ORIGINAL ARTICLE

# Factors Associated with Length of Hospital Stays in COVID-19 Patients in Yazd Province Hospitals

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**Received:** 20 April 2023
**Revised:** 21 May 2023
**Accepted:** 02 June 2023

## Abstract

**Background:** Considering the high prevalence of COVID-19 in Iran, it is necessary to allocate health resources in response to this pandemic. Due to limitations in the number of hospital beds, analysis of the length of hospital stay in COVID-19 patients may be helpful for decision-making.

**Methods:** This retrospective cohort study (survival study) was conducted through a follow-up of 1465 COVID-19 patients in Yazd Province, Iran. Demographic, diagnostic, and clinical data were collected using the COVID-19 data dashboard of Shahid Sadoughi University of Medical Sciences. The Kaplan-Meier method and Cox regression were used to calculate the survival probability and hazard ratio; the log-rank test was applied to compare survival function according to qualitative variables.

**Results:** The median and mean survival time was 25 days (95% CI: 19.10-30.89 days) and 28.38 days (95% CI: 25.6-31.16 days), respectively. The Survival probability for one week, two weeks, three weeks, four weeks, five weeks, six weeks, and seven weeks and more was 92%, 76%, 57%, 48%, 45%, 33%, and 20%, respectively. There was a significant relationship between survival time and age categories, CT scan results, history of chronic pulmonary disease, history of diabetes, history of cardiovascular disease, and disease severity ($P<0.05$).

**Conclusion:** According to the results, age, history of cardiovascular and pulmonary diseases, and history of diabetes increased the length of hospital stay. Preventive measures should be followed to prevent COVID-19 infection and manage hospital beds required for efficient treatment of patients.

Please cite this article as: Mirjalili MR, Dehghani MR, Raadabadi M, Madadizadeh F, Sharifyazdi M, Shojaefar H, Sharifi M, Yavari M, Dehghani A. Factors Associated with Length of Hospital Stays in COVID-19 Patients in Yazd Province Hospitals. J Health Sci Surveillance Sys. 2023;11(Supplement 3):614-619.

**Keywords:** COVID-19, Hospital, Length of stay, Proportional hazards models, Survival analysis

## Introduction

Hospitals are constantly facing challenges related to internal and external environments like demographic transitions, the use of new and expensive technologies, changes in the health market and economic conditions, and reforms of the healthcare systems.[1] These changes and advances result in management challenges, indicating the need for constant modification of health systems.[2]

In most countries, the costs of healthcare services have increased drastically in the past years. Although hospitals cover a limited population, they consume much of the health budget.[3] Therefore, much attention has been paid to costs and efficient use of resources in the healthcare sector and hospitals. In response to pressures to reduce costs, healthcare organizations have been forced to adopt strategies to decrease the use of resources while maintaining the quality of services.[4]

One of the methods for managing hospital beds and reducing hospitalization costs is to focus on optimizing the length of stay in inpatient wards.[5]

Length of hospital stay is defined as the time between admission and discharge from the hospital.[6] This index can be used for managing hospital care, hospital care quality control, appropriateness of hospital services, hospital planning and policy-making, measurement of hospital activities efficiency, and determining the hospital resources consumption.[7]

Reducing the length of hospital stay is associated with many benefits, such as decreased hospitalization costs, increased quality of services, and increased economic profit. Moreover, a large body of evidence indicates that reducing the length of hospital stay improves the capacity of the hospitals to admit new patients and provide better health care services.[8]

One of the unpredictable factors prompting the need to optimize hospital beds and manage the length of stay is the COVID-19 pandemic.

Due to extensive pulmonary damage caused by coronavirus infection, the mortality rate is very high in patients, especially those requiring mechanical ventilation.[9] There is no specific anti-viral drug for COVID-19, and treatment is mainly supportive through monitoring vital signs, blood pressure, and oxygen saturation and reducing the complications like secondary infections and organ failures.[10]

Since COVID-19 infection has a high prevalence and patients in extreme conditions need intensive care and respiratory support, it is necessary to reduce the patients' length of stay to provide care in acute conditions.[11]

However, the researchers' information about different aspects of this disease is being updated continuously, and there is no accurate information regarding geographic characteristics. Therefore, attention should be paid to censored data for a more accurate analysis of such data. Survival analysis is one of the methods used to evaluate such data.

Due to changes in COVID-19 care guidelines, the length of stay (LOS) depends on the level of care and the geographical setting. Evolving knowledge about effective treatments and clinical pathways and the availability of staff, beds, and equipment might influence the required duration and level of care.

Evaluating the epidemiology and survival rate of COVID-19 infection to identify its causes and address the causative agents is the main strategy for increasing patients' survival and improving public health. In this regard, this study aimed to conduct a survival analysis of the hospitalized COVID-19 patients' length of stay in Yazd Province.

