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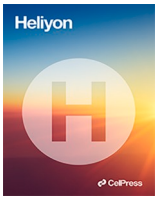

# Time to recovery and determinant factors of COVID-19 patients under treatment in Sidama region, Ethiopia: A retrospective cohort study

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ABSTRACT

*Introduction:* Evidence from several studies shows that the median recovery time among COVID-19 patients varies in different settings, and why that difference occurs is questionable. The current study was aimed to estimate the time to recovery and to identify determinant factors among COVID-19 patients admitted to treatment centers in the Sidama region, Ethiopia.

*Methods:* The secondary data was extracted from the Sidama Public Health Institute (SPHI), data management unit. A total of 1038 COVID-19 patients who were under treatment from 1, June 2020, to 30, June 2022, at different treatment centers in the region were included in the study. The Log-Logistic Accelerated Failure Time (AFT) model was employed to estimate the effects size of different covariates on recovery time of COVID-19 patients under treatment.

*Results:* Among the total number of patients in the study, 704 (67.82 %) were recovered, while 334(32.18 %) were censored. The median recovery time was 14 days (IQR: 10–18 days). Patients who were above 65 years old had nearly 1.17 times more prolonged recovery time as compared to patients who were below 25 years old, (OR = 1.168, p-value = 0.032, CI = 0.013,0.298). The log odds of recovery for patients who were in critical severity status at admission was 1.279 times more decelerated as compared to asymptomatic patients (P-value = 0.005, CI = 0.076, 0.417). The log odds of recovery for patients who had no history of headache was 1.107 times more accelerated as compared to patients who had a history of headache (OR = 1.107, p-value = 0.027, CI = 0.011, 0.192). The log odds of recovery for non-diabetic patients was 1.244 times more accelerated as compared to patients who were diabetic (OR = 1,244, p-value = 0.002, CI = 0.077, 0.360), holding other covariates constant in the model.

*Conclusion:* Age, critical severity status of infection, having symptoms of infection, having a history of headaches, and being diabetic had statistically significant effects on time to recovery among COVID-19 patients admitted to the treatment centers in the Sidama region.

## 1. INTRODUCTION

Coronavirus disease-2019 (COVID-19) is defined as a new clinical entity caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. The outbreak of COVID-19 began in Wuhan, China, in December 2019, and the World Health Organization (WHO)

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declared the outbreak a public health threat and a worldwide pandemic on March 11, 2020 [2]. As of April 24, 2022, COVID-19 confirmed cases were 507,184,387, with 6219,657 deaths being reported worldwide [3]. In Ethiopia, the first case of COVID-19 was reported on March 13, 2020, and there were 470,434 confirmed cases; of these, 7510 were reported deaths [4]. Thus, COVID-19 remains one of the public health issues affecting all people around the world [5].

Globally, different researches have been conducted to estimate the median recovery time and identify determinant covariates among COVID-19 patients under follow-up at treatment or isolation centers. The recovery time for patients with mild infection status was estimated to be 2 weeks, and 3–6 weeks for those with serious illness [6]. However, the recovery time among patients differs with patients' age, presence of symptoms, and commodities, in which the median time of recovery is more than 14 days for some settings and less than 14 days for others [7]. Evidence from several studies shows that the median recovery time for COVID-19 patients ranges from 8 to 30 days while the longest time reported was 47 days [8–12].

Studies conducted on COVID-19 patients hospitalized at Eka Kotebe General Hospital and Millennium COVID-19 Care Center in Addis Ababa, Ethiopian, reported that the median recovery time was 19 days and 16 days, respectively [13,14]. Other studies conducted in Bokoji, Orimia region South-Central Ethiopia; Dilla, Southern Ethiopia; Amhara region; Wollega zone, Oromia region; and a multi-center study taken in the Southern Nation Nationalities and Peoples Region (SNNPR) of Ethiopia have also reported that the median recovery time was 13, 5, 11, 18 and 10 days, respectively. This shows that the median recovery time among COVID-19 patients admitted to the different treatment centers ranges from 5 to 19 days [15–19].

The estimated median recovery time for patients depends on various factors according to studies, but the main causes for the reported difference are not well-understood. On the other hand, most of the studies and reported findings were based on the analysis of data taken from specific treatment centers in the country. The reports were also made based on descriptive analysis and limited to estimating the magnitude of the recovery rate (accelerated or decelerated recovery) using appropriate statistical models with all the model assumptions checked. Which covariates significantly determining the time to recovery among patients is not also fully assessed using data from the rest parts of the country. Specifically, there is no study conducted on time to recovery among COVID-19 patients admitted to treatment centers in the Sidama region. Some of the studies undertaken earlier used shorter study periods, while other studies were based on longer study periods [15–19]. Therefore, the current study was aimed at estimating the time to recovery and identifying determinant factors among COVID-19 patients admitted to treatment centers in the Sidama region, Ethiopia.

