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Investigating the recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients: a systematic review and meta analysis of survival analysis

Abstract

Introduction: COVID-19 is a great global public health concern, which is caused by a fatal causative agent SARS-COV-2. It is one of the viruses that have appeared in the last 50 years that have affected multiple countries but one of the most distributed worldwide. This systematic review and meta-analysis were aimed to investigate the recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients admitted to treatment centers worldwide.

Methods: Web of Science, EMBASE, PubMed, Scopus, and Google Scholar electronic databases were used to search published articles on this topic up to June 28/2023. The report of result was guided by Preferred Reporting Items for Systematic Reviews and Meta analyses (PRISMA) 2020 flowchart diagram and PRISMA checklist. Quality assessments of the included articles were performed by using Newcastle-Ottawa Scale (NOS) for cohort studies.

Result: A total of 22 articles with 12,350 study participants were included into this systematic review. The pooled median recovery time from SARS-CoV-2 infection was estimated to be 13.94 days (95% CI:12.02, 15.87, I^2 = 89.4%: p=0.000). The minimum and maximum recovery time from SARS-CoV-2 infection among COVID-19 patients were reported were 5 and 26 days, respectively. Statin use during the 30 days prior to admission for COVID-19, presence of comorbidity, shortness of breath, body weakness, age, symptoms on admission, gender, body temperature, severity of disease, breathing rate, history of international incoming travel, Intranasal oxygen, residence, source of contamination, critical stage of COVID-19, severe stage of COVID-19, mechanical ventilation, treatment center, occupation, oxygen saturation, levels of D-dimer, neutrophil-lymphocyte ratio, lactate dehydrogenase, and ferritin were the identified risk factors of recovery time from SARS-CoV-2 infection.

Conclusion: Most of the countries have reported a delayed recovery time from SARS-CoV-2 infection. The identified risk factors need to be incorporated into prevention and management protocol of COVID-19.

Keywords: COVID-19, risk factors, SARS-CoV-2 infection, survival analysis, systematic review

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Introduction

COVID-19 is a great global public health concern, which is caused by a fatal causative agent SARS-COV-2.[1] COVID-19 is amongst the viruses that have appeared in the last 50 years and that have affected different regions and multiple countries but one of the most distributed worldwide.[2] Globally, 28 June 2023, there have been 767,518,723 confirmed cases of COVID-19, including 6,947,192 deaths reported to the world health organization. Whereas, as of 19 June 2023, a total of 13,461,344,203 vaccine doses have been administered.[3]

COVID-19 has made an imbalance in all sectors globally while disrupting the global economy massively.[4,5] This pandemic has caused substantial human suffering and societal disruption.[6] This pandemic has put an intense impact on the mental health of young people worldwide. Sustained school closures and social distancing have affected the well-being of young people across multiple dimensions.[7] Besides, since the start of COVID-19, the increment in the amount of biomedical waste has affected human health and the environment. Medical waste during this pandemic was considerably higher than before.[8]

In addition to adhering to public health measures, the vaccine was considered the most crucial tool to fight the disease.[9] COVID-19 vaccines have saved millions of lives. It prevented the severe forms of this disease.[10] The risk of SARS-CoV-2 reinfection post-COVID-19 recovery was relatively high in people who remained unvaccinated, whereas; it is reduced by half among individuals who were vaccinated against COVID- 19.[11]

Long COVID is often a devastating illness that happens in at least 10% of SARS-CoV-2 infections.[12] Long COVID-19 is a critical public health problem, and how COVID-19 vaccination affects patients with long COVID-19 is unclear.[10] Vaccination against COVID-19 prior to SARS-CoV-2 infection may be linked to a decrease in long COVID. However, most of those with ongoing long COVID did not experience symptomatic changes

succeeding vaccination.[13] To address long COVID-19 care, multidisciplinary teams are fundamental to develop rehabilitation techniques, preventive measures, and clinical management strategies designed with entire patient perspectives.[14]

The benefits of vaccines were affected by misinformation, rumors, and narratives regarding its safety and effectiveness.[9] The majority of individuals who develop COVID-19 fully recover. However, about 10 to 20% of individuals experience a variety of mild and long-term effects post recovery from their initial illness.[15]

Patients recovered from COVID-19 infection have an enlarged incidence of heart structural changes and cardiovascular disease.[16] The affected individuals by this virus were differing in the extent of severity of the infection, which were fatal for some, and the extent of severity is as ordinary as the common cold for others. These individuals are declared to have recovered from the disease without hospitalization and taking medicine and home remedies. Individuals who have comorbidities (geriatric, high blood pressure, heart and lung problems, diabetes, cancer, etc.) are at high risk of developing serious illness of this disease.[17]

Research questions

a. What is the time to recovery from SARS-CoV-2 infection among COVID-19 patients?

b. What are the predictors of time to recovery from SARS-CoV-2 infection among COVID-19 patients?

