



# Post-COVID-19 syndrome: assessment of short- and long-term post-recovery symptoms in recovered cases in Saudi Arabia

Mohammed A. Garout<sup>1</sup> · Saleh A. K. Saleh<sup>2,3</sup> · Heba M. Adly<sup>1</sup> · Altaf A. Abdulkhaliq<sup>2</sup> · Abdullah A. Khafagy<sup>1</sup> · Magda R. Abdeltawab<sup>4</sup> · Ali A. Rabaan<sup>5,6,7</sup> · Alfonso J. Rodriguez-Morales<sup>8,9,10</sup> · Jaffar A. Al-Tawfiq<sup>11,12,13</sup> · Maher N. Alandijjany<sup>14,15</sup>

Received: 5 February 2022 / Accepted: 22 February 2022 / Published online: 16 March 2022  
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany 2022

## Abstract

**Introduction** Recent studies investigated the endurance of symptoms and occurrence of complications three months after SARS-CoV-2 infection. This study aims to examine the prevalence, variation, and severity of continual symptoms in the post-COVID-19 using a single-center questionnaire.

**Methods** The questionnaire was distributed among population in Saudi Arabia who recovered from COVID-19 between April 1, 2020 and December 31, 2021.

**Results** A total of 744 participants completed the questionnaire, 318 (42.8%) recovered less than 3 months, 75 (10.1%) recovered 3–6 months, while 351 (47.2%) recovered more than 6 months. About half of the participants 353 (47.5%) had incessant symptoms and of those patients, more than half had two or more symptoms. Common symptoms included fatigue 189 (25.4%), headache 118 (15.9%), and myalgia 63 (8.5%). Of the participants, 189 (21.4%) experienced continual symptoms including anxiety in 98 (13.2%) and depression in 70 (9.5%).

**Conclusion** The current study showed a high proportion of individuals with long-COVID-19 symptoms. Thus, proper assessment of the individuals in the post-recovery period can guide the patients to the relevant clinics for rehabilitation. Moreover, there is a great importance to decrease COVID-19 infection, populations should be targeted to boost vaccine efficiency.

**Keywords** COVID-19 · Pandemic · Infection · Coronavirus · Post recovery · Symptoms · Saudi Arabia

## Introduction

Globally, as of 4 January 2022, COVID-19-confirmed cases have been recorded in 290,959,019 caes including 5,446,753 deaths, as reported to the WHO, and the recovered cases were 256,200,554 [1]. COVID-19 vaccination uptake of at least one dose has been 58.6% and 9.28 billion doses were dispensed worldwide [2]. On 10 December 2020, the Kingdom of Saudi Arabia (KSA) had authorized the Pfizer/BioNTech COVID-19 vaccine and focused on older citizens and residents and frontline healthcare workers in the initial phase [3]. On 19 February 2022, KSA had achieved at least 25,840,571 (73.12%) vaccine doses, with completed vaccinations of 24,023,925 (67.98%) at rate of 1.22/second or 105,219 each day [2].

Even though the COVID-19 disease has triggered fear ever since the start of the pandemic, the existence of several post-recovery symptoms has attracted additional interest. Many studies revealed that COVID-19 has the potential to cause long-term effects on nearly all systems including respiratory, cardiovascular, gastrointestinal, neurological, and psychiatric manifestations [4]. A significant percentage of patients (87.5%) who had improved after acute infection continued to endure from a diversity of symptoms such as fatigue, dyspnea, cough, myalgia, and headache [5, 6]. Published data indicated that individuals who experienced mild illness or had no apparent symptoms may also suffer from long-term symptoms. The terminology regarding ongoing symptoms after recovery and the resolution of the disease differ among studies and societies' definitions as the Centers for Disease Control and

✉ Jaffar A. Al-Tawfiq  
jaffar.tawfiq@jhah.com; jaltawfi@yahoo.com

Extended author information available on the last page of the article

Prevention (CDC) and The National Institute for Health and Care Excellence (NICE) [7, 8]. Continuing symptoms beyond 3 weeks from the disease onset were designated as post-acute COVID-19 [9] and beyond 12 weeks as chronic COVID-19 [10]. The US CDC suggested separating the disease into different categories as: acute COVID-19 (the first 2 weeks from symptom start), post-acute hyperinflammatory illness (between 2 and 4 weeks from symptoms start), and late period symptoms (more than 4 weeks from symptom start) [11].

Few studies were principally included hospitalized patients for acute COVID-19, and investigated the endurance of symptoms and occurrence of complications after SARS-CoV-2 infection and showed that 15–76% of such patients may have persistent symptoms six months after severe illness [12–16]. In addition, one study found that up to 20% of patients had to be re-hospitalized [17], and 80% may need follow-up in primary care centers within 2 months of hospital discharge [18]. Additional studies also showed that post-COVID-19 syndrome is not only present in those requiring hospitalization or in older individuals with comorbidities, but was observed in young and healthy people with mild disease [18, 19] with lack of data on the full spectrum of symptoms of post-COVID-19 [20]. To care for such patients, few countries have set up clinics to check post-recovery symptoms and to enhance the overall knowledge [21–23].

In this study, we examine the prevalence, and severity of persistent symptoms post-COVID-19 and investigate the post-recovery follow-up, and compare these symptoms among the different spectrum of COVID-19 disease.

## Materials and methods

### Study Design

This study was conducted among recovered COVID-19 patients, between April 1, 2020 and December 31, 2021. The participants declared that they have been diagnosed as COVID-19 by confirmed (SARS-CoV-2) polymerase chain reaction (PCR).

