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Subsequent Complications Following COVID-19 an Systematic Reviews

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ABSTRACT
Introduction: From COVID-19, a broad spectrum of early, intermediate and late complexities have been recognized with this SARS-CoV-2 since then. Still, there can be sequelae that persist from recovery following the acute illness of COVID-19. Research aim is to thoroughly examine the current evidence on delayed consequences given to COVID-19.
Methods: A broad search was performed in various electronic databases including Scopus, Web of Science, PubMed, Embase (up to Oct 2024) using specific keywords for an exhaustive review.
Results: A systematic review on the most common complications underlying COVID-19 Long COVID in 30 selected studies revealed a diverse set of major complications of developing long COVID-19. Neurologic and psychiatric presentations dominated the list of the sequelae that followed next were respiratory, musculoskeletal, rheumatologic considerations and ciring cardiovascular as well hepatic and gastrointestinal aspects.
Conclusion :Concluding, the lingering consequences of COVID-19 influence multiple physiological systems ranging from mild to severe and cases with these latter extremes. Long COVID-19 patients with my journey fatigue, and a swath of neuropsychiatric morbidities, therefore fatigue has been among the most consistently described late complications seen in individuals affected by prolonged COVID. Next are the respiratory problems that include dyspnea, cough and chest tightness representing important long coronavirus disease 2019. Due to the enduring and delayed nature of these sequelae, there should be ongoing vigilance for the demonstration of characteristic signs and symptoms in both patients who are well as those who have deteriorated.

Keywords: COVID-19, SARS-CoV-2; Post-Acute COVID-19 Syndrome; Outcome Assessment of Patient

INTRODUCTION

Since the emergence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in 2019, there has been a lot of debate about the clinical impact of COVID-19,which is a viral disease caused by this entity. Most importantly, SARS-CoV-2 infects host cells via angiotensin-converting enzyme 2 (ACE2) receptors . With ACE2 expressed on many human organs, this has led to the multiplicity of clinical forms of COVID-19 including pneumonia, myocarditis, myocardial infarction, renal injuries as well as neurological symptoms and gastrointestinal symptoms(1,2,3,4) [f1]. Emerging evidence on the global spread of SARS-CoV-2 shows emerging clinical manifestations of COVID-19. Duration of symptoms and the acute-phase virus-specific

complications also may vary in times as early-mid-late manifestation after infection (1-4) Complications after any infection that remain for days to months more than the normal baseline post-infection are considered postCOVID-19 complications [5, 6, 7,8,9]. Most of the complications do in early stage of COVID-19 as well, but with growing evidence we saw some late complications weeks and months after clearance of SARS-CoV-2 in survivors. These late complications are unlikely to arise from direct organ damage. Immune dysregulation, coagulopathy and endothelial injury have been put forward as explanations for these late effects. It also seems that COVID-19 affects almost every system in the body, with widely varying patterns, degrees, and lengths of the late manifestation. Lastly,the late complications likewise correspond to poor laboratory results numbers inconsistent with organ dysfunction [10, 11,12].
Systematic reviews and meta-analyses have thoroughly documented the late complications of COVID-19, displaying the range of organ injuries linked with this illness. AbstractThis umbrella review aims to collate the evidence on the late sequelae of COVID-19 in people, will inform clinical care for healthcare workers and summarises all exacerbations likely after COVID-19, advocating a focus on follow-up after COVID-19.

Methods
Systematic reviews and meta-analyses have extensively reported late complications with COVID-19, and the setting of this umbrella review.

2.2 Data sources
We searched inthe following resources: Web of Science (WoS) for systematic reviews, PubMed/MEDLINE®, Scopus and Embase. The search was restricted to those who reported in an english language.

2.2 Selection criteria
two-step selection of studies was applied
A. Title and Abstract Screening
Studies were initially evaluated according to their titles as well the abstracts in order to identify potentially relevant studies.
B. Full Text Screening
The second stage involved a full text review of the papers which passed preliminary screening Phase 2.
Eligible for inclusion in the review: full systematic review and long-term studies regarding complications specific to COVID-19.

2.3 Exclusion Criteria
Studies were excluded based on the following types:
A. Published human studies
B. Duplicate publications
C. Narrative reviews
D. Umbrella reviews
E. Preprints
F. Conference abstracts

Results
We included studies from several countries, indicating a global effect of COVID-19 in our systematic review. Countries represented are as following:
U. S. Britain Italy Canada China Australia Germany Ireland, Saudi Arabia Spain, Switzerland India Iraq India Mexico Mexico Pakistan South Africa United Arab Emirates
Analysis of these studies indicated the most common complications were neurologic and psychiatric problems, respiratory symptoms, musculoskeletal & rheumatologic diseases as well as cardiovascular crises as well as hepatic and gastrointestinal failures
Methods of care have not been found to be very efficacious for permanently resolving these symptoms, although the severity of symptoms tends to decrease over time [1].