Methods

Study setting

This systematic review was conducted by reviewing the studies that have addressed the recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients over different countries worldwide.

PECO framework

The acronym PECO (E for exposure) can replace PICO in observational studies. This acronym is already used for environmental exposures but can be used for any exposure.[18] PECO statement, which refers to the population (P), exposure (E), comparator (C), and outcome (O) of interest of this systematic review and meta-analysis was used.[19,20]

Population: adult patients admitted with COVID-19.

Exposure: risk factors of recovery time from SARS-CoV-2 infection as reported in the included articles.

Comparator: the reference group of the included risk factors recovery time from

SARS-CoV-2 infection.

Outcome: recovery time from SARS-CoV-2 infection.

Search strategies

Web of Science, EMBASE, PubMed, Scopus, and Google Scholar electronic databases were used to search published articles on this topic up to June 28/2023. The search was conducted by using the following search terms; "time to recovery", "time-to-recovery", "recovery time", "recovery", "duration of hospital stay", "duration", "hospitalization", "COVID-19", "SARS-CoV-2", "novel coronavirus", "nCoV", "severe acute respiratory syndrome coronavirus 2", "coronavirus disease 2019 virus", " 2019-nCoV", "2019 novel coronavirus", "coronavirus", "factors", "associated factors", "determinants", and "predictors". "AND" and "OR" Boolean operators were used to integrate the search terms.

Eligibility criteria

Inclusion criteria: the inclusion criteria for this systematic review were; **Study setting:** all relevant studies conducted in different countries worldwide. **Study subjects:** adult patients admitted with COVID-19. **Publication status:** published and unpublished studies. **Language:** articles done by using English language. **Study design:** prospective and retrospective cohort studies. **Publication date:** articles published up to up to June 28/2023.

Methodological quality: studies are included based on the score of Newcastle- Ottawa Scale (NOS) for cohort studies. Articles with non-survival analysis, articles

which were not fully accessible, and outcome variables not correctly analyzed were excluded from this systematic review.

Outcome variable

The primary outcome of this study was time to recovery from SARS-CoV-2 infection among COVID-19 patients admitted to the treatment center. Recovery was considered as the event of interest in the articles included in this systematic review. The recovery time refers to the length of days from the date the patient's polymerase chain reaction (PCR) test was positive to the date the patient was diagnosed negative for the test and discharged. The time was calculated in days. The secondary outcome of this study was predictors of time to recovery from SARS-CoV-2 infection among COVID-19 patients admitted to treatment the center.

Data extraction

Microsoft Excel was used to extract the required data from the selected articles. The inclusion criteria's were used carefully during data extraction. The information used for an extraction of data were author names, year of article publication, study setting, study country, sample size, recovery time, and risk factors. ADW and LTG have checked and screened the articles depending on the titles and abstract of all possible articles to be incorporated in this systematic review. Moreover, ADW and LTG have evaluated the methodological quality of articles using the Newcastle-Ottawa Scale (NOS) critical appraisal tool for a cohort studies.[21]

Quality assessment

The Newcastle-Ottawa Scale (NOS) for cohort studies was used to determine the methodological quality of the studies included in this systematic review.[21] It uses three elements: selection of participants, comparability, and outcomes. The maximum score on the NOS is nine. Scores of zero to three for low quality, four to six for moderate quality, and seven to nine are assigned for high quality studies.[22] The score for each study included is given as (supplementary file 1).

Data synthesis and reporting the results

Data synthesis of the studies done on recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients over different countries was based on PRISMA. Besides, the result of this systematic review is reported by using PRISMA 2020 flowchart diagram, and PRISMA 2020 checklist[23] were used for

study screening, selection, and inclusion in to this systematic review. PRISMA 2020 checklist is given as (supplementary file 2).

Result

Search results

A total of 8390 articles were identified through different search strategies. Of these, 4347 articles were excluded due to similarities, 3992 were excluded due to irrelevance, and 29 were excluded with reasons. Finally, 22 articles were fit the eligibility criteria and included into this systematic article (Figure 1).