## 2. Materials and methods

### 2.1. Study area and study period

The current study was conducted in the Sidama region, Southern Ethiopia. An institutional-based retrospective follow-up was made on COVID-19 patients admitted to treatment centers in the region. There were 10 treatment centers in the region of which 4 of them were in the Hawassa city, the regional capital, and the rest 6 were in different areas in the region. The study participants were COVID-19 patients who were hospitalized at treatment centers from June 1, 2020, to June 30, 2022. There were a total of 9056 COVID-19 patients admitted to treatment centers in the region, and their clinical and medical history (status records) was reported to Sidama Public Health Institute (SPHI) from all the treatment centers in the region.

The current study used secondary data extracted from the Sidama Public Health Institute (SPHI) data management unit. All the COVID-19 patients who were under follow-up at the COVID-19 treatment centers from June 1, 2020, to June 30, 2022, in the region were the sample frame of the study. The patients who had no date of admission, date of discharge, had no recorded outcome status, and those who were diseased on arrival were excluded from a sampling frame. Among 2157 patients fitting all the inclusion criteria, 1038 patients were selected based on a simple random sampling technique [20]. Sample size determination was made by assuming a 95% confidence level (CI), 80% statistical power, 5% level of significance, 2% margin of error, and 10% non-response rate.

### 2.2. Defining a study variables

The response variable of the current study was time to recovery among COVID-19 patients admitted at treatment centers in the region. The time length was assumed to be from the time of being diagnosed positive to the time of being diagnosed negative for the

**Table 1**
Summary statistics of socio-demographic characteristics of COVID-19 patients addmitted to treatment centers in the Sidama region.

| | | Status | | Total (n) |
|---|---|---|---|---|
| Characteristics | | Recovered/event (%) | Censored (%) | |
| Sex | Female | 219(67.92) | 107(32.08) | 326 |
| | Male | 485(68.1) | 227(31.9) | 712 |
| Age category | <25 | 170(82.5) | 36(17.5) | 206 |
| | 25–64 | 444(68.4) | 205(31.6) | 649 |
| | > = 65 | 90(49.2) | 93(50.8) | 183 |
| Residency | Out of Hawassa | 454(70) | 194(30) | 648 |
| | Hawassa | 250(64.1) | 140(35.9) | 390 |

*Others* category includes: students and housewife; *Private* category includes: who have own business, and or farmers.

virus. The maximum time of follow-up used in the study was 42 days (6 weeks). Patient who died, lost the follow-up, were transferred to another hospital, and discharged to home isolation without recovery were considered censored. Patients who had recovered within the study period were considered event outcomes. The event outcomes (recovered) are coded as 1, and censored cases are coded as 0. Socio-demographic, clinical (clinical signs and symptoms), past medical history (comorbidity), and severity status of patients were covariates used in the analysis (Tables 1 and 2).

### 2.3. Data analysis

The data was filtered, summarized, coded, and then entered into STATA, version 14. The survival analysis method was performed to assess the stated objective of the study. The Kaplan-Meier method was used to estimate the median recovery time. The log-rank test was used to compare the recovery rate among patients in the different categories. The Log-logistic Accelerated Failure Time (LLAFT) regression model was used to estimate the effect size of different covariates on the recovery time of patients under treatment. All nominal and categorical variables that had a p-value less than 0.25 in the univariate analysis were included in the model.

**Table 2**
Summary statistics of clinical characteristics and past medical history of COVID-19 patients **addmitted to treatment centers in the Sidama region**.

