ORIGINAL RESEARCH

# Comparison of Quality of Life and Functional Capacity of Long COVID-19 Patients and Asymptomatic Individuals: A Cross-sectional Study

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## Abstract

**Aims and background:** Long COVID-19 is a condition in which persistent symptoms persist even months after COVID-19 infection, affecting millions of people. Long COVID-19 (LC) causes disruption of multiple tissue/organ symptoms. The aim was to compare the impact on functional capacity and health-related quality of life (HRQoL) levels of symptomatic LC patients 6–18 months after COVID-19 infection compared to asymptomatic individuals.

**Methods:** The study included 70 participants (45 females and 25 males) who had COVID-19 infection 6–18 months previously. Participants were divided into two groups as symptomatic ($n = 33$) and asymptomatic ($n = 37$), according to the persistence of COVID-19 symptoms. Post-COVID-19 Functional Scale (PCFS) was used to determine activity limitation and functional capacity between the groups; SF-36 questionnaire was used to assess HRQoL; 6-minute walking test (6MWT) and 30-second sit-to-stand (30s-STS) test were used to assess functional capacity. Mean differences between the groups were analyzed using the independent samples *t*-test.

**Results:** The 6MWT mean walking distance ($p = 0.005$) and 30s-STS mean value ($p = 0.028$) were significantly lower in the symptomatic group than in the asymptomatic group. Symptomatic participants had significantly lower mean scores in the physical function ($p = 0.003$), emotional role difficulties ($p = 0.009$), physical role difficulties ($p = 0.001$), general health ($p = 0.006$), and pain ($p = 0.002$) subdimension of the SF-36 compared to the asymptomatic group.

**Conclusion:** This study emphasizes that the deterioration in quality of life and functional capacity is not limited to the acute phase but leads to a multisystemic and long-term health condition and emphasizes the need for long-term follow-up.

**Clinical trial registration number:** NCT06528145.

**Keywords:** Functional capacity, Long COVID-19, Post-COVID-19, Quality of life.

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## What is Known

Long COVID-19 is associated with multisystemic symptoms and reduced health-related quality of life (HRQoL), but controlled studies comparing symptomatic individuals to asymptomatic recovered peers are limited.

## What is New

This study uniquely demonstrates significantly lower functional capacity [*via* 6-minute walking test (6MWT), 30-second sit-to-stand (30s-STS) test] and HRQoL (physical, emotional, and pain subdimensions) in Turkish symptomatic long COVID-19 patients vs asymptomatic controls, highlighting persistent impairments beyond acute infection.

## Clinical Implications

Findings underscore the necessity for long-term monitoring and tailored rehabilitation programs targeting physical function, pain management, and emotional well-being to improve outcomes in individuals with persistent post-COVID-19 symptoms.

## Background

The global dissemination of SARS-CoV-2 has led to an unprecedented epidemiological burden, with millions of confirmed cases and a mortality toll reaching tens of thousands internationally. Most patients (81%) infected with COVID-19 did not develop pneumonia and recovered at home without specialized medical treatment. Critical (5%) and severe (14%) cases developed pneumonia and respiratory illnesses that could cause prolonged symptoms and were treated in a hospital ward or intensive care unit.[1] It was reported that 14.8% of patients with mild COVID-19 had at least one COVID-19 symptom persisting even

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**Conflict of interest:** None

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after 12 weeks. In addition, 76% of patients with severe COVID-19 had at least one COVID-19 symptom persisting even after 24 months.[2,3] Long COVID-19 is a chronic health condition arising from SARS-CoV-2 infection, persisting for a minimum of 3 months and characterized by a continuous, relapsing–remitting, or progressive clinical course that impacts one or multiple organ systems.[4]

Long COVID-19 (LC) mainly causes respiratory, cardiovascular, gastrointestinal, neurological, and psychological disorders. The most frequently reported symptoms were cognitive impairment (28.8%), fatigue (29.2%), anxiety (27.7%), joint pain (28.25%), dyspnea (21.4%), cough (17.8%), loss of smell (14.7%), headache (10.4%), and muscle pain (13.3%).[5]

Pulmonary function, functional capacity, and HRQoL of patients with COVID-19 infection in the intensive care unit did not significantly improve even 6 months after discharge.[6] There was a significant decrease in the physical activity of the patients. The reason for these findings is not known exactly.[7] While the precise pathophysiology remains contentious, emerging evidence implicates inflammatory cascades and angiotensin-converting enzyme 2 (ACE2) as pivotal contributors to the disease mechanism. The most common musculoskeletal symptoms include sarcopenia, fatigue, back pain, arthralgia, myalgia, muscle weakness, impaired exercise capacity, and physical performance.[8]