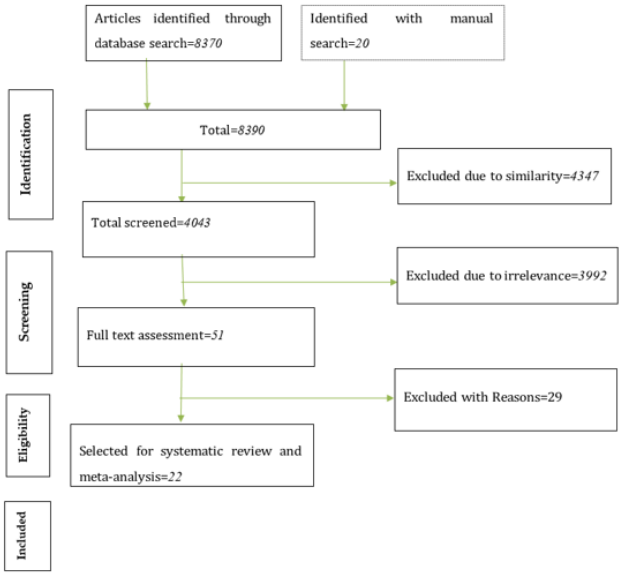

Figure 1 PRISMA flowchart diagram of the study selection for systematic review on recovery time and from SARS- CoV-2 infection and risk factors among COVID-19 patients. Note: (Figure1) was Adapted from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi: 10.1136/bmj.n71. [23].

Study characteristics

This systematic review has addressed studies done on recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients admitted to treatment center worldwide. In this systematic review, a total of 22 studies conducted worldwide were included. Countries such as California, Ethiopia, Nigeria, Australia, Saudi Arabia, Vietnam, Italy, China, and India.

Both the minimum and maximum time to recovery from SARS-CoV-2 infection among COVID-19 patients were reported from Ethiopia, which was 5[24] and 26 days,[25] respectively. Regarding to the predictors of time to recovery from SARS-CoV-2 infection, statin use during the 30 days prior to admission for COVID-19, the presence of comorbidities, shortness of breath, body weakness, age, symptoms on admission, gender, body temperature, severity of disease, breathing rate, history of international incoming travel, being on Intranasal oxygen, residence, sources of contamination, critical stage of COVID-19, severe stage of COVID-19, mechanical ventilation, treatment center, occupation, oxygen saturation, levels of D-dimer, neutrophil-lymphocyte ratio, lactate dehydrogenase, and ferritin. These are supported by the included studies from different countries narrated below.

A study done in University of California, San Diego, California showed that using statin 30 days before admission for COVID-19 was associated with a faster time to recovery in patients who had no severe disease.[26] A study conducted in Tigray, Ethiopia reported that there were a higher recovery rate among patients' aged less than 40 years (Vs age≥60years old), who had no underline comorbidity diseases (Vs who had comorbidity), who had no shortness of breath (Vs who had shortness of breath) and who had no body weakness (Vs who had body weakness).[25]

A study conducted in Ekiti State, Nigeria displayed that patient with symptoms on admission (Vs without symptoms on admission), and patients that were not admitted previously (Vs previously admitted) were less likely to recover from the COVID-19 virus. Whereas, patients with hypertension only (Vs multiple comorbidities) had faster recovery time.[26,27] A study conducted in Eka Kotebe General Hospital, Ethiopia reported that the rate of recovery from SARS-CoV-2 infection was higher in males (Vs females) and patients without any comorbidity (Vs who had at least one comorbidity).[28]

A study conducted in the state of New South Wales, Australia reported that those patients aged 50-69 (Vs age 30-49years) and 70+years (Vs age 30-49years), and the presence of comorbidity (Vs without comorbidity) took longer to recover. Whereas, men (Vs female) were faster to recover from COVID-19.[29] A study conducted in Dilla University Referral Hospital, Ethiopia reported that having normal body temperature (Vs hypothermia), and severe/critical (Vs mild) had longer recovery time. Whereas, patients who had a normal breathing rate (Vs bradypnea) had faster recovery time.[24]

A study done in Amhara regional state; Ethiopia displayed that the patients who were symptomatic on admission (Vs asymptomatic on admission) had lower recovery time. For every one-point increase in age of the patient, the recovery time got delayed. Whereas, patients without any comorbid illness/s (Vs with comorbidities) had faster recovery time.[30] A study done in Vietnam reported that older patients had a lower recovery time (Vs younger), whereas patients with a history of international incoming travel had a higher recovery time.[31]

A study conducted in Bokoji hospital, Ethiopia revealed that age ≥60years (Vs 18-29 years), male gender (Vs female), having chronic pulmonary disease (Vs who had no chronic pulmonary disease), and Intranasal oxygen care use (Vs who were not used Intranasal oxygen care) had delayed recovery time.[32] Another study done in Vietnam showed that >48years (≤48years), and being infected inside Vietnam (Vs foreign infected group) had delayed recovery time.[33]

A study conducted in Southern Nations, Nationalities and Peoples Region (SNNPR), Ethiopia reported that critical stage of disease (Vs asymptomatic), severe stage of disease (Vs asymptomatic), mild (Vs asymptomatic), oxygen supplementation via mechanical ventilation (Vs no oxygen supplementation) had delayed recovery time.[34]

A study done in Addis Ababa; Ethiopia showed that the presence of symptoms on admission (Vs asymptomatic) had delayed recovery time.[35]