| | | Status | | Total (n) |
|---|---|---|---|---|
| Covariates | Category | Recovered/event (%) | Censored (%) | |
| Symptom status | Asymptomatic | 220(94.4) | 13(5.6) | 233 |
| | Symptomatic | 484 (60.1) | 321(39.9) | 805 |
| History of fever | No | 373(75.4) | 122(24.6) | 495 |
| | Yes | 331(61) | 212(39) | 543 |
| History of cough | No | 330(82.1) | 72(17.9) | 402 |
| | Yes | 374(58.8) | 262(41.2) | 636 |
| Shortness of breath | No | 376(79.5) | 97(20.5) | 473 |
| | Yes | 328(58.1) | 237(41.9) | 565 |
| History of sore thought | No | 561(71.6) | 222(28.4) | 783 |
| | Yes | 143(56.1) | 112(43.9) | 255 |
| Headache | No | 466(72.6) | 176(27.4) | 642 |
| | Yes | 238(60.1) | 158(39.9) | 396 |
| General body weakness | No | 446(78.4) | 123(21.6) | 569 |
| | Yes | 258(55.0) | 211(45.0) | 502 |
| Chest pain | No | 700(68.2) | 327(31.8) | 1027 |
| | Yes | 4(36.4) | 7(63.6) | 11 |
| Diarrhea | No | 701(67.8) | 333(32.2) | 1034 |
| | Yes | 3(75) | 1(25) | 4 |
| Loss of appetite | No | 688(67.7) | 328(32.3) | 1016 |
| | Yes | 16(72.7) | 6(27.3) | 22 |
| Fever at admission | No | 604(70.9) | 248(29.1) | 852 |
| | Yes | 100(53.8) | 86(46.2) | 186 |
| Severity status at admission | Asymptomatic | 69(84.1) | 13(15.9) | 82 |
| | Mild | 234(85.1) | 41(14.9) | 275 |
| | Moderate | 140(66.4) | 71(33.6) | 211 |
| | Sever | 165(67.9) | 78(32.1) | 243 |
| | Critical | 96(42.3) | 131(57.7) | 227 |
| History of Comorbidity | No | 500(74.8) | 168(25.1) | 668 |
| | Yes | 204(55.1) | 166(44.9) | 370 |
| History of Hypertension | No | 645(69.7) | 281(30.3) | 926 |
| | Yes | 59(52.7) | 53(47.3) | 112 |
| History of heart disease | No | 678(68.2) | 316(31.8) | 994 |
| | Yes | 26(59.1) | 18(40.9) | 44 |
| History of HIV/AIDS | No | 694(68.2) | 323(31.8) | 1017 |
| | Yes | 10(47.6) | 11(52.4) | 21 |
| History of diabetes | No | 651(71.5) | 259(28.5) | 910 |
| | Yes | 53(41.4) | 75(58.6) | 128 |
| History of kidney disease | No | 699(68.5) | 321(31.5) | 1020 |
| | Yes | 5(27.8) | 13(72.2) | 18 |
| History of cancer | No | 695(67.9) | 329(32.1) | 1024 |
| | Yes | 9(64.3) | 5(35.7) | 14 |
| History of Tuberculosis | No | 693(68.2) | 323(31.8) | 1016 |
| | Yes | 11(50) | 11(50) | 22 |
| History of Asthma | No | 694(68) | 327(32) | 1021 |
| | Yes | 10(58.8) | 7(41.2) | 17 |

### 2.4. Ethical approval statement

The study received ethical clearance from the College of Medicine and Health Sciences, Institutional review Board (Ref. No: IRB/038/14), Hawassa University, and written consent on data use was issued from Sidama Public Health Institute (SPHI). No information obtained from the medical records was disclosed to any third party.

## 3. RESULTS

### 3.1. Descriptive statistics

Out of 1038 COVID-19 patients included in the study, 712(68.59%) were male and 326(31.41%) were female; of these, 38% were Hawassa city residents, while 62% were from other areas in the region. Nearly, 69% of patients were recovered, and the rest, 31%, were censored. The mean age of the patient was 43.13 ± SD: 20.35 years (Table 1).

### 3.2. Clinical related characteristic and past medical history of patients (comorbidities)

About 77.5% of patients had shown symptoms of the virus 14 days prior to their admission date. The most common symptom among patients was cough (61.27%), followed by shortness of breath (54.43%), and fever (52.31%). Among asymptomatic patients, 94.4% were recovered, while 60.1% were recovered among symptomatic patients. Among the patients who had a history of comorbidity, 55.1% recovered; among them, the least recovery status was observed among those who had a history of kidney disease (27.8%), followed by patients who had a history of diabetics (41.4%) (Table 2).

### 3.3. The treatment outcomes

Out of the total patients included in the study (n = 1038), 715(69%) were recovered, 113(11%) were discharged with consent after a clinical improvement (home isolation), 29(3%) were referred (transferred out) for further treatment, and the rest, 181(17.4 %) were reported to have died (Fig. 1).

### 3.4. The median recovery time

The median recovery time among COVID-19 patients admitted to treatment centers in the region was 14 days, with a minimum and maximum of 10 and 18 days, respectively. The median recovery time for patients who were in severe and critical infection status was 12 and 16 days, respectively. Male and female patients had the same median recovery time of 14 days. Patients in the older age category ( ≥ 65 years) showed prolonged median recovery time of 15 days compared to patients in the other age category (12 days for those who were below 25 years old and 14 days for those who were between 25 and 64 years old) (Table 3).