A questionnaire was designed to study the current health status of patients and their continual symptoms in the post-COVID period. As this survey aimed to examine the incidence of post-COVID syndrome, participants who have had COVID-19 at least 2 months before the questionnaire, were included in the survey. The questionnaire was distributed using different social media channels between November 2021 and December 2021. Before completing the questionnaire, all participants were requested

to accept to participate in the study. The study protocol was approved by the Ethics Review Board for Human Studies at the Faculty of Medicine, Umm Al-Qura University (Approval no. HAPO-02-K-012–2022-01-902 in accordance with Saudi National Committee for Bioethics HABO-02-K-012).

### Questionnaire design

Basic data information included in the survey were age, gender, chronic diseases status, history of hospitalization (disease severity, extent of hospital stays, necessity for respiratory supports, and necessity for intensive care unit [ICU]), period since symptoms started, occurrence of insistent symptoms by systems. Data about acute COVID-19 were attained from participants' themselves. COVID-19 disease severity was classified as mild to moderate, severe, and critical based on the WHO COVID-19 technical guidelines (30). The symptoms of patients were congregated by systems as follows: general (fatigue, myalgia), respiratory (chest pain, cough, and wheezing), cardiovascular (palpitation), neuropsychiatric (headache, hypersomnia, depression, and anxiety), dermatologic (hair loss), gastrointestinal (diarrhea, and constipation). Participants were asked to score symptoms from 0 (no symptoms) to 10 (extreme symptoms) to assess the level of severity based on the scale of COVID-19 Yorkshire Rehabilitation Screening (C19-YRS). The C19-YRS assesses symptom severity and functional disability performance. The tool has been recommended in England by the National Institute for Health and Care Excellence (NICE) in its guidelines for managing the long-term effects of COVID-19 [24, 25]. The questionnaire has 19 questions about the severity of and impact on function of the following: breathlessness, voice, swallowing, nutrition, mobility, fatigue, personal care, usual activities, pain and discomfort, anxiety, depression, post-traumatic stress disorder, continence, cognition, perceived health status and family views [26]. The scale is used to examine participants' situation for their ongoing symptoms of COVID-19 and to offer management plan for the essential restorations and we can advise the patients to the relevant clinic for more rehabilitation after COVID-19 recovery.

### Statistical analysis

All analyses were performed using SPSS V.21 software version 21. Descriptive statistics were described as mean  $\pm$  standard deviation (SD) or medians plus with quartiles (25th–75th percentile) for continuous variables that do not have a normal distribution and as frequency and percentages for definite variables. A *t* test was applied in the evaluation of continuous

variables for normally distributed data. The  $\chi^2$  test was used for comparing categorical variables in parametric conditions. A *p* value of less than 0.05 was considered statistically significant.

**Table 1** Demographic and general characteristics of participants (n = 744)

Characteristics of participants	Value	
Age, years, <i>n</i> (%)	18–29, 138 (18.6%)	
	30–50, 398 (53.5%)	
	≥ 50, 207 (27.9%)	
Gender	Males 366 (49.3%)	
	Females 378 (50.7%)	
Time since diagnosis (months, <i>n</i> , %)	≤ 3 months, 318 (42.8%)	
	≥ 3 months, 75 (10.1%)	
	≥ 6 months, 351 (47.2%)	
Initial symptom severity, <i>n</i> (%)	Asymptomatic 81 (11.1%)	
	Mild to moderate 554 (67.3%)	
	Severe to very severe 160 (21.6%)	
Hospitalization and ICU stay		
	Non-hospitalized, <i>n</i> (%)	677 (91.1%)
	Hospitalized without ICU stay, <i>n</i> (%)	66 (8.9%)
Hospitalized with ICU stay, <i>n</i> (%)	7 (11.1%)	
Comorbidities		
	No comorbidity	459 (61.7%)
	At least one comorbidity	285 (38.3%)

## Results

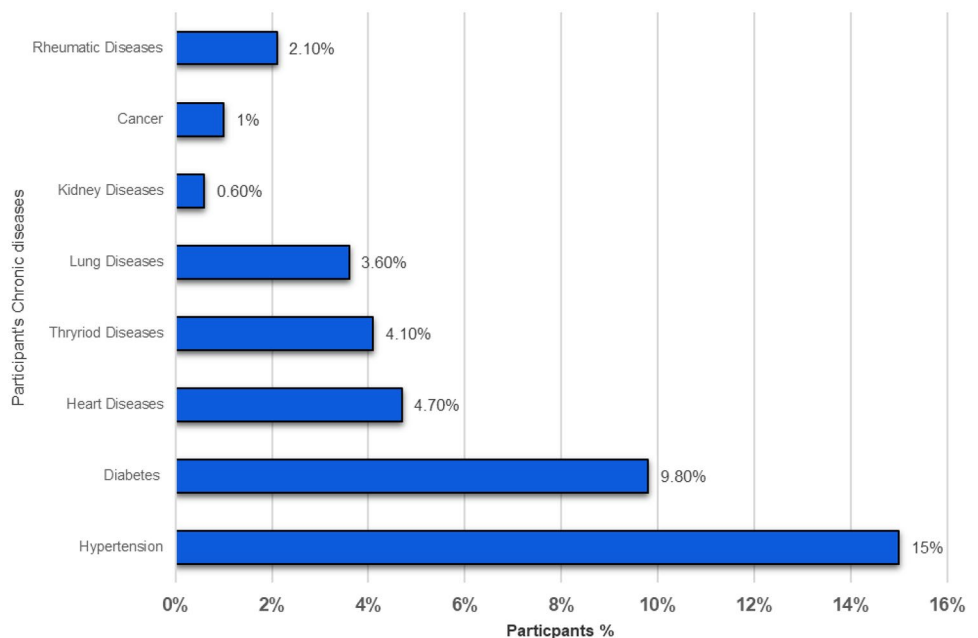
### Patients demographic characteristics