## Methods

### *Study Population*

This is a retrospective-cohort study (survival study) conducted in the ICUs and infectious diseases wards admitting COVID-19 patients in Yazd Province, Iran. 1465 COVID-19 patients were followed from 20 February 2020 to 20 May 2020. According to the Iranian Ministry of Health statistics, Yazd Province was sometimes on the list of provinces with "red status". The study population comprised all COVID-19 patients admitted to ICUs and infectious diseases wards of all hospitals across Yazd Province with positive PCR tests. Sampling was not done and all patients' data were evaluated in a Census manner.

All COVID-19 patients with positive PCR results and complete data profiles admitted to ICUs and infectious diseases wards of all hospitals in Yazd Province were included in the study.

### *Data Collection Tool*

The data collection tool was a researcher-made form based on the data available in the COVID-19 data dashboard of Shahid Sadoughi University of Medical Sciences. This form contained demographic, diagnostic, and clinical data, such as age, sex, underlying diseases, CT scan results, consumed drugs, travel history, respiratory disease severity, history of mechanical ventilation, and length of hospital stay.

The ethics committee of Shahid Sadoughi University of Medical Sciences reviewed and approved the study (No: IR.SSU.REC.1399.101).

### *Data Analysis*

Median and mean survival are used to describe the data. The events of interest were death and survival. The Kaplan-Meier method was used to calculate the survival probability and hazard ratio, and the log-rank test was applied to compare survival functions according to qualitative variables. To conduct Cox regression, essential assumptions such as random censoring of observations and constancy of hazard ratio over time were evaluated in study groups. Random observation censoring was investigated by plotting censored data against time and constancy of the relative risk was evaluated by generating a log minus log plot and checking Lines crossing in the plot. The SPSS software version 24 was used for data analysis. P values less than 0.05 were considered significant.

## Results

The mean and median hospital stay were 7.94 and 6 days, respectively. Of 1465 COVID-19 patients, 261 (14.9%) died during the study, and the status of 13 patients (0.9%) was Right-censored. Most of the patients (56.6%) were male, 71.6% were above 45 years old, 8.3% were admitted to the ICU, and half were diagnosed based on CT scan findings. As for underlying diseases, 29.6% had cardiovascular disease, 24.5% had diabetes, 2.7% had kidney disease, 2.8% had chronic nervous disease,

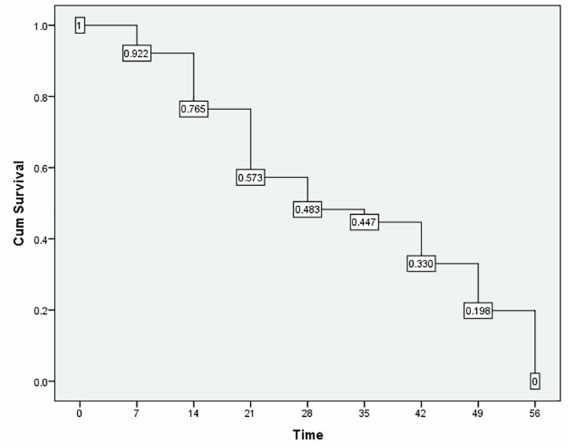


**Figure 1:** Kaplan-Meier Survival analysis for time to hospital discharge

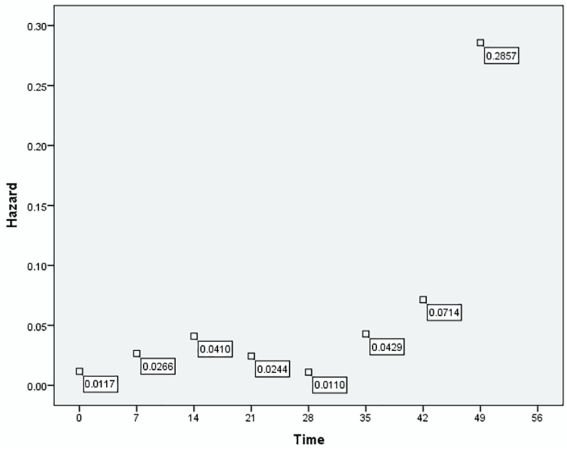


**Figure 2:** Hazard Function in Covid-19 patients

and 8.6% had chronic pulmonary disease. The drug regimen of most patients (24.1%) was a combination of oseltamivir and Kaletra.

According to Figure 1, the Survival probability for one week, two weeks, three weeks, four weeks, five weeks, six weeks, and seven weeks and more was 92%, 76%, 57%, 48%, 45%, 33%, and 20%, respectively.

The results showed that the hazard of death increased with an increase in the length of hospital stay from 1% in the first week to 28% in the seventh week (Figure 2).