DISCUSSION
The far-reaching physiological systems of the human body from various late complications developed in response to COVID-19 infection. This full-range umbrella review has classified the residual sequelae of long COVID-19 as 9 different classes. In the following conversation, I will discuss all of these delineated categories one by one.
Neurological and psychiatric abnormalities

Briefly, delayed neurological and psychiatric sequelae triggered by COVID-19 are critical because of their high prevalence among the terminologies of this disease. In the long-COVID patients fatigue is the most frequent symptom.
Analysis of 16 studies with nearly 9000 COVID-19 patients suggests the presence of post-acute COVID-19 syndromes that persist beyond three months after the initial infection. The ongoing effects included psychiatric symptoms (like fatigue, cognitive dysfunction (memory lapses and attention deficits) and sleep disturbances). Also, converging themes across different studies pointed to symptoms of depression-PTSD (post-traumatic stress disorder),anxiety, wrath and mood swings et al.
Not surprisingly, there was no straightforward association between the acute COVID-19 severity and worse symptom burden in the post-acute phase of the disease. Some studies reported neurological manifestations like headaches, myelitis, neuropathies, paresthesias, parksonian features, cogwheel rigidity, optic neuritis, distorted olfactory perceptions, encephalitis, epilepsy, Bell's Palsy and myoclonus. 7,40 13,46,49,50

Respiratory Implications
Pulmonary Hypertension: The lungs remain the predominant target organ of severe COVID-19 infection in its acute phase; the same is true for long-term consequences from long COVID-19. A number of patients have described symptoms like dyspnea, chronic cough, thoracic constraint into post-COVID phase that is prolonged; longer in time I guess. Dyspnea is generally made worse with exertion. Despite treatments showing scant efficacy at symptom relief, the severity of these tend to fade over time.
Musculoskeletal and Rheumatology Sciences
Reports from the studies indicated long COVID-19 patients may have musculoskeletal manifestations, joint effusion and persistent pain. Some patients even have small or medium and large vasculitis in long COVID-19. Mediastinal involvement (inflammatory myopathies) Systemic lupus erythematosus (SLE) sarcoidosis; arthritis etc. Cutaneous vasculitis after COVID-19 is usually refractory and tends to clear with time. (14, 29, 54)
The Hepatobiliary and GI
Research suggested that long COVID-19 s have higher risk of GI symptoms (tingling in mouth or anorexia, dyspepsia, constipation, taste impairment, IBS [defined now as long COVID]), loss of appetite and abdominal pain, diarrhea and nausea/vomiting. (57)

Ocular:
Remythologic disorders have been rarely reported in long COVID-19, with Ophthalmologic Problems being conjunctivitis, dry eye / difficulty seeing/ blurred vision, photophobia, sore eyes/eye pain54,59
Thrombosis or Embolism and Stroke:
Alinaghi et al., SeyedAlinaghi et al.; (40) Reviewed 65 studies refuting that venous/arterial thrombosis and cardiac/brain stroke maybe observed in long COVID− disease..
Others:
Other infrequent and extremely late complications of COVID-19 include sputum/nasal congestion, hyperhidrosis, rhinorrhea cough myalgia arthralgias body weight changes otalgia sore throat altered heart rates dysphonia fever palpitations hair loss dysphagiastuttering speech comparable reduction in proteins and menstrual problems etc.

Conclusion:
Characteristics of the research suggests that COVID-19 patients may encounter late and prolonged manifestations demonstrating "long Covid" in general other symptoms also include described above, often lasting for more than 6 months and difficult to manage though can improve gradually over time. Common Long COVID sequelae are fatigue and other neuropsychiatric symptoms; respiratory, dyspnea,cough and chest tightness are the most frequent long-term complications of COVID-19.
Because these complications are persistent and delayed, healthcare providers, as well as patients, need to know what signs and symptoms to look for.

First Auth oran dCou ntry	**Complication Assessment methods**	**Time of late complicationonset**	**Time of recovery from mentioned Seque**	**Late complications**

