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A randomized controlled trial examining the impact of low *vs.* moderate-intensity aerobic training in post-discharge COVID-19 older subjects

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Abstract. – OBJECTIVE: Post-COVID-19 patients complained of pain, fatigue, breathlessness, and reduction in quality of life which required planned intervention. This study aimed to compare the impact of 10 weeks of low *vs.* moderate-intensity aerobic training on physical fitness, psychological status, and quality of life in post-COVID-19 older subjects.

PATIENTS AND METHODS: 72 patients were randomized into 3 equal groups, moderate-intensity exercise (MIG, n = 24), low-intensity exercise (LIG, n = 24), and control group (CG, n = 24). The exercise was done 40 min/4 times per week for 10 weeks. We measured exercise capacity using the six-minute walking test, 1 min sit-to-stand test, post-COVID-19 functional scale (PCFS), and quality of life using the SF-36 questionnaire and HAMILTON Anxiety and Depression Scale (HADS).

RESULTS: There was no difference between groups regarding the demographic and most clinical characteristics of the subjects. Compared with CG there were statistically significant improvements in studying groups (MIG and LIG) with ($p < 0.05$) in most outcomes and the improvement was higher in MIG than in LIG in most outcomes.

CONCLUSIONS: 10-week moderate-intensity and low-intensity aerobic training programs are effective with superior effect to moderate-intensity. Moderate-intensity aerobic exercise is more effective and feasible in post-discharge COVID-19 older subjects regarding exercise capacity, quality of life, and psychological status than low-intensity aerobic exercise.

Key Words:
COVID-19, Aerobic, Physical therapy, Function, Quality of life.

Introduction

Coronavirus disease (COVID-19) was first identified in December 2019, after which, the disease spread throughout all parts of China. By February 2020, COVID-19 had spread to numerous countries worldwide[1,2]. In 2020 the World Health Organization announced a global pandemic due to COVID-19[3]. It was reported[4] that post-COVID-19 patients experienced pain, fatigue, and muscle weakness.

The consequences, such as fatigue and breathlessness, have been reported[5,6] to persist after hospital discharge and the impact at different functioning levels over time remains unclear. A recent systematic review[7] highlighted that all included studies found a reduction in the activity of daily living performance after COVID-19. Interestingly 87.4% of the recovered patients from COVID-19 complain of at least one symptom especially dyspnea and fatigue[5].

Literature on COVID-19 patients have reported pathological changes including pulmonary fibrosis, atelectasis, muscular weakness, and neuromuscular and psychological disorders which might be attributed to extended bed rest. Additionally, COVID-19 patients have an impairment in their quality of life which leads to decrease physical and pulmonary capacity. Previous studies[8,9] showed that COVID-19 patients were under exposure to long-term corticosteroid therapy which led to common problems like musculoskeletal pain, decreased range of motion, muscular weakness, neuropathy, myopathy, pulmonary dysfunction, dyspnea, confusion, and impaired activities of daily living, which could be managed by rehabilitation.

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It was highlighted[6] that planning a rehabilitation program after COVID-19 is needed especially to overcome fatigue, psychological distress, and breathlessness which lead to a significant reduction in quality of life. Physical therapy has an essential role in the multidisciplinary team in the management of the consequences of COVID-19[10]. It has been shown[11] that regular physical exercise leads to a reduction in the severity of infectious diseases, as well as protection against COVID-19 infection. It provides strong evidence for the incorporation of rehabilitation into COVID-19 management[12,13].

To enhance COVID-19 patients' physical, functional, and psychological status, physical therapy management should include the evaluation of any rehabilitative needs and effective interventions according to the patient's needs[14]. Physical therapy exercises such as strengthening, aerobic, and coordination exercises have been recommended[15] for COVID-19 patients to improve the patient physical, psychological, and quality of life. It is important not to push the exercise intensity high due to the risk of post-exercise fatigue[10]. The purpose of the current study was to compare moderate and low-intensity exercise on the exercise capacity, psychological status, and quality of life of post COVID-19 elderly patients.