A study conducted in Hawassa Treatment Centers, Ethiopia reported that age ≥65, being daily laborers, being in critical condition, having a history of headaches, and diabetic patients had shown prolonged time to recovery.[36] A study conducted in Wollega University Referral Hospital, Ethiopia recorded that age ≤24 years (Vs≥41), and having no headache (Vs having headache) had faster recovery time. Whereas, having comorbidity (Vs no comorbidity) had delayed recovery time.[37]

A study done in Southwestern Ethiopian hospital COVID-19 treatment centers showed that age 18-29years (Vs age >60years old), had no hypertension (Vs had hypertension), no diabetes mellitus (Vs had diabetes mellitus), without congestive heart failure (Vs had congestive heart failure), had no cancer (Vs had cancer), had no tuberculosis (Vs had tuberculosis), no acute kidney injury (Vs had acute kidney injury) had faster recovery time. Whereas, severely/Critically ill (Vs moderate) had delayed recovery time.[38] A study done in Bejing, China reported that bilateral pneumonia on CT scan (Vs unilateral), shorter time from illness onset to admission (Vs longer time), severe disease (Vs non severe) and had no lymphopenia (Vs had lymphopenia) were longer duration of hospitalization.[39]

A study conducted in Tibebe Ghion Specialized Hospital, Ethiopia revealed that a one year increase in age, had low oxygen saturation (Vs had no low oxygen saturation), had severe COVID-19 severity score (Vs mild), had comorbidity (Vs had no comorbidity), had shortness of breathing (Vs had no shortness of breathing), had high white blood cells (Vs normal), had low platelet (Vs normal), had high hemoglobin (Vs normal) had delayed recovery time. Whereas, patients who had taken corticosteroid (Vs had not taken corticosteroid) faster recovery time.[40] A study conducted in Sri Ramachandra Institute of Higher Education and Research Tamil Nadu, India showed that had ≥3 comorbidities (Vs no comorbidity), having <95% oxygen saturation (Vs≥95% oxygen saturation), having >0.55µg/mL D-dimer (Vs ≤0.55µg/mL) , having >3 neutrophil-lymphocyte ratio (Vs≤3), having >300IU/L lactate dehydrogenase (Vs≤300IU/L) , and having <25 or >200ng/ml ferritin (Vs 25-200ng/ml) had prolonged hospital stay[41] (Table 1).

Table 1 Characteristics of the Studies Conducted on Recovery Time and Risk Factors from SARS-CoV-2 infection among COVID-19 patients admitted to treatment center in different countries and included in this systematic review, 2023. [n=22 studies]

S.N	Authors	Year	Country	Study setting	Sample size	Median recovery time	Predictors of time to recovery
1	Daniels et al[26]	2020	California	University of California San Diego	170	7 days	Statin use during the 30 days prior to admission for COVID-19.
2	Abebe et al[25]	2022	Ethiopia	Tigray	139	26 days	Presence of comorbidity (had no underline comorbidity diseases), shortness of breath, body weakness, and age <40 years.
3	Ibitoye et al.[27]	2022	Nigeria	Ekiti State	586	21 days	Previous admission status, and symptoms on admission.
4	Abrahim et al.[28]	2020	Ethiopia	Eka Kotebe General Hospital	306	19 days	Gender (male) and presence of comorbidities (without comorbidity).
5	Liu et al.[29]	2021	Australia	state of New South Wales	2904	16 days	Age (0-29 years), gende (men) were faster to recover and those with pre-existing co-morbidities took longer to recover.
6	Churiso et al. [24]	2022	Ethiopia	Dilla University Referral Hospital	220	5 days	Body temperature, severity of disease, and breathing rate.
7	Al-Thaqafy et al.[42]	2023	Saudi Arabia	King Abdulaziz Medical City in Jeddah.	1776	11.75 days Female and 10.95 days for male patients	NA
8	Dessie et al.[30]	2022	Ethiopia	Amhara regional state	622	11 days	Symptoms status at admission (have no symptoms), presence of comorbidity (without comorbidity)
9	Long et al.[31]	2020	Vietnam	Vietnam	255	17 days	Older patients had a lower likelihood of recovery, whereas patients with a history of international incoming travel had a higher likelihood of recovery.
10	Kaso et al.[32]	2022	Ethiopia	Bokoji Hospital	422	13 days	Age (≥60years), gender (male), and being Intranasal oxygen care had delayed recovery time.
11	Thai et al.[33]	2020	Vietnam	Vietnam	133	21 days	age, residence and sources of contamination.
12	Lemma Tirore et al.[34]	2022	Ethiopia	SNNPR	845	10 days	Critical stage of Covid-19, severe stage of Covid-19, mechanical ventilation, and treatment center were significant predictors of delayed time to recovery.
13	Leulseged et al.[35]	2020	Ethiopia	Addis Ababa	360	16 days	Presence of symptoms (Symptomatic) was significant predictors of delayed time to recovery.