Qiuyue Long, China	Complications were categorized using systematic review and meta-analysis methodology. Post-discharge symptoms in the ICU as well as discharge with acute post-acute care and pulmonary function tests among discharged COVID-19 patients.	Late complication onset occurred during time of recovery from acute phase of COVID-19 as patients. Follow-up at least 1 months after discharge or more than more 2 weeks post admission to identify and classify late complications in the study.	Recovery time from the sequelae or late complications of above sequel was variable, different consequents. Results of the study being that due to it being a post-acute COVID-19 syndrome focus clearly seems to be that some symptoms wont resolve for weeks, if not months in some patients even after their initial discharge from hospitalsetupeрь	It explored the persistence of symptoms and signs throughout the post-acute phase, suggestive of longer-term complications or sequelae that negatively impact the long-term health of COVID-19 patients. Late complications listed in the study include fatigue or weakness, psychosocial symptoms such as anxiety or depression, memory impairment and dyspnea, joint pain, reduced diffusion capacity and lung volume measurement, among others.
Taghreed Shams, KSA	This study is a cross-sectional comparison study of pregnancy outcomes between symptomatic and asymptomatic COVID-19 infected pregnant women during the COVID 19 pandemic in Saudi Arabia. Maternal, perinatal, and neonatal outcomes were assessed by symptoms, ARI score, age grips and other variables.	The document does not follow traditional definitions of the timing of late complications. It does mention complications like maternal death from respiratory failure, and also lists neonatal deaths that happened during the time the studies were done.	Details are missing on the timing of recovery from the described sequelae. Recovery from complications such as pneumonia, ICU admissions, and other maternal and fetal complications would depend on each specific case and the severity of the condition.	The document includes late complications such as maternal death (in respiratory failure), maternal pneumonia, neonatal deaths, preterm deliveries, cesarean deliveries, abortions, intrauterine fetal deaths, low birth weight, and others (maternal/neonatal complications attributable to the COVID-19 infection in pregnancy). All complications emphasise the risks and challenges of COVID-19 in pregnant women, particularly those with symptoms and older age of the mother.
Yudha NurPatria,Indonesia	Most studies assessed complications mainly relying on lung function tests in recovered COVID-19 patients.	Late complications were evaluated at different time points from 14 days post discharge from the hospital up to 10 weeks following rehabilitation.	Recovery from the reported sequelae (eg, impaired pulmonary function) was variable. Some had spontaneous improvement of lung function with time, and others improved only with rehabilitative measures.	Late complications in previously ill COVID-19 patients were reported including diffusion and restrictive lung impairments which may linger for weeks to months after recovery. Such complications can impact the patients' long-term lung function.
Pietro De Luca,	he complications were appraised through a systematic review of	Because the study mostly concentrated on ongoing	They also mention the need for longer follow up studies to	The reviewed studies reported persistent hearing or chemosensory

Italy	literature data on audiovestibular symptoms and loss of olfactory/gustatory function after SARS-CoV-2 infection.	audiovestibular and chemosensory impairments due to COVID-19	clarify the long term effects of auditory, vestibular, olfactory, and gustatory dysfunction after COVID-19.	impairments associated with SARS-CoV-2 infection. Although the prevalence of persistent audiovestibular symptoms varied between articles, olfactory and gustatory disturbances were reported more uniformly. Longer-term follow-up studies are therefore required to fully assess the long-term consequences of these conditions.
Premraj L	A meta-analysis was probably conducted in this investigation to evaluate mid and long-term neurological and neuropsychiatric sequelae from post-COVID-19 syndrome.	The article may have also looked at the timing of the development of late neurological and neuropsychiatric sequelae in people with post-COVID-19 syndrome.	They might have studied recovery time from the neurological and neuropsychiatric manifestations of post-COVID-19 syndrome3.	Through meta-analysis, the study presumably intended to investigate and evaluate the mid and bi long-term neurological and neuropsychiatric complications shown in those with post-COVID-19 syndrome.
Jasmine Turna, Canada	urveys and validated scales for Generalized Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), and Perceived Stress Scale (PSS-10).	was not clearly stated in the provided document.	In the document, the time of recovery from sequelae was not stated.	The text you provided was an excerpt from that document, it did not specifically mention late complications.
WalaaElnaiem, Sudan	The complication assessment in the case report was based on cadaveric dissection demonstrating a second brachial artery.	Secondary complications that occurred later from the presence of accessory brachial artery were noted at the time of cadaveric dissection consistent with congenital pathoanatomy.	Since the case report is based on an anatomical observation made in a cadaver, the duration of recovery from the above-mentioned sequelae is not relevant. It was mainly focused on describing the anatomical variation achieved.	Late complications of accessory brachial artery include difficulties in performing angiographic or coronary catheterization, venepunction, traumatic injuries, and arm or forearm fractures management. These variations are important for clinicians to appreciate especially in radiology and surgery.
S.A. Behnood, United Kingdom	It was not aimed at specific complication/cross organ assessment methodology irrespective of any one complication or organ, but about persistent symptoms post SARS-CoV-2 infection in	Document did not state late complication occurred in a specific time.	Details on the timing of recovery from the sequelae (long symptoms post-SARS-CoV-2 infection among children and adolescents) are not included in the document.	The document focused mainly on the long-lasting COVID-19 symptoms of children and young people that occurred after infection with SARS-CoV-2. The study did not focus on specific late complications on top of

