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Time to recovery of COVID-19 patients and its predictors: a retrospective cohort study in HUCSH, Sidama, Ethiopia

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Abstract

Introduction The 2019 COVID-19 pandemic had a global impact, leading to numerous deaths, long recovery times, and economic challenges worldwide, especially in countries with limited financial resources like Ethiopia. In Ethiopia, Hawassa lacks viral shedding information. Identifying predictors can help ease economic impact of illness.Therefore, this research aimed to examine the demographics, clinical features, and recovery time of COVID-19 patients, as well as determine predictive markers for severe adverse outcomes.

Methods Study at Hawassa University Comprehensive Speciality Hospital COVID-19 quarantine and therapy facility in Ethiopia (Sep 24, 2020 - Nov 26, 2021) with 804 patients. Extracted clinical, epidemiological, demographic info from medical records. Researchers used statistical tests like T tests, Chi-square tests, and Fisher's exact tests to analyze relationships between variables. They also used a Cox PH model to identify risk factors for COVID-19 patient recovery time. Significance level was set at 0.05 for all analyses.

Results Out of 804 COVID-19 patients, 74% recovered at an average age of 44.8 years, with 64.1% being male. Severe and critical cases were 24.1% and 21.4% of the population, respectively, with only 16.0% of critical cases and 19.5% of severe cases recovering. Average length of stay was 12.3 days. 88.4% of recovered patients had symptoms, with chest pain (66.7%), cough (64.4%), shortness of breath (59.2%), and fever (57.1%) being common. Nearly half had comorbidities, with diabetes (15.9%) and hypertension (15.2%) prevalent. Male patients had higher recovery rates, while severe/critical patients had lower rates. Patients over 39 age category had lower recovery chance. Existence of at least one comorbidities, diabetes, fever, and hypertension impacted recovery. Fever with gender and shortness of breath affected recovery. Assumptions were met with no multicollinearity.

Conclusions Recent studies found that about 95% of COVID-19 patients recover within 30 days, with a median of 12 days. Severe cases, elderly, and those with comorbidities may take longer to recover. By effectively managing hypertension and diabetes, individuals can improve their prognosis and facilitate a quicker recovery. Public health concerns persist regarding COVID-19, especially for comorbidities like diabetic and hypertension. Early detection of fever and treatment of hypertension may expedite recovery.

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Keywords Survival model, Cox model, Risk factors of death, COVID-19

Introduction

The coronavirus is associated with a novel strain of the severe acute respiratory syndrome coronavirus (SARS-CoV). The term "coronavirus" originates from the Latin word "corona," which describes the crown-like appearance of the virus particles [1, 2]. Since the 1960s, many strains of human coronaviruses have been identified and studied. Notable examples include SARS-CoV, which emerged in China in 2003; HCoV NL63, discovered in Amsterdam in 2004; HCoV HKU1, identified in Hong Kong in 2015; MERS-CoV, first reported in Saudi Arabia in 2012; and the more recent COVID-19 outbreak, which started in Wuhan, China, in 2019 [3–7]. These coronaviruses have been the focus of extensive virological research in various regions around the globe. COVID-19 emerged in Wuhan, China, in December 2019 and quickly spread globally [8]. Unfortunately, almost all countries have been affected within 6 months. The initial shock of the pandemic was uniform across economies due to the hard lockdown approach adopted by countries. However, because to varying vulnerabilities and levels of resilience, each nation and region has experienced COVID-19 differently.[9] As of June 28, 2022, COVID-19 had impacted over 549 million individuals globally, resulting in 6.3 million deaths, 525 million recoveries, and 17.8 million active cases despite widespread awareness.However, the pandemic is still affecting 36,558 people globally, with 17,779,458 current cases [10]. The COVID-19 pandemic has had varying effects on different global locations, with Europe having the highest number of cases followed by America, the Western Pacific, South East Asia, the Eastern Mediterranean, and Africa; the United States has the highest number of deaths, followed by Brazil, India, Russia, and Mexico [10].

Notably, Africa should not be overlooked despite the fact that Europe, the Americas, and the West Pacific are all severely impacted. Many African countries, particularly those with dense populations like Nigeria and Ethiopia, struggle to stop the virus's spread due to a lack of skilled workers, funding, and logistical infrastructure. Ethiopia, one of the most populous countries in Africa, saw a 2.64% rise in population from 2020 to 2021, totaling 120,283,026 people [11]. On March 13, 2020, the first case of COVID-19 was identified in Addis Ababa, Ethiopia. By November 26, 2020, 306 cases, 5 fatalities, and 113 recoveries had been documented. By June 28, 2022, however, there were 487,683 cases overall, including 7,532 fatalities, 459,714 recoveries, 20,437 active cases, and 46 severe cases [10].

This study seeks to address the ethnic diversity of the population living in Sidama regional state because Ethiopia's varied climatic conditions and the availability of diverse cultures among different ethnic groups make it difficult to generalize results from other locations of the world. The main goals of this study were to assess the length of recovery, evaluate the impact of various factors, identify the predictors of recovery status, look into the clinical features and patient demographics at Hawassa Comprehensive Specialty Hospital specifically, and identify relationships between the severity of the disease and the patient's outcome. This will reduce the number of new cases and deaths, prevent breakouts, minimize and eventually stop the spread of the pandemic, enhance the status of recovery, and shorten the recovery period.

Materials and methods

Study design and population

Patients who were hospitalized at the COVID-19 treatment center at Hawassa University Comprehensive Specialized Hospital (HUCSH) between September 24, 2020, and November 26, 2021 were examined using a single-center retrospective cohort research design centered on a hospital. The hospital is situated in Hawassa City, in the Sidama Regional State, 275 km away from Addis Ababa, the capital of Ethiopia. HUCSH, one of the region's leading hospitals, serves as a specialized teaching hospital at the regional level and supplies one of the recovery and treatment facilities during the COVID-19 expansion. The hospital provides care for around 3 million people in the surrounding areas as well as in other regions of the states of Central, Southern, and Oromia, Ethiopia.

All patients admitted to the hospital during the specified study period, who tested positive for COVID-19 with a confirmed laboratory report using real-time reverse transcriptase-polymerase chain reaction (RT-PCR) or a clinical diagnosis and/or radiological findings consistent with signs and symptoms, at Hawassa University Referral Hospital, were included in the analysis. Patients' ages ranged from 2 days to 100 years. The patient selection criteria comprised individuals whose primary reason for hospitalization was attributed to COVID-19 and came from different sources, as well as those in whom the presence of the virus was incidentally detected among patients receiving care in various departments of Hawassa University Comprehensive Speciality Hospital, possibly during their initial admission unrelated to COVID-19. The analytical unit was the patient as an individual. Since an individual may have been hospitalized at multiple hospitals during the observation period due to transfers between hospitals, we merged consecutively completed hospital stays into a single patient. Each patient was in the hospital for a minimum of 0.5 days

(discharges on the day of admission are counted as 0.5 days) and a maximum of 62 days. The study was conducted between September 24, 2020, and November 26, 2021.

Data collection tools and procedure

In a retrospective single-center cohort study, data was systematically gathered from the medical records of hospitalized patients, COVID-19 intake forms, and registration logbooks at Hawassa University Comprehensive Speciality Hospital. The information encompassed demographic details, clinical manifestations, symptoms, comorbidities, patient source, duration of hospitalization, and final outcomes. The diagnosis was established according to the guidelines outlined in the Ethiopian Ministry of Health's National Comprehensive COVID-19 Management Guide [41]. Certified medical professionals carefully reviewed the patients' medical histories to extract additional data following specialized training in data abstraction protocols, with daily oversight by the principal investigator to ensure data coherence and completeness. The scope of our analysis was restricted to patients undergoing treatment for COVID-19 and hospitalized from the initial observation date of September 24, 2020, until November 26, 2021, the latest date for data availability.

Study variables

The admission of patients entailed the consideration of various factors such as demographic variables (age, gender, report source (private hospital, home isolation or from the community, government hospital, and different wards of HUCSH)), the presence of comorbidities characterized by at least one cardiovascular conditions (such as chronic heart failure, anemia, ischemic heart disease, myocardial infarction, generalized edema, cardiomegaly, thrombocytopenia, including Hypertension), at least one trauma (including amputated leg, bullet injury, distal tibial fracture), renal diseases or virological conditions (such as acute kidney injury, bladder outlet obstruction, urinary tract infection), diabetes mellitus, hypertension only, malignancy or cancer (e.g., rectal cancer, bladder cancer, brain tumor, gastric cancer, sarcoma, esophageal cancer, cholangiocarcinoma, left breast cancer), HIV/RVI (Human Immunodeficiency virus/ status), and other respiratory conditions (e.g., Tuberculosis, Pulmonary Tuberculosis, Asthma, Lung abscess, Bronchi, Central Nervous System, and Tuberculoma), disease severity status (The severity classification of COVID-19 disease is based on the WHO Clinical management guidelines: Mild disease for symptomatic patients without signs of viral pneumonia, Moderate disease for those with pneumonia, Severe disease for severe pneumonia, and Critical disease for Acute Respiratory Distress Syndrome (ARDS) [17, 41]), Clinical and epidemiological factors present at admission (included fever, cough, shortness of breath, sore throat, generalized body weakness, chest pain, headache), and other unspecified symptoms (such as Hiccup, vomiting, loss of appetite, chills, myalgia, sneezing, easy fatigue, rapid breathing, chest tightness, epilepsy, weight loss, epigastric pain diarrhea, dyspepsia, and difficulty swallowing). Upon hospital release, the patient's status censored (due to death, transferred to other hospital and home isolation), recovered and the duration of hospital stay were the dependent variables in the Cox-PH model.