According to the Kaplan-Meier estimates, the median and mean survival e were 25 days (95% CI: 19.10-30.89 days) and 28.38 days (95% CI: 25.6-31.16 days). The estimates of quartiles of survival times using

**Table 1:** Log Rank Test for Comparing Survival Function in Covid-19 Subjects

| Variables | Levels | F (%) | Median of survival time | 95% CI | P |
|---|---|---|---|---|---|
| Gender | Female | 643 (43.9) | 26 | 16.27-35.73 | 0.849 |
| | Male | 822 (56.1) | 23 | 18.55-27.45 | |
| Age | <45 | 425 (29) | 38.82 | 30.70-38.94 | <0.001 |
| | >45 | 1040 (71) | 26.18 | 23.34-29.01 | |
| Drugs | Hydroxychloroquine | 92 (6.3) | 25 | 9.128-36.86 | 0. 09 |
| | Oseltamivir | 174 (11.9) | 18 | 4.008-31.99 | |
| | Kaletra | 172 (11.7) | 16 | 13.408-18.59 | |
| | Hydroxychloroquine+Oseltamivir | 79 (5.4) | 34 | 14.95-53.04 | |
| | Oseltamivir+Kaletra | 348 (23.8) | 25 | 17.24-32.69 | |
| | Hydroxychloroquine+Oseltamivir+kaletra | 134 (23.8) | 25 | 13.79-36.21 | |
| | Others | 466 (31.8) | | | |
| Travel | Yes | 1118 (76.3) | 25 | 19.03-30.96 | 0.38 |
| | No | 63 (4.3) | 25 | 17.29-32.70 | |
| | Unknown | 284 (19.4) | | | |
| Chronic pulmonary Disease | Yes | 124 (8.5) | 17 | 11.76-22.24 | 0.001 |
| | No | 1341 (91.5) | 26 | 17.71-34.29 | |
| Chronic Nervous Disease | Yes | 42 (2.9) | 21 | 8.69-25.30 | 0.145 |
| | No | 1423 (97.1) | 25 | 19.32-30.68 | |
| Kidney Disease | Yes | 39 (2.7) | 19 | 11.44-20.56 | 0.573 |
| | No | 1426 (97.3) | 25 | 19.24-30.76 | |
| Liver Disease | Yes | 7 (0.5) | 29 | 19.16-30.84 | 0.629 |
| | No | 1458 (99.5) | 31 | 17-38.21 | |
| Diabetes | Yes | 355 (24.2) | 17 | 14.45-19.55 | <0.001 |
| | No | 1110 (75.8) | 29 | 20.44-37.55 | |
| Cardiovascular Disease | Yes | 426 (29.1) | 20 | 14.43-25.57 | <0.001 |
| | No | 1039 (70.9) | 34 | 24.197-43.80 | |
| Severity of Pulmonary Disease | Mild | 533 (36.4) | 52 | 16.038-37.96 | 0.001 |
| | Severe | 60 (4.1) | 17 | 5.12-28.89 | |
| | RDS (Respiratory distress syndrome) | 20 (1.4) | 9 | 4.-23.13.76 | |
| | Unknown | 852 (58.2) | | | |

Covid-19: Coronavirus disease, Coronavirus disease; F: frequency; CI: Confidence interval

this method showed that 75% of the participants had a survival time equal to or less than 13 days. Comparison of survival function using the log-rank test between different variables showed that the age group below 45 had a significantly longer median survival than the age group above 45 years (P<0.001). Patients with a history of chronic pulmonary disease, diabetes, and cardiovascular disease had significantly lower median survival than subjects with a negative history (P=0.001). Patients with mild disease had a significantly higher median survival than those with severe disease and respiratory distress syndrome (P=0.001) (Table 1).

Comparison of the survival function using the log-rank test between men and women showed that the median survival was 26 (95% CI: 16.27-35.73) in women and 23 (95% CI: 18.55-27.45) in men. Still, the difference was not statistically significant (P=0.849). Moreover, the comparison of the survival function according to the consumed drugs, travel history, chronic nervous disease, kidney disease, and liver disease was not significant (P>0.05) (Table 1).

Based on the results of multiple Cox regression, the risk of death was 79% less in patients below 45 years compared to those above 45 years (HR=0.21, P<0.001). On the other hand, the risk of death was 76% (HR=1.76, P=0.002), 71% (HR=1.71, P=0.001), and 98% (HR=1.98, P<0.001) higher in patients with a history of chronic pulmonary disease, diabetes, and cardiovascular disease compared to patients with a corresponding negative history, respectively. As for the respiratory status, the risk of death was 2.26 times (HR=2.26, P<0.001) and 3.23 times (HR=3.23, P<0.001) higher in patients with severe disease and respiratory distress syndrome compared to those with a mild disease, respectively (Table 2).