	children and young people.			these chronic symptoms.
Mohammad Said ,Italy	Different diagnostic techniques including cardiac magnetic resonance imaging (CMR), echocardiography, electrocardiogram (ECG), and cardiac biomarkers were used to evaluate cardiac sequelae after recovery from COVID-19 infection in this study. .	This document did not specify exactly when late complication occurs after recovery from COVID-19, though	It has not been specified on how long it takes to recover from the above-mentioned sequelae after COVID-19 recovery.	the study identified residual de novo cardiac injury following recovery from COVID-19 (particularly subclinical myocardial injury in the early phase, diastolic dysfunction in the medium term) and risk of heart failure, arrhythmias and myocardial infarction in COVID-19 survivors.
Matsuo So , USA.	Methods: The study was designed as a systematic review and meta-analysis to evaluate radiological and functional lung sequelae among COVID-19 patients.	They used chest computed tomography (CT) and pulmonary function tests (PFT)data of discharged patients for data collection and analysis. The follow-up time after recovery of COVID 19 was from 1-6 months.	Late complications were evaluated at approximately 90 days post symptom onset or hospital discharge. The summary did not provide an explicit recovery time from the aforementioned sequelae. The average follow-up time for evaluation of residual abnormalities was approximately 90 days after symptom onset or discharge.	Late complications consisted of residual abnormalities seen on chest CT and PFT results. Such sequelae highlighted evidence of persistent lung abnormalities including ground glass opacity, parenchymal band or fibrous stripe, impaired diffusion capacity, restrictive and obstructive patterns of lung function even 3 months post-COVID-19 recovery. More long-term studies are needed to understand the endurance and significance of these complications and their sequelae in patients.
César Fernández-de-las-Peñas,Spain.	To estimate the prevalence of post-COVID headache in survivors of COVID-19, the authors performed a meta-analysis, collating data from multiple databases and preprint servers. This data were collected from patients who were either hospitalized or non-hospitalized and recovering from SARS-CoV-2 infection.	The study investigated post-COVID headache prevalence across multiple time points (at symptom onset/hospital admission, at 30 days, 60 days, 90 days, and >180 days after either symptom onset or hospital discharge).	The time it took the mentioned sequelae to resolve was not specifically mentioned in the summary. The prevalence of post-COVID headache decreased in both acute onset and follow-up periods, then plateaued until 180 days after infection.	Late complications are represented by post-COVID headache, with prevalence within 6 months post-SARS-CoV-2-infection ranging from 8% to 15%. The prevalence was higher during hospitalization and decreased over time, but remained stable after the acute phase. The study underscored the need for post-COVID headache risk factor identification and appropriate management in this population.
Jaafar	Assessment of	The mean time	The document is not	The late complication

Omer, Iraq	complication was performed with a systematic review of all published studies using databases including Web of Science, PubMed, MEDLINE on OVID, and Google Scholar. The selection criteria targeted the articles which confirmed SARS-CoV-2 infection and reported neurological disorders that developed post-recovery.	from COVID-19 infection to neurological sequelae was 33.2 days (range 8-130 days)	alluding to a specific time period of recovery from the aforementioned sequelae, as this will vary from person to person.	found are: • Guillain-Barre Syndrome (GBS) • Transverse Myelitis • Stroke • Critical Illness • Encephalopathy • Optic Neuritis • Status Epilepticus • Bell's Palsy • Vestibular Neuritis • Opsoclonus Myoclonus Syndrome • Myopathy • Parkinsonism
James B. Badenoch, UK.	The study used observational methods, such as patient self-reports, clinical interviews, and standardized cognitive tests for the assessment of neuropsychiatric symptoms.	Complications were evaluated post-acute, generally beginning from 4 weeks post COVID-19 infection.	Follow-up was a mean of 77 days (range, 14 to 182 days) after infection.	The most common late complications were sleep disturbances (27.4%), fatigue (24.4%), cognitive impairment (20.2%), anxiety (19.1%), and post-traumatic stress symptoms (15.7%).
Bandar ,Saudi Arabia	Cardiac magnetic resonance imaging (CMR), echocardiography, electrocardiograms (ECG), and cardiac enzyme tests (e.g., troponin levels) were used to assess complications.	Late complications were generally assessed in the post-recovery phase (11-194 days post COVID-19 diagnosis in some studies).	Recovery from cardiovascular complications individuals recommended for re-evaluation four weeks post-infection, or longer, particularly when myocarditis was diagnosed.	Late sequelae determined were diagnosis of myocarditis, pericarditis, pericardial effusion, and elevated troponin levels, with a heterogeneous rate of prevalence across the studies included.
QuinHealey,UK	The study searched longitudinal cohort studies from January 2020 to July 2021, which explored adults with long COVID at least four weeks post-acute infection. Risk of bias was assessed using the Joanna Briggs Institute checklist for cohort studies.	The follow-up periods considered in these studies varied from 30 days to 340 days. Chronic consequences of long COVID were evaluated at least four weeks following acute infection, with outcomes including fatigue, dyspnoea, olfactory dysfunction, myalgia, cough, and	No data were given on recovery time of the cited sequela. But it stressed that long COVID symptoms persisted after the acute phase of infection, with varying prevalence rates over time until 340 days after being infected.	The late complications of long COVID were long symptomatic manifestations such as tiredness, dyspnoea, olfactory dysfunction, myalgia, cough, and gustatory dysfunction. A considerable percentage of patients experienced these symptoms at least four weeks after getting infected with acute SARS-CoV-2 — evidence of the challenge that the disease presents to all patients.

