Impact of Post-COVID-19 Condition on Health Status and Functional Capacity: A Cross-Sectional Study

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The present study was approved by the HE-FP Ethics Committee (87/2021, December 30).

Purpose: To assess health status and functional capacity in adults with post-COVID-19 condition. **Methods:** Observational, retrospective cross-sectional study. Outpatients from the Physical Medicine and Rehabilitation Department of the Hospital Fernando Pessoa, Porto, Portugal, were included. A convenient sample included 54 participants aged over 18 years old (52.4 ± 15.5 years, 61% female), with diagnosis of SARS-CoV-2 infection at least 12 weeks before the study, persistent or new-onset symptomatology consistent with post-COVID-19 condition. Clinical assessment included the collection of symptoms (COVID-19 Questionnaire and Modified Medical Research Council Dyspnea scale), lung function (spirometry), functional capacity (1-minute-sit-to-stand test and the 6-minute walk test), and emotional status (Anxiety, Depression, and Stress Scale). **Results:** A total of 46.3% of participants reported fatigue, 29.6% dry cough, 24.1% dyspnea, 24.1% myalgia, 22.2% weakness, and 20.4% memory loss. On functional capacity, 1-minute-sit-to-stand (20.1 ± 5.7) and 6-minute walk test (483.0 ± 110.3) performances were lower than the predicted values ($P < .001$). **Conclusions:** Adults with post-COVID condition in this study demonstrated evidence of reduced health status and functional capacity. These findings highlight the potential long-term effects of COVID-19. **(Cardiopulm Phys Ther J. 2025;36:74–80)** *Key Words: COVID-19, lung, dyspnea, mental disorders*

INTRODUCTION

Coronaviruses, including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), are highly contagious pathogens known to cause a wide range of symptoms with significant variability in their presentation.[1] Although most patients report symptoms that are similar to a common cold, with mild respiratory effects, more severe SARS-CoV-2 infections can cause damage to multiple organs, thus increasing morbidity and the risk of death.[2] Curiously, while most patients recover from acute infection without recognizable sequelae, a proportion of them show long-term effects.[3] Indeed, after the acute infection with SARS-CoV-2, some patients have persisting or new-onset symptoms after a long time of being negative for the disease, without explanation by another differential diagnosis,[4] which has been termed in the community as Long COVID, post-COVID-19 condition, postacute sequelae of SARS-CoV-2 infection, and post-COVID syndrome.[5] Depending on the literature, the prevalence of post-COVID-19 condition can vary from 10% to 20%[6] to 80%.[4] According to the World Health Organization,[7] post-COVID-19 condition is defined as the continuation or development of new symptoms 3 months after the initial SARS-CoV-2 infection, with these symptoms lasting for at least 2 months with no other explanation. Although the underlying mechanisms remain poorly understood, it can affect anyone exposed

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The authors declare no conflicts of interest.

DOI: 10.1097/CPT.0000000000000272

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Clinical Pearls

- Adults with post-COVID condition in this study demonstrated evidence of reduced health status and functional capacity.
- These findings highlight the potential long-term effects of COVID-19.

to SARS-CoV-2, regardless of sex, age, or severity of original symptoms.[8]

The diagnosis of post-COVID-19 condition is based only on the persistent symptomatology reported by the patients, which are highly heterogeneous, varying from fatigue (58%), headache (44%), attention disorder (27%), hair loss (25%), to dyspnea (24%).[4] In addition, patients can show other manifestations related to respiratory (cough, chest discomfort, reduced pulmonary diffusing capacity, sleep apnea, and pulmonary fibrosis), cardiovascular (arrhythmias, myocarditis), neurological (dementia, depression, and anxiety) and osteoarticular (arthralgia) and musculoskeletal (myalgia and muscle weakness) systems.[4] Histological changes are seen in myopathies such as mitochondrial modifications, including reduced cytochrome c oxidase activity, subsarcolemmal accumulation, and/or abnormal cristae structure.[9] Due to the diversity of signs and symptoms associated with long COVID, a new definition was necessary, a task undertaken by the National Academies of Sciences, Engineering, and Medicine, which encompasses and stratifies the most common symptoms, as well as identifiable conditions that may affect 1 or more organs, along with 7 important features. This aims to increase the specificity and sensitivity of clinical diagnosis.[10]