Most patients infected with COVID-19 recover quickly, but some patients with persistent symptoms need to be investigated long-term and the effects of their symptoms examined. The persistence of symptoms such as anxiety, depression, and pain 6 months or more after COVID-19 is the most common problem affecting the HRQoL of patients.[9] A considerable proportion of COVID-19 survivors exhibit prolonged multisystem dysfunction, with enduring symptomatology affecting diverse physiological domains persisting beyond the 12-month postrecovery milestone.[10] Sanchez-Ramirez et al. reported that COVID-19 may have significant lasting effects on respiration, functional capacity, fatigue, and quality of life at 6 months after acute infection.[11] Most previous studies have examined the impact of COVID-19 on HRQoL through cross-sectional data mainly from China, Europe, or the United States. Moreover, the focus has mainly been on hospitalized COVID-19 patients or its impact on different body systems.[6,12] However, although there are studies in the literature examining the long-term effects of LC beyond 6 months,[9,10] most lack a control group or do not systematically compare results with asymptomatic individuals. The use of a control group increases the validity of cross-sectional studies and improves the reliability of research results.[13] To the best of our knowledge, this study will be the first to compare symptomatic and asymptomatic groups in Turkey, thus demonstrating the impact of COVID-19 in other countries outside the literature. In addition, comparing the HRQoL and functional capacity of symptomatic individuals with asymptomatic individuals will provide new insights into understanding the impact of the virus.

This study aimed to determine the impact of functional capacity and HRQoL of symptomatic LC patients 6–18 months after acute infection compared to asymptomatic participants. We hypothesized that symptomatic individuals have lower HRQoL and less functional capacity compared to asymptomatic individuals.

# Methods

## Study Location and Ethical Principles

The ethics review board of Pamukkale University (meeting date: September 21, 2021, Approval ID: 17) authorized this study prior to its commencement. The study was conducted at Süleyman Demirel University, Department of Physical Medicine and Rehabilitation, between November 2021 and December 2022. All participants provided written informed consent voluntarily, and the study conformed to the ethical standards mandated by the Declaration of Helsinki. After the study was accepted, the evaluation was completed on the same day. STROBE criteria were followed in reporting the study.

## Design and Participants

The study was designed as a cross-sectional study to compare the HRQoL and functional capacity of LC patients and asymptomatic volunteers. Patients who had an infection at Süleyman Demirel University Hospital (tertiary healthcare institution) at least 6 and up to 18 months ago and were readmitted to the hospital due to symptoms were included. Symptomatic participants included patients presenting with dyspnea, fatigue, smell loss, musculoskeletal pain, back pain, headache, arrhythmia, or persistent cough 6–18 months after infection. Symptoms suffered were determined to be associated with LC, persisted for at least 3 months or longer, alternative diagnoses were excluded, and there was no history of symptoms before COVID-19 infection. Exclusion criteria comprised participants outside the 18–65 age range, those with cognitive or communication deficits, and individuals with preexisting neuromuscular or musculoskeletal conditions that precluded safe engagement in physical assessments. None of the participants discontinued the study, and no life risk was revealed during the evaluations. All participants were diagnosed with COVID-19 *via* polymerase chain reaction (PCR) tests conducted during the acute phase of infection. These results were verified through medical records provided by healthcare facilities. Data on participants' hospitalization, outpatient follow-up, identifying preexisting conditions that could mimic or contribute to similar symptoms, or home isolation protocols were collected through a comprehensive review of healthcare facility records and patient histories. Individuals reporting analogous symptoms prior to their COVID-19 diagnosis were excluded from the study. Symptom onset was defined as occurring within the first 4 weeks following COVID-19 diagnosis. S– group was identified from the hospital database, selecting individuals who had documented COVID-19 infection confirmed by a healthcare institution during the acute phase and had recovered 6–18 months prior without persistent symptoms requiring medical follow-up. These individuals were contacted and invited to participate as a control group. This recruitment approach ensured demographic comparability with the symptomatic group, allowing for a robust assessment of functional capacity and HRQoL outcomes.

There were 87 participants with ongoing symptoms and hospital admissions. We excluded 14 participants who reported similar symptoms before the COVID-19 diagnosis, 3 participants whose symptom onset occurred after the 1st month of COVID-19 diagnosis, 7 participants with orthopedic limitations, 7 participants with pre-COVID-19 symptoms, and 23 participants who did not want to be included in the study. We reached 57 participants whose symptoms did not persist. Seventeen participants who did not want to be included in the study and three participants with orthopedic limitations were excluded from the study. The symptomatic group (S+) consisted of 33 participants (female = 25, male = 8) with one or more symptoms. The asymptomatic group (S–) consisted of 37 (female = 20, male = 17) participants without any symptoms. We calculated that the sample size should be at least 64 people,

considering Cohen's d type 1 error margin (α) = 0.05, effect size = 0.5, and test power = 0.85.

