Exercise Capacity and Fatigue in Post-COVID-19 Patients

Hadeel Alqahtani, Tamadher Aljouiee, Mohammed Alsultan, Mohsen Ayyash, Amani Abu-shaheen

***Abstract*— Background: While many researchers have investigated the influence of COVID-19 on fatigue and quality of life, its impact on exercise capacity has been little considered. It is therefore our aim to examine the impact of COVID-19 on exercise capacity and fatigue among individuals who have recovered from the virus. Methods: A cross-sectional study was conducted at the outpatient physical therapy department of a tertiary hospital and Primary health care center. The study comprised 116 participants divided into two groups: a normative group composed of individuals who had not been infected with COVID-19 in the past three months, and a control group consisting of those who had contracted COVID-19 within the preceding three months. The one-minute sit-to-stand test (1STST) was carried out to assess exercise capacity, following which fatigue was measured using the validated Arabic version of the Fatigue Severity Scale (FSS). Results: Of the 116 participants enrolled in this study, 76 (65.5%) were in the normative group and 40 (34.5%) in the control group. Following the intervention, the mean FSS score differed significantly between the normative (26.6; SD 10.9) and the control group (36.9; SD 14.8); p-value < 0.001, with participants in the control group reporting higher levels of weariness than those in the normative group. Moreover, as measured by 1STST, the median number of sit-to-stand repetitions completed by participants in the normative group (21.0) was considerably greater than that of the control group (20.0); p-value = 0.025. Conclusion: Participants in the control group reported higher levels of fatigue and demonstrated lower exercise capacity than those in the normative group.**

***Index Terms*— COVID-19, Endurance, Exercise Capacity, Fatigue.**

I. INTRODUCTION

Despite COVID-19 predominantly affecting the lungs and internal organs, the illness also manifests musculoskeletal damage, as detailed by the significant increase in creatine kinase and lactate dehydrogenase levels [1]. Researchers have found that COVID-19 has an impact on mortality and morbidities, causing post-viral complications that may be disabling and lifelong [2].

Those most affected by the virus may advance to a hyper-inflammatory and hypercoagulable state, leading to life-threatening complications such as acute respiratory distress syndrome, deep vein thrombosis and pulmonary embolism, stroke, acute coronary syndrome, and acute kidney failure [3,4].

During the COVID-19 outbreak, it was established that this disease causes a number of social, physical, and psychological effects. It caused psychological stress, for example, which in turn impacted quality of life [5].

Furthermore, fatigue has been a major symptom noted in patients with COVID-19, with up to 46% reporting fatigue that lasts from weeks to months. Researchers found that persistent fatigue ranges from 13% to 33% at 16–20 weeks post-symptom onset [6].

Since the outbreak, we have noticed during daily practice several cases of significant change in endurance and lowered quality of life. According to a review of the literature, many researchers have investigated the impact of COVID-19 on fatigue and quality of life, while less attention has been given to the poor exercise capacity of the same cohort of patients. To our knowledge, this study has not yet been conducted in Saudi Arabia. Thus, this study aims to assess the impact of COVID-19 on exercise capacity and fatigue in post-COVID-19 Saudi patients.

II. MATERIALS AND METHODS

Study design, settings and participants:

A cross-sectional study was conducted from June 2022 to December 2023 in the outpatient physical

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therapy department of a tertiary hospital in Almasiaf District. We included patients who were exposed and non-exposed to COVID-19 and who visited the outpatient physical therapy department or Primary health care center in Almasiaf District for any other follow-up visit. According to these criteria, we invited all male and female adults aged between 16 and 65 years to participate in the study. We excluded patients with ongoing participation in another intervention study; those suffering neurological diseases that affect functional level; pregnant women; and those with mobility impairments.

Assessments and measurements:

All participants who met the inclusion criteria were approached by trained physical therapists who explained the study objective and conducted a one-minute sit-to-stand test (1STST). They were contacted, and appointments were scheduled for them to undergo 1STST. Additionally, the participants completed an electronic questionnaire that took 15 to 20 minutes; this included a consent form, demographic data, date of COVID-19 infection (if infected), medical history, and details of dyspnoea and fatigue.

The participants were divided into two groups: (1) the control group, who had been infected by COVID-19 in the previous three months and had/had not been admitted due to COVID-19; (2) the normative group, who had not been infected by COVID-19 in the previous three months or had never been infected by COVID-19. Exposure duration was considered within three months, according to a cohort study in Australia that showed that 80% of COVID-19 cases recover within a month, but about 5% will continue to experience symptoms three months later [7].