The reason why some patients develop post-COVID-19 condition is unclear, but the deleterious impact on their quality of life is unequivocal.[11] It was already established that the immune-mediated action involves cellular and humoral responses, but the immunity to SARS-CoV-2, the protection to reinfection, and the viral clearance mechanisms remains unclarified.[12] Indeed, it was suggested that SARS-CoV-2 could evolve to a chronic form of the disease similar to other viruses like the human immunodeficiency virus, hepatitis B and C virus, and some herpesviruses, but this possibility is controversial.[13] Nevertheless, considering the impact of the long-term sequelae of SARS-CoV-2 infection in functional capacity, independence, and quality of life of patients, a proper and constant monitorization is needed. Therefore, the main aim of the present study was to assess the health status and functional capacity in adults with post-COVID-19 condition.

METHODOLOGY

Study Design

The present study is classified as an observational, retrospective cross-sectional study.

Sample

Initially, potential participants were identified by the physician based on the patients' clinical history and symptomatology. Participants were then recruited by invitation according to the following inclusion criteria: outpatients from the Physical Medicine and Rehabilitation department of 1 urban hospital, private, with multifunctional units for primary, secondary, and tertiary care (Hospital Fernando Pessoa, Porto, Portugal), aged over 18 years old, diagnosis of SARS-CoV-2 infection at least 12 weeks before the study, persistent or new-onset symptomatology consistent with post-COVID-19 condition. Participants were excluded if they were unable to walk or had some gait impairment, if they had a history of myocardial infarction or unstable angina, tachycardia (resting heart rate$>$ 120 bpm), resting blood pressure (systolic $<$90 mm Hg or $>$180 mm Hg; diastolic $<$60 mm Hg or $>$90 mm Hg), retinal detachment, pulmonary oedema, thoracic aortic aneurysm, acute systemic disease, at the time of the enrollment, or inability to perform any physical exercise.

Ethical Procedures

The present study was approved by the Hospital Fernando Pessoa, Porto, Portugal, Ethics Committee, and all participants gave their written consent in compliance with the Declaration of Helsinki and the Oviedo Convention.

Study Procedures

Data were collected between May 9th and June 3rd, 2022, at Hospital Fernando Pessoa, Porto, Portugal, and each participant was individually assessed on the same day. Baseline sociodemographic characteristics (sex, age, height, weight, and body mass index [BMI]) were collected through a questionnaire specifically designed by the authors of this study, while the clinical information was obtained through the COVID-19 Questionnaire, in order to screen the presence of persistent COVID-19 symptoms. This questionnaire can be applied to everyone during the postacute phase of SARS-CoV-2 infection, in order to assess the presence of remaining symptoms and, therefore, to diagnose post-COVID syndrome.[14] The severity of comorbid diseases was scored according to the Charlson Comorbidity Index (CCI), and subjects were divided into 4 groups: CCI score of 0, 1 to 2, 3 to 4, and ≥5.[15]

Emotional status (i.e., psychological and emotional states) was assessed through the Portuguese version of the Anxiety, Depression, and Stress Scale (DASS-21).[16] Anxiety, Depression, and Stress Scale-21 is a 21-item self-administered questionnaire, divided into 3 subscales, depression, anxiety, and stress, where highest scores indicate a more negative mental condition.[17] Anxiety, Depression, and Stress Scale-21 has a good internal consistency and reliability Cronbach α between 0.74 and 0.85.[16]