## Discussion

According to the results, the median and mean survival time were 25 and 28.38 days, respectively. A study in Vietnam showed that the median survival time of COVID-19 patients was 21 (95% CI: 16-34) days.[12] According to a study in China, the median survival time was 19 days (95% CI: 3-41 days),[13] which is consistent with the results of the present study.

The mean and median hospital stay were 7.94 and 6 days, respectively. Some studies conducted in the US and[14] European countries reported a shorter stay, ranging from 6-7 days.[15, 16] These differences in the results may be due to differences in strategies adopted for disease prevention and treatment, time of onset and peak, and hospital treatment facilities.

According to the Cox regression analysis results, several demographic and epidemiologic factors affected the length of stay. The risk of death was 79% lower in patients below 45 years versus those above 45. Similarly, Thai et al. found a longer duration of hospitalization in patients above 46 years.[12] The results of studies conducted in several countries show that the length of hospital stay increases with age.[13, 15, 16] COVID-19 is usually more severe in the elderly; moreover, they usually suffer from other underlying diseases, increasing their need for care and the risk of death following infection.

Patients with mild disease had a significantly longer median survival than those with severe disease and respiratory distress syndrome. A study conducted by Ji et al. in China also showed that the patients' median length of stay with severe symptoms was longer than that of patients with mild symptoms.[17]

The risk of death was 76%, 71%, and 98% higher in patients with a history of chronic pulmonary disease, diabetes, and cardiovascular disease compared to patients with a negative history of the corresponding disease, respectively. According to the results of other studies, patients with cardiovascular disease have the

**Table 2:** Risk factors for hospitalization of COVID-19 patients: hazard ratios from Cox regression model

| Variable | Levels | HR | 95% CI | P |
|---|---|---|---|---|
| Age | <45 | 0.21 | 0.117-0.377 | <0.001 |
| | >45 | 1 | -- | |
| Chronic pulmonary Disease | Yes | 1.76 | 1.24-2.5 | 0.002 |
| | No | 1 | -- | |
| Chronic Nervous Disease | Yes | 1.48 | 0.86-2.52 | 0.15 |
| | No | 1 | | |
| Kidney Disease | Yes | 1.21 | 0.62-2.36 | 0.579 |
| | No | 1 | -- | |
| Liver Disease | Yes | 1.61 | 1.13-2.01 | 0.636 |
| | No | 1 | -- | |
| Diabetes | Yes | 1.71 | 1.29-2.26 | 0.001 |
| | No | 1 | -- | |
| Cardiovascular Disease | Yes | 1.98 | 1.51-2.59 | <0.001 |
| | No | 1 | -- | |
| Severity of Pulmonary Disease | Mild | 2.26 | 1.39-3.67 | <0.001 |
| | Severe | 3.23 | 1.6-6.89 | |
| | RDS | 1 | -- | |

The significant level was 0.05; HR: hazard ratios; RDS: Respiratory distress syndrome

highest sensitivity to COVID-19, followed by those who have diabetes, chronic respiratory disease, hypertension, and cancer.[9, 13, 18]

As for sex, although the length of stay was longer in men than women, the difference was insignificant. A study found a higher mortality rate in men.[13] Nonetheless, most studies have shown no inter-gender difference in mortality and disease outcomes in COVID-19 patients.[19, 20] The longer length of stay in men can be attributed to the higher prevalence of this disease.

The large sample size and the selection of patients with PCR positive was the strength of the present study, as it increases the generalizability of the results. One of the limitations of this study was changes in the quality and quantity of some data in the data dashboard. The authors excluded samples with incomplete data from the study to address this limitation. The effects of some variables were not investigated in this study; therefore, further studies are warranted considering the role of different factors in the length of stay.

## Conclusion

During the COVID-19 pandemic, all hospitals face an epidemiologic transition of the disease in Iran with an increasing demand for hospitalization and hospital services. This event indicates the need for managing hospital beds as the most important resource after workforce to optimize the patients' length of stay for more effective and efficient use of this key, sensitive, rare, and costly hospital resource. In the current situation, a longer hospital stay means more admission, especially when the number of patients with special needs increases quickly. Therefore, the data presented in this study, especially for patients with mechanical ventilation, underlying diseases, and old patients, can help design appropriate COVID-19 prevention and control measures. Knowledge of the mean length of hospital stay and its associated factors can be effective for decision-making and planning.

## Acknowledgment

This study is related to project NO—7867 in Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

## Funding

The authors sincerely thank Shahid Sadoughi University of Medical Sciences for all its supports. Grants from the Research Committee in Medicine School of Shahid Sadoughi University of Medical Sciences supported this study.

**Conflict of interest:** None declared.

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