Statistical analysis

Descriptive analyses were performed using graphs (R library(vtree)), frequencies (%) for categorical variables, mean ± standard deviation (SD) for the normally distributed data, or median with range for Continuous variables. Additionally, we compared the characteristics of patients hospitalized in the medical ward to those different severity and recovery status using the Chi-square or Fisher exact test when appropriate. A separate Kaplan–Meier survivor functions curve was constructed to estimate the survival time based on different predictors to see the existence of differences in recovery rate between categories of individual predictors and the log-rank test was applied to compare the survival experience of different Covariates. Correlation matrix were develop to check the correlation between the independent variable to apply multivariate Cox model. Furthermore, a uni-variate and multivariate Cox regression analysis approach were used to identify the potential risk factors associated with the duration of recovery time among COVID-19 patients. In order to conduct data analysis using a multivariate model, we employed both forward and backward selection procedures. This involved incorporating all variables from a univariate analysis, as well as selected interactions, in the first stage. We then removed any variables that did not meet assumptions by testing for stratification using Cox.zph based on p-values and checking for multicollinearity using VIF. To ensure the significance of our results and determine whether the elimination of one variable significantly impacted the coefficients of others, we conducted a likelihood ratio test. Additionally, we examined each variable for non-linearity, looked for interactions, and assessed the proportional hazard assumption through the Schoenfeld residual test. To obtain the most suitable model for our specific case, we compared the final best-fitted models selected through both forward and backward selection procedures using AIC and BIC with the "selectcox" package. Finally, we conducted time-to-event analyses using the "survminer" and "survival" libraries in R (version 4.2.1) for our statistical studies.

Inclusion and exclusion criteria

Inclusion criteria encompassed all patients within the designated timeframe who presented with laboratory-confirmed infection via real-time reverse transcriptase-polymerase chain reaction (RT-PCR) or a clinical diagnosis and/or radiological findings consistent with signs and symptoms of COVID-19, and were duly included in the study. Patients who sought medical attention prior to 24/9/2020 and subsequent to 26/11/2021 were excluded, while select incomplete hospital records from patients' follow-up cards were incorporated.

Result

Socio-demographic characteristics of COVID-19 patients

A total of 804 COVID-19 patients from September 24, 2020, to November 26, 2021, were included in this study. Out of the participants, 595 patients (74%) recovered, with a median age of 40, ranging from 2 days to 95 years. The censored group was significantly older, with a median age of 57, and ages ranged from 9 days to 100 years. The recovery group had a median hospital stay of 12.0 days, with an average duration from admission to discharge of 12.3 days (standard deviation of 6.69 days). (Refer to Table 1; Fig. 1 for more details.)

Results from Fig. 1 revealed that patients in the age category under 39 exhibited a significantly augmented probability of recovering from COVID-19 in comparison to those in the highest age category of (59,69] and (69, Inf] (84.4% vs. 65.5% and 53.3%, chi-square (4 df) = 47.7, $p < 0.0001$). Furthermore, 368 (61.8%) recovered patients were men, and 227 (38.2%) were Female. The proportion of female patients have significantly higher chance of COVID-19 recovery compared to males (78.5% vs. 71.5%, chi-square (1 df) = 4.8377, $p = 0.02784$) (Table 1) and there was significant association with the recovery category ($p = 0.027$). Probing the source of the patients, 440 (73.9%) were from Hawassa University Comprehensive Specialized Hospital, 62 (10.4%) were from private hospitals, 56 (9.4%) were from other government hospitals, and 37 (6.2%) patients were from home isolation or community have recovered. Patients from home isolated and HUCSH have significantly higher chance of COVID-19 Recovery compared to patients from private and government hospitals (82%,78%,vs. 62% and 57.7% chi-square (3 df) = 27.79, $p < 0.001$) Table 1.

Recovery rates tend to be significantly higher in cases categorized as mild or moderate in comparison to those classified as severe or critical. Analyzing the distribution of recoveries based on severity level, it is evident that 176 (29.6%) recoveries were attributed to mild cases, 207 (34.8%) to moderate cases, 116 (19.5%) to severe cases, and 96 (16.1%) to critical cases. In addition, the severity on admission ranged increases from mild to critical, the chance of COVID-19 recovery significantly decreased (89.3%, 85.9%, 59.8% and 55.8% chi-square (3 df) = 91.74, $p < 0.001$), and only 55.8% of the total critical patients recover (Fig. 2; Table 1). On the contrary, the censored group expands as the severity level escalates from mild to critical. This trend may be attributed to the heightened risk of mortality associated with the progression of pneumonia from a mild stage to acute respiratory distress syndrome. Additionally, most study participants did not visit the health facility before the onset of symptoms, and 188 (23%) visited hospitals before the onset of symptoms.

Baseline symptom prevalence and outcomes of COVID-19 cases

The study showed that the most common clinical signs/symptoms observed in recovered COVID-19 patients were general body weakness (56.2%), shortness of breath (65.7%), cough (68.7%), and chest pain (68.9%). These symptoms were found to be significantly associated with the recovery status. On the other hand, fever, sore throat, headache, and chest pain were also common, but not significantly associated with the recovery status. The study also found that symptomatic patients had a smaller recovery percentage than non-symptomatic patients. Interestingly, individuals who had fewer than three symptoms were more likely to recover from COVID-19 than those who had three to five or more symptoms. The recovery rates for patients with fewer than three symptoms, three to five symptoms, and more than five symptoms were 87.9%, 74.5%, and 60.3%, respectively. This difference was statistically significant (chi-square (2 df) = 33.58, $p < 0.001$), Table 2.

Baseline co-morbidity prevalence and outcomes of COVID-19 cases

Out of the 395 patients who had one co-morbidity, 267 (67.6%) were able to recover. Conversely, 267 (44.9%) of the patients who recovered had at least one co-morbidity. As the number of coexisting co-morbidities increase, the proportion of recovery decreases. Among COVID-19 patients, diabetes was the most common co-morbidity, with hypertension, other respiratory disorders, cancer, trauma, and HIV following closely behind. The result showed a significant association ($p < 0.05$) between the number of comorbidities, particularly cardiovascular conditions such as hypertension, diabetes, and the presence of at least one comorbidity with the likelihood of recovery. Patients with the specified comorbidities exhibited the lowest proportion of recovery from COVID-19 compared to those without comorbid conditions (refer to Tables 1 and 3). In contrast, patients with cancer displayed a higher recovery rate.

Table 1 Socio-demographic and background characteristics and outcomes of COVID-19 cases admitted to treatment centers of Hawassa University Comprehensive Specialty Hospital, Sidama Region, Ethiopia from September 24, 2020, to November 8, 2021. (count, percent, proportion)