Patients and Methods

Research Design

Ten-week double-blind (subject and assessor) randomized controlled study was conducted from March to August 2022. The protocol of this research was registered at www.clinicaltrials.gov (NCT05373407). The ethical approval was granted from the Research Ethical Committee at the University of Hail dated 13/12/2021 (H-2021-236) through research project No. (RG-21058). The authors conducted this research following the guidelines of the Helsinki Declaration of 2013. The inclusion criteria were both genders post-COVID-19, and the age range of 60-80 years. The exclusion criteria were a history of any orthopedic, or neurological problems, and any other contraindications for aerobic training.

G*POWER software (V. 3.1.9.2, Dusseldorf, Germany) was utilized to calculate the sample size. In order to determine 0.31 effect size with power 80%, alfa level 0.05, and 3 equal groups, 63 subjects (21 per group) should be recruited. To compensate for any dropouts, the number was raised to 72 (24 per group).

The allocation process was conducted by an independent researcher, who used permuted blocks [6 and 9] to achieve equal distribution of participants across the three groups. The allocation sequence was concealed from all research participants. Yet subjects and assessor were kept blind until the end of the study. Figure 1 shows the flow diagram of the study. The first group was named the moderate-intensity aerobic group (MIG) and received moderate-intensity exercise, the second group was named the low-intensity aerobic group (LIG) and received low-intensity aerobic exercises, while the last group was the control group (CG) and received medical care and advice. After explaining the experiment to the participant and taking the consent form, demographic data were collected (age, gender, weight, height, level of education, comorbidities, clinical course of COVID-19).

Interventions

Moderate-intensity aerobic exercises: administered to the MIG where walking on treadmill (Kettler Treadmill Axos sprinter 4 – By Kettler Ense-Parsit, Germany) for 20 minutes at 50-70% of the maximum heart rate was the main working out period. Prior to the working out, 15 minutes of warm-up was performed through self-stretching of the upper and lower extremity muscles in addition to trunk muscles. At the end of the session, 10 mins of cooling down were performed through low pace waking on the treadmill. Sessions were performed 4 times per week for 10 weeks. Low-intensity aerobic exercises were performed using the same parameters used in the MIG except for the intensity where it was between 40-50% of the maximum heart rate[16,17]. The control group (CG) received medical care and advice. The maximum heart rate was calculated by subtracting the age of the participant from 220. A similar regime has been used for the elderly population by a previous study[18]. American heart association guide was used to select the required intensity based on the heart rate range.

Outcome Measures

The primary outcomes included the evaluation of functional exercise capacity using the 6-min walk test (6-MWT). It measures the distance that a patient can walk on a flat, hard surface as quickly as possible in 6 minutes[19]. Post- COVID-19 Functional Scale (PCFS) was used to measure the functional state and independence of patients after COVID-19 infection, it includes two items

scored from 0-4 and 0-5. A high value indicates more restrictions in function and independence during daily life[20,21].

The secondary outcome measures included the 1-min sit-to-stand (STS) test to measure the functional capacity of the lower limb muscle[22,23]. Quality of life was measured using the SF-36 questionnaire to evaluate self-reported domains of health status, it consists of 36 items compiled into scales: physical functioning (PF), physical role functioning (RP), bodily pain (BP), general health (GH), vitality (VT), social role functioning (SF), mental health (MH) and emotional role functioning (RE). These scales range from 0 to 100; a higher score is more positive[24]. Anxiety and depression are evaluated by the Hamilton Anxiety and Depression Scale (HADS)[25,26].

Statistical Analysis

The data were entered into SPSS software version 28.0.1.1 (IBM Corp., Armonk, NY, USA) after collecting for statistical analysis. Body mass index (BMI) was calculated by dividing the weight by the height squared. The magnitude of change was calculated by subtracting the value of the outcome at baseline from the value after 10 weeks for each participant per group. The nominal demographic characteristics were compared between groups at baseline using One-way ANOVA after checking for assumptions. To investigate if gender differed between the groups, the Chi-square test of homogeneity was used. Four comparisons were conducted: three between groups and one within the group. Between groups, differences between groups at baseline, after 10 weeks, and magnitude of change were compared. For between-groups comparison One-way ANOVA was used after checking for the assumption. The final comparison was made within-group (baseline to 10 weeks) using Paired sample *t*-test after checking for the assumption. When the One-way ANOVA test showed a significant difference, the post hoc test was used to conduct the pairwise comparison. The statistical significance level was set at $p < 0.05$.