A total of 744 participants who recovered from COVID-19 disease completed the study questionnaire, 318 (42.8%) recovered less than 3 months, 75 (10.1%) recovered 3–6 months, while 351 (47.2%) of the patients recovered more than 6 months. Of the total participants, 366 (49.3%) were male, and 378 (50.7%) were females. Of the study population, 398 (53.5%) aged 30–50 years, 207 (27.9%) were above 50 years, while 186 (18.6%) aged 18–29 years (Table 1). Only 66 (8.9%) of the participants were hospitalized, and 82 (11.1%) required ICU admission, and 677 (91.1%) required only home isolation with no oxygen support. Of the patients, 534 (71.8%) had mild-to-moderate COVID-19, 459 (61.7%) declared no comorbidity, 117 (15.8%) had hypertension, 72 (9.8%) had diabetes mellitus, and 34 (4.7%) had heart disease (Figs. 1 and 2).

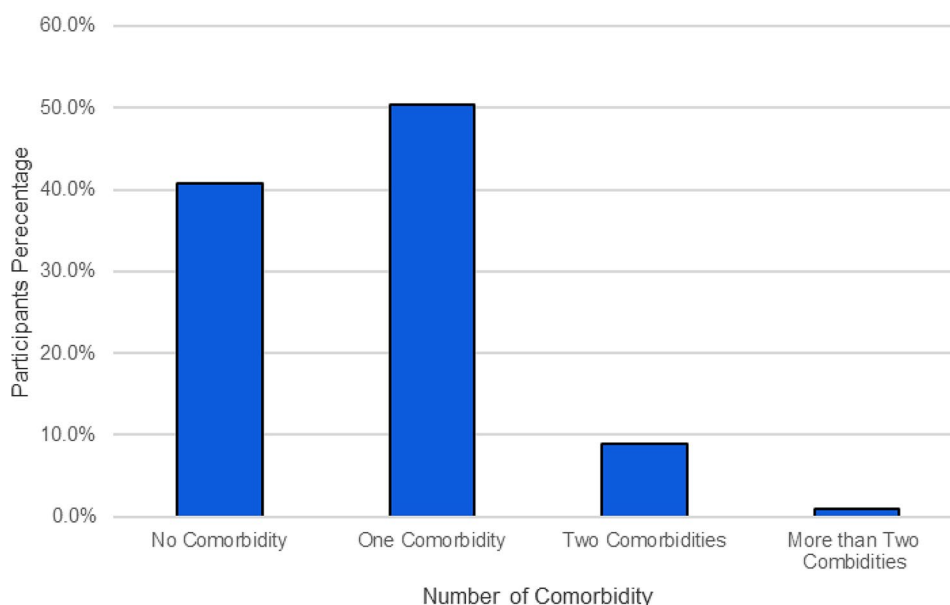
### Characteristics of post-COVID-19 symptoms

Approximately half of the participants 410 (47.5%) had incessant symptoms, and more than half of them had two or more symptoms. Common systemic symptoms included: fatigue 189 (25.4%), headache 118 (15.9%), myalgia 63 (8.5%), and at least one of these symptoms was present in 128 (31.3%) of patients. In general, respiratory symptoms including cough, wheezing and chest pain together were common persistent symptoms in 137 (66.5%) and 51 (6.9%) had subjective feelings of dyspnea. Of the participants, 189

**Fig. 1** Clinical characteristics of participants with chronic diseases



**Fig. 2** Number of comorbidities distributed among in the study participants



(21.4%) experienced continual physical symptoms combined with neuropsychiatric symptoms in the form of concentration or memory deficit 79 (10.7%) or headache 118 (15.9%). Anxiety and depression were reported by 98 (13.2%) and 70 (9.5%) of the patients. Hair loss was reported as a recurrent dermatological symptom by 11.5%. On the other hand, 334 (45%) of the patient did not report any of the mentioned post-recovery symptoms (Figs. 2, 3).

### Prevalence of post-recovery short- and long-term symptoms

Initial analysis showed a number of associated factors with the development of post-COVID-19 symptoms. A higher ratio of female participants and primarily hospitalized patients stated that they did not fully recover compared to males and non-hospitalized patients, respectively (Table 2). In a multivariable evaluation amongst primarily symptomatic patients, both age > 50 years and the presence of comorbidities correlated with post-COVID-19 symptoms. However, there was no statistical difference in relation to gender, severity of illness or need for hospitalization (Table 2).

### Discussion

In this study, we evaluated the incidence and features of post-COVID syndrome in a slightly large number of 744 recovered patients in Saudi Arabia. In a multivariate analysis, hospitalization and presence of comorbidity were independent associated factors with persistent symptoms. It is important to elucidate the prevalence, diversity, and duration

of the post-COVID symptoms that may impact the quality of life, follow-up, and treatment schemes (Fig. 3).