	Censored (*N* = 209)	**Recovered (*N* = 595)**	**MD [95% CI]**	**TukeyHSD *P*-Value**
Age of Patient				
Mean (SD)	53.5 (19.7)	41.8 (20.1)	-11.7 [-14.89, -8.58]	< 0.001
Median[Min, Max]	57.0[0.025,100]	40.0[0.006,95.0]		
Difference between date of admission and onset (DADM_DONS)				
Mean (SD)	5.74 (5.10)	6.00 (5.28)	0.26 [-0.66, 1.18]	0.577
Median[Min, Max]	5.00[0,43.0]	5.00[0,51.0]		
Missing	33 (15.8%)	156 (26.2%)		
Difference between date of discharge and onset				
Mean (SD)	12.6 (7.86)	18.0 (8.15)	5.36 [3.93, 6.79]	< 0.001
Median [Min, Max]	11.0 [1.00,46.0]	17.0 [1.00, 63.0]		
Missing	39 (18.7%)	160 (26.9%)		
Difference between date of discharge and admission				
Mean (SD)	6.86 (7.01)	12.3 (6.69)	5.4[4.33, 6.49]	< 0.001
Median [Min, Max]	5.00[0.5,60.0]	12.0[0.50,53.0]		
Missing	6 (2.9%)	4 (0.7%)		
Sex			**Overall***N* = **804**	**P-Value**
Female	62 (29.7%,0.215)	227(38.2%,0.785)	289 (35.9%)	0.027
Male	147(70.3%,0.285)	368(61.8%, 0.715)	515 (64.1%)	
Age category				
(0,39]	51 (24.4%,0.156)	276 (46.4%,0.844)	327 (40.7%)	< 0.001
(39,49]	28 (13.4%,0.248)	85 (14.3%,0.752)	113 (14.1%)	
(49,59]	32 (15.3%,0.271)	86 (14.5%,0.729)	118 (14.7%)	
(59,69]	48 (23.0%,0.345)	91 (15.3%,0.655)	139 (17.3%)	
(69,Inf]	50 (23.9%,0.467)	57 (9.6%,0.533)	107 (13.3%)	
Source of Reporting				
Private	38 (18.2%,0.380)	62 (10.4%,0.620)	100 (12.4%)	< 0.001
Community	8 (3.8%,0.178)	37 (6.2%,0.822)	45 (5.6%)	
Government	41 (19.6%,0.423)	56 (9.4%,0.577)	97 (12.1%)	
From HUCSH	122 (58.4%,0.217)	440 (73.9%,0.783)	562 (69.9%)	
Severity status (sevstat2)				
Mild	21 (10.0%,0.107)	176 (29.6%,0.893)	197 (24.5%)	< 0.001
Moderate	34 (16.3%,0.141)	207 (34.8%0.859)	241 (30.0%)	
Sever	78 (37.3%,0.402)	116 (19.5%,0.598)	194 (24.1%)	
Critical	76 (36.4%,0.442)	96 (16.1%,0.558)	172 (21.4%)	
HFVBOS				
No	161 (77.0%,0.261)	455 (76.5%,0.739)	616 (76.6%)	0.869
Yes	48 (23.0%,0.255)	140 (23.5%,0.745)	188 (23.4%)	
Symptoms (At least one symptom)				
No	11 (5.3%,0.138)	69 (11.6%,0.863)	80 (10.0%)	0.009
Yes	198 (94.7%,0.273)	526 (88.4%,0.727)	724 (90.0%)	
UCC				
No	80 (38.3%,0.196)	328 (55.1%,0.804)	408 (50.7%)	< 0.001
Yes	128 (61.2%,0.324)	267 (44.9%,0.676)	395 (49.1%)	

MD = Mean Difference of Recovered and Censored Patients, CI = 95% Confidence Interval

Demographic factors with severity status

Out of a total of 804 reported cases of COVID-19, 194 were classified as severe and 172 were critical. Interestingly, over 60% of patients in both groups were male. Additionally, it was discovered that 59.7% (116 cases) of severe patients and 54% (93 cases) of critically ill patients were aged 49 or older. The majority of severe and critical cases (50% and 76.7%, respectively) were reported from Hawassa University Comprehensive Specialty Hospital (HUCSH) across various wards, while only a small percentage (5.6%) of severe and critical cases were

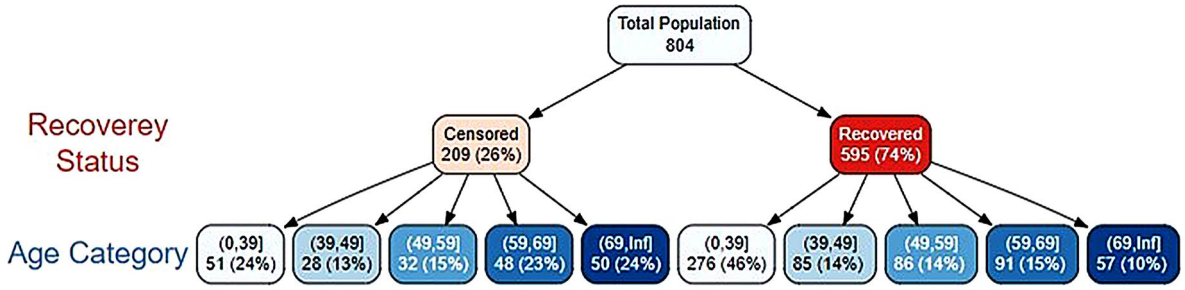

Fig. 1 Recovery status by age category among COVID-19 cases at HUCSH treatment centers, Sidama Region, Ethiopia, from Sept. 24, 2020, to Nov. 26, 2021.

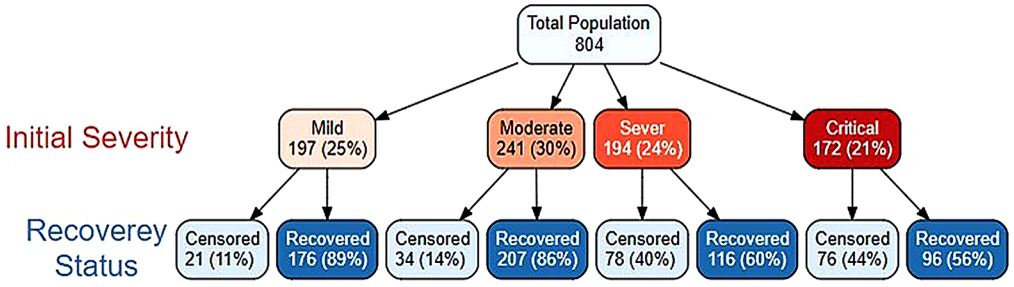

Fig. 2 Recovery status by severity level among COVID-19 cases at HUCSH, Sidama Region, Ethiopia, from Sept 24, 2020, to Nov 26, 2021

from isolated patients at home. Notably, 63% of the 100 patients reported from private hospitals were also classified as severe or critically ill, Table 4.

Presence of clinical characteristics with severity status of COVID-19

Among the 804 patients observed, 194 were classified as severe cases and 172 were critically ill. Notably, 97.9% of severe cases and 94.8% of critical cases exhibited at least one symptom. Additionally, more than three symptoms were experienced by 92.2% of severe cases and 89% of critical cases. The most common symptoms among severe cases were sore throat (34.0%), headache (52.1%), fever (56.7%), general body weakness (72.2%), chest pain (80.4%), cough (85.1%), and shortness of breath (87.1%). Similarly, sore throat (43.0%), headache (55.2%), general body weakness (60.5%), chest pain (68.0%), fever (71.5%), cough (71.5%), and shortness of breath (72.7%) were the most common symptoms observed among critical cases. More than half of the critically and severely ill patients had at least one co-morbidity. Hypertension, diabetes, and cardiovascular conditions were prevalent among them. Multiple co-morbidities were present in around 18% of severe and 16% of critically ill cases. Renal disorders were found in 4.6% of severe and 1.7% of critically ill patients. Finally, other respiratory conditions were reported by 7.2% of severe and 4.7% of critically ill patients.

Certain medical conditions, particularly the presence of comorbidities such as diabetes, as well as the occurrence of trauma, have a significant association with the severity of the disease. Patients with at least one comorbidity, especially diabetes mellitus, are more likely to experience critical or severe conditions. Additionally, the occurrence of trauma further increases the likelihood of patients getting a status critical. Various cardiovascular conditions, specifically hypertension are also linked to a higher incidence of evolving into critical and severe states. Furthermore, patients with renal diseases, respiratory conditions, or retroviral infections (such as HIV) were at increased risk of showing severe symptoms compared to those without these conditions; however, there is no significant association with severity status (Table 4).

Estimation of survival over time to recovery for various covariates

The survival function for time to recovery with 95% confidence intervals, estimated using the Kaplan-Meier technique, is shown in Fig. 3. The intersection of the horizontal red line (indicating a 50% chance of survival) with the curve on the x-axis represents the expected median survival duration of 12 days.

The overall graph of the Kaplan-Meier survival function revealed that the curve tends to rapidly drop between 7 and 20 days. In the first 5 days after being admitted to the hospital, only 8.3% of cases had recovered but by 10 days 38.2% had recovered; by 12 days, 50% had recovered; by 20 days 88.2% had recovered and by 25 days 92.9% had recovered.