For the assessment of exercise capacity, participants performed a 1STST. The chair was positioned against a wall (illustrated in Figure 1). The participants were seated upright with knees and hips flexed at 90°, feet placed flat on the floor at hip-width apart, and arms held stationary by placing their hands on their hips. They were then asked to repeatedly stand upright and then sit down at a safe and comfortable speed, as many times as possible for one minute. They were instructed not to use their arms for support while rising or sitting; however, they were allowed to rest during the one-minute period. The number of repetitions was recorded.

The modified Borg Scale (rated from 0 to 10) was employed to evaluate dyspnoea and fatigue before and after the test. Fatigue was also measured using the validated Arabic version of the Fatigue Severity Scale (FSS) [8]. This was found to be sensitive, reliable, and consistent, with a good response rate. The FSS consists of nine statements describing the severity and impact of fatigue, with possible responses ranging from 1 (strongly disagree) to 7 (strongly agree). Total FSS scores are usually reported as the mean score across the nine items, with higher scores indicating greater severity [8]. The Arabic version of the FSS demonstrated acceptable test-retest reliability, internal consistency (intraclass correlation coefficient model 2,1 = 0.80; Cronbach's alpha = 0.84), and psychometric properties [9].

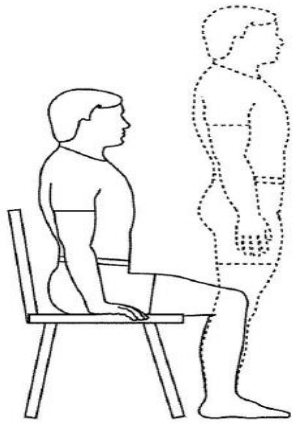

Figure 1. The assessment of exercise capacity.

Ethical considerations:

Written informed consent was obtained from the study participants, and the study was reviewed and approved by the Institutional Review Board, Riyadh, Saudi Arabia, with IRB log number 21-568.

Statistical analysis:

Participants' characteristics are described using counts and percentages, and study outcomes are depicted as means with standard deviations (SD) or medians with ranges where applicable. A chi-square test was employed to compare baseline characteristics between the control and normative groups. Pre-post-test changes within each group were assessed using the Wilcoxon signed-rank test, while differences between the two groups were analysed using the Mann-Whitney test. Fatigue, evaluated with a cutoff value of a composite average score of FSS > 4, was compared between control and normative groups and illustrated using a stacked bar chart. Statistical significance was considered at values below 5%. All statistical analyses were performed using the

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Statistical Package for Social Sciences (SPSS), version 26.0 [10].

III. RESULTS

Of a total of 116 participants, 76 (65.5%) were in the normative group and 40 (34.5%) in the control group. Table 1 shows the descriptive statistics of the study participants. The distribution of the sample by gender shows 80 (69.0%) females and 36 (31.0%) males.

Our findings revealed a statistically significant difference in median score of the modified Borg Scale between the normative and control groups, both pre-test; at rest or no exertion before intervention in both groups (0.0: Range = 5 – 0 versus 0.5: Range = 6 – 0; p-value = 0.006) and post-test (2.0: Range = 10 – 0 versus 2.5: Range = 7 – 0; p-value = 0.024). When comparing the change from pre-test to post-test for each group, the results indicate a significant increase in median score for both the normative group (0.0: Range = 5 – 0 versus 2.0: Range = 10 – 0; p-value < 0.001) and the control group (0.5: Range = 6 – 0 versus 2.5: Range = 7 – 0; p-value < 0.001). However, there is no significant difference between the change in median score of the normative group (1.0: Range = 9.5 – 1.0) and the control group (1.8: Range = 7.0 – 0.0; p-value = 0.252), as shown in Table 2. Participants of both groups reported a light level of exertion after the intervention, as measured by the average RPE.

Table 1. Baseline characteristics of the study sample

Characteristics	Categories	Total sample (n = 116)	Normative (n = 76)	Control (n = 40)	p-value
Gender	Female	80 (69.0)	52 (68.4)	28 (70.0)	0.861
	Male	36 (31.0)	24 (31.6)	12 (30.0)	
Age group	16 - 25	35 (30.2)	24 (31.6)	11 (27.5)	0.419
	26 - 35	52 (44.8)	37 (48.7)	15 (37.5)	
	36- 45	15 (12.9)	8 (10.5)	7 (17.5)	
	46 - 55	9 (7.8)	5 (6.6)	4 (10.0)	
	56 - 65	5 (4.3)	2 (2.6)	3 (7.5)	
Smoker	Yes	19 (16.4)	11 (14.5)	8 (20.0)	0.566
	No	91 (78.4)	60 (78.9)	31 (77.5)	
	Ex-smoker	6 (5.2)	5 (6.6)	1 (2.5)	
Chronic disease	Yes	18 (15.5)	7 (9.2)	11 (27.5)	0.001
	No	98 (84.5)	69 (90.8)	29 (72.5)	
Doses of COVID-19 vaccine	1	1 (.9)	0 (.0)	1 (2.5)	0.467
	2	11 (9.5)	7 (9.2)	4 (10.0)	
	3	104 (89.7)	69 (90.8)	35 (87.5)	
Admission to ICU due to COVID-19	Yes	2 (1.7)	2 (2.6)	0 (0.0)	0.544
	No	114 (98.3)	74 (97.4)	40 (100.0)	