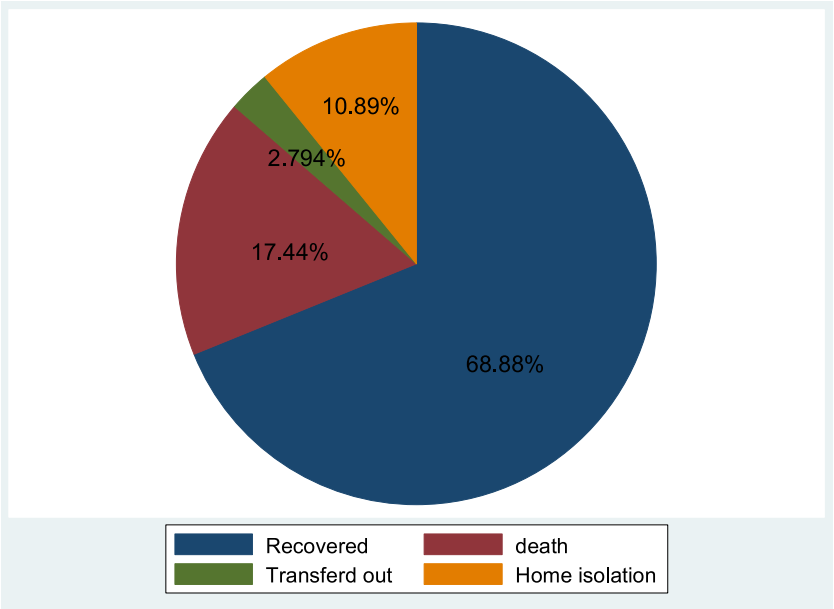


**Fig. 1.** Percentage distribution of treatment outcomes among COVID-19 patients admitted to treatment centers in the Sidama region.

### 3.5. The Recoevry Probability: The Life Table

As time increases, recovery probability relatively decreases, indicating that the chance of recovery among patients as time increases has decreased. Among the patients included in the study, 18% recovered within the first 10 treatment days (0–10 days). The patients those who were under treatment for 40 consecutive days had recovery probability between 0.0396 and 0.0815 (survival prob. = 0.0581, CI = 0.0396, 0.0815); this means that patients who were under treatment for 40 days had a 5.82% chance of recovery, while patients who were under treatment beyond 40 days had a 2.3%–6.7% chance of recoevry. This indicates that the patients who were under treatment beyond 40 days had the highest chance (95.6%) of not recovering from COVID-19 (Table 4).

### 3.6. Log-rank test

The log-rank test is used to validate and identify covariates that have an association with time to recovery at a 5% level of significance.

Hypothesis testing: The null hypothesis - there is no significant difference in recovery probabilities among patients in the different categories. The log-rank test (chi-square test) of association between different covariates and time to recovery is presented in Table 5. Symptom status, ($\chi^2 = 20.25$, p-value = 0.0000), having a history of fever ($\chi$^2) = 8.18, p-value = 0.0042) history of cough ($\chi^2 = 11.61$, p-value = 0.0007), shortness of breath ($\chi^2 = 14.43$, p-value = 0.0001), headache ($\chi^2$) = 34.4, p-value = 0.0000), general body weakness ($\chi^2 = 23.47$, p-value <0.000), severity status ($\chi^2 = 46.58$, p-value <0.000), history of comorbidity ($\chi^2 = 15.23$, p-value = 0.0001), history of diabetics ($\chi^2 = 18.21$, p-value <0.000), and kidney disease ($\chi^2 = 6.79$, p-value = 0.0092) had a significant association with time to recovery among COVID-19 patients under treatment.

### 3.7. Kaplan Meier (KM) analysis: recovery rate

The-Kaplan Meier (KM) analysis was done to estimate the median recovery probability distribution for each categorical covariate. As it is presented in Fig. 2, the accelerated recovery rate was observed within the first 20 treatment days. The asymptomatic patients showed faster recovery time than the symptomatic patients (Fig. 3). The patients who had no history of comorbidity had higher probability of recovering from COVID-19 than those who had a history of comorbidity (Fig. 4).

There was no recovery time difference between patients who had or had no a history of comorbidity for the first 10 days of treatment. However, the recovery time gap increases afterward, indicating patients who had a history of comorbidity required a prolonged recovery time than patients who had no history of comorbidity as treatment time increases (Fig. 5). As illustrated in Fig. 6, non-diabetic patients had a shorter recovery time than their counterparts.

## 4. Accelerated Failure Time (AFT) Analysis

### 4.1. Model comparison

The model comparison aims to select the best model fit for the data used in the analysis. Before we do regression analysis using the Accelerated Failure Time (AFT) model, we have to test the Proportional Hazard (PH) model assumptions. The model assumption was tested using the Schoenfeld residuals (Fig. 7). The results of the global test result (p-value = 0.0001) indicate that the Proportional Hazard model assumptions are violated (Table 6).