Table 2 Baseline Presence of symptoms and outcomes of COVID-19 cases admitted to treatment centers of Hawassa University Comprehensive Specialty Hospital, Sidama Region, Ethiopia from September 24, 2020, to November 26, 2021. (count, percent, proportion)

	Other (*N* = 209)	Recovered (*N* = 595)	Overall (*N* = 804)	*P*-Value
Num-symp ≤ **3**	19 (9.1%0.0.121)	138 (23.2%,0.879)	157 (19.5%)	< 0.001
3 to 5	115 (55.0%,0.255)	336 (56.5%,0.745)	451 (56.1%)	
Above 5	73 (34.9%,0.397)	111 (18.7%,0.603)	184 (22.9%)	
Fever **No**	85 (40.7%,0.251)	253 (42.5%,0.749)	338 (42.0%)	0.651
Yes	123 (58.9%,0.266)	340 (57.1%,0.734)	463 (57.6%)	
Cough **No**	40 (19.1%0.159)	211 (35.5%,0.841)	251 (31.2%)	< 0.001
Yes	169 (80.9%0.306)	383 (64.4%,0.694)	552 (68.7%)	
ShBreath **No**	33 (15.8%,0.120)	243 (40.8%,0.880)	276 (34.3%)	< 0.001
Yes	176 (84.2%,0.333)	352 (59.2%,0.667)	528 (65.7%)	
Sore throat **No**	130 (62.2%,0.241)	409 (68.7%,0.759)	539 (67.0%)	0.0708
Yes	78 (37.3%,0.301)	181 (30.4%,0.699)	259 (32.2%)	
Head-ache **No**	106 (50.7%,0.233)	349 (58.7%,0.767)	455 (56.6%)	0.039
Yes	103 (49.3%,0.298)	243 (40.8%,0.702)	346 (43.0%)	
GBW **No**	58 (27.8%,0.166)	291 (48.9%,0.834)	349 (43.4%)	< 0.001
Yes	151 (72.2%,0.334)	301 (50.6%,0.666)	452 (56.2%)	
Pain **No**	52 (24.9%,0.209)	197 (33.1%,0.791)	249 (31.0%)	0.026
Yes	157 (75.1%,0.283)	397 (66.7%,0.717)	554 (68.9%)	
NSS **No**	193 (92.3%,0.268)	527 (88.6%,0.732)	720 (89.6%)	0.125
Yes	16 (7.7%,0.190)	68 (11.4%,0.810)	84 (10.4%)	

Numsymp: Number of symptoms, Sh.Breath: Shortness of Breath, Pain: Chest pain, GBW: General body weakness, NSS: Non-specified symptoms

Using Kaplan–Meier survival analysis (Fig. 4), we found that the time to recovery of COVID-19 patients was associated with disease severity, which was significantly delayed in patients who were Critical and sever cases compared with that of patients in the mild and moderate (log-rank test, $P < 0.0001$). Compared with patients with highest age category to patients with low low (0,39] showed a significant delay in the recovery time (log-rank test, $P < 0.0001$), but this did not vary with the history of health facility visit before the symptoms onset and sex difference.

Based on the symptoms reported at the time of COVID-19 diagnosis, Fig. 5 illustrates the likelihood of recovery. Individuals who experienced symptoms had a significantly lower chance of recovery compared to those who did not, regardless of the type of symptom (such as general body weakness, cough, or shortness of breath), with p values < 0.05. However, symptoms such as fever, sore throat, headaches, chest pain, or non-specific symptoms did not significantly affect the likelihood of recovery. Moreover, individuals reporting three to five or more than five symptoms at baseline had a longer recovery time (log-rank test, $P = 0.014$, Fig. 5).

Figure 6 shows the likelihood of recovery based on various comorbidities that were present at the time of COVID-19 diagnosis. Individuals with at least one comorbidity had a considerably reduced chance of recovery compared to those without, with p values < 0.05. This was especially true for those with diabetes and other respiratory conditions (such as TB, PTB, Asthma, Lung Abscess, Bronchi, CNS, and Tuberculoma). However, comorbidities such as renal disease, cardiovascular disease (including hypertension), hypertension, cancer, RVI/HIV, or trauma did not significantly affect the likelihood of recovery. Moreover, individuals with greater comorbidities had a worse chance of recovering compared to those without comorbidities (log-rank test, $P = 0.00073$, Fig. 6).

Predictors of time to recovery from COVID-19

Based on the findings presented in Table 5 from the univariate Case Specific Hazard (CSH) analysis, it was determined that patients with critical and severe COVID-19 status had significantly lower chances of recovery compared to those with mild symptoms. Additionally, age was identified as a significant predictor of COVID-19 recovery time from all causes. However, factors such as hospital visits before symptoms, sexual orientation, and reporting sources did not appear to be major risk factors for recovery time. Patients with at least one symptom, particularly those with more than five symptoms, experienced a longer length of stay and a lower rate of recovery compared to those without symptoms. Certain symptoms such as cough, shortness of breath, and general body weakness were also associated with a lower chance of recovery. Patients with comorbidities such as diabetes and respiratory conditions had significantly lower chances of recovery. However, comorbidities such as hypertension, RVI/HIV, cardiovascular diseases, renal disease, cancer, and trauma were not found to be significantly associated with recovery chances in the univariate analysis.

A study used a multivariate Cox regression analysis to determine the rate of recovery for COVID-19 patients who were hospitalized. The findings, presented in Table 6, indicate that male patients recovered more quickly than female patients (AHR = 1.44, 95% CI:

Table 3 Baseline Presence of comorbidity and outcomes of COVID-19 cases admitted to treatment centers of Hawassa University Comprehensive Specialty Hospital, Sidama Region, Ethiopia from September 24, 2020, to November 26, 2021. (count, percent, proportion)

		Other (N = 209)	Recovered (N = 595)	Overall (N = 804)	P-Value
Numsymp	≤ **3**	19 (9.1%,0.121)	138 (23.2%,0.879)	157 (19.5%)	< 0.001
	3 to 5	115 (55.0%,0.255)	336 (56.5%,0.745)	451 (56.1%)	
	Above 5	73 (34.9%,0.397)	111 (18.7%,0.603)	184 (22.9%)	
Fever	**No**	85 (40.7%,0.251)	253 (42.5%,0.749)	338 (42.0%)	0.651
	Yes	123 (58.9%,0.266)	340 (57.1%,0.734)	463 (57.6%)	
Cough	**No**	40 (19.1%0.159)	211 (35.5%,0.841)	251 (31.2%)	< 0.001
	Yes	169 (80.9%0.306)	383 (64.4%,0.694)	552 (68.7%)	
ShBreath	**No**	33 (15.8%,0.120)	243 (40.8%,0.880)	276 (34.3%)	< 0.001
	Yes	176 (84.2%,0.333)	352 (59.2%,0.667)	528 (65.7%)	
Sore throat	**No**	130 (62.2%,0.241)	409 (68.7%,0.759)	539 (67.0%)	0.0708
	Yes	78 (37.3%,0.301)	181 (30.4%,0.699)	259 (32.2%)	
Headache	**No**	106 (50.7%,0.233)	349 (58.7%,0.767)	455 (56.6%)	0.039
	Yes	103 (49.3%,0.298)	243 (40.8%,0.702)	346 (43.0%)	
GBW	**No**	58 (27.8%,0.166)	291 (48.9%,0.834)	349 (43.4%)	< 0.001
	Yes	151 (72.2%,0.334)	301 (50.6%,0.666)	452 (56.2%)	
Pain	**No**	52 (24.9%,0.209)	197 (33.1%,0.791)	249 (31.0%)	0.026
	Yes	157 (75.1%,0.283)	397 (66.7%,0.717)	554 (68.9%)	
NSS	**No**	193 (92.3%,0.268)	527 (88.6%,0.732)	720 (89.6%)	0.125
	Yes	16 (7.7%,0.190)	68 (11.4%,0.810)	84 (10.4%)	

NCom: Number of Comorbidity, HTN: Hypertension, OResConB: Other Respiratory Conditions, DM: Diabetic Mellitus, CVC: Cardiovascular conditions, RD: Renal Disease

1.10–1.90). The recovery status of patients aged 39 to 69 was more than 30% worse than that of patients aged under 39 (AHR = 0.71; 95% CI: 0.54, 0.92, AHR = 0.61; 95% CI: 0.47, 0.81, AHR = 0.52; 95% CI: 0.40, 0.69 and AHR = 0.53; 95% CI: 0.39, 0.73 correspondingly). The likelihood of recovery was decreased for older patients. The prognosis was worse for patients who were categorized as critical or severe (AHR = 0.70, 95%CI: 0.52, 0.94; P = 0.017, AHR = 0.74, 95%CI: 0.548, 0.997; P = 0.048, respectively). Patients whose source of reporting was from HUCSH had a lower probability of recovery than those from private sources (AHR = 0.81, 95%CI: 0.47, 0.86; P = 0.003). Patients with at least one comorbidity disease and diabetes mellitus had a lower status of recovery (AHR = 2.48, 95% CI: 0.654, 0.999; P = 0.049, AHR = 0.68, 95% CI: 0.50, 0.92; P = 0.013 respectively). Patients with a fever symptom and hypertension had an increased status of recovery (AHR = 1.77, 95% CI: 1.20, 2.61; P = 0.004, AHR = 1.58, 95% CI: 1.17, 2.13; P = 0.003 respectively).

Finally, the study found that fever symptoms of COVID-19 had a significant interaction effect with gender and shortness of breath, which influenced the probability of recovery. The study showed that males with fever symptoms had a 13.6% decrease in the likelihood of recovery (AHR: 0.60, 95% CI: 0.42, 0.86, P = 0.004). On the other hand, patients with both fever symptoms and shortness of breath upon admission showed a 23.9% improvement in the likelihood of recovery (AHR: 0.70, 95% CI: 0.55, 0.90, P = 0.005). The study confirmed that the proportional hazard assumption satisfied the Schoenfeld residual test, there was no multicollinearity based on the variance inflation factor (VIF) result, and the small Akaike information criterion (AIC) value determined which model was the best.