Results

77 participants were recruited for the study and 4 of them were excluded for not meeting the inclusion criteria. One participant refused to participate in the study which led to the final sample size being 72 participants, equally randomized (n = 24) into groups: MIG, LIG, and CG group. Recruitment procedures were summarized in the study flow chart (Figure 1). One-way ANOVA showed no significant difference between the groups in age and BMI (Table I).

Functional Capacity Measurement

The 6 MWT and 1-min STS were used to measure the functional capacity; the baseline result revealed that there was no statistically significant difference between the three groups in STS (p-value = 0.34). There was a significant difference in the value of the baseline of 6 MWT between the groups with the control group being significantly higher than the LIG. After 10 weeks of exercise intervention, there was an improvement in 6 MWT for LIG and MIG and in STS for all groups (Table II). When comparing the value of 6 MWT and STS after 10 weeks between the groups, MIG showed significantly improvement than other groups while LIG showed a significantly higher value than CG in STS only. The magnitude of change showed a similar trend with significantly higher improvement for MIG than LIG and CG while LIG showed significant improvement in comparison to CG.

Post COVID-19 Functional Scale (PCFS)

Regarding the PCFS the three groups demonstrated statistically significant improvement after the end of the exercise training program when compared to baseline measurements ($p < 0.05$ – Table II). The value of PCFS score after 10 weeks showed a statistical difference between the groups. Post hoc comparison showed a significantly lower value for MIG compared to LIG and CG and for LIG compared to CG ($p < 0.05$ – Table III). The magnitude of change showed a significant difference between the group with ($p < 0.01$ – Table IV). The post hoc comparison showed a larger magnitude of change for MIG and LIG than CG ($p < 0.01$ – Table V).

Quality of Life (QOL)

Regarding the QOL subscales, 3 (bodily pain, social functioning, mental health) showed a significant difference between groups at the bassline ($p < 0.5$ – Table II). Post hoc analysis showed a significantly lower value for MIG compared to CG in BP, a lower value in SF for LIG compared to CG, and a significantly lower value in MH for CG compared to LIG and MIG (Table III). LIG and MIG showed significant im-