Thus, it is important to propose other parametric survival models that best fit the data. The model compassion was done using single and multiple regression analysis for each parametric model in the Accelerated Failure Time (AFT) family (Exponential, Log-Logistic, Log-Normal, Weibull, and Generalized Gamma). Based on the BIC and AIC statistics, the Log-Logistic model best fitted the data used in the analysis (Table 7).

**Table 3**
The median recovery time of COVID-19 patients based on different indicators variables.

| Variable | Category | Median recovery time (in days) | 95% CI |
|---|---|---|---|
| Sex | Male | 14 | 13 14 |
| | Female | 14 | 13 14 |
| Age-category | <25 | 12 | 12 13 |
| | 25–64 | 14 | 13 14 |
| | > = 65 | 15 | 13 17 |
| Symptom status | Asymptomatic | 13 | 12 14 |
| | Symptomatic | 14 | 13 14 |
| Severity status | Asymptomatic | 12 | 10 13 |
| | Mild | 13 | 13 14 |
| | Moderate | 14 | 13 15 |
| | Sever | 12 | 11 14 |
| | Critical | 16 | 14 20 |
| Comorbidity | No | 13 | 12 14 |
| | Yes | 14 | 14 16 |

**Table 4**
The median recovery probability of COVID-19 patients based on the treatment duration in the centers.

| Days of follow ups | Total (n) | Recovered (n) | Censored (n) | Recovery probability | [95 % C.I.] | Non-recovery probability |
|---|---|---|---|---|---|---|
| 0–10 | 1038 | 171 | 198 | 0.8179 | 0.7917 0.8411 | 0.1821 |
| 10–20 | 669 | 441 | 95 | 0.2310 | 0.2018 0.2613 | 0.7690 |
| 20–30 | 128 | 59 | 17 | 0.1150 | 0.0911 0.1419 | 0.8850 |
| 30–40 | 51 | 27 | 9 | 0.0581 | 0.0396 0.0815 | 0.9419 |
| 40–50 | 19 | 4 | 4 | 0.0444 | 0.0275 0.0674 | 0.9556 |
| 50–60 | 11 | 0 | 1 | 0.0444 | 0.0275 0.0674 | 0.9556 |
| 60–70 | 10 | 0 | 3 | 0.0444 | 0.0275 0.0674 | 0.9556 |
| 70–80 | 7 | 0 | 4 | 0.0444 | 0.0275 0.0674 | 0.9556 |
| 90–100 | 3 | 0 | 3 | 0.0444 | 0.0275 0.0674 | 0.9556 |

**Table 5**
The Log-rank test of association between recovery time and indicator covariates for patients admitted to treatment centers in the Sidama region.

| Variables | Df | Chi-square value ($\chi^2$) | p-value |
|---|---|---|---|
| Sex | 1 | 0.01 | 0.9087 |
| Area of residence | 1 | 0.27 | 0.6040 |
| Symptom status | 1 | 20.25 | **0.0000** |
| History of fever | 1 | 8.18 | **0.0042** |
| History of cough | 1 | 11.61 | **0.0007** |
| Shortness of breath | 1 | 14.43 | **0.0001** |
| History of sore thought | 1 | 2.70 | 0.1001 |
| Headache | 1 | 34.41 | **0.0000** |
| General body weakness | 1 | 23.47 | **0.0000** |
| Chest pain | 1 | 1.26 | 0.2614 |
| Diarrhea | 1 | 0.90 | 0.3428 |
| Loss of appetite | 1 | 1.09 | 0.2971 |
| Fever at admission | 1 | 3.29 | 0.0699 |
| Severity status at admission | 4 | 46.58 | **0.0000** |
| History of Comorbidity | 1 | 15.23 | **0.0001** |
| Hypertension | 1 | 2.01 | 0.1561 |
| Heart disease | 1 | 2.60 | 0.1070 |
| HIV/AIDS | 1 | 0.19 | 0.6623 |
| Diabetics | 1 | 18.21 | **0.0000** |
| Kidney disease | 1 | 6.79 | **0.0092** |
| Cancer | 1 | 1.00 | 0.3174 |
| Tuberculosis | 1 | 1.43 | 0.2315 |
| Asthma | 1 | 0.14 | 0.7074 |

Whereas, sex, area of residence, sore thought, chest pain, diarrhea, loss of appetite, fever at admission, history of hypertension, heart disease, cancer disease, HIV/AIDS, tuberculosis, and asthma had no statically significant association with recovery time of patients under treatment (Table 5).