Discussion

The research discovered that 95% of patients recovered their health after a maximum of 30 days. These results are consistent with previous studies conducted in Jimma, Ethiopia [12], and Guangzhou, China [13], which reported recovery rates of 92% within 33 days and 94.4% within 28 days, respectively. The recovery period for COVID-19 ranged from 0.50 to 53 days, with a median recovery time of 12 days. This median recovery time is comparable to findings from studies conducted in the Southern Nations Nationalities and Peoples Region (SNNPR) in 10 days [15], Southwestern Ethiopian in 10 days [12], the Amhara regional state of Ethiopia in 11 days [14], Bekoji, Ethiopia in 13 days [17], the Millennium Covid-19 Care Center [18] and Assosa western Ethiopia [32] in 16 days. Other similar retrospective case studies conducted in China 10 days [16], South Wales in 10 days [30], Guangzhou, in China 12 days [13], Singapore in 12 days [27], and also a comparable recovery times 17 to 21 days have reported [19–24, 31] in different area around the world. A study conducted in Tigray,

Table 4 Descriptive statistics for demography and baseline clinical characteristics and subgroups by the severity status of 804 Covid-19 patients in HUCSH, 2022

		Moderate (N = 241)	Sever (N = 194)	Critical (N = 172)	Overall (N = 804)	P-value
Sex						
Female	76 (38.6%)	79 (32.8%)	76 (39.2%)	58 (33.7%)	289 (35.9%)	0.576
Male	121(61.4%)	162 (67.2%)	118 (60.8%)	114(66.3%)	515 (64.1%)	
Age category (0,39]	119 (60.4%)	101 (41.9%)	47 (24.2%)	60 (34.9%)	327 (40.7%)	< 0.001
(39,49]	24 (12.2%)	39 (16.2%)	31 (16.0%)	19 (11.0%)	113 (14.1%)	
(49,59]	20 (10.2%)	33 (13.7%)	29 (14.9%)	36 (20.9%)	118 (14.7%)	
(59,69]	20 (10.2%)	41 (17.0%)	46 (23.7%)	32 (18.6%)	139 (17.3%)	
(69,Inf]	14 (7.1%)	27 (11.2%)	41 (21.1%)	25 (14.5%)	107 (13.3%)	
Sorep						
Private	13(6.6%)	24(10.0%)	46(23.7%)	17(9.9%)	100(12.4%)	< 0.001
Community	19(9.6%)	16 (6.6%)	6(3.1%)	4 (2.3%)	45 (5.6%)	
Government	12(6.1%)	21(8.7%)	45(23.2%)	19 (11.0%)	97 (12.1%)	
From HUCSH	153(77.7%)	180(74.7%)	97(50.0%)	132(76.7%)	562(69.9%)	
Symptomatic						
No	58 (29.4%)	9 (3.7%)	4 (2.1%)	9 (5.2%)	80 (10.0%)	< 0.001
Yes	139 (70.6%)	232 (96.3%)	190 (97.9%)	163(94.8%)	724 (90.0%)	
Fever						
No	122 (61.9%)	85 (35.3%)	84 (43.3%)	47 (27.3%)	338 (42.0%)	< 0.001
Yes	74 (37.6%)	156 (64.7%)	110 (56.7%)	123(71.5%)	463 (57.6%)	
Cough						
No	114 (57.9%)	59 (24.5%)	29 (14.9%)	49 (28.5%)	251 (31.2%)	< 0.001
Yes	83 (42.1%)	181 (75.1%)	165 (85.1%)	123(71.5%)	552 (68.7%)	
ShBreath						
No	123 (62.4%)	81 (33.6%)	25 (12.9%)	47 (27.3%)	276 (34.3%)	< 0.001
Yes	74 (37.6%)	160 (66.4%)	169 (87.1%)	125(72.7%)	528 (65.7%)	
Sorethroat						
No	160 (81.2%)	155 (64.3%)	127 (65.5%)	97 (56.4%)	539 (67.0%)	< 0.001
Yes	35 (17.8%)	84 (34.9%)	66 (34.0%)	74 (43.0%)	259 (32.2%)	
Headache						
No	135 (68.5%)	151 (62.7%)	92 (47.4%)	77 (44.8%)	455 (56.6%)	< 0.001
Yes	62 (31.5%)	88 (36.5%)	101 (52.1%)	95 (55.2%)	346 (43.0%)	
GBW						
No	132 (67.0%)	96 (39.8%)	53 (27.3%)	68 (39.5%)	349 (43.4%)	< 0.001
Yes	65 (33.0%)	143 (59.3%)	140 (72.2%)	104(60.5%)	452 (56.2%)	
Chest Paine						
No	88 (44.7%)	69 (28.6%)	38 (19.6%)	54 (31.4%)	249 (31.0%)	< 0.001
Yes	109 (55.3%)	172 (71.4%)	156 (80.4%)	117(68.0%)	554 (68.9%)	
HFVBOS						
No	139 (70.6%)	192 (79.7%)	143 (73.7%)	142(82.6%)	616 (76.6%)	0.0479
Yes	58 (29.4%)	49 (20.3%)	51 (26.3%)	30 (17.4%)	188 (23.4%)	
Numsymp						
≤ 3	95 (48.2%)	33 (13.7%)	14 (7.2%)	15 (8.7%)	157 (19.5%)	< 0.001
3 to 5	74 (37.6%)	162 (67.2%)	105 (54.1%)	110(64.0%)	451 (56.1%)	
Above 5	25 (12.7%)	42 (17.4%)	74 (38.1%)	43 (25.0%)	184 (22.9%)	
UCC						
No	139 (70.6%)	104 (43.2%)	93(47.9%)	72 (41.9%)	408 (50.7%)	< 0.001
Yes	58 (29.4%)	137 (56.8%)	101(52.1%)	99 (57.6%)	395 (49.1%)	
RVI /HIV						
No	190 (96.4%)	231 (95.9%)	183(94.3%)	168(97.7%)	772 (96.0%)	0.282
Yes	5 (2.5%)	8 (3.3%)	10 (5.2%)	2 (1.2%)	25 (3.1%)	
HTN						
No	180 (91.4%)	202 (83.8%)	159(82.0%)	141(82.0%)	682 (84.8%)	0.0594

Table 4 (continued)

		Moderate (N = 241)	Sever (N = 194)	Critical (N = 172)	Overall (N = 804)	P-value
Sex						
Yes	17 (8.6%)	39 (16.2%)	35 (18.0%)	31 (18.0%)	122 (15.2%)	
OResCon						
No	192 (97.5%)	228 (94.6%)	180(92.8%)	164(95.3%)	764 (95.0%)	0.324
Yes	5 (2.5%)	13 (5.4%)	14 (7.2%)	8 (4.7%)	40 (5.0%)	
DM						
No	187 (94.9%)	204 (84.6%)	154(79.4%)	131(76.2%)	676 (84.1%)	< 0.001
Yes	10 (5.1%)	37 (15.4%)	40 (20.6%)	41 (23.8%)	128 (15.9%)	
CVC						
No	166 (84.3%)	184 (76.3%)	147(75.8%)	127(73.8%)	624 (77.6%)	0.135
Yes	31 (15.7%)	57 (23.7%)	47 (24.2%)	45 (26.2%)	180 (22.4%)	
NCom						
No	136(69.0%)	103(42.7%)	95(49.0%)	74(43.0%)	408(50.7%)	< 0.001
One	50(25.4%)	110(45.6%)	62(32.0%)	69(40.1%)	291(36.2%)	
2 and above	11(5.6%)	27(11.2%)	36(18.6%)	28(16.3%)	102(12.7%)	
NSS						
No	166 (84.3%)	217 (90.0%)	174(89.7%)	163(94.8%)	720 (89.6%)	0.0271
Yes	31 (15.7%)	24 (10.0%)	20 (10.3%)	9 (5.2%)	84 (10.4%)	
Cancer						
No	190(96.4%)	227 (94.2%)	189 (97.4%)	168(97.7%)	774 (96.3%)	0.333
Yes	7 (3.6%)	14 (5.8%)	5 (2.6%)	4 (2.3%)	30 (3.7%)	
RD						
No	191(97.0%)	237 (98.3%)	184 (94.8%)	169(98.3%)	781 (97.1%)	0.349
Yes	6 (3.0%)	4 (1.7%)	9 (4.6%)	3 (1.7%)	22 (2.7%)	
Trauma						
No	192(97.5%)	222 (92.1%)	190 (97.9%)	156(90.7%)	760 (94.5%)	0.0027
Yes	4 (2.0%)	18 (7.5%)	4 (2.1%)	16 (9.3%)	42 (5.2%)	