Table 1 Continued...

S.N	Authors	Year	Country	Study setting	Sample size	Median recovery time	Predictors of time to recovery
14	Ciceri et al.[43]	2020	Italy	Milan	410	14 days	NA
15	Samrawit Fantaw[36]	2022	Ethiopia	Hawassa Treatment Centers	1038	14 days	Patients in age 65 and above (older age), a patient who worked as daily laborers, patients in critical condition, patients who had a history of headaches, and diabetic patients had shown prolonged time to recovery from COVID-19.
16	Lu et al.[44]	2020	China	Wuhan	121	14 days	NA
17	Tolossa et al.[37]	2021	Ethiopia	Wollega University Referral Hospital	263	18 days	Being older age, presence of fever on admission, and comorbidity were found to have statistically significant association with recovery time.
18	Barman et al.[45]	2020	India	India	221	25 days	NA
19	Tsegaye et al.[38]	2022	Ethiopia	Southwestern Ethiopian hospital COVID-19 treatment centers	300	10 days	Age, hypertension, diabetes, being critical, cancer, and tuberculosis were found to be independent predictors of time to recovery of COVID-19 patients.
20	Zhao et al.[39]	2021	China	Bejing	77	14 days	Bilateral pneumonia on CT scan, shorter time from the illness onset to admission, severity of disease and lymphopenia.
21	Desiyalew Habtamu[40]	2022	Ethiopia	Tibebe Ghion Specialized Hospital	452	9 days	Age, Oxygen saturation, Shortness of breath, Severity of the disease, Comorbidity were significantly associated with median recovery time.
22	Thiruvengadam et al.[41]	2021	India	Sri Ramachandra Institute of Higher Education and Research Tamil Nadu.	730	7days	Presence of comorbidity, oxygen saturation, levels of D-dimer, neutrophil-lymphocyte ratio, lactate dehydrogenase, and ferritin.

Recovery time from SARS-CoV-2 infection

In this systematic review and meta-analysis, a random effect model was used to estimate the pooled median recovery time from SARS-CoV-2 infection. It was estimated to be 13.94 days (95%CI: 12.02, 15.87). The significance level of heterogeneity was (I^2=89.4%: p=0.000) (Figure 2).

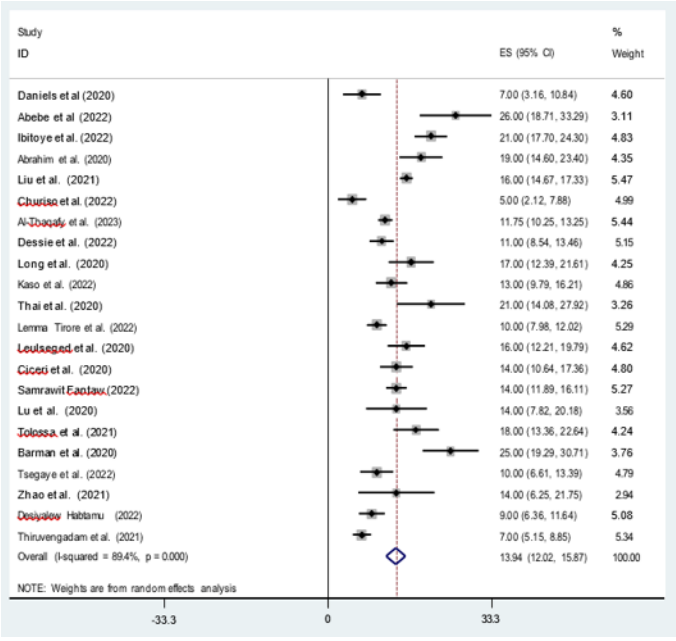

Figure 2 Forest plot of the Pooled Median Recovery Time from SARS-CoV-2 infection among COVID-19 patients globally.

Subgroup analysis

By publication year

Subgroup analysis by publication year was used to compare the overall estimates of median recovery time across groups and determine whether the considered grouping helps explain some of the observed between-study heterogeneity. The pooled median recovery time from SARS-CoV-2 infection was 15.39 days [95%CI: 12.28, 18.50; I^2=89.5%, p=0.000) among articles published in 2020 and 2021. Whereas, among the articles published in 2022 and 2023, the pooled recovery time from SARS-CoV-2 infection was 12.43 days [95%CI: 9.98, 14.88; I^2=99.7%, p=0.000) (Figure 3).