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Participant's functional capacity was evaluated by performing the 1-minute-sit-to-stand test (1MSTS) and the 6-minute walk test (6MWT). The 1MSTS has a good test–retest reliability (ICC = 0.80),[18] and it is valid for healthy adults, people with Chronic Obstructive Pulmonary Disease, and, more recently, for people diagnosed with COVID-19.[19] One-minute-sit-to-stand test was conducted in a chair with standard height and without armrests against the wall, in which participants were instructed to complete the maximum number of sit-to-stand cycles in 60 seconds at their own pace.[20] The results were considered according to the following predictive equation: 1MSTS = (61.53–[0.34 × age]–[3.57 × sex]–[0.33 × BMI]).[21] The 6MWT is a submaximal test that assess the distance that a person can walk for 6 minutes, and it is valid for subjects with a wide range of diagnosis, including moderate to severe lung diseases.[22] The 6MWT was carried according to the standard recommendations established by the American Thoracic Society,[23] with a continuous monitorization of the HR, peripheral oxygen saturation (%SpO_2) perceived dyspnea and fatigue, using the modified Borg scale. At the end of the test, the total distance covered by each participant was calculated and analyzed according to the following predictive equation: $6MWD = 721.7 - 1.6 \times Age - 4.0 \times BMI + 0.9 \times (HR_{posttest}\text{-}HR_{rest}) + 58.4 \times Gender$ (1 = male and 0 = female).[24]

In addition, the Portuguese version of the Modified Medical Research Council Dyspnea Scale (mMRC) was applied to assess the impact imposed by dyspnea on the activities of daily living (ADLs).[25] The mMRC scale is commonly used in patients with respiratory diseases, and it classifies dyspnea in 5 grades, ranging from 0 (no problems with shortness of breath except in case of intense exercise) to 4 (too tired or out of breath to leave the house, dress or undress). In this way, each patient was instructed to select the grade that describe more properly their shortness of breath.[26]

The lung function assessment was assessed through spirometry (Microlab portable device), by obtaining the forced expiratory volume in the first second (FEV1), the forced vital capacity (FVC), and the Tiffeneau Index (% FEV1/%FVC). According to Graham and collaborators, FEV1 and FVC must be greater than 80% and the Tiffeneau Index greater than 70%.[27] Spirometry is one of the most frequently tests used to assess post-COVID-19 lung function, and it is indicated after the acute phase of the disease, in patients with progressive or persistent respiratory symptoms.[28]

Statistical Analysis

Statistical analysis was performed with IBM SPSS Statistics V.27.0, and the level of significance was set at 0.05. Descriptive analysis was performed, and the results were presented as mean and standard deviation or frequencies. Normality and homogeneity of variances were verified by the Kolmogorov–Smirnov and Levene test. For variables with a normal distribution, the statistical inference was done through the paired sample *t*-test, while for those variables without a normal distribution, the statistical inference was done through the paired samples Wilcoxon test. The Chi-Square test was used for the association analysis, and the correlations were calculated through the Pearson coefficient.

RESULTS

Fifty-six participants were recruited for data collection. However, 2 participants did not complete the study due to lack of availability. Therefore, 54 patients fulfilled the inclusion criteria and completed the present study. Of these, 33 (61.1%) were females and 21 (38.9%) were males, aged 52.44 ± 15.52 years, with a mean BMI of 29.50 ± 4.22 Kg/m^2. At the moment of SARS-CoV-2 infection, 38.9% of the participants did not have any vaccination, 5.6% had the first dose, 33.3% had the second dose, and 22.2% was infected after the third dose. Six participants (11.1%) were reinfected. Only 6 patients (11.1%) required hospital care, from which 4 (7.4%) were admitted to an Intensive Care Unit. Regarding professional and occupational status, 16 participants (29.6%) reported a change in their status. Specifically, 15 (27.8%) did stop their occupational or professional activity and 1 (1.9%) reduced its amount. Finally, 10 participants (18.5%) reported a reduced functional status, meaning that their ability to perform ADLs including self-care significantly worsened after the infection. The characteristics of included participants are listed in Table 1.