		gustatory dysfunction.		

REFERENCES

1. Mehraeen E, Oliaei S, SeyedAlinaghi S, Karimi A, Mirza- pour P, Afsahi AM, et al. COVID-19 in pediatrics: a sys- tematic review of current knowledge and practice. In- fectDisord Drug Targets (Formerly Current Drug Targets- Infectious Disorders). 2022;22(5):47-57.
2. SeyedAlinaghi S, Karimi A, Barzegary A, Pashaei Z, Afsahi AM, Alilou S, Janfaza N, Shojaei A, Afroughi F, Moham- madi P, Soleimani Y, Nazarian N, Amiri A, Tantuoyir MM, Oliaei S, Mehraeen E, Dadras O. Mucormycosis infection in patients with COVID-19: A systematic review. Health Sci Rep. 2022 Feb 28;5(2):e529. doi: 10.1002/hsr2.529. PMID: 35252593; PMCID: PMC8885749.
3. Hoffmann M, Kleine-Weber H, Schroeder S, Krüger N, Herrler T, Erichsen S, et al. SARS-CoV-2 Cell Entry De- pends on ACE2 and TMPRSS2 and Is Blocked by a Clin- ically Proven Protease Inhibitor. Cell. 2020;181(2):271- 80.e8.
4. Wang X, Fang X, Cai Z, Wu X, Gao X, Min J, et al. Co- morbid Chronic Diseases and Acute Organ Injuries Are Strongly Correlated with Disease Severity and Mortality among COVID-19 Patients: A Systemic Review and Meta- Analysis. Research (Wash D C). 2020;2020:2402961.
5. Alimohamadi Y, Sepandi M, Taghdir M, Hosamirud- sari H. Determine the most common clinical symptoms in COVID-19 patients: a systematic review and meta- analysis. J Prev Med Hyg. 2020;61(3):E304-e12.
6. Raman B, Cassar MP, Tunnicliffe EM, Filippini N, Grif- fanti L, Alfaro-Almagro F, et al. Medium-term effects of SARS-CoV-2 infection on multiple vital organs, ex- ercise capacity, cognition, quality of life and men- tal health, post-hospital discharge. EClinicalMedicine. 2021;31:100683.
7. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, Sepul- veda R, Rebolledo PA, Cuapio A, et al. More than 50 long- term effects of COVID-19: a systematic review and meta- analysis. Sci Rep. 2021;11(1):16144.
8. Tenforde MW, Kim SS, Lindsell CJ, Billig Rose E, Shapiro NI, Files DC, et al. Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multistate health care systems net- work—United States, March–June 2020. MMWR Morb Mortal Wkly Rep. 2020;69(30):993-8.
9. Shah W, Hillman T, Playford ED, Hishmeh L. Manag- ing the long term effects of covid-19: summary of NICE, SIGN, and RCGP rapid guideline. BMJ. 2021 Jan 22;372:n136. doi: 10.1136/bmj.n136. Erratum in: BMJ. 2022 Jan 19;376:o126. PMID: 33483331.
10. Desai AD, Lavelle M, Boursiquot BC, Wan EY. Long-term complications of COVID-19. Am J Physiol Cell Physiol. 2022;322(1):C1-C11.
11. Singh Y, Gupta G, Kazmi I, Al-Abbasi FA, Negi P, Chellap- pan DK, et al. SARS CoV-2 aggravates cellular metabolism mediated complications in COVID-19 infection. Derma- tolTher. 2020;33(6):e13871.
12. Coperchini F, Chiovato L, Croce L, Magri F, Rotondi M. The cytokine storm in COVID-19: An overview of the involvement of the chemokine/chemokine-receptor sys- tem. Cytokine Growth Factor Rev. 2020;53:25-32.
13. Premraj L, Kannapadi NV, Briggs J, Seal SM, Battaglini D, Fanning J, et al. Mid and long-term neurological and neuropsychiatric manifestations of post-COVID-19 syn- drome: A meta-analysis. J Neurol Sci. 2022;434:120162.
14. Pinzon RT, Wijaya VO, Jody AA, Nunsio PN, Buana RB. Persistent neurological manifestations in long COVID- 19 syndrome: A systematic review and meta-analysis. J Infect Public Health. 2022 Aug;15(8):856-869. doi: 10.1016/j.jiph.2022.06.013. Epub 2022 Jun 23. PMID:35785594; PMCID: PMC9221935.
15. Long Q, Li J, Hu X, Bai Y, Zheng Y, Gao Z. Follow- Ups on Persistent Symptoms and Pulmonary Function Among Post-Acute COVID-19 Patients: A Systematic Re- view and Meta-Analysis. Front Med (Lausanne). 2021 Sep 3;8:702635. doi: 10.3389/fmed.2021.702635. PMID: 34540862; PMCID: PMC8448290.
16. Vanderlind WM, Rabinovitz BB, Miao IY, Oberlin LE, Bueno-Castellano C, Fridman C, et al. A systematic re- view of neuropsychological and psychiatric sequalae of COVID-19: implications for treatment. CurrOpinPsychi- atry. 2021;34(4):420.
17. Schou TM, Joca S, Wegener G, Bay-Richter C. Psychiatric and neuropsychiatric sequelae of COVID-19–A system- atic review. Brain Behav Immun. 2021;97:328-48.
18. Arora T, Grey I, Östlundh L, Lam KBH, Omar OM, ArnoneD. The prevalence of psychological consequences of COVID-19: A systematic review and meta-analysis of ob- servational studies. J Health Psychol. 2022;27(4):805-24.