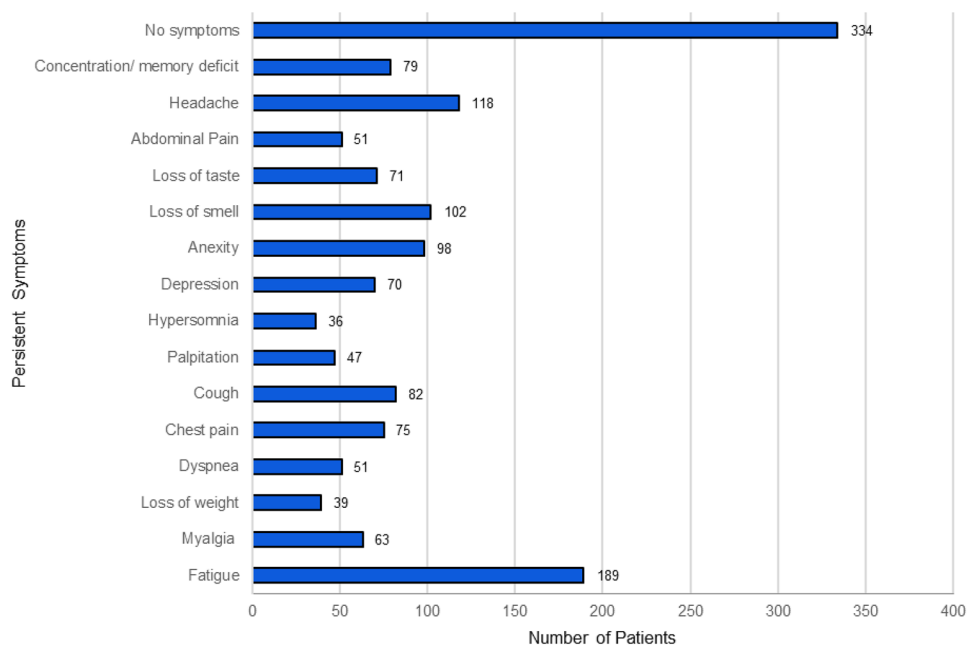
Several studies described persistent symptoms in 13.3% to 96% of patients who recovered from COVID-19 disease [18–20, 27, 28]. The differences in the reported results could be related to differences in the attributes of the study population (inpatients/outpatients, infection severity), study designs (patient self-reporting, questionnaire type, outpatient clinic/inpatients discharged) and the time that had elapsed after infection. A prospective study from Spain stated the occurrence of 50.9% post-COVID syndrome 10–14 weeks after the infection [29]. Another study from the U.K evaluated the electronic medical records of 47,780 hospitalized patients recovering from COVID-19, and showed 33% were re-hospitalized, and about 10% died during the follow-up period of 140 days [30]. Our study included both inpatient and outpatients recovered COVID-19 patients with different levels of severity from mild to severe infection, therefore, our study population signifies nearly the whole spectrum of the COVID-19 illness. However, it is not clear why long-term symptoms continue in certain patients recovered from COVID-19. It is thought that long-term consequences of COVID-19 correlate with the SARS-CoV-2 ability to trigger a substantial provocative response in certain persons [31–33]. The contribution of variants of concerns to the post-COVID-19 syndrome could not be evaluated in this study. However, vaccination provides protection against hospitalization and thus severe cases were decreased even with variants of concerns such as the delta variant [34]. Thus, further studies are needed to elucidate the contribution of the different variants to post-COVID-19 syndrome and the impact of vaccination.

**Table 2** Univariate and odd ratio for the development of short- and long-term symptoms post-COVID-19

Short- and long-term symptoms post-COVID-19					
	Present	Absent	<i>p</i> value	Odds Ratio	95% CI
<b>Age, (group range; n (%))</b>					
18–29	59 (42.7)	79 (57.3)	<0.005		
30–50	200 (50.2)	198 (49.7)			
≥ 50	151 (75)	57 (25)		3.547	2.251–5.588
<b>Males, n (%)</b>					
	198, (54.1)	168 (45.9)	>0.05	0.9229	0.6909–1.233
<b>Females, n (%)</b>					
	212 (56)	166 (44)			
<b>Hospitalized, n (%)</b>					
	40 (60.6)	26 (39.4)	>0.05	1.28	0.762–2.161
<b>Non - Hospitalized, n (%)</b>					
	370 (54.7)	307 (45.3)			
<b>Chronic Diseases, n (%)</b>					
	214 (75)	71 (25)	<0.005	4.04	2.921–5.614
<b>no chronic disease, n (%)</b>					
	196 (42.7)	263 (57.3)			
<b>COVID-19 severity level</b>					
<b>Asymptomatic, n (%)</b>					
	41 (50.6)	40 (49.3)	>0.05		
<b>Mild to moderate, n (%)</b>					
	273 (54.3)	230 (45.7)			
<b>Severe to very severe, n (%)</b>					
	96 (60)	64 (40)			

In this study, persistent symptoms did not correlate with severity of illness or gender. Our findings match those from

**Fig. 3** COVID-19 persistent symptoms in the study participants



a study conducted in Egypt [35]. In another study, disease severity and comorbidity were risk factors for the persistence of symptoms [36]. Additionally another study reported that age above 65 years and co-morbid diseases were risk factors of persistent symptoms [37]. We also found correlation with age and presence of comorbidities with post-COVID-19 symptoms.

In agreement with our study results, several studies stated fatigue as the most common symptom [18–20, 27]. COVID-19 disease can lead to pulmonary complications such as fibrosis, cough, and bronchiectasis. Long-term dyspnea is one of the feared long-term outcomes of COVID-19 disease [38]. In accordance with our study, Moreno-Pérez et al. assessed 277 patients in follow-up clinic 10–14 weeks after the onset of infection and they observed post-COVID syndrome in almost half of the COVID-19 patients, and < 25% had abnormal radiological changes [29].

Our study showed that the incidence of depression and anxiety appeared in about 9.5% and 13.2%, respectively. These results match those of a meta-analysis that showed the prevalence of depression, anxiety, and insomnia as 15.97%, 15.15%, and 23.87%, respectively [39]. Of the study participants, 10.1% reported hair loss similar to those in one study where 24% reported hair loss on average 110.9 days after disease onset [40].