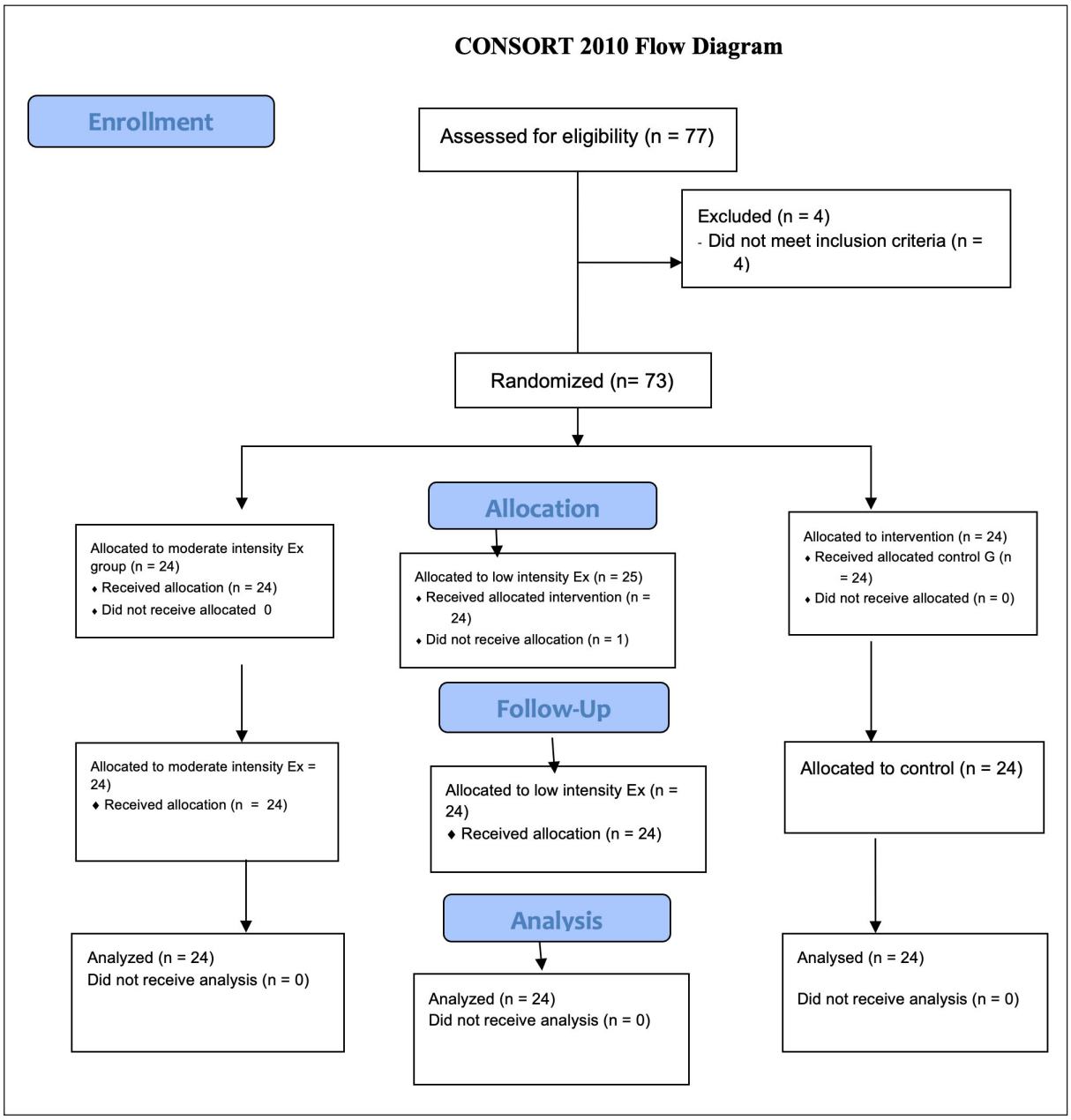

Figure 1. Flow diagram for recruitment procedures of participants.

provement after 10 weeks in all QOL subscales in comparison to their baseline (Table II). Only in general health, the CG showed significant improvement in comparison to the baseline. There was a significant difference in the magnitude of change between the groups in all QOL subscales ($p < 0.01$ – Table IV). Almost in all subscales MIG showed better improvement than LIG except in RF subscale. In all subscales of QOL, MIG and LIG showed significant improvement than CG ($p < 0.01$ – Table V).

Hamilton Anxiety and Depression Scale

There was no significant difference in anxiety and depression between the groups at the baseline. The within-group comparison showed significant improvement for all groups after 10 weeks compared to the baseline ($p < 0.01$ – Table IV). When comparing the value of anxiety and depression after 10 weeks between groups there was a significant difference. Post hoc analysis showed a lower value in depression and anxiety in MIG and LIG compared to CG ($p < 0.01$ – Table III). The mag-

Table I. Demographic and clinical characteristics of the patients enrolled in the study.

Characteristics	MIG (n = 24)	LIG (n = 24)	CG (n = 24)	*p*-value
Age, year	62.6 ± 5.01	62.5 ± 4.67	62.7 ± 4.3	0.73
Sex, M/F	11/13	12/12	8/16	0.68
BMI, Kg/m^2	24.07 ± 2.7	23.7 ± 2.4	23.02 ± 2.3	0.378
Levels of education, n (%)				
Without recognized education	6 (25)	8 (33.3)	3 (12.5)	
Primary to secondary school	13 (54)	9 (37.5)	10 (43.75)	
Higher education or more	5 (21)	7(29.1)	11 (37.5)	
Comorbidities distribution n (%)				
Heart disease	22 (90.2)	20 (82)	18 (73.8)	
Dyslipidemia	21 (86.1)	23 (94.3)	19 (77.9)	
Type 2 diabetes mellitus	19 (77.9)	21 (86.1)	20 (82)	
Cancer	4 (16.4)	2 (8.4)	2 (8.2)	
Chronic inflammatory lung disease	17 (69.7)	20 (82)	15 (61.5)	
Clinical course of COVID-19				
Mild illness	5 (20.5)	8 (32.8)	4 (16.4)	
Pneumonia	6 (24.6)	10 (41)	12 (49.2)	
Severe pneumonia	13 (53.3)	6 (24.6)	8 (32.8)	