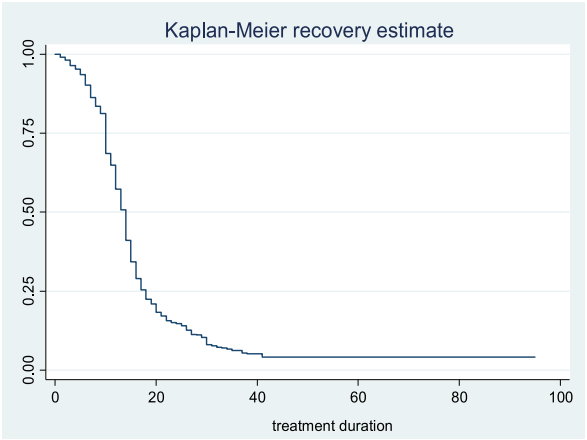


**Fig. 2.** The Kaplan-Meier graph of the cumulative recovery probability distribution over study period for COVID-19 patients under treatment in the Sidama region.

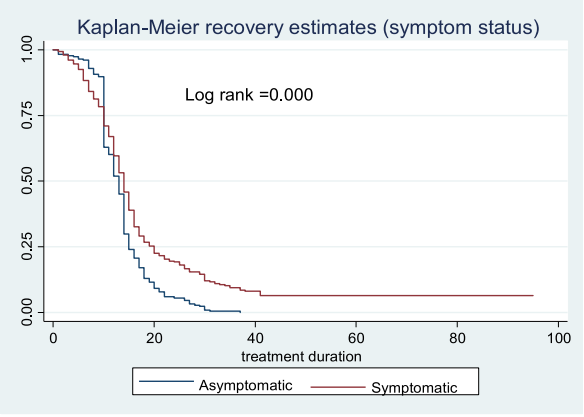


**Fig. 3.** The Kaplan-Meier graph of the cumulative recovery probability distribution of COVID-19 patients by their symptom (asymptomatic and symptomatic) status.

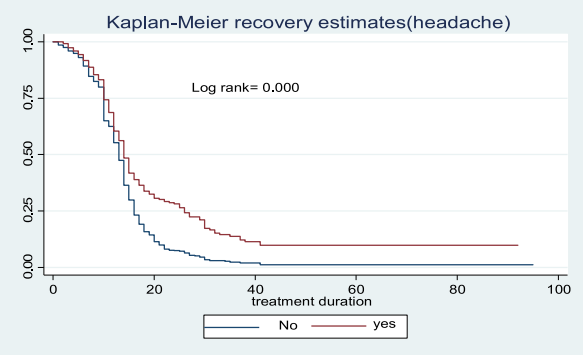


**Fig. 4.** The Kaplan-Meier graph of the cumulative recovery probability distribution of COVID-19 patients by history of headache.

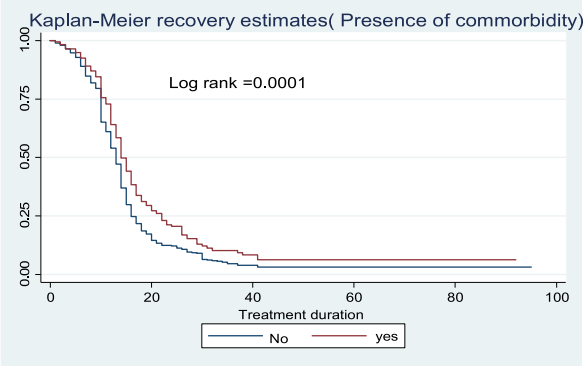


**Fig. 5.** The Kaplan-Meier graph of the cumulative recovery probability distribution of COVID-19 patients by history of comorbidity.

### *4.2. Log-Logistic Accelerated Failure Time analysis*

The univariable and multivariable Log-Logistic model parameter estimation was done to identify covariates that had a significant association with recovery time among COVID-19 patients under treatment (Table 8). The statistical significance was set at a 95% confidence level.

The time to recovery was significantly associated with the age of the patients. The odds of recovery time for older patients (above 65 years old) was significantly different from the recovery time of younger patients (below 25 years old) (OR ($e^{\beta}$) = 1.168; P-value = 0.032; CI = 0.013–0.298). Patients in the older age category had 1.168 times more prolonged recovery time compared to patients in

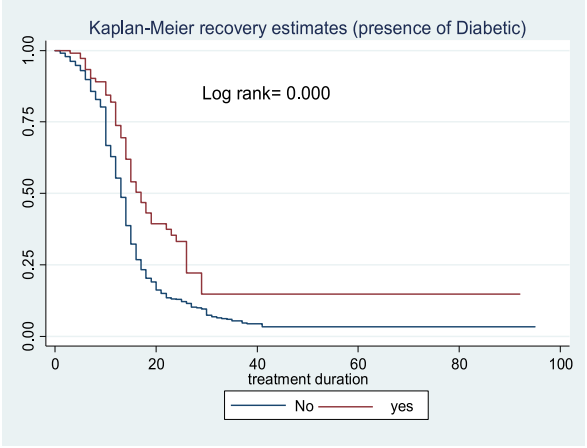


**Fig. 6.** The Kaplan-Meier graph of the cumulative recovery probability distribution of COVID-19 patients by a history of diabetics.