## Data Collection

Participants were included in one of the two groups according to whether symptoms persisted or not. A total of 70 participants were included, including 37 asymptomatic individuals and 33 symptomatic individuals (28 with one symptom and 5 with two symptoms). "Post-COVID-19 Functional Scale (PCFS)" and "Short Form (SF)-36" questionnaires were used to assess the functional capacity and HRQoL of the participants. Functional capacity was evaluated using standardized protocols, including the 30s-STS test and 6MWT, both widely recognized.

Participants' age, height, smoking, weight, body mass index, gender, time since COVID-19 diagnosis, recovery from infection at home, hospital service or intensive care unit, number of doses of vaccine, and presence of comorbid chronic conditions were recorded.

Post-COVID-19 Functional Scale is a reliable six-point scale measuring activity limitation and functional capacity after COVID-19. The lowest score is considered to be functional limitation without symptoms, pain, depression, or anxiety. The highest scoring is the stage where help is needed in activities of daily living and nursing care, and attention is required. The last item is death and is not included in the scoring. The Turkish validity of the scale has a Cronbach's α value of 0.82.[14]

To assess HRQoL, the SF-36 is a questionnaire consisting of eight subdimensions used both in general patients and in respiratory-related patients. It asks how the person thinks about their health and how their physical and mental health affects their daily HRQoL. These parameters are pain, emotional role difficulties, physical function, physical role difficulties, mental health, energy, social functioning, and general health perception. Each parameter is evaluated on its own. A good HRQoL can be determined by a high score on the SF-36 scale. Cronbach's α value for each subgroup of the scale is between 0.73 and 0.76.[15]

About 30-second sit-to-stand is a test that assesses sit-to-stand activity, dynamic balance, and lower extremity muscle strength. A chair with a sitting level of 44 cm, without armrests, and with a recliner was used. The patient was asked to cross his/her arms in front of the trunk and sit and stand while maintaining the position. They were asked to stand up until they were fully upright, and when seated, their hips were asked to fully touch the chair. For 30 seconds, the maximum amount of sitting up was recorded (Fig. 1).[16]

About 6-minute walking test measures the distance the participant covers in meters in 6 minutes. The test results provide information about the exercise capacity required by the participant in activities of daily living. The test was performed in a straight corridor 30-m long. Arterial oxygen saturation, leg fatigue (modified Borg scale), and perceived dyspnea were recorded. Patients were asked to walk as fast as possible. During the test, patients were given standardized encouraging statements every minute. After 6 minutes, the distance walked was recorded in meters. The recorded distance was evaluated with the ideal distance calculated according to age and body mass index (BMI) (Fig. 1).[17] The ideal distance formulas are given in Table 1.

## Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics (Version 23.0). The normality analysis of the data was interpreted by looking at the Shapiro–Wilk test and Skewness–Kurtosis values. The data had a normal distribution. Descriptive statistics data are given as mean and standard deviation (SD). Ordinal and nominal variables are given as numbers of data and percentages (%). Numerical data were analyzed using an independent samples *t*-test and Pearson's correlation analysis; nominal data were analyzed using $\chi^2$-test and Fisher's exact test.

**Table 1:** Ideal and acceptable data formula for the 6-minute walk test, taking into account gender, BMI, and age[18]

| |
|---|
| For men: |
| Ideal 6MWT distance (m) = 1140 – (5.61 × BMI) – (6.94 × age) |
| Low limit (m) = Ideal 6MWT distance – 153 |
| For women: |
| Ideal 6MWT distance (m) = 1017 – (6.24 × BMI) – (5.83 × age) |
| Low limit (m) = Ideal 6MWT distance – 139 |

6MWT, 6-minute walking test; BMI, body mass index; m, meter




**Figs 1A to D:** Thirty-second sit-to-stand test and 6-minute walking test practice: (A) The desired position to sit fully in the chair; (B) Intermediate transition when standing up; (C) Full standing position; and (D) 6-minute test in a 30-m corridor

# Results

## Main Outcomes

Participants were divided into groups according to the presence ($n$ = 33) or absence ($n$ = 37) of LC symptoms. Descriptive statistics data were then analyzed. There was no statistically significant difference in the demographic data of the S+ (25 female; 8 male; age mean ± SD: 37.51 ± 11.97; BMI mean ± SD: 25.94 ± 4) group compared to the mean of the S− (20 female; 17 male; age mean ± SD: 35.78 ± 12.64; BMI mean ± SD: 26.38 ± 5.1) group. There was no statistically significant difference between the groups in gender ($p$ = 0.06), smoking ($p$ = 0.57), vaccination dose ($p$ = 0.44), and recovery location ($p$ = 0.05). The mean value of PCFS was significantly higher in the symptomatic group (mean ± SD: 1.57 ± 0.83) than in the asymptomatic group (mean ± SD: 0.05 ± 0.22) ($p$ < 0.001) (Table 2). Distribution to the groups was equal. Two participants in the S+ group had hypertension. One participant in the S− group had prehypertension, and one participant had type 2 diabetes mellitus.