Functional Capacity

The values obtained in the 1MSTS and 6MWT were significantly lower when compared to the predicted values ($P < .001$) (Table 2).

Dyspnea

Most (53.7%) of the participants' dyspnea was classified as grade 1, "*shortness of breath when in a hurry or when walking on a slightly inclined floor*", and only 1.9% of the patients had grade 3 dyspnea, "*stops for breathe every 100 meters or after walking for a few minutes*" (Table 3).

Emotional Status

All participants showed normal values on the Anxiety, Depression, and Stress subscales (Sinclair et al., 2012), meaning that they did not present significant sequelae on emotional status (Table 4).

Correlation Between Functional Capacity, Dyspnea, and Emotional Status

The correlation between the grade of dyspnea and the DASS-21 score was significant, positive, and moderate. Although significant and moderate, there was a negative

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TABLE 1

Baseline Characteristics of Included Participants

Sex, Female (%)	33 (61.1)
Age (yr)	52.44 ± 15.52
BMI (Kg/m^2)	29.50 ± 4.22
Spirometry (%)	
FEV1	91.56 ± 17.16
FVC	88.61 ± 18.55
Tiffeneau index	108.44 ± 12.12
COVID-19	
Time since acute infection, n (%)	
12 wk-6 mo	21(38.9)
6 mo- 1 yr	16 (29,61)
1 yr-2 yr	20 (37)
Severity, n (%)	
Mild	40 (74.1)
Moderate	8 (14.8)
Severe	4 (7.4)
Critical	2 (3.7)
Remaining symptoms, n (%)	
Fatigue	25 (46.3)
Dry cough	16 (29.6)
Dyspnea	13 (24.1)
Myalgia	13 (24.1)
Weakness (legs or arms)	12 (22,2)
Memory lost	11 (20.4)
CCI (categories), n (%)	
0	19 (35.1)
1–2	23 (42.6)
3–4	11 (20.4)
≥5	1 (1.9)

Data are expressed as mean ± SD

BMI, body mass index; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; CCI, Charlson Comorbidity Index.

correlation between the grade of dyspnea and the 1MSTS. The distance achieved during the 6MWT correlated significantly, negatively, and moderately with DASS-21 score, positively and strongly with the number of repetitions performed during the 1MSTS, and negatively and strongly with the grade of dyspnea (Table 5).

TABLE 2

Performance of the 1MSTS and 6MWT

1MSTS (nº of Repeats) Performed	20.11 ± 5.66	$P < .001$[a]
1MSTS (nº of Repeats) Predicted	38.91 ± 5.91	
6MWT (m) performed	483.04 ± 110.33	$P < .001$[a]
6MWT (m) predicted	553.18 ± 46.68	

[a]$P < .01$.

Data are expressed as mean ± SD

1MSTS, 1-minute-sit-to-stand test; 6MWT, 6-minute walk test.

TABLE 3

Grade of Dyspnea Assessed by mMRC

mMRC	Frequency	Percentage (%)
Grade 0	22	40.7
Grade 1	29	53.7
Grade 2	2	3.7
Grade 3	1	1.9
Grade 4	0	0
Total	54	100.0

mMRC, Modified Medical Research Council Dyspnea Scale.