Sorep: Patient source of reporting, Symptomatic: Occurrence of at least one symptom, Fever: Fever at the Baseline, Cough: Cough at the Baseline, ShBreath: Shortness of Breath at the Baseline, Sorethroat: Sore throat at the Baseline, Headache: Headache at the Baseline, GBW: General Body Weakness at the Baseline, HFVBOS: Health facility visit before onset, Numsymp: Number of symptoms observed, UCC: Occurrence of at least one Underline comorbidityconditions, HTN: Hypertension, OResCon: Other Respiratory Conditions, DM: Diabetes Mellitus, CVC: Cardiovascular conditions, NCom: Number of Comorbidity, NSS: Non specified symptoms, RD: Renal Disease

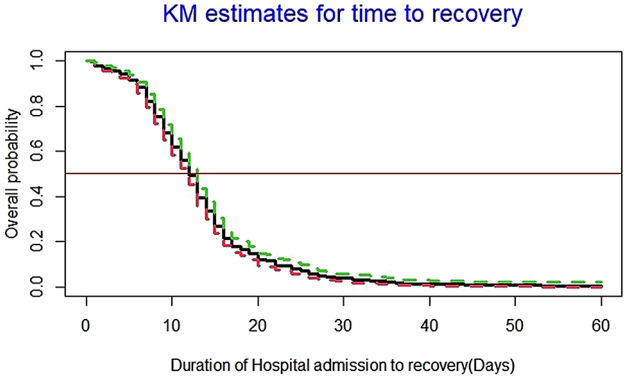

Fig. 3 Time to recovery estimate using the Kaplan-Meier method among COVID-19 patients at HUCSH in Hawassa, Ethiopia

Ethiopia, found that severe illnesses necessitate an average recovery period of 26 days [25]. This finding aligns with our results in the Kaplan Meier plot, which indicate that severe and critical conditions typically result in longer recovery times. In comparison, patients from Dilla, Ethiopia, took an average of (5 days) [26], Saudi Arabia (6.0 days) [35], and South India (7 days) [29] to recover. The disparities in recovery times can attributed to various factors, including differences in the quality of care, organizational structures, healthcare providers' qualifications, socioeconomic status, the timing of the studies, and the expertise of healthcare professionals.

In both univariate and multivariable analyses, recovery time was significantly predicted by age, severity status, history of comorbidity, and diabetes. Symptoms such as cough, shortness of breath, and general body weakness were significant predictors in univariate analysis; and in multivariable analysis, significant predictors included sex, source of reporting, fever, hypertension, and interactions between sex and fever, as well as fever and shortness of breath.

The study revealed that males exhibited a heightened susceptibility to contracting COVID-19 compared to females, a trend substantiated by various researchers in Ethiopia and globally [12, 14, 17, 19, 20, 25, 28]. However,

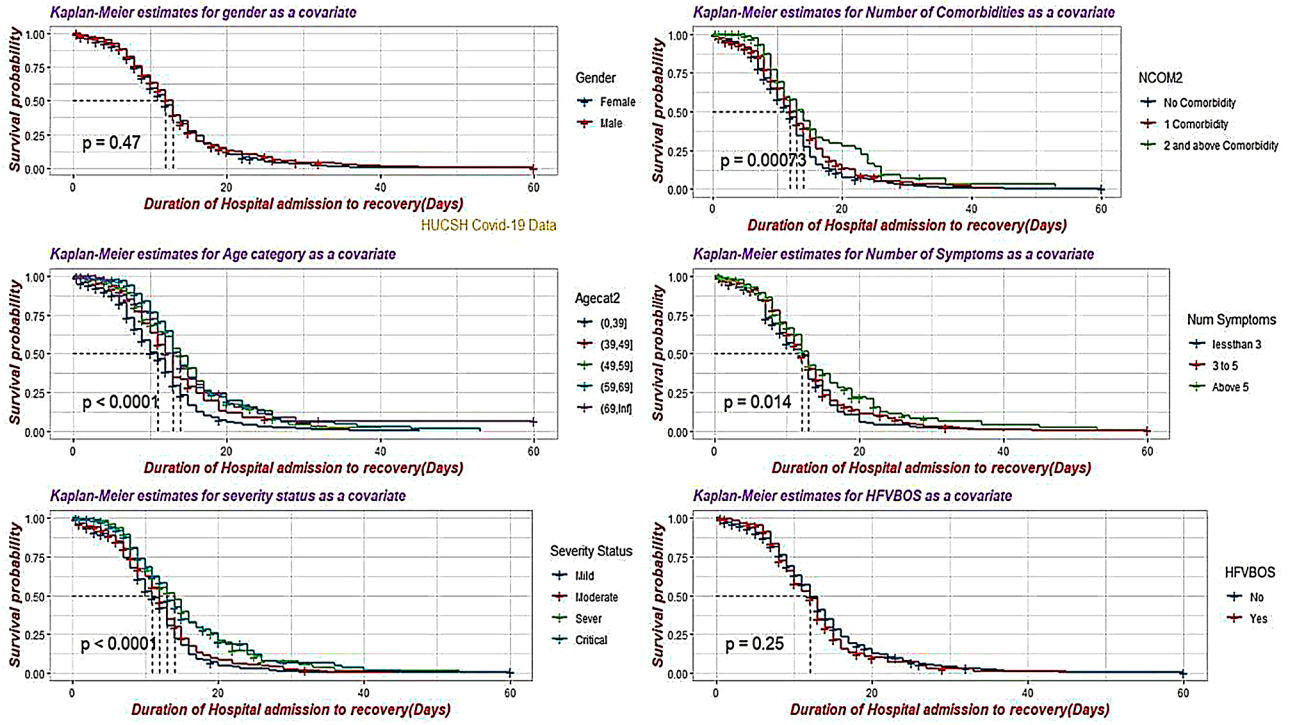

Fig. 4 Comparison between the survival curves of demographic, number of comorbidity, and number of symptoms variables on time to recovery. The number of symptoms, number of comorbidity, Age category, and severity status of the disease has a significant effect on time to recovery of covid-19 patients

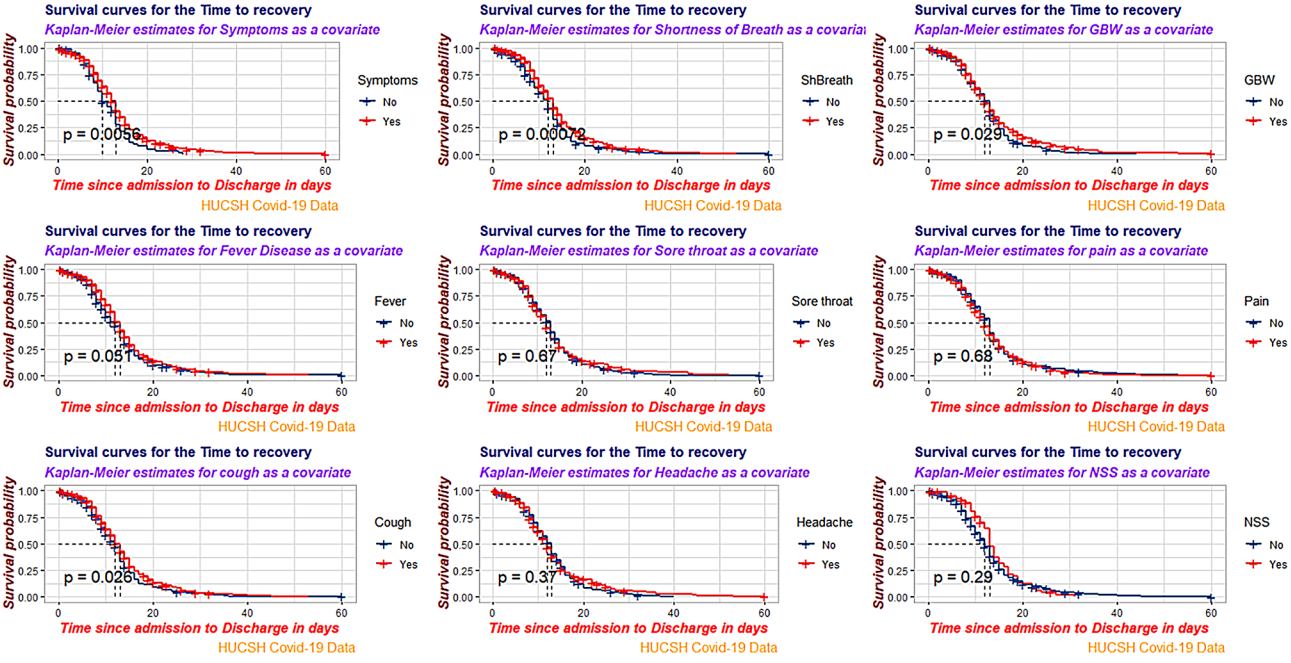

Fig. 5 Comparison between the survival curves of the occurrence of symptoms before admission on time to recovery. The occurrence of at least one symptom, cough, shortness of breath, and General body weakness has a significant effect on the time to recovery of covid-19 patients