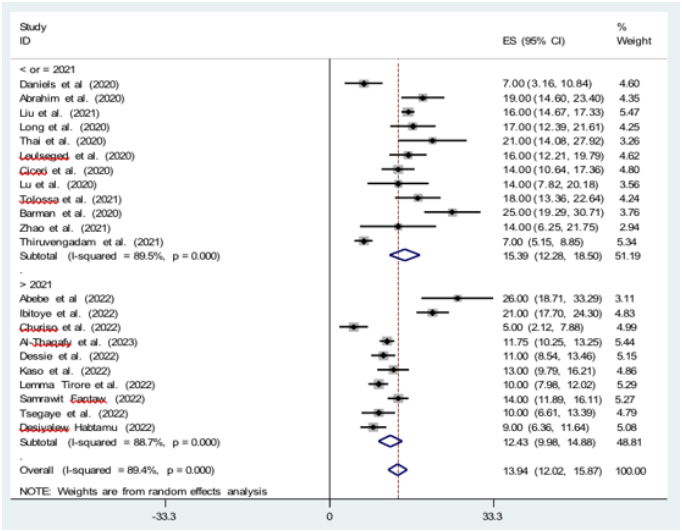

Figure 3 Subgroup Analysis by Publication Year on the Pooled Median Recovery Time from SARS-CoV-2 infection among COVID-19 patients globally.

By sample size

Subgroup analysis by sample size category was used to compare the overall estimates of median recovery time across groups and determine whether the considered grouping helps explain some of the observed between-study heterogeneity. The pooled median recovery time from SARS-CoV-2 infection was 15.68 days [95%CI: 11.79, 19.56; I^2=88.2%, p=0.000) for sample size ≤400. Whereas, for sample size >400, the pooled recovery time from SARS-CoV-2 infection was 12.58 days [95%CI: 10.29, 14.88; I^2=91.3%, p=0.000) (Figure 4).

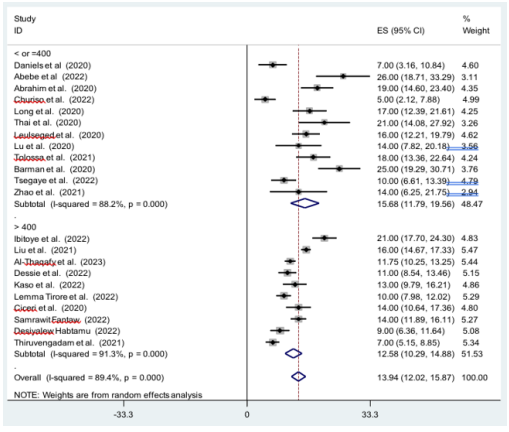

Figure 4 Subgroup Analysis by Sample size Category on the Pooled Median Recovery Time from SARS-CoV-2 infection among COVID-19 patients globally.

Publication bias and heterogeneity

The publication bias was checked by using Begg's Test and a p-value was 0.080. Furthermore, publication bias was also determined by using the Egger's test, and a p- value was 0.192. As the p-value is >0.05, there is no statistical evidence of publication bias using both the Begg's and Egger's test. Based on the I^2 statistics, there was a significant heterogeneity among the included articles (I^2=89.4%, p=0.000). The funnel plot displays the symmetrical distribution of the included articles, and this suggests that there was no publication bias (Figure 5).

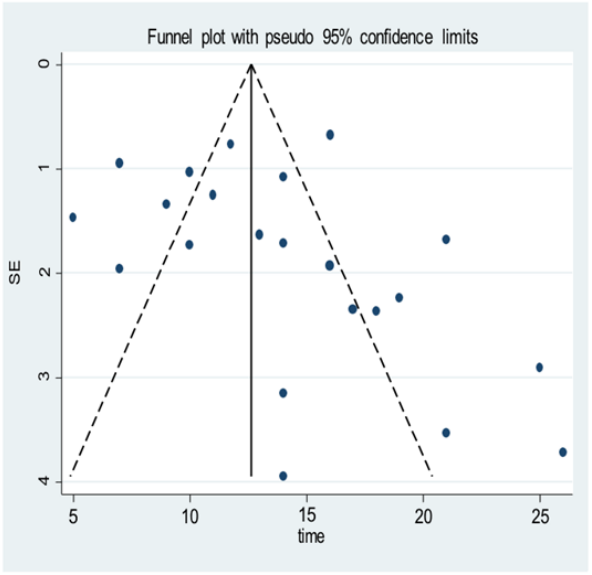

Figure 5 Funnel plot with 95% confidence limits of the pooled recovery time from SARS-CoV-2 infection among COVID-19 patients globally.

Sensitivity analysis

The Sensitivity analysis for the present meta-analysis was performed by using the random effects model. The result indicated that there was no single study influencing the pooled recovery time from SARS-CoV-2 infection (Figure 6).