19. Badenoch JB, Rengasamy ER, Watson C, Jansen K, Chakraborty S, Sundaram RD, et al. Persistent neuropsy- chiatric symptoms after COVID-19: a systematic review and meta-analysis. Brain Commun. 2022;4(1):fcab297.
20. Bourmistrova NW, Solomon T, Braude P, Strawbridge R, Carter B. Long-term effects of COVID-19 on men- tal health: A systematic review. J Affect Disord. 2022;299:118-25.
21. Ahmed H, Patel K, Greenwood DC, Halpin S, Lewthwaite P, Salawu A, et al. Long-term clinical outcomes in sur- vivors of severe acute respiratory syndrome and Middle East respiratory syndrome coronavirus outbreaks after hospitalisation or ICU admission: A systematic review and meta-analysis. J Rehabil Med. 2020;52(5):jrm00063.
22. Alkodaymi MS, Omrani OA, Fawzy NA, Shaar BA, Almam- louk R, Riaz M, et al. Prevalence of post-acute COVID- 19 syndrome symptoms at different follow-up periods: a systematic review and meta-analysis. ClinMicrobiol In- fect. 2022;28(5):657-66.
23. Ceban F, Ling S, Lui LMW, Lee Y, Gill H, Teopiz KM, et al. Fatigue and cognitive impairment in Post-COVID-19 Syndrome: A systematic review and meta-analysis. Brain Behav Immun. 2022;101:93-135.
24. Chen C, Haupert SR, Zimmermann L, Shi X, Fritsche LG, Mukherjee B. Global Prevalence of Post-Coronavirus Dis- ease 2019 (COVID-19) Condition or Long COVID: A Meta- Analysis and Systematic Review. J Infect Dis. 2022 Nov 1;226(9):1593-1607. doi: 10.1093/infdis/jiac136. PMID:35429399; PMCID: PMC9047189.
25. Fernández-de-Las-Peñas C, Palacios-Ceña D, Gómez- Mayordomo V, Florencio LL, Cuadrado ML, Plaza-Manzano G, et al. Prevalence of post-COVID-19 symp- toms in hospitalized and non-hospitalized COVID-19 survivors: A systematic review and meta-analysis. EurJIntern Med. 2021;92:55-70.
26. Michelen M, Manoharan L, Elkheir N, Cheng V, Dagens A, Hastie C, O'Hara M, Suett J, Dahmash D, Bugaeva P, Rigby I, Munblit D, Harriss E, Burls A, Foote C, Scott J, Carson G, Olliaro P, Sigfrid L, Stavropoulou C. Char- acterising long COVID: a living systematic review. BMJ Glob Health. 2021 Sep;6(9):e005427. doi: 10.1136/bmjgh- 2021-005427. PMID: 34580069; PMCID: PMC8478580.
27. Nguyen NN, Hoang VT, Dao TL, Dudouet P, Eldin C, Gautret P. Clinical patterns of somatic symptoms in patients suffering from post-acute long COVID: a systematic review. Eur J ClinMicrobiol Infect Dis. 2022;41(4):515-45.
28. Salamanna F, Veronesi F, Martini L, Landini MP, Fini M. Post-COVID-19 Syndrome: The Persistent Symptoms at the Post-viral Stage of the Disease. A Systematic Review of the Current Data. Front Med (Lausanne). 2021;8:653516.