DISCUSSION

This study aimed to assess health status and functional capacity in adults with post-COVID-19 condition. Most participants were women, which, similarly to the study of Bai and coworkers,[29] seem to be more likely to develop long-term COVID-19 sequelae. It was suggested that sex-based differences in the immune response may justify this difference, particularly between 40 to 60 years old.[30] Indeed, mean age of participants was within this range, which is, according to Carvalho-Schneider and colleagues,[31] the most vulnerable age group to long-term symptoms of COVID-19. The symptoms related to post-COVID-19 condition are several; however, in our study, 6 symptoms were highlighted. In particular, fatigue was undoubtedly the most common reported symptom, similar to the study of Aiyegbusi and collaborators[32] that observed the presence of fatigue in 47% of these patients. In addition, 2 recent meta-analyses also concluded that persistent fatigue was the most frequent sequel in patients with post-COVID-19 condition, but the prevalence observed was inferior when compared to our results, i.e., 32% in the study of Ceban et al[33] and 29% in the study of Natarajan et al.[34] Although very common, there are currently limited data regarding the pathophysiology of post-COVID-19 condition-related fatigue. In this way, Mackay[35] mentioned that SARS-CoV-2 infection may act as a severe physiological stressor that can induce fatigue by promoting hypothalamic dysfunction and systemic inflammation, which cause chronic damage to the pulmonary, cardiac, neurologic, and musculoskeletal systems. As seen in the present study, Davis et al[36] observed that dyspnea and dry cough are the most common respiratory manifestations in

TABLE 4

Anxiety (A), Depression (D), and Stress (S) Scale Scores

DASS_A	2.59 ± 2.70
DASS_D	3.22 ± 4.29
DASS_S	4.07 ± 3.93
DASS_Total	9.89 ± 2.70

Data are expressed as mean ± SD.

DASS, Anxiety, Depression, and Stress Scale.

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TABLE 5

Correlation Between Functional Capacity, Dyspnea, and Emotional Status

	1MSTS	6MWT	mMRC
DASS-21			
r	−0.269	−0.373	0.435
p	0.052	0.006[a]	0.001[a]
1MSTS			
r	—	0.703	−0.475
p	—	0.000[a]	0.000[a]
6MWT			
r	—	—	−0.515
p	—	—	0.000[a]

[a] $P < .01$, Pearson correlation.

1MSTS, 1-minute-sit-to-stand test; 6MWT, 6-minute walk test; DASS-21, Anxiety, Depression, and Stress Scale; mMRC, Modified Medical Research Council Dyspnea Scale.

patients with post-COVID-19 condition and persisted for at least 7 months in 40% and 20% of them, respectively. Besides the respiratory symptoms, an important number of participants reported myalgia (24.1%) or weakness (22.2%), which were also observed in other studies. In a recent meta-analysis, Natarajan et al.[34] observed that myalgia was the second most prevalent symptom in post-COVID-19 condition, with an overall incidence of 13.3% among the 13 included studies. Moreover, Hejbøl et al[9] observed the occurrence of muscle weakness in 50% of participants, and after analyzing their skeletal muscle biopsies, the authors noted a significant myofiber atrophy, with mitochondrial changes, inflammation, and capillary injury that could justify the muscle weakness reported. Finally, 20.4% of participants in the present study also reported memory lost that began after SARS-CoV-2 infection. Cognitive symptoms are a major feature of post-COVID-19 condition that can tend to increase over time, thus reducing the quality of life of these patients.[37] Accordingly, in a survey of almost 1000 patients that were infected with SARS-CoV-2, 26% of them showed mild cognitive impairment 6 to 11 months after the event.[38] Today we know that such cognitive deficits can persist for more than 2 years and the underlying mechanisms point to the development of neuroinflammation, endothelial dysfunction, and neuronal injury.[39]