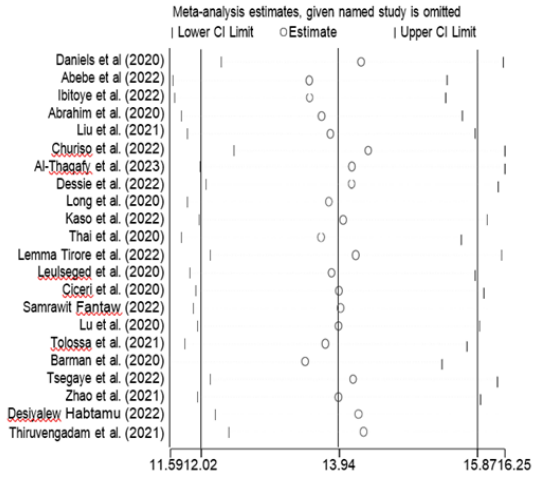

Figure 6 Result of sensitivity analysis of the 22 articles included into this meta-analysis on pooled recovery time from SARS-CoV-2 infection among COVID-19 patients globally.

Citation: Gebreyohannes LT, Wake AD. Investigating the recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients: a systematic review and meta analysis of survival analysis. *J Microbial Exp* . 2025;13(1):16–25. DOI: 10.15406/jmen.2025.13.00427

Discussion

Globally, COVID-19 has distressed communities and economies. It has exposed socioeconomic inequalities and weaknesses in health systems. The recovery from long- term health effects and economics are the major concerns.[46] COVID-19 has now spread with growing morbidity and mortality among all populations[47] COVID-19 has a high rate of transmission and becomes a global pandemic. SARS-CoV-2 resulted a serious risk to human health worldwide.[48] There are several factors that lead to poor prognosis, although many patients recover from SARS-CoV-2.[49]

This systematic review and meta-analysis have included survival analysis articles conducted on the recovery time from SARS-CoV-2 infection and risk factors among COVID-19 patients. This is because investigating for this information would offer valuable insight and direction for community and clinical implementation. Moreover, for incorporation of the identified risk factors into the health policy and health care service to avoid the delayed recovery from COVID-19. A total of 22 survival analysis articles with 12,350 study participants were included into this systematic review. The minimum and maximum time to recovery from SARS-CoV-2 infection among COVID-19 patients were reported from Ethiopia, which was 5[24] and 26 days,[25] respectively.

The pooled recovery time from SARS-CoV-2 infection was estimated to be 13.94 days (95%CI: 12.02, 15.87). The significance level of heterogeneity was (I^2= 89.4%: p=0.000). The difference in pooled median recovery time was seen in subgroup analysis of this study. Subgroup analysis was done by publication year, and sample size. The pooled median recovery time from SARS-CoV-2 infection was 15.39 days [95%CI: 12.28, 18.50; I^2=89.5%, p=0.000) among articles published in 2020 and 2021. Whereas, among the articles published in 2022 and 2023, the pooled recovery time from SARS-CoV-2 infection was 12.43 days [95%CI: 9.98, 14.88; I^2=99.7%, p=0.000). The pooled median recovery time from SARS-CoV-2 infection was 15.68 days [95%CI: 11.79, 19.56; I^2=88.2%, p=0.000) for sample size ≤400. Whereas, for sample size >400, the pooled recovery time from SARS-CoV-2 infection was 12.58 days [95%CI: 10.29, 14.88; I^2=91.3%, p=0.000).

Regarding to the risk factors of time to recovery from SARS-CoV-2 infection, statin use during the 30 days prior to admission for COVID-19, presence of comorbidity, shortness of breath, body weakness, age, symptoms on admission, gender, body temperature, severity of disease, breathing rate, history of international incoming travel, being Intranasal oxygen, residence, sources of contamination, critical stage of COVID-19, severe stage of COVID-19, mechanical ventilation, treatment center, occupation, oxygen saturation, levels of D-dimer, neutrophil-lymphocyte ratio, lactate dehydrogenase, and ferritin were the identified risk factors of recovery time from SARS-CoV-2 infection.

A study done among healthcare workers in China showed that that older healthcare workers with severe COVID-19 recovered slower than younger age healthcare workers regarding persistent symptoms, functional fitness, health-related quality of life, and immune function at 28 months after discharge.[50] A study conducted among general population of canton of Zurich, Switzerland revealed that 22.9% of participants infected with SARS-CoV-2 did not fully recover by six months.[51]

A study done in United Kingdom revealed that 29.7% respondents had long-standing COVID-19 symptoms for ≥4weeks and 12.4% of them had for ≥12weeks. Respondents with pre–COVID-19 web-based expanded disability status scale scores ≥7, respondents with probable anxiety and/or depression (hospital anxiety and depression scale scores ≥11) before COVID-19 onset, and women were less likely to recovery from this pandemic.[52] A study done in India revealed delayed recovery from COVID -19 is seen in females, moderate COVID infection and elderly individuals. Moreover, few of the individuals reported as they may develop long COVID syndrome.[53]