Cardiac manifestations are also well-defined disorders and clearly foresee mortality between COVID-19 patients [41]. When the pandemic is over, it is estimated that there will be residual lung and cardiac disorders in a significant number of patients. Our study also supports this result as 10–15% of participants claimed that they are suffering from chest pain and palpitation. A study conducted in Saudi Arabia between May and July 2020 among patients discharged from hospital, showed shortness of breath, cough and fatigue in 40.1%, 27.5%, and 29.7%, respectively [42]. Another cohort study, in the same period, using a standardized telephone assessment between 6 weeks and 6 months post-hospital discharge, confirmed that age, dyslipidemia, hypertension, pre-existing lung disease and duration of symptoms were negatively associated with the WHO's five well-being index [43].

We applied C19-YRS tool scale to study the symptoms intensity among COVID-19 patients. Participants were asked to put a score for long-term symptoms as 0 (no problem) to 10 (extreme symptoms). However, most of our study participants reported mild to moderate levels of persistent symptoms with a score of 4 to 6, and patients scored loss of smell and taste as 5–6 and fatigue as 4–5. We think most of the participants have not mentioned symptoms as they believe these were common and do not need to be reported.

The process of post-COVID ailments is yet not well studied although is assumed to be secondary to virus-particular pathophysiological alterations, long-lasting inflammatory

reaction to severe infection and possibly related to post-intensive care illness [44, 45]. Our study was designed to assess patients with different SARS-CoV-2 severity requiring either in-patients or only outpatient care; however, many studies assessed only inpatients after discharged from hospital. A systematic review article reported that clinical characteristics of post-acute COVID-19 infection may appear more than 60 days after the occurrence of infection [46]. A study in the UK, patients with long COVID-19 described persistent multisystem association and substantial disability. In seven months, several patients have not yet recovered (mostly from systemic and neurological symptoms), have not come back to earlier stages of work, and remain with considerable symptoms [18]. A cohort study reported that nearly all COVID-19 patients had a good physical and functional recovery for the period of one-year follow-up and had resumed their previous work and life. The health level in this cohort of COVID-19 patients at twelve months was yet lesser than those in the control population [47]. A meta-analysis of 12 studies and 4828 post-acute COVID-19 syndrome (PCS) showed that persistent symptoms were associated with poor quality of life, tenacious symptoms, and mental health [48]. This suggests that we need more research on PCS patients to understand risk factors and those leading to poor quality of life in order to decrease COVID-19 infection. In addition, populations should be encouraged to receive booster doses of the vaccine and to have better disease control including physical distancing and use of personal protective measures, in the post-vaccination period [49]. To our knowledge, this study explored post-COVID syndrome through spectrum of disease severity from mild to severe in Saudi Arabia. However, the study is based on the patient's self-declaration about their persistent symptoms. Thus, there may be inconsistencies in stating the severity of the patients' symptoms.

Additional study limitations could be attributed to other factors. We had not been able to evaluate the impact of vaccination on the occurrence of such syndrome. However, this is an important point to address in future studies to give additional advantages of vaccination and to decrease hesitancy [50] given the rate of hesitancy across the world [51–54]. One study showed that the risk of having persistent symptoms > 28 days post-vaccination breakthrough infection was associated with an Odd Ratio (OR) of 0.51 in those who received two doses of the vaccine [49]. Thus, it is important to study the effects of vaccination and the contribution of different variants on the development of this syndrome, as these variants may cause different severity of COVID-19 [34, 55].



## Conclusion

This study revealed that a significant number of patients with COVID-19 had persistent symptoms for 3 to 6 months after COVID-19 onset, and patients with a mild-to-moderate disease experienced persistent symptoms. Follow-up of these symptoms in the post-recovery time is vital to maintain good life quality.

**Author contributions** All authors similarly contributed to the article: (1) study conceptualization and design, data analysis and interpretation; (2) investigation, article drafting; and (3) final article review and approval.

**Funding** The authors would like to thank the Deanship of Scientific Research at Umm Al-Qura University for supporting this work by Grant Code: (22 UQU 4240001DSR01).

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interests, financial or otherwise.

**Ethics approval** The study protocol was approved by the Ethics Review Board for Human Studies at the Faculty of Medicine, Umm Al-Qura University. Approval no. HAPO-02-K-012-2022-01-902 in accordance with Saudi National Committee for Bioethics HABO-02-K-012.

**Human and animal rights** Participants had stated their approval to participate in the study before starting to answer the questionnaire.