N = Number; BMI = Body Mass Index; M/F = Male/Female.

nitude of change showed a significant difference between the groups with post hoc showing higher reduction for LIG and MIG in comparison to CG ($p < 0.01$ – Table V).

Discussion

This study was conducted to compare moderate and low-intensity exercise on the physical and psychological functions in addition to the quality of life of post-COVID-19 patients. Results demonstrated that a 10-week moderate-intensity and low-intensity exercise are effective in comparison to their baseline. The control group which received medical care and advice also showed some improvement in 4 out of 13 outcomes. Interestingly, moderate intensity group showed better results than the low-intensity group and the control group while the low-intensity group showed better improvement than the control group.

A study[27] published in 2020 reported that COVID-19 patients had reduced levels of physical function, muscle strength, and psychological well-being. According to more recent studies[28], these consequences persist even 6 months after discharge. Several studies now demonstrate that moderate-intensity aerobic exercise sessions of less than 60 minutes duration improve the immune system as well as physical capacity, which is crucial to the body's ability to defend itself[29,30].

It has been suggested[31,32] that moderate-intensity aerobic exercise can enhance older adults' resistance to upper respiratory tract infections and decrease the rate of infection and promote recovery from respiratory infections such as COVID-19 when compared to less active individuals. A 6 MWT is an important post-COVID-19 follow-up test because it correlates with acute disease severity and functional impairment in the chronic phase[33].

Our result demonstrated that a 10-week moderate-intensity exercise training program was more effective for improving functional capacity measured by 6 MWT, and STS (Tables II-III). The study done by López et al[34] show similar results, they observed significant improvement in 6 MWT, and STST[34]. The same findings were found by Lau et al[8] in post-SARS patients who trained aerobically. Additionally, the study conducted by Hasenoehrl et al[35] used supervised resistance plus aerobic exercise, two sessions per week for eight weeks provided to post-COVID-19 subjects. Both groups were significantly improved in their functional capacity which was measured by 30 sec STS and 6 MWT[35].

The possible cause of that improvement is because the post-COVID-19 syndrome shares similarities both in terms of symptoms and possible pathogenic mechanisms with many pathologies in which exercise is beneficial. It may have a potentially positive impact on their recovery and in-

Table II. Differences within each group (pre-treatment to post-treatment) and between groups at baseline and post-intervention.