In the S+ group, 29 (87.9%) people had COVID-19 infection at home, 3 (9.1%) in the service, and 1 (3%) in the intensive care unit. In the S− group, 37 (100%) people had the disease at home. S+ group participants experienced fatigue in 10 (14.3%), breathlessness in 9 (12.9%), smell loss in 6 (8.6%), back pain in 3 (4.3%), arrhythmia in 2 (2.9%), coughing in 1 (1.4%), headache in 1 (1.4%), and musculoskeletal pain in 1 (1.4%). In the S+ group, 1 participant was not vaccinated, 1 participant received one dose, 17 participants received two doses, 8 participants received three doses, and 6 participants received four doses. In the S− group, 1 participant was not vaccinated, 26 participants received two doses of vaccine, 5 participants received three doses of vaccine, and 5 participants received four doses of vaccine. There is no statistically significant difference between the two groups in terms of vaccine dose ($p$ = 0.44). In the S− group, there were 5 participants with 6 months, 2 participants with 7 months, 6 participants with 8 months, 4 participants with 9 months, 1 participant with 10 months, 14 participants with 12 months, 4 participants with 14 months, and 1 participant with 18 months after COVID-19. In the S+ group, there were 9 participants with 6 months, 2 participants with 7 months, 2 participants with 8 months, 2 participants with 10 months, 2 participants with 10 months, 14 participants with 12 months, 1 participant with 16 months, and 3 participants with 18 months. The symptoms of symptomatic individuals and the number of vaccine doses administered by the participants are shown in Figure 2.

## Health-related Quality of Life and Functional Capacity

Comparative analysis found no statistically significant difference between the symptomatic cohort (S+: 10.36 ± 3.74 months) and the asymptomatic cohort (S−: 10.27 ± 2.92 months) in terms of mean time after COVID-19 diagnosis ($p$ = 0.90). The mean 30s-STS data were significantly higher in the S− group (mean ± SD: 18.02 ± 3.41) compared to the S+ group (mean ± SD: 16.12 ± 3.68) ($p$ = 0.02). Similarly, the mean data of 6MWT were significantly higher in the S− group (mean ± SD: 605.62 ± 57.73) than in the S+ group (mean ± SD: 561.24 ± 71.01) ($p$ = 0.005). Modified Borg scale mean scores measured after 6MWT were significantly higher in the S+ group (mean ± SD: 6.81 ± 2.29) than in the S− group (mean ± SD: 4.78 ± 2.60) ($p$ = 0.001). The mean PCFS scores measured after 6MWT were significantly higher in the S+ group (mean ± SD: 1.57 ± 0.83) than in the S− group (mean ± SD: 0.05 ± 0.22) ($p$ < 0.001). When SF-36

**Table 2:** Descriptive statistical data between the two groups and the relationship between group data

| | *S− (n = 37)* | | *S+ (n = 33)* | | *t-test* |
|---|---|---|---|---|---|
| *Variables* | *Min/max* | *Mean ± SD* | *Min/max* | *Mean ± SD* | *p* |
| Age (years) | 18/64 | 37.51 ± 11.97 | 18/61 | 35.78 ± 12.64 | 0.56 |
| BMI (kg/cm$^2$) | 18.59/35.94 | 25.94 ± 4 | 18.42/38.75 | 26.38 ± 5.1 | 0.69 |
| PCFS | 0/1 | 0.05 ± 0.22 | 0/3 | 1.57 ± 0.83 | 0.000* |
| TFD (month) | 6/18 | 10.27 ± 2.92 | 6/18 | 10.36 ± 3.74 | 0.9 |
| *DV* | *n* | % | *n* | % | *t*-test |
| No dose | 1 | 2.7 | 1 | 3.05 | 0.44 |
| One dose | 0 | 0 | 1 | 3.05 | |
| Two doses | 26 | 70.3 | 17 | 51.5 | |
| Three doses | 5 | 13.5 | 8 | 24.2 | |
| Four doses | 5 | 13.5 | 6 | 18.2 | |
| *Gender* | *n* | % | *n* | % | *Chi-square* |
| Female | 20 | 54.1 | 25 | 75.8 | 0.06 |
| Male | 17 | 45.9 | 8 | 24.2 | |
| *Smoking* | n | % | n | % | *Chi-square* |
| Yes | 9 | 24.3 | 10 | 30.3 | 0.57 |
| No | 28 | 75.7 | 23 | 69.7 | |
| *Recovery location* | *n* | % | *n* | % | *Fisher's exact test* |
| Home | 37 | 100 | 29 | 87.9 | |
| Service | 0 | 0 | 3 | 9.1 | 0.05 |
| Intensive care | 0 | 0 | 1 | 3 | |