COVID-19: Coronavirus Disease of 2019; ICU: Intensive Care Unit

Table 2 shows a substantial difference in mean FSS scores between the normative (26.6; SD 10.9) and control groups (36.9; SD 14.8); p-value < 0.001, following the intervention.

That is, the level of fatigue is higher among participants in the control group than in the normative group. Figure 2 shows that 18.4% (n = 14) of participants in the normative group are fatigued with its intensity correlating positively with increasing points (i.e., average FSS score > 4), while 47.5% (n = 19) of those in the control group are similarly fatigued; this difference was statistically significant (p-value = 0.001). Furthermore, the median number of sit-to-stand repetitions completed by participants in the normative group (21.0: Range = 41 – 10) was higher than that in the control group (20.0: Range = 35 – 4), as measured by 1STST; p-value = 0.025.

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Table 2. Differences in outcome measures after exercise intervention between normative and control groups.

Outcome		**Normative**	**Control**	**p-value**
Modified Borg Scale, median (range)	Pre-test	0.0 (5– 0)	0.5 (6 – 0)	0.006
	Post-test	2.0 (10 – 0)	2.5 (7 – 0)	0.024
	p-value	< 0.001	< 0.001	
	Change	1.0 (9.5 – 1)	1.8 (7.0 – 0.0)	0.252
FSS, mean ± SD	Post-test	26.6 ± 10.9	36.9 ± 14.8	< 0.001
Sit-to-stands completed, median (range)	Post-test	21.0 (41 – 10)	20.0 (35 – 4)	0.025

SD: Standard deviation

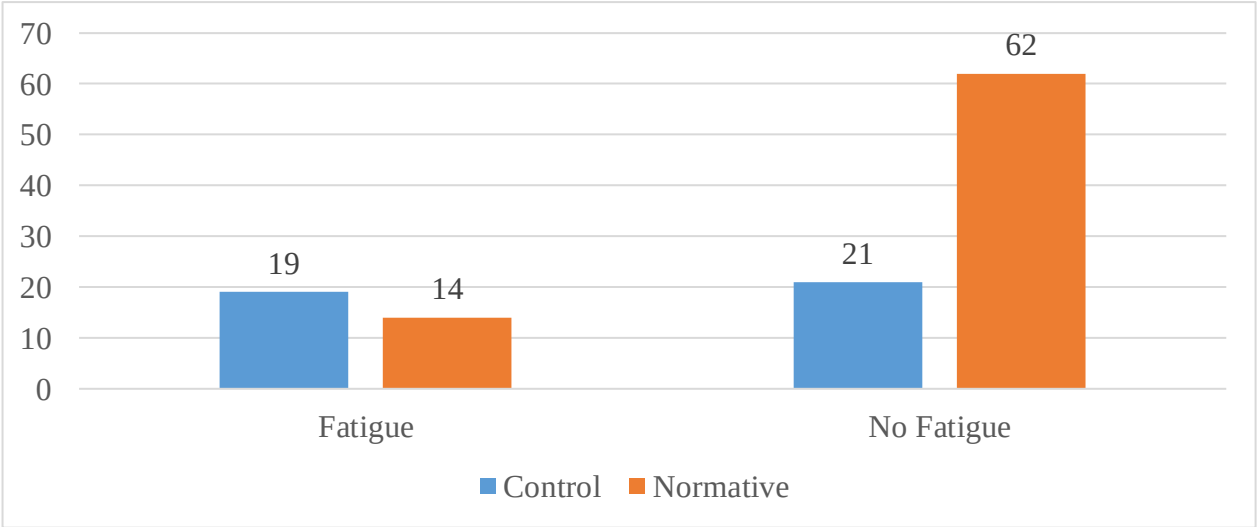

Figure 2. Post-test distribution of fatigued and non-fatigued participants in both groups.

IV. DISCUSSION

This study assessed the impact of COVID-19 on exercise capacity and fatigue in post-COVID-19 patients. A 1STST was used to assess exercise capacity before and after exercise intervention; the level of fatigue after exercise was also reported. These results were then compared between the normative and control groups. According to our findings, participants in both groups reported no exertion at baseline, but the average Borg Scale score differed between the groups. Furthermore, participants in the control group had a higher average modified Borg Scale score than those in the normative group. However, both groups showed a light level of exertion as measured by RPE, and the magnitude of the change pre-post exercise was not significantly different between them. This indicates that COVID-19 infection has no effect on the affected the rated perceived exertion in the exposed group.