Considering all the symptoms reported above, and the impact on quality of life and ADLs we assessed the emotional status of participants and, contrary to Menges et al.,[40] that observed a high prevalence of anxiety, depression, and stress in patients with post-COVID syndrome, we found no data indicating a potential presence of anxiety, depression, and stress on these patients, according to the DASS-21 score. However, it must be noted that, while in our study 11% of participants needed hospital care and 4% showed severe symptoms, in the study of Menges et al,[40] 19% of patients were initially hospitalized and the disease was classified as severe in 38% of cases, which could explain the observed discrepancy. In this way, 6 months after the onset of symptoms, Huang et al[41] found that 23% of previously hospitalized patients suffered from anxiety or depression. Besides emotional status, the impact of such symptoms on functional capacity must be also considered, and, in accordance to the study of Faria et al[42] in which post-COVID-19 patients preformed significant fewer repetitions on the 1MSTST than non-COVID subjects, our results showed a decreased performance on this test when compared to the predictive values. Moreover, the results obtained in the 6MWT was also significative lower than the prediction, similar to other observations.[41,43] Specifically, in the study of Baranauskas et al,[43] participants reported shortness of breath and difficulty to recover 1 minute after the test. Exercise intolerance is commonly present after SARS-CoV-2 infection and may have several causes that is not only explained by deconditioning itself.[44] Indeed, as cardiorespiratory fitness relies on the interplay between the pulmonary, cardiovascular, and musculoskeletal systems,[45,46] and the results of spirometry did not reveal significant changes in our study, the decreased functional capacity observed here could be explained by other means. Specifically, the presence of a central cardiovascular limitation related to low oxygen (O_2) delivery, due to chronic inflammatory myocardial or endothelial lesions, or the development of a peripheral limitation, related to decreased O_2 extraction and molecular reduction, due to mitochondrial injury, with a consequent decrease in energy production.[44]

Finally, the results of functional capacity tests correlated significantly and positively with each other, and negatively with the dyspnea degree, thus emphasizing the contribution of cardiorespiratory fitness to the physical performance. Of these, the 6MWT score was negatively correlated with the score of DASS-21, which means that higher levels of anxiety, depression, and stress are associated with lower cardiorespiratory fitness. Inversely, dyspnea degree was positively correlated with DASS-21 score, meaning that higher levels of dyspnea are associated with a worst emotional status, in these patients. Therefore, it seems that besides the physical sequelae, post-COVID-19 condition appears to impact the emotional status. The fact that it is a cross-sectional study means that cause and effect cannot be determined and, therefore, more longitudinal studies are needed.

This paper makes a critical contribution to the growing body of literature on post-COVID-19 by detailing the diverse symptomatology experienced by adults with post-COVID-19 condition, with particular emphasis on persistent fatigue, dry cough, dyspnea, myalgia, weakness, and memory loss. By documenting these symptoms, the study underscores the profound physical and cognitive burden faced by individuals with post-COVID-19, which is critical for guiding rehabilitation efforts. In addition, while the emotional impact of post-COVID-19 remains an area for further research, the study highlights the urgent need for targeted interventions in rehabilitation care to address

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the persistent and multifaceted effects of the condition. This work uniquely strengthens the literature by providing specific insights into the prevalence and severity of symptoms, thereby informing clinicians and policy makers of the complex needs of post-COVID-19 patients and emphasizing the importance of comprehensive and multidisciplinary rehabilitation strategies.

LIMITATIONS

Nevertheless, the present study has some limitations, related to the assessment procedures that were performed with participants wearing a mask due to the prophylactic measures imposed at that time and regarding the lack of clinical records with the information about the symptoms during the acute phase of COVID-19 infection.

This is a convenience sample with a small sample size, not representative of the study population, which hinders comparison with the literature. Another limitation is that it is a cross-sectional study with a single observational point, restricting the analysis of clinical and/or functional progression.

CONCLUSION

This study demonstrates that adults with post-COVID-19 condition experience a range of symptoms, particularly persistent fatigue, dry cough, dyspnea, myalgia weakness, and memory loss. While emotional impact requires further investigation, our findings highlight the significant burden of this condition. We recommend long-term monitoring and specialized health care services to optimize patient care.

As a suggestion for further studies, a systematic and long-term monitoring of health status and functional capacity is recommended to manage patients with post-COVID-19 condition appropriately. This would the health care systems to ensure comprehensive patient care for individuals experiencing post-COVID-19 condition, facilitated by a specialized service, and supported by a team of health care professional experts.

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