Outcomes	Variables	MIG (n=24)	LIG (n = 24)	CG (n = 24)	*p*-value	F
6 MWT	Baseline	337.54 ± 14.29	333.58 ± 14.52	343.71 ± 11.66	**0.04**	3.40
	10-week	364.21± 12.74	348.29 ± 17.40	344.33 ± 11.42	**< 0.01**	13.38
	***p*-value**	**< 0.01**	**< 0.01**	0.368		
PCFS	Baseline	2.58 ± 12.74	2.75 ± 0.44	2.88 ± 0.34	0.07	2.74
	10-week	1.00 ± 0	1.38 ± 0.49	2.25 ± 0.74	**< 0.01**	37.59
	***p*-value**	**< 0.01**	**< 0.01**	**< 0.01**		
STS	Baseline	12.75 ± 1.39	13.33 ± 1.37	12.96 ± 1.37	0.34	1.11
	10-week	20.33 ± 1.01	19.00 ± 1.50	13.33 ± 1.49	**< 0.01**	180.61
	***p*-value**	**< 0.01**	**< 0.01**	**0.036**		
QOL-PF	Baseline	66.79 ± 1.67	67.21 ± 2.34	66.13 ± 2.25	0.21	1.61
	10-week	76.50 ± 2.80	70.79 ± 2.28	66.63 ± 2.24	**< 0.01**	97.93
	***p*-value**	**< 0.01**	**< 0.01**	0.117		
QOL-BP	Baseline	70.83 ± 3.84	68.71 ± 3.33	66.04 ± 4.27	**< 0.01**	9.42
	10-week	77.04 ± 3.65	72.46 ± 3.28	66.25 ± 4.41	**< 0.01**	48.51
	***p*-value**	**< 0.01**	**< 0.01**	0.458		
QOL-GH	Baseline	60.08 ± 4.70	60.75 ± 4.75	63.17 ± 4.37	0.06	2.97
	10-week	68.33 ± 4.66	64.75 ± 4.57	63.96 ±	**< 0.01**	7.02
	***p*-value**	**< 0.01**	**<0.01**	**0.027**		
QOL-RP	Baseline	63.13 ± 5.46	63.13 ± 5.66	64.38 ± 4.57	0.64	0.45
	10-week	68.92 ±4.45	66.54 ± 6.57	64.63 ± 4.61	**0.02**	3.95
	***p*-value**	**< 0.01**	**< 0.01**	0.388		
QOL-VT	Baseline	64.04 ± 4.90	65.29 ± 3.82	65.25 ± 4.76	0.56	0.59
	10-week	71.67 ± 3.67	69.38 ± 4.97	64.79 ± 5.85	**< 0.01**	12.20
	***p*-value**	**< 0.01**	**< 0.01**	0.435		
QOL-SF	Baseline	63.17 ± 3.61	64.04 ± 4.57	60.46 ± 3.90	**0.01**	5.11
	10-week	70.46 ± 3.86	68.00 ± 4.30	61.29 ± 3.18	**< 0.01**	37.25
	***p*-value**	**< 0.01**	**< 0.01**	0.067		
QOL-MH	Baseline	60.25 ± 5.85	58.79 ± 4.58	64.50 ± 6.41	**0.00**	6.58
	10-week	66.54 ± 4.26	62.75 ± 4.63	65.08 ± 6.32	**0.04**	3.31
	***p*-value**	**< 0.01**	**< 0.01**	0.065		
QOL-RE	Baseline	67.21 ± 3.74	66.00 ± 4.95	67.54 ± 4.60	0.46	0.79
	10-week	71.33 ± 3.29	69.92 ± 3.91	67.79 ± 4.20	**0.01**	5.22
	***p*-value**	**< 0.01**	**< 0.01**	0.479		
HADS-depression	Baseline	17.17 ± 1.58	17.92 ± 2.32	17.25 ± 1.45	0.30	1.22
	10-week	11.54 ± 1.02	12.38 ± 1.28	14.54 ± 1.56	**< 0.01**	33.79
	***p*-value**	**< 0.01**	**< 0.01**	**< 0.01**		
HADS-anxiety	Baseline	20.00 ± 1.44	20.17 ± 1.69	19.79 ± 1.93	0.75	0.29
	10-week	12.21 ± 1.22	12.71 ± 1.40	14.79 ± 2.57	**< 0.01**	13.47
	***p*-value**	**< 0.01**	**< 0.01**	**< 0.01**		

Bold = significant. 6 MWT = 6-minute walk test; PCFS= post-COVID-19 functional scale; STS= 1-min sit-to-stand; QOL-PF= Quality of life (SF-36) physical functioning domain; QOL-BP= Quality of life (SF-36) bodily pain domain; QOL-GH= Quality of life (SF-36) general health domain; QOL-RP = Quality of life (SF-36) physical role functioning domai, QOL-VT= Quality of life (SF-36) vitality domain; QOL-SF= Quality of life (SF-36) social role functioning domain; QOL-MH= Quality of life (SF-36) mental health domain; QOL-RE= Quality of life (SF-36) emotional role functioning domain; HADS-depression= Hamilton Anxiety and Depression Scale= degression domain; HADS-anxiety= Hamilton Anxiety and Depression Scale= anxiety domain; MIG= moderate-intensity aerobic group; LIG= low-intensity aerobic group; CG= control group; F= F-distribution (F-test); Sig.= Significant.

creases physical and functional performance, in addition to promoting an anti-inflammatory state on a systemic level[35,36].