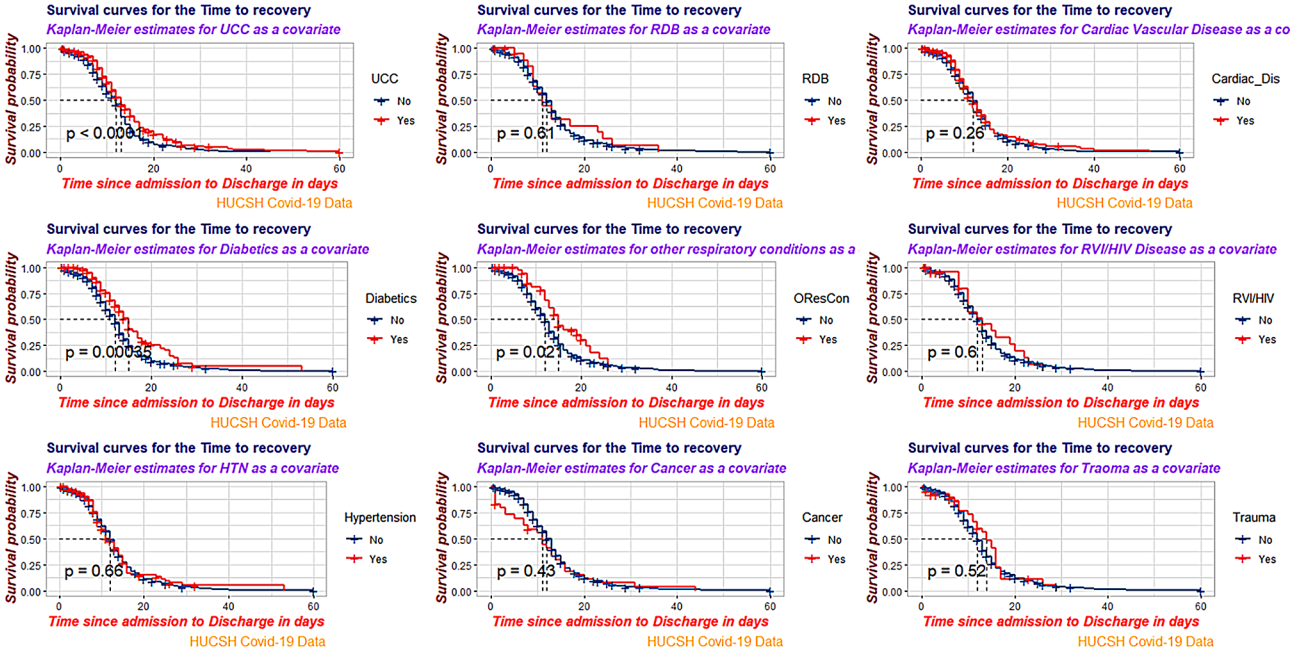

Fig. 6 Comparison between the survival curves of the occurrence of comorbidity on time to recovery. The occurrence of at least one comorbidity (UCC), Diabetics, and Other respiratory conditions have a significant effect on time to recovery of covid-19 patients

the proportion of female patients who recovered from COVID-19 was greater than that of male patients (78.5 vs. 71.5). This is possibly due to less SARS-CoV-2 contraction in women, and because men generate more androgen hormones, which increase the expression of the gene that causes viral cell entrance [36, 37]. Nevertheless, males recovered from SARS-CoV-2 infection at a greater rate than females, as shown by the Multivariable Case Specific Hazard model. This finding was supported by studies in New South Wales [30] and Eka Kotebe General Hospital in Ethiopia [20]. However, some investigations indicated that female patients may recover before male patients [17, 24, 29, 32].

A multivariate semi-parametric Cox proportional regression analysis also revealed a significant correlation between age and COVID-19 recovery time. Getting older is a reliable indicator of a slower recovery rate from coronavirus illness. This result is consistent with other research conducted in hospitals across the globe, including in China [21], Nigeria [24], South Wales Australia [30], Vietnam [31], Southwestern Ethiopia [12], the Amhara regional state of Ethiopia [14], South Central [17], WURH [19], Tigray [25], North West [28], Indian [29], Assosa Ethiopian [32], and Israel [36]. This is because aging influences an organism's entire physiology, affecting functions at the molecular, cellular, and systemic levels, and increasing susceptibility to major chronic diseases [34, 36].

A prolonged recovery period from COVID-19 is predicted based on the severity of the cases, specifically those categorized as severe and critical. This study found that patients who were hospitalized with mild COVID-19 symptoms had a higher likelihood of recovery compared to those admitted to treatment facilities with severe or critical conditions. These findings align with studies conducted in Beijing [33] and Ethiopia [12, 15, 18, 19, 26, 28, 32].

In addition to respiratory and physiological complications, the likelihood of recovery were reduced by the presence of one or more (multiple) symptoms. Various studies supported this finding: the research conducted in India [29], the Amhara regional state [14], Assosa [32], South-West Nigeria [24], Australia's New South Wales [30], and the Addis Ababa Millennium Covid-19 Care Center [18]. The rate of recovery decreases proportionally with the escalation in the number of symptoms.

The univariate analysis found individuals with shortness of breath take longer to recover. Those with coughs also recover slowly. Similar findings were reported in Tigray [25], India [29], North West Ethiopia [28], Australia's New South Wales [30], and France [38]. Abebaw et al. [28] suggest that those experiencing shortness of breath may also be suffering with respiratory conditions such as hypoxia. This may consequently reduce the chance of recovery. Cough and shortness of breath, however, do not appear to have any significant effects in the multivariate model. Similarly, individuals with generalized weakness of body recovered slowly [25, 28]. Earlier research showed fever reduces patient's likelihood of recovering from COVID-19 [19, 30]. In this trial, patients

Table 5 Predictors of time to recovery from 804 COVID-19 patients in HUCSH, 2022

Covariates	Univariate COX Analysis for Time to Recovery of COVID-19 Patients					
	coef	HR	se(coef)	Z	[LB, UB]	Pr(>|z|)
Sex: Male	-0.05803	0.9436	0.0848	-0.684	[0.799,1.114]	0.494
Age category : (0,39]						
Agecat(39,49]	-0.3204	0.7259	0.1244	-2.575	[0.569, 0.926]	0.01 *
Agecat(49,59]	-0.5507	0.5766	0.1248	-4.411	[0.451, 0.736]	< 0.001***
Agecat(59,69]	-0.6066	0.5452	0.1222	-4.965	[0.429, 0.693]	< 0.001***
Agecat(69,Inf]	-0.5780	0.5610	0.1485	-3.892	[0.419, 0.751]	< 0.001***
Source of reporting: Private Hospital						
Comm/Home Isolati	-0.05553	0.9460	0.20987	-0.265	[0.627, 1.427]	0.791
Government Hospit	-0.21271	0.8084	0.18718	-1.136	[0.560, 1.167]	0.256
HUCSH	-0.13958	0.8697	0.13721	-1.017	[0.665,1.138]	0.309
Severity status: Mild						
Moderate	-0.1595	0.8526	0.1029	-1.549	[0.697, 1.043]	0.121
Sever	-0.5490	0.5775	0.1211	-4.533	[0.456, 0.732]	< 0.001***
Critical	-0.5404	0.5825	0.1279	-4.224	[0.453,0.749]	< 0.001***
Number of symptoms: less than 3						
NUMSYMP3 to 5	-0.1456	0.8645	0.1014	-1.436	[0.709, 1.055]	0.1510
NUMSYMPAbove 5	-0.3761	0.6865	0.1284	-2.930	[0.534, 0.883]	0.0034 **
NCOM: No Comorbidity						
1 Comorbidity	-0.2056	0.814	0.0890	-2.311	[0.684, 0.969]	0.0209 *
2 and above Comorbid	-0.4955	0.609	0.1436	-3.452	[0.460, 0.807]	< 0.001***
Symptomatic: Yes	-0.3583	0.6988	0.1286	-2.786	[0.543, 0.899]	0.0053 **
Fever: Yes	-0.1617	0.8507	0.0835	-1.938	[0.722, 1.002]	0.0527
Cough: Yes	-0.1929	0.8245	0.0860	-2.243	[0.697, 0.976]	0.0249 *
ShBreath: Yes	-0.2821	0.7542	0.0837	-3.369	[0.640, 0.889]	< 0.001***
Sore throat: Yes	-0.0397	0.9611	0.0901	-0.44	[0.806, 1.147]	0.66
Headache: Yes	-0.0796	0.9235	0.0845	-0.942	[0.783, 1.090]	0.346
GBW: Yes	-0.1874	0.8291	0.0831	-2.255	[0.704, 0.976]	0.0242 *
Pain: Yes	0.0319	1.0325	0.0876	0.365	[0.870, 1.226]	0.715
HFVBOS: Yes	0.1177	1.1250	0.0970	1.214	[0.930, 1.360]	0.225
UCC: Yes	-0.3466	0.7071	0.0834	-4.157	[0.601, 0.833]	< 0.001***
Diabetic: Yes	-0.4481	0.6388	0.1276	-3.51	[0.497, 0.820]	< 0.001***
Hypertension: Yes	-0.0540	0.9475	0.1239	-0.436	[0.743, 1.208]	0.663
Cardiac_Dis: Yes	-0.1166	0.8900	0.1037	-1.124	[0.726, 1.090]	0.261
RVI/HIV: Yes	-0.1300	0.8781	0.2464	-0.528	[0.542, 1.423]	0.598
OResConB: Yes	-0.4581	0.6325	0.2048	-2.237	[0.423, 0.945]	0.0253 *
RDB: Yes	-0.1319	0.8764	0.2542	-0.519	[0.533, 1.442]	0.604
TraomaB: Yes	-0.1209	0.8862	0.1939	-0.623	[0.606, 1.296]	0.533
CancerB: Yes	0.1372	1.1470	0.1945	0.705	[0.784, 1.679]	0.481
NSSB: Yes	-0.1289	0.8791	0.1292	-0.997	[0.682, 1.132]	0.319

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

with COVID-19 who developed fever had higher chance of recovering. Early detection of disease may play role in patients' quick recovery.