29. Yang T, Yan MZ, Li X, Lau EHY. Sequelae of COVID-19 among previously hospitalized patients up to 1 year after discharge: a systematic review and meta-analysis. Infec- tion. 2022;50(5):1067-109.
30. Zeng N, Zhao YM, Yan W, Li C, Lu QD, Liu L, Ni SY, Mei H, Yuan K, Shi L, Li P, Fan TT, Yuan JL, Vitiello MV, Kosten T, Kondratiuk AL, Sun HQ, Tang XD, Liu MY, Lalvani A, Shi J, Bao YP, Lu L. A systematic review and meta-analysis of long term physical and mental sequelae of COVID- 19 pandemic: call for research priority and action. Mol Psychiatry. 2023 Jan;28(1):423-433. doi: 10.1038/s41380- 022-01614-7. Epub 2022 Jun 6. PMID: 35668159; PMCID: PMC9168643.
31. Almas T, Malik J, Alsubai AK, JawadZaidi SM, Iqbal R, Khan K, Ali M, Ishaq U, Alsufyani M, Hadeed S, Alsufyani R, Ahmed R, Thakur T, Huang H, Antony M, Antony I, Bhullar A, Kotait F, Al-Ani L. Post-acute COVID-19 syn- drome and its prolonged effects: An updated systematic review. Ann Med Surg (Lond). 2022 Aug;80:103995. doi: 10.1016/j.amsu.2022.103995. Epub 2022 Jun 15. PMID:35721785; PMCID: PMC9197790.
32. Ahmad MS, Shaik RA, Ahmad RK, Yusuf M, Khan M, Al- mutairi AB, et al. "LONG COVID": An insight. Eur Rev Med Pharmacol Sci. 2021;25(17):5561-77.
33. Healey Q, Sheikh A, Daines L, Vasileiou E. Symp- toms and signs of long COVID: A rapid review and meta-analysis. J Glob Health. 2022 May 21;12:05014. doi: 10.7189/jogh.12.05014. PMID: 35596571; PMCID: PMC9125197.
34. d'Ettorre G, GentiliniCacciola E, Santinelli L, De Giro- lamo G, Spagnolello O, Russo A, et al. Covid-19 sequelae in working age patients: A systematic review. J Med Virol. 2022;94(3):858-68.
35. Groff D, Sun A, Ssentongo AE, Ba DM, Parsons N, Poudel GR, et al. Short-term and long-term rates of postacutesequelae of SARS-CoV-2 infection: a systematic review. JAMA network open. 2021;4(10):e2128568-e.
36. Han Q, Zheng B, Daines L, Sheikh A. Long-Term seque- lae of COVID-19: A systematic review and meta-analysis of one-year follow-up studies on post-COVID symptoms. Pathogens. 2022;11(2):269.
37. Iwu CJ, Iwu CD, Wiysonge CS. The occurrence of long COVID: a rapid review. Pan Afr Med J. 2021 Jan 20;38:65. doi: 10.11604/pamj.2021.38.65.27366. PMID: 33889231; PMCID: PMC8028365.
38. Iqbal FM, Lam K, Sounderajah V, Clarke JM, Ashrafian H, Darzi A. Characteristics and predictors of acute and chronic post-COVID syndrome: A systematic review and meta-analysis. EClinicalMedicine. 2021;36:100899.