## References:

- World Health Organization. WHO Coronavirus (COVID-19) Dashboard n.d. <https://covid19.who.int/> (Accessed April 21, 2021).
- Covidvax.live—Saudi Arabia n.d. <https://covidvax.live/location/sau> (Accessed February 4, 2022).
- Assiri A, Al-Tawfiq JA, Alkhalifa M, Al Duhailan H, Al Qahtani S, Dawas RA, et al. Launching COVID-19 vaccination in Saudi Arabia: Lessons learned, and the way forward. *Travel Med Infect Dis.* 2021;43: 102119. <https://doi.org/10.1016/j.tmaid.2021.102119>.
- Adly HM, Aljahdali IA, Garout MA, Khafagy AA, Saati AA, Saleh SAK. Correlation of COVID-19 pandemic with healthcare system response and prevention measures in Saudi Arabia. *Int J Environ Res Public Health.* 2020;17:1–13. <https://doi.org/10.3390/ijerph17186666>.
- Sivan M, Taylor S. NICE guideline on long covid. *BMJ.* 2020. <https://doi.org/10.1136/BMJ.M4938>.
- Carfi A, Bernabei R, Landi F. Persistent symptoms in patients after acute COVID-19. *JAMA.* 2020;324:603–5. <https://doi.org/10.1001/jama.2020.12603>.
- Datta SD, Talwar A, Lee JT. A proposed framework and timeline of the spectrum of disease due to SARS-CoV-2 infection: illness beyond acute infection and public health implications. *JAMA.* 2020;324:2251–2. <https://doi.org/10.1001/JAMA.2020.22717>.
- Fernández-De-las-peñas C, Palacios-Ceña D, Gómez-Mayordomo V, Cuadrado ML, Florencio LL. Defining post-COVID symptoms (post-acute COVID, long COVID, persistent post-COVID): an integrative classification. *Int J Environ Res Public Health.* 2021;18:1–9. <https://doi.org/10.3390/IJERPH18052621>.
- Greenhalgh T, Knight M, A'Court C, Buxton M, Husain L. Management of post-acute covid-19 in primary care. *BMJ.* 2020. <https://doi.org/10.1136/BMJ.M3026>.
- Halpin S, O'Connor R, Sivan M. Long COVID and chronic COVID syndromes. *J Med Virol.* 2021;93:1242–3. <https://doi.org/10.1002/jmv.26587>.
- CDC. Post-COVID conditions n.d. <https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html> (Accessed February 5, 2022).
- Huang C, Huang L, Wang Y, Li X, Ren L, Gu X, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet (London, England).* 2021;397:220–32. [https://doi.org/10.1016/S0140-6736\(20\)32656-8](https://doi.org/10.1016/S0140-6736(20)32656-8).
- Bellan M, Soddu D, Balbo PE, Baricich A, Zeppego P, Avanzi GC, et al. Respiratory and psychophysical sequelae among patients with covid-19 four months after hospital discharge. *JAMA Netw Open.* 2021. <https://doi.org/10.1001/jamanetworkopen.2020.36142>.
- Logue JK, Franko NM, McCulloch DJ, McDonald D, Magedson A, Wolf CR, et al. Sequelae in adults at 6 months after COVID-19 infection. *JAMA Netw Open.* 2021. <https://doi.org/10.1001/JAMANETWORKOPEN.2021.0830>.
- Taquet M, Geddes JR, Husain M, Luciano S, Harrison PJ. 6-month neurological and psychiatric outcomes in 236 379 survivors of COVID-19: a retrospective cohort study using electronic health records. *The Lancet Psychiatry.* 2021;8:416–27. [https://doi.org/10.1016/S2215-0366\(21\)00084-5](https://doi.org/10.1016/S2215-0366(21)00084-5).
- Havervall S, Rosell A, Phillipson M, Mangsbo SM, Nilsson P, Hober S, et al. Symptoms and functional impairment assessed 8 months after mild COVID-19 among health care workers. *JAMA.* 2021;325:2015–6. <https://doi.org/10.1001/JAMA.2021.5612>.
- Donnelly JP, Wang XQ, Iwashyna TJ, Prescott HC. Readmission and death after initial hospital discharge among patients with COVID-19 in a large multihospital system. *JAMA.* 2021;325:304–6. <https://doi.org/10.1001/JAMA.2020.21465>.
- Davis HE, Assaf GS, McCorkell L, Wei H, Low RJ, Re'em Y, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. *EClinical Med.* 2021. <https://doi.org/10.1016/j.eclinm.2021.101019>.
- Sudre CH, Murray B, Varsavsky T, Graham MS, Penfold RS, Bowyer RC, et al. Attributes and predictors of long COVID. *Nat Med.* 2021;27:626–31. <https://doi.org/10.1038/S41591-021-01292-Y>.
- Norton A, Olliaro P, Sigfrid L, Carson G, Paparella G, Hastie C, et al. Long COVID: tackling a multifaceted condition requires a multidisciplinary approach. *Lancet Infect Dis.* 2021;21:601–2. [https://doi.org/10.1016/S1473-3099\(21\)00043-8](https://doi.org/10.1016/S1473-3099(21)00043-8).
- Walter K. An inside look at a post-COVID-19 clinic. *JAMA-J Am Med Assoc.* 2021;325:2036–7. <https://doi.org/10.1001/jama.2021.2426>.
- Rovere-Querini P, De Lorenzo R, Conte C, Brioni E, Lanzani C, Yacoub MR, et al. Post-COVID-19 follow-up clinic: depicting chronicity of a new disease. *Acta Biomed.* 2020;91:22–8. <https://doi.org/10.23750/abm.v91i9-S.10146>.
- Santhosh L, Block B, Kim SY, Raju S, Shah RJ, Thakur N, et al. Rapid design and implementation of post-COVID-19 clinics. *Chest.* 2021;160:671–7. <https://doi.org/10.1016/j.chest.2021.03.044>.
- Sivan M, Halpin S, Gee J. Assessing long-term rehabilitation needs in COVID-19 survivors using a telephone screening tool (C19-YRS tool). *Adv Clin Neurosci.* 2020;19:14.
- Parkin A, Davison J, Tarrant R, Ross D, Halpin S, Simms A, et al. A multidisciplinary NHS COVID-19 service to manage post-COVID-19 syndrome in the community. *J Prim Care Community Heal.* 2021. <https://doi.org/10.1177/21501327211010994>.
- Sivan M, Halpin S, Hollingworth L, Snook N, Hickman K, Clifton JJ. Development of an integrated rehabilitation pathway