Regarding quality of life, our study showed improvement in group A (moderate-intensity training) more than in group B (low-intensity training) only in

Table III. Pairwise comparison for between groups difference baseline and after 10 weeks.

Outcome	Comparison		Mean Difference	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
6 MWT baseline	MIG	LIG	3.96	0.57	-5.41	13.33
		CG	-6.17	0.26	-15.54	3.20
	LIG	CG	-10.13	**0.03**	-19.50	-0.75
6 MWT 10 weeks	MIG	LIG	15.92	**< 0.01**	6.17	25.66
		CG	19.88	**< 0.01**	10.13	29.62
	LIG	CG	3.96	0.60	-5.78	13.70
PCFS 10 weeks	MIG	LIG	-.38	**0.04**	-0.73	-0.02
		CG	-1.25	**< 0.01**	-1.60	-0.90
	LIG	CG	-.88	< 0.01	-1.23	-0.52
STS 10 weeks	MIG	LIG	1.33	**< 0.01**	0.40	2.27
		CG	7.00	**< 0.01**	6.06	7.94
	LIG	CG	5.67	**< 0.01**	4.73	6.60
QOL-PF 10 weeks	MIG	LIG	5.71	**< 0.01**	4.01	7.41
		CG	9.88	**< 0.01**	8.18	11.57
	LIG	CG	4.17	**< 0.01**	2.47	5.86
QOL-BP baseline	MIG	LIG	2.13	0.14	-0.52	4.77
		CG	4.79	**< 0.01**	2.14	7.44
	LIG	CG	2.67	0.05	0.02	5.32
QOL- BP 10 weeks	MIG	LIG	4.58	**< 0.01**	1.95	7.22
		CG	10.79	**< 0.01**	8.16	13.43
	LIG	CG	6.21	**< 0.01**	3.57	8.84
QOL-GH 10 weeks	MIG	LIG	3.58	**0.01**	0.60	6.56
		CG	4.38	**< 0.01**	1.39	7.36
	LIG	CG	0.79	0.80	-2.19	3.77
QOL-RP 10 weeks	MIG	LIG	2.38	0.27	-1.29	6.04
		CG	4.29	**0.02**	0.63	7.96
	LIG	CG	1.92	0.43	-1.75	5.58
QOL-VT 10 weeks	MIG	LIG	2.29	0.25	-1.10	5.69
		CG	6.88	**< 0.01**	3.48	10.27
	LIG	CG	4.58	**0.01**	1.19	7.98
QOL-SF baseline	MIG	LIG	-0.88	0.74	-3.67	1.92
		CG	2.71	0.06	-0.09	5.51
	LIG	CG	3.58	**0.01**	0.78	6.38
QOL-SF 10 weeks	MIG	LIG	2.46	0.07	-0.18	5.09
		CG	9.17	**0.00**	6.53	11.80
	LIG	CG	6.71	**0.00**	4.07	9.34
QOL-MH baseline	MIG	LIG	1.46	0.65	-2.46	5.37
		CG	-4.25	**0.03**	-8.17	-0.33
	LIG	CG	-5.71	**< 0.01**	-9.62	-1.79
QOL-MH 10 weeks	MIG	LIG	3.79	**0.03**	0.23	7.35
		CG	1.46	0.59	-2.10	5.02
	LIG	CG	-2.33	0.27	-5.89	1.23
QOL-R 10 weeks	MIG	LIG	1.42	0.41	-1.23	4.06
		CG	3.54	**0.01**	0.90	6.18
	LIG	CG	2.13	0.14	-0.52	4.77
HADS-depression 10 weeks	MIG	LIG	-0.83	0.08	-1.74	0.07
		CG	-3.00	**< 0.01**	-3.90	-2.10
	LIG	CG	-2.17	**< 0.01**	-3.07	-1.26
HADS-anxiety 10 weeks	MIG	LIG	-0.50	0.61	-1.76	0.76
		CG	-2.58	**< 0.01**	-3.85	-1.32
	LIG	CG	-2.08	**< 0.01**	-3.35	-0.82

Bold = significant.