39. SeyedAlinaghi S, Afsahi AM, MohsseniPour M, Behnezhad F, Salehi MA, Barzegary A, Mirzapour P, Mehraeen E, Dadras O. Late Complications of COVID-19; a Systematic Review ofCurrent Evidence. Arch AcadEmerg Med. 2021 Jan 20;9(1):e14. doi: 10.22037/aaem.v9i1.1058. PMID: 33681819; PMCID: PMC7927752.
40. Jennings G, Monaghan A, Xue F, Mockler D, Romero- Ortuño R. A systematic review of persistent symptoms and residual abnormal functioning following acute COVID-19: ongoing symptomatic phase vs. post-COVID- 19 syndrome. J Clin Med. 2021;10(24):5913.
41. Ma Y, Deng J, Liu Q, Du M, Liu M, Liu J. Long-Term Con- sequences of COVID-19 at 6 Months and Above: A Sys- tematic Review and Meta-Analysis. Int J Environ Res Pub- lic Health. 2022;19(11):6865.
42. Malik P, Patel K, Pinto C, Jaiswal R, Tirupathi R, Pillai S, et al. Post-acute COVID-19 syndrome (PCS) and health- related quality of life (HRQoL)—A systematic review and meta-analysis. J Med Virol. 2022;94(1):253-62.
43. Cabrera Martimbianco AL, Pacheco RL, Bagattini ÊM, Riera R. Frequency, signs and symptoms, and criteria adopted for long COVID-19: A systematic review. Int J ClinPract. 2021;75(10):e14357.
44. Sanchez-Ramirez DC, Normand K, Zhaoyun Y, Torres- Castro R. Long-term impact of COVID-19: a systematic review of the literature and meta-analysis. Biomedicines. 2021;9(8):900.
45. Sandler CX, Wyller VBB, Moss-Morris R, Buchwald D, Crawley E, Hautvast J, Katz BZ, Knoop H, Little P, Taylor R, Wensaas KA, Lloyd AR. Long COVID and Post-infective Fatigue Syndrome: A Review. Open Forum Infect Dis. 2021 Sep 9;8(10):ofab440. doi: 10.1093/ofid/ofab440. PMID: 34631916; PMCID: PMC8496765.
46. Renaud-Charest O, Lui LM, Eskander S, Ceban F, Ho R, Di Vincenzo JD, et al. Onset and frequency of depression in post-COVID-19 syndrome: A systematic review. J Psychi- atr Res. 2021;144:129-37.
47. Zürcher SJ, Banzer C, Adamus C, Lehmann AI, Richter D, Kerksieck P. Post-viral mental health sequelae in infected persons associated with COVID-19 and previous epidemics and pandemics: Systematic review and meta-analysis of prevalence estimates. J Infect Public Health. 2022 May;15(5):599-608. doi: 10.1016/j.jiph.2022.04.005. Epub 2022 Apr 20. PMID:
48. 35490117; PMCID: PMC9020842.
49. Mehraeen E, Dadras O, Afsahi AM, Karimi A, Pour MM, Mirzapour P, et al. Vaccines for COVID-19: A System- atic Review of Feasibility and Effectiveness. Infect Disord Drug Targets. 2022;22(2):e230921196758.
50. Ahmed JO, Ahmad SA, Hassan MN, Kakamad FH, Salih RQ, Abdulla BA, Rahim Fattah FH, Mohammed SH, Ali RK, Salih AM. Post COVID-19 neurological compli- cations; a meta-analysis. Ann Med Surg (Lond). 2022 Apr;76:103440. doi: 10.1016/j.amsu.2022.103440. Epub 2022 Mar 3. PMID: 35261766; PMCID: PMC8891214.
51. Fernández-de-las-Peñas C, Navarro-Santana M, Gómez- Mayordomo V, Cuadrado ML, García-Azorín D, Arendt- Nielsen L, et al. Headache as an acute and post-COVID- 19 symptom in COVID-19 survivors: A meta-analysis of the current literature. Eur J Neurol. 2021;28(11):3820-5.
52. So M, Kabata H, Fukunaga K, Takagi H, Kuno T. Radi- ological and functional lung sequelae of COVID-19: a systematic review and meta-analysis. BMC Pulm Med. 2021 Mar 22;21(1):97. doi: 10.1186/s12890-021-01463-0. PMID: 33752639; PMCID: PMC7983097.
53. Patria YN, Sabirin RM. COVID-19 potentially causes long-term deterioration of lung function: a systematic review and meta-analysis. Med. J. Indones. 2021;30(4):279-89.
54. Gracia-Ramos AE, Martin-Nares E, Hernández-Molina
55. G. New Onset of Autoimmune Diseases Following COVID-19 Diagnosis. Cells. 2021 Dec 20;10(12):3592. doi: 10.3390/cells10123592. PMID: 34944099; PMCID: PMC8700122.
56. Alosaimi B, AlFayyad I, Alshuaibi S, Almutairi G, Alshaebi N, Alayyaf A, et al. Cardiovascular complications and out- comes among athletes with COVID-19 disease: a system- atic review. BMC Sports Sci Med Rehabil. 2022;14(1):74.
57. Ramadan MS, Bertolino L, Zampino R, Durante- Mangoni E. Cardiac sequelae after coronavirus disease 2019 recovery: a systematic review. Clin Microbiol Infect. 2021;27(9):1250-61.
58. Choudhury A, Tariq R, Jena A, Vesely EK, Singh S, Khanna S, et al. Gastrointestinal manifestations of long COVID: A systematic review and meta-analysis. TherapAdv Gas- troenterol. 2022;15:17562848221118403.
59. Lopez-Leon S, Wegman-Ostrosky T, Ayuzo Del Valle NC, Perelman C, Sepulveda R, Rebolledo PA, et al. Long- COVID in children and adolescents: a systematic review and meta-analyses. Sci Rep. 2022;12(1):9950.