*Independent samples *t*-test; %, percentage; BMI, body mass index; cm, centimeter; DV, doses of vaccine; kg, kilogram; kg/m$^2$, kilogram/square meter; max, maximum; min, minimum; *n*, number of participants; PCFS, post-COVID-19 functional scale; S+, symptomatic group; S−, asymptomatic group; SD, standard deviation; TFD, time from diagnosis; X, mean

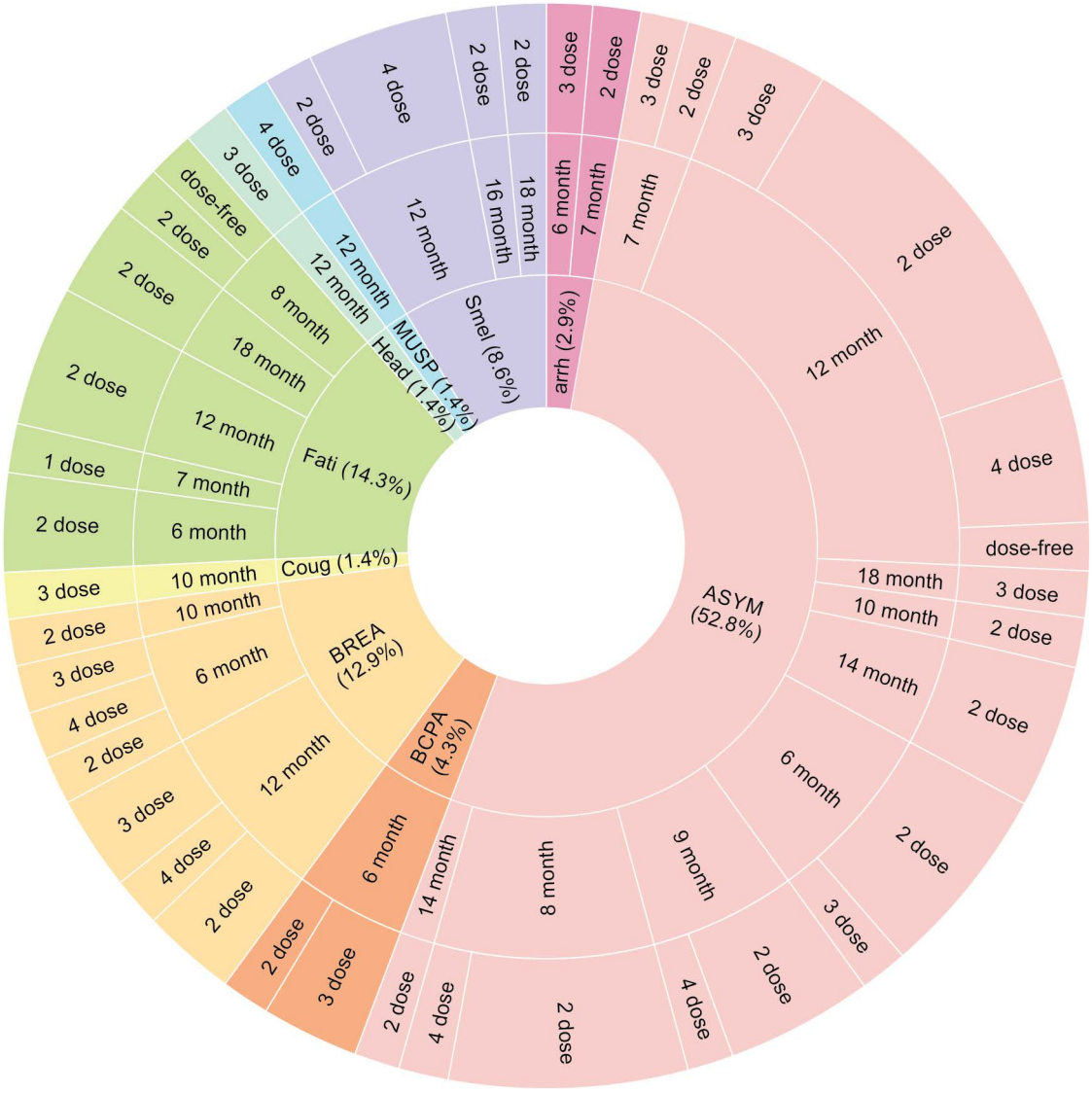



**Fig. 2:** Representation of S+ participants' symptoms (from innermost to outermost circles in order: symptoms, time since infection, number of vaccine doses) and S group's information (from innermost to outermost circles in order: asymptoms, time since infection, and number of vaccine doses); arrh, arrhythmia; asym, asymptomatic; bcpa, back pain; brea, breathlessness; coug, coughing; fati, fatigue; head, headache; musp, musculoskeletal pain; smel, smell loss