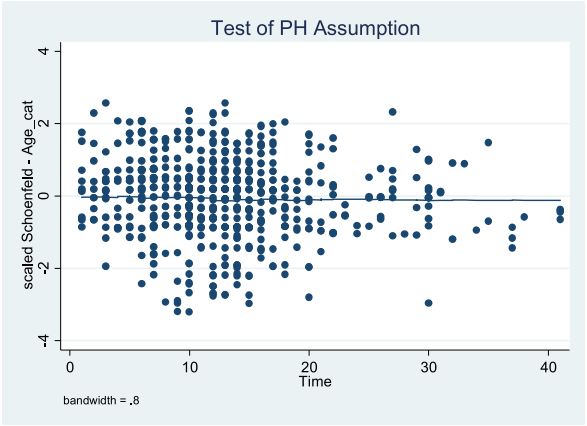


**Fig. 7.** The Schoenfeld residual plot of the Proportional Hazard model assumption test.

**Table 6**
Test of proportional-hazard assumption by Schoenfeld residuals.

| Covariate | rho | Chi2 | p-value |
|---|---|---|---|
| Age category | −0.07860 | 4.73 | 0.0297 |
| Headache | −0.01095 | 0.09 | 0.7605 |
| GBW | −0.04696 | 1.64 | 0.1997 |
| Severity status | −0.09013 | 6.02 | 0.0142 |
| Diabetics | 0.07357 | 3.86 | 0.0494 |
| Global test | | 28.76 | 0.0000 |

**Table 7**
Summery statistics of model comparison criteria.

| Information criteria | | AFT Models | | | |
|---|---|---|---|---|---|
| | Exponential | Log-Logistics | Weibull | Log-Normal | Generalized Gamma |
| AIC | 2043.57 | **1559.731** | 1688.614 | 1656.1 | 1638.147 |
| BIC | 2093.02 | **1658.709** | 1797.49 | 1755.09 | 1742.07 |

the younger age category. This indicates that the time to recovery for patients in the older age category (65 years old and above) was 16.8% more prolonged as compared to patients in the younger age, holding other covariates constant in the model. The estimated acceleration factor for patients who had a history of headache was significantly different from patients who had no history headache

**Table 8**
The estimated time to recovery of COVID-19 patients under treatment based on the Log-Logistics AFT analysis.

| Covariates | Categories | | Coefficient (β) | Odds ratio ($e^{\beta}$) | SE | p-value | [95% CI] |
|---|---|---|---|---|---|---|---|
| Age category | <25 | Ref | | | | | |
| | 25–64 | | 0.019 | 1.019 | 0.049 | 0.169 | −0.078 0.116 |
| | ≥65 | | 0.156 | 1.168 | 0.073 | **0.032** | 0.013 0.298 |
| Had headache | No | Ref | | | | | |
| | Yes | | 0.102 | 1.107 | 0.046 | **0.027** | 0.011 0.192 |
| Severity status | Asymptomatic | Ref | | | | | |
| | Mild | | 0.107 | 1.113 | 0.072 | 0.138 | −0.034 0.248 |
| | Moderate | | 0.134 | 1.143 | 0.078 | 0.087 | −0.019 0.287 |
| | Sever | | −0.092 | 0.911 | 0.081 | 0.251 | −0.251 0.066 |
| | Critical | | 0.246 | 1.279 | 0.087 | **0.005** | 0.076 0.417 |
| History of diabetes | No | Ref | | | | | |
| | Yes | | 0.218 | 1.244 | 0.072 | **0.002** | 0.077 0.360 |
| Constant | | | 2.419 | 11.23 | 0.071 | **0.000** | 2.278 2.559 |

95% CI: confidence interval; SE: standard error.

(OR ($e^{\beta}$) = 1.107; p-value = 0.027; CI = 0.011–0.192).