The most common comorbidities in this study were diabetes mellitus and cardiovascular conditions, specifically hypertension. These findings align with various research [12–15, 17, 18, 25, 28, 30]. Comorbidities delayed recovery from COVID-19 cases, according to earlier research. Additionally, univariate analysis showed individuals with one comorbid condition have 19% lower chance of recovery, while those with two or more have a 40% lower likelihood. Recovery rate is 30% lower for patients with at least one comorbidity. These findings align with prior international and Ethiopian regional research [14, 24, 28–30]. Similarly, patients with diabetes [12, 29] and other respiratory conditions (like Tuberculosis (TB), Pulmonary TB, Asthma, Lung abscess, Bronchi, CNS, and Tuberculum) had a significantly lower chance of recovering from COVID-19 compared to those who did not have these conditions.

In the multivariate reduced model, patients with at least one comorbid condition had a lower chance of recovery.

Table 6 Multivariable case specific hazard (CSH) analysis of predictors of Time to Recovery among COVID-19 patients admitted to Treatment Centers of HUCSH from September 26, 2020–November 26, 2021

Covariates	Multivariable Case specific Hazard (CSH) Analysis for Time to Recovery					
	coef	HR	Se(coef)	Z	[LB, UB]	Pr(>|Z|)
Sex: Male	0.37	1.44	0.14	2.61	[1.10, 1.90]	< 0.009**
Age category : (0,39]						
Agecat(39,49]	-0.35	0.71	0.13	-2.59	[0.54, 0.92]	< 0.010**
Agecat(49,59]	-0.49	0.61	0.14	-3.51	[0.47, 0.81]	< 0.001***
Agecat(59,69]	-0.65	0.52	0.14	-4.70	[0.40, 0.69]	< 0.001***
Agecat(69,Inf]	-0.63	0.53	0.16	-3.86	[0.39, 0.73]	< 0.001***
Severity status: Mild						
Moderate	0.02	1.02	0.13	0.19	[0.80, 1.31]	0.850
Sever	-0.36	0.70	0.15	-2.38	[0.52, 0.94]	0.017*
Critical	-0.30	0.74	0.15	-1.98	[0.55, 0.99]	0.048*
Source of reporting: Private Hospital						
Comm/Home Isolati	-0.14	0.87	0.23	-0.64	[0.56, 1.35]	0.525
Government Hospital	-0.31	0.73	0.20	-1.59	[0.50, 1.08]	0.112
HUCSH	-0.46	0.63	0.15	-2.97	[0.47, 0.86]	< 0.003**
Symptomatic: Yes	-0.24	0.79	0.18	-1.36	[0.56, 1.11]	0.175
Fever: Yes	0.57	1.77	0.20	2.88	[1.20, 2.61]	< 0.004**
Cough: Yes	0.14	1.15	0.11	1.34	[0.94, 1.42]	0.181
Sore throat: Yes	0.06	1.06	0.10	0.54	[0.87, 1.29]	0.586
Chest Pain: Yes	0.11	1.12	0.10	1.10	[0.92, 1.36]	0.270
Headache: Yes	0.15	1.16	0.10	1.52	[0.96, 1.41]	0.128
Hypertension: Yes	0.46	1.58	0.15	3.01	[1.17, 2.13]	< 0.003**
UCC: Yes	-0.21	0.81	0.11	-1.97	[0.65, 0.99]	0.049*
Diabetic: Yes	-0.39	0.68	0.16	-2.48	[0.50, 0.92]	0.013*
Trauma: Yes	-0.34	0.71	0.22	-1.58	[0.47, 1.09]	0.114
OResConB: Yes	-0.26	0.77	0.22	-1.20	[0.50, 1.18]	0.229
Renal Disease: Yes	0.20	1.23	0.27	0.75	[0.72, 2.08]	0.451
RVI/HIV: Yes	-0.09	0.91	0.26	-0.34	[0.55, 1.53]	0.732
SexMale: FeverBYes	-0.51	0.60	0.18	-2.83	[0.42,0.86]	< 0.005**
FeverBNo: ShBreathBYes	0.12	1.12	0.17	0.69	[0.81, 1.56]	0.488
FeverBYes: ShBreathBYes	-0.35	0.70	0.13	-2.84	[0.55, 0.90]	< 0.005**

Findings align with research from various regions including Amhara [14], Wuhan [16], Wollega [19], Tigray [25], North West Ethiopia [28], New South Wales, Australia [30], and Assosa [32]. The reduced model also found that diabetes patients had a lower chance of recovering from COVID-19 due to diabetes weakening immunity on top of the infection, as supported by various researchers [12, 29, 30]. In contrast, hypertensive people more likely than those without to recover from COVID-19. Medication utilized for the treatment of hypertension or the management provided for hypertensive patients facilitates a more expeditious recovery process. This finding by Peng et al. [39], indicate that anti-hypertensive medication do not worsen COVID-19 infections and may even provide benefits; In addition, Seyed Alinghi et al. [40] presented that well-managed hypertension in COVID-19 patients might improve their prognoses and shorten recovery time.

Conclusion

The findings of this study indicated that the average recovery time for COVID-19 patients was 12 days, with 95% recovering within 30 days. Older individuals and those with severe or critical conditions experienced longer recovery times. Patients with at least one comorbidity, particularly diabetes, also had extended recovery durations. Additionally, men were significantly more likely to recover than women.

Early fever detection was associated with improved recovery rates, and patients with hypertension exhibited better recovery outcomes, possibly due to anti-hypertensive treatment. Therefore, healthcare providers should consider these factors when developing treatment strategies. Timely medical intervention at the onset of fever symptoms could greatly enhance recovery chances, and managing hypertension through medication may further improve recovery outcomes in COVID-19 patients.

We recommend further research into the effects of hypertension treatment on recovery from COVID-19.

Limitations of the study

Our research was limited by the retrospective nature of our study and by our reliance on secondary data sources. As a result, we did not have access to various first-line and second-line treatments, laboratory results, ICU admissions, and details about oxygen therapy in the patients' medical records, which may have affected their recovery time from the COVID-19 infection. Additionally, patients' ages spanned from 2 days to 100 years, encompassing a broad spectrum that may introduce significant confounding factors in relation to clinical symptoms, treatment approaches, and outcomes."

Abbreviations

HUCSH Hawassa University Comprehensive Specialized Hospital

Supplementary Information

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Supplementary Material 1

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Author contributions

ABA and ZGA have formulated the problem and spent considerable time on data collection. The corresponding author ABA has made the data analysis and interpretation. Besides, he has significant contributions to data editing and cleaning. ZGA has played an overall advisory role. Both authors read and approved the final manuscript.

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Data availability

To obtain access to the dataset, materials and codes that were used to support the conclusion of this research, kindly reach out to the corresponding author.

Declarations

Ethical approval

The dean of Hawassa University College of Natural and Computational Sciences received an official letter of verification from the head of the statistics department concerning a proposed study. The Ethical Review Committee of the college received this letter from the dean and approved the study (Reference number: CNCS-RC027/21). After this approval, the letter was delivered to HUCSH's head of COVID-19 treatment and isolation, and it was likewise approved. Patient cards and registration logbooks were kept in absolute confidence, providing all the missing data. Any personal identifiers were purposefully left off the data-collecting checklist to strictly maintain the privacy and confidentiality of each patient's information.

Consent for participation

Since the study's data collection method was a medical record review, the REC/Ethics Committee waived the requirement for informed consent by the Research Ethics Committee (REC) of the College of Natural and Computational Sciences, Hawassa University, Hawassa, Ethiopia.

Consent for publication

N/A.

Competing interests

The authors declare no competing interests.

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