scale subdimension mean scores were analyzed in the S– group, physical function (S–/S+: 86.08 ± 15.72/72.12 ± 21.72) ($p = 0.003$), pain (S–/S+: 78.85 ± 19.53/62.12 ± 24.62) ($p = 0.002$), emotional role difficulty (S–/S+: 77.50 ± 33.37/51.51 ± 44.94) ($p = 0.009$), physical role difficulty (S–/S+: 82.43 ± 29.38/53.48 ± 40.14) ($p = 0.001$), and general health scores (S–/S+: 67.02 ± 15.83/55.45 ± 18.47) ($p = 0.006$) were found to be higher than the S+ group (Table 3).

Pearson's correlation test was performed within both groups. In the S+ group, the PCFS score showed a negative correlation with the 6MWT ($r = -0.46$, $p < 0.01$), 30s-STS ($r = -0.48$, $p < 0.01$), physical function ($r = -0.56$, $p < 0.01$), physical role difficulty ($r = -0.57$, $p < 0.01$), emotional role difficulty ($r = -0.37$, $p < 0.05$), mental health ($r = -0.41$, $p < 0.05$), pain ($r = -0.47$, $p < 0.01$), and general health ($r = -0.41$, $p < 0.05$). In the S– group, the PCFS variable has a negative relationship only with energy ($r = -0.4$, $p < 0.05$) and pain ($r = -0.34$, $p < 0.05$). In both groups, physical function was positively correlated with 6MWT (S+: $r = 0.49$, $p < 0.01$; S–: $r = 0.49$, $p < 0.01$) and 30s-STS (S+: $r = 0.48$, $p < 0.01$; S–: $r = 0.32$, $p < 0.05$).

## Discussion

Studies in the literature have focused on the symptoms of LC patients at 1–6, 6–12, and 12–18 months after infection.[9,10,19] This study compared the effect on functional capacity and HRQoL of individuals with persisting symptoms 6–18 months after COVID-19 infection with the control group. The functional capacity of individuals with LC symptoms was reduced according to the 6-minute walking distance and 30s-STS test data. Additionally, significantly lower HRQoL scores were observed in the physical function, emotional role difficulty, physical role difficulty, pain, and general health subdimensions.

When considering the change in functional capacity and HRQoL of patients with persistent symptoms in this study, it is necessary to consider factors that influence the presentation and persistence of LC symptoms. The previous research has investigated factors such as gender, age, and comorbidities that may contribute to changes in LC presentation and severity. The risk of LC exposure is 1.26 times

**Table 3:** Statistical comparison of quality of life and functional capacity between the two groups

| | S− | | | S+ | | | |
|---|---|---|---|---|---|---|---|
| | *n* | *Min/max* | *Mean ± SD* | *n* | *Min/max* | *Mean ± SD* | *p* |
| 6MWT (m) | 37 | 510/750 | 605.62 ± 57.73 | 33 | 387/690 | 561.24 ± 71.01 | 0.005* |
| 30s-STS | 37 | 13/29 | 18.02 ± 3.41 | 33 | 9/22 | 16.12 ± 3.68 | 0.028* |
| Borg | 37 | 0/10.00 | 4.78 ± 2.60 | 33 | 3/10 | 6.81 ± 2.29 | 0.001* |
| PF | 37 | 30/100 | 86.08 ± 15.72 | 33 | 15/100 | 72.12 ± 21.72 | 0.003* |
| PRG | 37 | 0/100 | 82.43 ± 29.38 | 33 | 0/100 | 53.48 ± 40.14 | 0.001* |
| ERD | 37 | 0/100 | 77.50 ± 33.37 | 33 | 0/100 | 51.51 ± 44.94 | 0.009* |
| Energy | 37 | 15/95 | 57.29 ± 19.13 | 33 | 5/85 | 50.45 ± 16.36 | 0.11 |
| MH | 37 | 40/92 | 64.43 ± 13.05 | 33 | 20/84 | 57.93 ± 15.33 | 0.06 |
| SF | 37 | 12.5/100 | 72.97 ± 21.35 | 33 | 25/100 | 67.04 ± 22.27 | 0.26 |
| Pain | 37 | 35/100 | 78.85 ± 19.53 | 33 | 22.5/100 | 62.12 ± 24.62 | 0.002* |
| GH | 37 | 30/100 | 67.02 ± 15.83 | 33 | 10/90 | 55.45 ± 18.47 | 0.006* |