- for individuals recovering from COVID-19 in the community. *J Rehabil Med*. 2020. <https://doi.org/10.2340/16501977-2727>.
27. Chopra V, Flanders SA, O'Malley M, Malani AN, Prescott HC. Sixty-day outcomes among patients hospitalized with COVID-19. *Ann Intern Med*. 2021;174:576–8. <https://doi.org/10.7326/M20-5661>.
  28. Michielsen HJ, De Vries J, Van Heck GL. Psychometric qualities of a brief self-rated fatigue measure: the fatigue assessment scale. *J Psychosom Res*. 2003;54:345–52. [https://doi.org/10.1016/S0022-3999\(02\)00392-6](https://doi.org/10.1016/S0022-3999(02)00392-6).
  29. Moreno-Pérez O, Merino E, Leon-Ramirez JM, Andres M, Ramos JM, Arenas-Jiménez J, et al. Post-acute COVID-19 syndrome. Incidence and risk factors: a Mediterranean cohort study. *J Infect*. 2021;82:378–83. <https://doi.org/10.1016/j.jinf.2021.01.004>.
  30. Ayoubkhani D, Khunti K, Nafilyan V, Maddox T, Humberstone B, Diamond I, et al. Post-covid syndrome in individuals admitted to hospital with covid-19: Retrospective cohort study. *BMJ*. 2021. <https://doi.org/10.1136/bmj.n693>.
  31. Buonsenso D, Munblit D, De Rose C, Sinatti D, Ricchiuto A, Carfi A, et al. Preliminary evidence on long COVID in children. *Acta Paediatr*. 2021;110:2208–11. <https://doi.org/10.1111/APA.15870>.
  32. Kayaaslan B, Eser F, Kalem AK, Kaya G, Kaplan B, Kacar D, et al. Post-COVID syndrome: A single-center questionnaire study on 1007 participants recovered from COVID-19. *J Med Virol*. 2021;93:6566–74. <https://doi.org/10.1002/JMV.27198>.
  33. Menges D, Ballouz T, Anagnostopoulos A, Aschmann HE, Domenghino A, Fehr JS, et al. Burden of post-COVID-19 syndrome and implications for healthcare service planning: a population-based cohort study. *PLoS ONE*. 2021. <https://doi.org/10.1371/JOURNAL.PONE.0254523>.
  34. Al-Tawfiq JA, Koritala T, Alhumaid S, Barry M, Alshukairi AN, Temsah M-H, et al. Implication of the emergence of the delta (B.1.617.2) variants on vaccine effectiveness. *Infection*. 2022. <https://doi.org/10.1007/S15010-022-01759-1>.
  35. Abdelrahman MM, Abd-Elrahman NM, Bakheet TM. Persistence of symptoms after improvement of acute COVID19 infection, a longitudinal study. *J Med Virol*. 2021;93:5942–6. <https://doi.org/10.1002/JMV.27156>.
  36. Kamal M, Abo Omirah M, Hussein A, Saeed H. Assessment and characterisation of post-COVID-19 manifestations. *Int J Clin Pract*. 2021. <https://doi.org/10.1111/IJCP.13746>.
  37. 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 network—United States, March–June 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69:993–8. <https://doi.org/10.15585/MMWR.MM6930E1>.
  38. Robinson P. Long COVID and breathlessness: an overview. *Br J Community Nurs*. 2021;26:438–43. <https://doi.org/10.12968/BJCN.2021.26.9.438>.
  39. Cénat JM, Blais-Rochette C, Kokou-Kpolou CK, Noorishad PG, Mukunzi JN, McIntee SE, et al. Prevalence of symptoms of depression, anxiety, insomnia, posttraumatic stress disorder, and psychological distress among populations affected by the COVID-19 pandemic: a systematic review and meta-analysis. *Psychiatry Res*. 2021. <https://doi.org/10.1016/j.psychres.2020.113599>.
  40. Hussain N, Agarwala P, Iqbal K, Omar HMS, Jangid G, Patel V, et al. A systematic review of acute telogen effluvium, a harrowing post-COVID-19 manifestation. *J Med Virol*. 2021. <https://doi.org/10.1002/jmv.27534>.
  41. Xiong TY, Redwood S, Prendergast B, Chen M. Coronaviruses and the cardiovascular system: acute and long-term implications. *Eur Heart J*. 2020;41:1798–800. <https://doi.org/10.1093/EURHEARTJ/EHAA231>.
  42. Tleyjeh IM, Saddik B, AlSwaidan N, AlAnazi A, Ramakrishnan RK, Alhazmi D, et al. Prevalence and predictors of post-acute COVID-19 syndrome (PACS) after hospital discharge: a cohort study with 4 months median follow-up. *PLoS ONE*. 2021. <https://doi.org/10.1371/JOURNAL.PONE.0260568>.
  43. Tleyjeh IM, Saddik B, Ramakrishnan RK, AlSwaidan N, AlAnazi A, Alhazmi D, et al. Long term predictors of breathlessness, exercise intolerance, chronic fatigue and well-being in hospitalized patients with COVID-19: a cohort study with 4 months median follow-up. *J Infect Public Health*. 2022;15:21–8. <https://doi.org/10.1016/J.JIPH.2021.11.016>.
  44. Hosey MM, Needham DM. Survivorship after COVID-19 ICU stay. *Nat Rev Dis Prim*. 2020. <https://doi.org/10.1038/S41572-020-0201-1>.
  45. Inoue S, Hatakeyama J, Kondo Y, Hifumi T, Sakuramoto H, Kawasaki T, et al. Post-intensive care syndrome: its pathophysiology, prevention, and future directions. *Acute Med Surg*. 2019;6:233–46. <https://doi.org/10.1002/AMS2.415>.
  46. Malik J, Muhammad Jawad Zaidi S, Iqbal R, Khan K, Ali M, Sattar Rana A, et al. Post-acute COVID-19 syndrome and its prolonged effects: an updated systematic review. *MedRxiv*. 2021. <https://doi.org/10.1101/2021.05.09.21256911>.
  47. Huang L, Yao Q, Gu X, Wang Q, Ren L, Wang Y, et al. 1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study. *Lancet (London, England)*. 2021;398:747–58. [https://doi.org/10.1016/S0140-6736\(21\)01755-4](https://doi.org/10.1016/S0140-6736(21)01755-4).
  48. 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;94:253–62. <https://doi.org/10.1002/jmv.27309>.
  49. Antonelli M, Penfold RS, Merino J, Sudre CH, Molteni E, Berry S, et al. Risk factors and disease profile of post-vaccination SARS-CoV-2 infection in UK users of the COVID Symptom Study app: a prospective, community-based, nested, case-control study. *Lancet Infect Dis*. 2022;22:43–55. [https://doi.org/10.1016/S1473-3099\(21\)00460-6](https://doi.org/10.1016/S1473-3099(21)00460-6).
  50. Koritala T, Hussain A, Pleshkova Y, Dondapati L, Tirupathi R, Rabaan AA, et al. A narrative review of emergency use authorization versus full FDA approval and its effect on COVID-19 vaccination hesitancy. *Le Infez Med*. 2021;29:339–44. <https://doi.org/10.53854/LIIM-2903-4>.
  51. Temsah MH, Barry M, Aljamaan F, Alhuzaimi A, Al-Eyadhy A, Saddik B, et al. Adenovirus and RNA-based COVID-19 vaccines' perceptions and acceptance among healthcare workers in Saudi Arabia: a national survey. *BMJ Open*. 2021. <https://doi.org/10.1136/bmjopen-2020-048586>.
  52. Temsah MH, Barry M, Aljamaan F, Alhuzaimi AN, Al-Eyadhy A, Saddik B, et al. SARS-CoV-2 B.1.1.7 UK variant of concern lineage-related perceptions, COVID-19 vaccine acceptance and travel worry among healthcare workers. *Front Public Heal*. 2021. <https://doi.org/10.3389/fpubh.2021.686958>.
  53. Barry M, Temsah MH, Aljamaan F, Saddik B, Al-Eyadhy A, Alenezi S, et al. COVID-19 vaccine uptake among healthcare workers in the fourth country to authorize BNT162b2 during the first month of rollout. *Vaccine*. 2021;39:5762–8. <https://doi.org/10.1016/J.VACCINE.2021.08.083>.
  54. Barry M, Alotaibi M, Almohaya A, Aldrees A, AlHijji A, Althabit N, et al. Factors associated with poor outcomes among hospitalized patients with COVID-19: experience from a MERS-CoV referral hospital. *J Infect Public Health*. 2021;14:1658–65. <https://doi.org/10.1016/j.jiph.2021.09.023>.
  55. Al-Tawfiq JA, Hoang V-T, Le Bui N, Chu D-T, Memish ZA. The emergence of the omicron (B.1.1.529) SARS-CoV-2 variant: what is the impact on the continued pandemic? *J Epidemiol Glob Health*. 2022. <https://doi.org/10.1007/s44197-022-00032-w>.