A study reported that most recovered COVID-19 patients had reported negligible to slight functional limitations as measured by the Post COVID-19 Functional Status Scale (PCFS), while most of them reported RPE as somewhat difficult to very hard, as measured by the Borg Scale [11]. Another study showed that higher levels of dyspnoea, comorbidity, and muscle weakness were among the factors contributing to reduced exercise capacity in people with post-COVID-19 syndrome [12], while a recent literature review review by Kaulback showed that higher RPE scores were significantly associated with acute symptoms of COVID-19 [13].

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Our findings also revealed that participants in the control group reported higher levels of fatigue than those in the normative group, confirming the findings of most previous studies that post-COVID-19 fatigue was persistent among recovered patients after three months of infection or recovery. This suggests a negative impact of COVID-19 on individuals, which is more pronounced within three months of infection. A cross-sectional study showed that the prevalence of fatigue following COVID-19 infection ranged from 52—70% within one to three months of hospital discharge [14]. A population-based study conducted on non-hospitalised participants in Norway indicated that 46% of respondents reported fatigue four months following the onset of COVID-19 symptoms, which is greater than that of the general population [15]. The same study also revealed increased fatigue levels among women; divorced, single, or widowed individuals; those with a short time since symptom onset; and those who experienced confusion during acute COVID-19 infection. There were also indications of an association with prior depression, dyspnoea, and BMI [15]. A community-based study in the Faroe Islands showed that the prevalence of fatigue post-COVID-19 infection was 24%, which is lower than that reported in our study [16]. Other studies also reported fatigue to be prevalent in more than half of patients who had recovered from acute COVID-19 infection after approximately three months [17- 23].

In the present study, the average number of sit-to-stand repetitions achieved by the control group was significantly higher than that of the normative group, as measured by 1STST. This indicates that COVID-19 infection has a negative impact on participants' physical capacity and exertional desaturation three months after infection or recovery. A study by Núñez-Cortés examined physical capacity using 1STST and exertional desaturation using the Borg Scale, and compared the results according to the participants' length of hospital stay (i.e., ≤ 10 days and > 10 days). The average number of repetitions in the 1STST was 20.9 ± 4.8, which is consistent with our findings [24]; however, there was no significant difference in this number between the two groups, which is not consistent with our findings. Moreover, the subgroup with a hospital stay > 10 days exhibited a notable increase in exertional desaturation and dyspnoea compared with the group that stayed ≤ 10 days.

The findings of our study confirm the negative impact of COVID-19 infection on physical capacity, exertional desaturation, and fatigue; this effect is more pronounced among exposed groups within three months of COVID-19 infection. Hence, this study raises awareness of the need for rehabilitation programs to improve patient outcomes in relation to post-COVID-19 syndrome. Previous studies have demonstrated prominent results of such exercise intervention programs in improving patients' physical capacity and activity [19, 25, 26]. Moreover, a recent meta-analysis assessed the influence of physical activity on the recovery of physical function in individuals with COVID-19, and found that physical activity interventions significantly improve exercise capacity and pulmonary function in COVID-19 patients [26].

V. LIMITATIONS

This study has several drawbacks. Firstly, it did not achieve the required sample size, and the comparison groups were not balanced; this resulted in a response rate of 55.8%, which may affect the reliability of the results and the power of the tests used. This low response may also be attributed to the fact that there was a significant decrease in confirmed positive COVID-19 cases during the study period.. However, the pattern of low response is common in such studies [27]. Moreover, this study was based on self-reported the results might be affected with response bias. Additionally, subjective measures were used, and time is required for participants to understand these scales and their sensitivity. These limitations might limit the generalisability of the results, and further research is required to overcome such limitations.

VI. CONCLUSION

This study confirms the detrimental effects of COVID-19 on exercise capacity and fatigue, particularly within the initial three months post-infection. The findings emphasise the importance of rehabilitation programs to enhance patient outcomes and address post-COVID-19 syndrome. Previous

research has demonstrated the positive impact of exercise intervention programs on physical capacity and activity in individuals recovering from COVID-19, emphasising the potential benefits of such rehabilitation strategies. Further research and intervention efforts in this direction are crucial for addressing the multifaceted challenges posed by post-COVID-19 conditions.

VII. ACKNOWLEDGMENTS

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VIII. CONFLICT OF INTEREST

The authors declare that this research was conducted in the absence of any commercial or financial relationship that may be construed as a potential conflict of interest.

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