The odds of recovery time for patients who had no history of headache was 1.107 times more accelerated compared to patients who had a history of headache, holding other covariates constant. This means the recovery time for patients who had no history of headaches was 10.7% more accelerated compared to patients who had a history of headache. The odds of recovery time for patients who were in critical infection status was 1.279 times higher compared to asymptomatic patients (OR ($e^{\beta}$) = 1.279; p-value = 0.005; CI = 0.076–0.417). This shows that the time to recovery for patients who were in critical infection status was 27.9% more prolonged compared to asymptomatic patients. The log odds of recovering for non-diabetic patients was 1.244 times more accelerated compared to diabetic patients (OR ($e^{\beta}$) = 1.244; p-value = 0.002; CI = 0.077–0.360). This shows the recovery time for diabetic patients was 24% more prolonged compared to non-diabetic patients, holding other covariates constant (Table 8).

## 5. Discussions

The current study attempted to estimate the median recovery time and identify determinant factors associated with the time to recover among COVID-19 patients admitted to different treatment centers from June 1, 2020, to June 30, 2022, in the Sidama region, Ethiopia.

The majority (69%) of the patients recovered, and the rest censored (32.18%). This is the least recovery proportion compared to other studies conducted in the Western part of Ethiopia (86.3%), Southern Nations, Nationalities and People's region (88.88%), South Central Ethiopia (83.8%) and Amhara region (86.82 %) [15,17–19]. This difference might be due to difference in study period or types of data the researchers used in the analysis.

The median recovery time of patients under treatment in the region was 14 days, with a minimum and maximum recovery time of 10 and 18 days, respectively. A study undertaken in the South Central Ethiopia also reported almost similar, 13 days, median recovery time [19]. However, this result contradicts with the results from studies conducted in other areas in the country [14–18]. This discrepancy could be sample size difference, study period and infection severity stage and the difference in infection identification time.

The current study shows that, cough 636 (61.27%), shortness of breath 565 (54.3%) and fever 543 (52.31 %) were the most common symptom observed among COVID-19 patients under treatment. This proportion is higher compared to the study conducted in Kuyha COVID-19 Isolation and Treatment Centre, Mekelle, North Ethiopia, where cough 354 (50.6 %) and fever 161 (23.6 %) were the most frequently observed clinical symptoms reported [21]. This proportion is lower than reports from study conducted in Dilla university Referral Hospital treatment center, Southern Ethiopia, where cough 209 (95 %), shortness of breath 153 (69.5 %), fever 133 (60.5 %) were the most common clinical symptoms [16]. The dissimilarities between the study findings might be due to sample size difference and length of study periods.

Based on the AFT regression analysis, age, headache, severity status at admission, and history of diabetes had a significant association with the recovery time of COVID-19 patients under treatment. The patients who were 65 years of age and older had a prolonged recovery time as compared to patients who were below 25 years old. This finding is consistent with a study [15,17,19] that reported that COVID-19 patients in the older age group had a prolonged recovery time compared to patients in the younger age group. This might be due to the presence of comorbidity conditions, compromised immunity, and degeneration of pulmonary function in older patients [15]. Patients who had a history of headaches showed a significantly slower recovery rate compared to patients who had no history of headaches. This finding is consistent with many other studies reporting that symptomatic patients need longer recovery times than asymptomatic patients [14,15]. This might be due to asymptotic patients being those who were at a severe COVID-19 infection level, which might prolong their recovery duration. Diabetic patients need prolonged recovery time compared to non-diabetic patients. Even though several studies revealed that comorbidities were one of the determinant factors that prolonged the recovery time of COVID-19 patients [15–17,19], other findings have reported no significant association between comorbidity and recovery time among COVID-19 patients [14,18]. The current study also shows that patients with a critical infection status at admission had a significantly slower recovery rate as compared to asymptomatic patients. This shows patients who are in critical

infection conditions need a longer recovery time than asymptomatic patients. A similar conclusion was drawn from other studies [18, 19] that confirmed patients who were in critical condition during admission time needed longer recovery times as compared to asymptomatic patients.

## Limitation of the study

The current has study used secondary data of COVID-19 patients admitted to different treatment centers in the Sidama region. Most of the cases were excluded during sample size determination due to the large number of missing observations in the data. So those patients excluded from the study could influence the estimated model coefficients and other model diagnostic statistics.

## CONCLUSION

This study found that patients of older age (>65 years old) who had a history of headaches, who were diabetic, and those who were in critical infection status at admission needed significantly more prolonged time to recovery from the COVID-19 infection.

## Recommendation

Health service providers should give special care and attention to elderly patients andpatients in the critical infection status. Emphasis should also be given to patients who had a history of comorbidity besides the treatment of COVID-19 infection. In addition, stakeholders should support health facilities for better care and treatment to decrease the length of recovery time among patients with COVID-19 infection. Further study is important to identify more determinant factor that were not included in the current study.

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## Availability of data and materials

Data will be made available on request.

## CRediT authorship contribution statement

**Samrawit Fantaw:** Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Dereje Danbe:** Writing – review & editing, Supervision, Methodology, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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