*Independent samples *t*-test; 6MWT, 6-minute walking test; 30s-STS, 30-second sit-to-stand test; ERD, emotional role difficulty; GH, general health; m, meters; max, maximum; MH, mental health; min, minimum; *n*, number of participants; PF, physical function; PRG, physical role difficulty; s, seconds; S+, symptomatic group; S−, asymptomatic group; SD, standard deviation; SF, social functioning

higher in women than in men,[20] and a relationship with advanced age has not been fully established.[21] Marciniak et al. reported that any lung disease did not cause LC symptoms when comorbidities were considered.[22] In addition, it has been reported that comorbidities such as diabetes, hypertension, asthma, and chronic lung disease do not affect the presence of inspiratory capacity (IC) symptoms.[23,24] Tleyjeh et al. reported that patients with diabetes were less likely to develop LC symptoms.[25] These findings were supported in our study. There were no statistically significant associations between the groups in terms of age, gender, smoking status, or metabolic diseases. This suggests that the observed reductions in functional capacity and HRQoL were likely directly attributable to the persistence of symptoms rather than underlying demographic or health-related factors.

Long COVID-19 symptoms are not life-threatening, but they are important in the postrecovery period as they impair HRQoL. This has made it necessary to examine the impact on functional capacity and HRQoL.[9,26] LC symptom duration and diversity vary. It has been reported that symptoms and long-term effects persist for years following SARS (severe acute respiratory syndrome) and MERS (Middle East respiratory syndrome) viral infections, which are closely related to the COVID-19 virus.[27] Guo et al. reported that residual lung function impairments, exercise limitations, and mental health disorders persisted up to 18.5 months after infection.[26] Similarly, Yang et al. reported a continued decline in the general health subdimension of HRQoL and detectable pulmonary abnormalities and symptoms in a 3-year follow-up of symptomatic individuals.[28] The symptoms observed in our study had a direct impact on HRQoL and functional capacity, an average of 10.36 months after infection. In addition, the values in the general health subdimension of HRQoL were close to the values of Yang et al. in symptomatic individuals 36 months later. When the studies of Guo et al. and Yang et al. are taken into consideration, the loss in quality of life and functional capacity of LC individuals at 10.36 months suggests that it will last longer, as in SARS and MERS viral infections.

It has been reported that symptoms such as fatigue, dyspnea, cognitive impairment, postexertional weakness, musculoskeletal pain, cough, loss of smell, and headache are commonly associated with LC.[29] In a study investigating symptoms 1 year after infection, it was reported that patients most commonly had decreased exercise capacity, fatigue, dyspnea, and quality of life.[30] Among the participants in our study, the most frequently observed symptoms were fatigue, dyspnea, loss of smell, back pain, heart rhythm disturbances, cough, headache, and muscle-joint pain. The symptoms observed in the individuals who participated in our study are consistent with those reported in the literature. This consistency with the literature suggests that the functional impairments and reductions in HRQoL observed in our study may be generalizable to the broader LC patient population. It also highlights the importance of long-term follow-up and targeted interventions for individuals with persistent symptoms.

Several studies have examined the factors influencing HRQoL in LC patients and sought to identify the additional challenges caused by persistent symptoms. Ma et al. reported that pain, anxiety, and depression were the most prevalent conditions affecting long-term HRQoL among individuals with COVID-19, whereas self-care difficulties were the least common.[9] Malesevic et al. reported that the HRQoL of LC patients was significantly reduced compared to before the pandemic. They reported that patients experienced impairment in performing their usual activities, pain/discomfort, and anxiety.[31] Individuals with persistent COVID-19 symptoms over a 2-year period demonstrated a significant decline in HRQoL, heightened psychological distress, and increased healthcare utilization following discharge compared to those without long-term symptoms.[32] de Oliveira Almeida et al. reported that a decrease in HRQoL for up to 1–6 months after COVID-19 is common.[33] Nandasena et al. reviewed studies evaluating LC patients using the SF-36 and reported that the physical role subdimension of HRQoL was the most affected, while the physical function subdimension was the least affected. They also reported that total scores ranged between 52.7 and 79.96.[34] In our study, the symptomatic group had the lowest score in the energy subdimension (50.45) and the highest score in the physical function subdimension (72.45). The values observed in our study align with the normative values reported by Nandasena et al. This consistency may be attributed to the widespread impact of LC on these specific health domains across different cohorts. Unlike previous studies in the literature, the data obtained from our control group may enable interpretations based on more accurate normative reference values. As reported by Nandasena et al., in addition to the significant differences observed in the

physical function and physical role difficulty subdimensions, the presence of significant differences in the emotional role difficulty, pain, and general health subdimensions has led us to consider the possibility of a more severe impact on HRQoL. The lack of differences in the energy, mental health, and social functioning subdimensions in our symptomatic group compared to our control group suggests that certain subdimensions of HRQoL may be impaired in all individuals who have experienced COVID-19, regardless of symptom presence or absence.