## Authors and Affiliations

Mohammed A. Garout<sup>1</sup> · Saleh A. K. Saleh<sup>2,3</sup>  · Heba M. Adly<sup>1</sup> · Altaf A. Abdulkhaliq<sup>2</sup> · Abdullah A. Khafagy<sup>1</sup> · Magda R. Abdeltawab<sup>4</sup> · Ali A. Rabaan<sup>5,6,7</sup> · Alfonso J. Rodriguez-Morales<sup>8,9,10</sup> · Jaffar A. Al-Tawfiq<sup>11,12,13</sup>  · Maher N. Alandiyjany<sup>14,15</sup>

Mohammed A. Garout  
magarout@uqu.edu.sa

Saleh A. K. Saleh  
saabdrabou@uqu.edu.sa

Heba M. Adly  
hebamadly@hotmail.com; hmhasan@uqu.edu.sa

Altaf A. Abdulkhaliq  
aaabdulkhaliq@uqu.edu.sa

Abdullah A. Khafagy  
aakhafagy@uqu.edu.sa

Magda R. Abdeltawab  
ramadan\_magda@yahoo.com

Ali A. Rabaan  
arabaan@gmail.com

Alfonso J. Rodriguez-Morales  
ajrodriguezmmmd@gmail.com

Maher N. Alandiyjany  
mmandiyjany@uqu.edu.sa; maher.najm@bmc.edu.sa

- <sup>1</sup> Community Medicine and Pilgrims Health Department, Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia
- <sup>2</sup> Biochemistry Department, Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia
- <sup>3</sup> Oncology Diagnostic Unit, Faculty of Medicine, Ain Shams University, Cairo, Egypt
- <sup>4</sup> Medical Microbiology and Immunology Department, Ain Shams University, Cairo, Egypt

<sup>5</sup> Molecular Diagnostic Laboratory, Johns Hopkins Aramco Healthcare, Dhahran 31311, Saudi Arabia

<sup>6</sup> College of Medicine, Alfaisal University, Riyadh 11533, Saudi Arabia

<sup>7</sup> Department of Public Health and Nutrition, The University of Haripur, Haripur 22610, Pakistan

<sup>8</sup> Grupo de Investigación Biomedicina, Faculty of Medicine, Fundación Universitaria Autónoma de las Américas, 660003 Pereira, Risaralda, Colombia

<sup>9</sup> Clinical Epidemiology and Biostatistics, Universidad Científica del Sur, Lima 4861, Peru

<sup>10</sup> School of Medicine, Universidad Privada Franz Tamayo (UNIFRANZ), 4780 Cochabamba, Bolivia

<sup>11</sup> Specialty Internal Medicine and Quality Department, Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia

<sup>12</sup> Infectious Diseases Division, Department of Medicine, Indiana University School of Medicine, Indianapolis, IN, USA

<sup>13</sup> Infectious Diseases Division, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA

<sup>14</sup> Laboratory Medicine Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah 21955, Saudi Arabia

<sup>15</sup> Quality and Development Affairs, Batterjee Medical College, Jeddah 21442, Saudi Arabia