Even among the recovered individuals from COVID-19 there is post-COVID-19 condition, which refers to a "wide range of new", "returning", or "ongoing health problems" in individuals who have had COVID-19. Most individuals previously hospitalized with COVID-19 displayed persistent symptoms three months after hospital discharge and it has a significant impact on their functional and occupational status.[54]

A study done at teaching and referral University hospital in Tehran revealed that dyspnea is a predictor of recovery time.[55] A study done in Bangladesh showed that approximately 70% of respondents had at least one acute post-COVID symptom. Of which, 43.0% of them developed fatigue, 13.4% of them developed sleep disturbance, 11.8% of them developed lack of concentration, 10.2% of them breathing difficulty, 6.5% of them developed headache, and 6.5% of them developed muscle pain.[56]

Limitations of the study

The study is subjected to at least two limitations. First, the pooled effect size of the association factors were not determined due to inconsistently measured in the included studies. Second, factors such as environmental related factors, which could determine the recovery time from SARS-CoV-2 infection, are not well investigated. Thus, future research needs to incorporate environmental and other factors that could delay or improve the recovery time from SARS-CoV-2 infection.

Implications for public health practice

The recurrence of COVID-19 infection is a common phenomenon.[57] The patients recovered from COVID-19 continued to experience both pulmonary and extra pulmonary dysfunction one year after hospital discharge.[58] For preventive measures and patient quality of life, long-term immunity and functional recovery after SARS- CoV-2 infection have great implications.[59] Even about 24% of individuals reported having long post-COVID symptoms among COVID-19 recovered individuals. Post- COVID symptoms are forthcoming burden to healthcare providers.[56] COVID-19 can lead to prolonged illness, even in young adults who have no underlying chronic medical conditions.[60]

Understanding the length of hospital stay because of COVID-19 can support in recognizing the prognosis of this disease.[61] The estimate length of hospital stay of COVID-19 patients encourages knowing the future demand since these patients need different levels of hospital care.[62] The information about the time of recovery from SARS-CoV-2 infection and its predictors is crucial to formulate preventive measures and optimize treatment options at national and international levels.[25]

This information on recovery time from SARS-CoV-2 infection will encourage planners to find out effective strategies.[45] The estimated length of stay due to COVID-19 patients is required to model bed occupancy and make contingency plans. This could

also help researchers in the field of artificial intelligence to create algorithms to this effect.[41] The information of the estimated time-to-recovery from SARS-CoV-2 can be used as an evidence-based estimation to encourage containment and mitigation policy decisions, even at the earlier stages of an outbreak.[63]

Conclusion

The pooled median recovery time from SARS-CoV-2 infection was estimated to be 13.94 days (95%CI: 12.02, 15.87). The significant level of heterogeneity was (I^2 = 89.4%: p=0.000). The minimum and maximum median recovery time from SARS-CoV-2 infection among COVID-19 patients were reported as 5 and 26 days, respectively. Statin use during the 30 days prior to admission for COVID-19, presence of comorbidity, shortness of breath, body weakness, age, symptoms on admission, gender, body temperature, severity of disease, breathing rate, history of international incoming travel, intranasal oxygen use, residence, sources of contamination, critical stage of COVID-19, severe stage of COVID-19, mechanical ventilation, treatment center, occupation, oxygen saturation, levels of D-dimer, neutrophil-lymphocyte ratio, lactate dehydrogenase, and ferritin were the identified risk factors of recovery time from SARS-CoV-2 infection.

The findings of this study will encourage the healthcare providers to offer suitable and time-based management to COVID-19 patients, which provides a positive clinical outcome of the affected individuals. Furthermore, the findings of this study would support in the designing of an applicable management strategy for COVID-19 patients who had identified risk factors of recovery time from SARS-CoV-2 infection.

Most of the countries have reported a delayed recovery time from SARS-CoV-2 infection. "Risk factors delay the road to recovery from COVID-19". Some individuals are prone to long-lasting symptoms of COVID-19 while others recover more quickly. This might be due to the existence of risk factors. Therefore, more consideration should be assumed for the management of the individuals who had identified risk factors in this study. The identified risk factors need to be incorporated into the prevention and management protocol of COVID-19. Priority management needs to be applied for patients who have identified risk factors to enhance early recovery from this infection.

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Author contributions

LTG and ADW have made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas, took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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Data availability

The data used to support the findings of the present study have been included in this article.

Ethical approval and consent to participate

Not applicable. This systematic review and meta-analysis were conducted by reviewing previously published studies. Data were not collected from the people for the purpose of this study.

Consent for publication

Not applicable.

Competing interests

The author declares that there is no competing of interest.

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