in the post-COVID-19 phase was 11:53:22 ± 6:52:20 h. Other studies recorded 8.5 ± 6.6 days as the average time of intervals between patients' admission and death. In another study, the average time from admission to death was reported to be 18 days.[52,53] The shorter interval between patients' admission and death is largely due to the time of the COVID-19 onset until the time of the patient's admission.

One of the limitations of our study was the lack of consideration of multicenter healthcare systems, which may also affect on exact evaluation of the COVID-19 survival rates. As the best mortality rate calculation is based on the interval times of symptoms onset to death of patients that were not the same, as well as inpatients and outpatients that were not considered in this study.

In conclusion, the findings of this study showed that the average age of death and the prevalence of male gender has increased after the start of COVID-19 among the deceased cases. Considering that elderly patients are at risk of death due to COVID-19, it is essential to take preventive measures in this group of age.

## AUTHOR CONTRIBUTIONS

**Mehran Kouchek**: Data curation; methodology. **Kamran Aghakhani**: Project administration; resources; Writing—original draft. **Azadeh Memarian**: Conceptualization; formal analysis; investigation.

## ACKNOWLEDGMENTS

There is no funding for the present study, and therefore the is no funder role, in the study design; collection, analysis, and interpretation of data; writing of the report; the decision to submit the report for publication.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

All of the data related to this study is mentioned in this manuscript.

## TRANSPARENCY STATEMENT

The lead author Azadeh Memarian 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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**How to cite this article:** Kouchek M, Aghakhani K, Memarian A. Demographic study of patients' mortality rate before and after the COVID-19 outbreak: a cross-sectional study. *Health Sci Rep*. 2024;7:e1845. doi:10.1002/hsr2.1845