Furthermore, symptomatic participants were not subjected to prolonged social isolation by society or the state.[35] This may have positively affected the energy, mental health, and social functioning subdimensions. It is not easy to provide a complete physiological or social mechanism for these changes in HRQoL. The observed decline in HRQoL in LC may be attributed to the severity of the immune-inflammatory response during the acute infection phase, which induces neuroimmunotoxicity and neuro-oxidative toxicity, ultimately affecting physiological and affective functions.[36]

In our study, the significant decrease in physical role difficulty, physical function, general health parameters, and emotional role difficulty in the S+ group may negatively affect patients' functional capacity. Both physical tests used to assess functional capacity successfully detected differences between the groups. The 30s-STS was included in the study as a telerehabilitation alternative in case of a pandemic-related lockdown during the study period.[37] However, since closure did not occur during the study, both physical tests were performed face-to-face. Daher et al. reported that the ideal walking distance of most of the patients decreased after infection.[38] Huang et al. were able to reach only 88.4% of the ideal walking distance value of patients with severe infection at 1 month after discharge. They also walked significantly less distance than those with mild disease.[39] Similarly, Beyer et al. reported a decreased $VO_2$ max and a reduced walking distance in the 6MWT.[40] Guo et al. reported a statistically significant decrease in 6-day walk test (DYT) at 18.5 months (mean = 535) compared to 6DYT at 9.3 months (mean = 565.2).[26] In our study, the 6-minute walking distance of the symptomatic group was significantly lower than that of the S− group. The mean 6MWT distance in the S+ group was 84.6% of the predicted ideal value. S+ participants experienced significantly higher dyspnea after the 6MWT than S− participants. The underlying cause of this condition may be attributed to a sedentary lifestyle resulting from COVID-19-related symptoms[6] or government-mandated quarantine measures.[41] Another potential reason could be the decline in HRQoL due to COVID-19, adverse effects of medical treatment, or a combination of these factors.[42] Another potential cause could be reduced HRQoL due to COVID-19, adverse effects of medical treatment or a combination of these factors,[42] or interleukin 6 (IL-6) released due to moderate/severe infection,[43] causing muscle atrophy leading to exercise restrictions.

The first limitation of our study is that we did not consider COVID-19 variants. The second limitation is that since some of our results are based on questionnaires, there may be some cognitive bias in the participants' responses. The third limitation is that our participants may have overestimated the assessment of symptoms due to voluntary bias. The last limitation is that the data on the symptoms of the participants were reported by the patients and not verified by a health professional. However, this does not significantly reduce the value of our findings. Because most of the LC symptoms are subjective symptoms such as fatigue.[18,44]

## Conclusion

Functional capacity and HRQoL (physical role difficulties, physical functioning, pain, emotional role difficulties, and general health perception subscale) were poorer in symptomatic participants than in asymptomatic participants. These findings emphasize that impairment in HRQoL and functional capacity is not limited to the acute phase but leads to a multisystemic and long-term health condition. It also emphasizes the need for long-term monitoring for individuals who experience persistent symptoms after COVID-19 infection.

The data from the study contribute to the investigation of long COVID-19 as recommended by the World Health Organization (WHO). The study provides important findings to understand the lasting effects of LC on functional capacity and HRQoL in symptomatic individuals. Furthermore, this study showed the need for rehabilitation studies focusing on HRQoL and functional capacity in symptomatic patients. Future research could focus on the mechanisms underlying these impairments and plan studies that encourage physical activity participation, taking into account decline in physical function, physical role difficulty, and functional capacity.

## Data Availability Statement

Individual, deidentified participant data (including data dictionaries) from this study will be made unrestricted and publicly available following publication of the article. Data to be shared include demographic information, clinical measures (6MWT, 30s-STS test), questionnaire results (SF-36, PCFS), and raw data from statistical analyses. In addition, relevant documents such as the study protocol and statistical analysis plan will be available with the full text. If requested by reviewers or editors during the review process, access to the data will be provided during correspondence. There are no restrictions on access to the data, and all interested parties (researchers, institutions, and the public) are welcome to download or review the data for academic research, meta-analysis, or validation purposes. Statistical datasets will be made directly available in the "Supplementary Material" section of the article.

## Supplementary Materials

All the supplementary materials are available online on the website of https://www.ijrc.in/journalDetails/IJRC. The data were also uploaded to the Mendeley data system.[45]

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