Table IV. Comparison between the groups in the magnitude of change (pre and post 10 weeks).

Outcome/group	Mean	Std. Deviation	95% Confidence Interval for Mean		*p*-value
			Lower Bound	Upper Bound	
	MIG	26.67	13.21	21.09	32.24	
6 MWT	LIG	14.71	7.07	11.72	17.69	**< 0.01**
	CG	0.63	3.33	-0.78	2.03	
	MIG	-1.58	0.50	-1.80	-1.37	
PCFS	LIG	-1.38	0.65	-1.65	-1.10	**< 0.01**
	CG	-0.63	0.71	-0.93	-0.32	
	MIG	7.58	2.00	6.74	8.43	
STS	LIG	5.67	1.31	5.11	6.22	**< 0.01**
	CG	0.38	0.82	0.03	0.72	
	MIG	9.71	2.90	8.49	10.93	
QOL-PF	LIG	3.58	1.53	2.94	4.23	**< 0.01**
	CG	0.50	1.50	-0.13	1.13	
	MIG	6.21	1.18	5.71	6.71	
QOL-BP	LIG	3.75	2.79	2.57	4.93	**< 0.01**
	CG	0.21	1.35	-0.36	0.78	
	MIG	8.25	1.82	7.48	9.02	
QOL-GH	LIG	4.00	3.06	2.71	5.29	**< 0.01**
	CG	0.79	1.64	0.10	1.48	
	MIG	5.79	1.96	4.97	6.62	
QOL-RP	LIG	3.42	2.22	2.48	4.36	**< 0.01**
	CG	0.25	1.39	-0.34	0.84	
	MIG	7.63	3.28	6.24	9.01	
QOL-VT	LIG	4.08	2.64	2.97	5.20	**< 0.01**
	CG	-0.46	2.83	-1.65	0.74	
	MIG	7.29	2.53	6.22	8.36	
QOL-SF	LIG	3.96	1.92	3.15	4.77	**< 0.01**
	CG	0.83	2.12	-0.06	1.73	
	MIG	6.29	2.73	5.14	7.44	
QOL-MH	LIG	3.96	2.20	3.03	4.89	**< 0.01**
	CG	0.58	1.47	-0.04	1.20	
	MIG	4.13	1.57	3.46	4.79	
QOL-RE	LIG	3.92	4.00	2.23	5.61	**< 0.01**
	CG	0.25	1.70	-0.47	0.97	
	MIG	-5.63	1.66	-6.33	-4.92	
HADS-depression	LIG	-5.54	2.34	-6.53	-4.55	**< 0.01**
	CG	-2.71	1.40	-3.30	-2.12	
	MIG	-7.79	1.72	-8.52	-7.07	
HADS-anxiety	LIG	-7.46	2.11	-8.35	-6.57	**< 0.01**
	CG	-5.00	2.21	-5.93	-4.07	

Bold = significant. Std. Deviation= standard deviation.

the following domain of the health-related quality of life questionnaire (SF-36) (QOL-physical function $p = 0.000$, QOL-body pain $p = 0.001$, QOL-general health $p = 0.01$, and QOL- social functioning $p = 0.032$). Similar results were reported by Lau et al[8] where the health-related quality of life (physical, emotional, and social functioning) of post-SARS patients improved over the 6 weeks regardless of the exercise program, but the improvement was not statistically significant in comparison to the control group. A direct comparison cannot be made, however. The results of some domains appeared to be linked with some factors like

Table V. Pairwise comparison for the magnitude of change.

Outcome	Comparison		Mean Difference	*p*-value	95% Confidence Interval	
					Lower Bound	Upper Bound
6 MWT	MIG	LIG	11.96	**< 0.01**	5.83	18.08
		CG	26.04	**< 0.01**	19.92	32.17
	LIG	CG	14.08	**< 0.01**	7.96	20.21
PCFS	MIG	LIG	-0.21	0.49	-0.64	0.22
		CG	-.96	**< 0.01**	-1.39	-0.53
	LIG	CG	-.75	**< 0.01**	-1.18	-0.32
STS	MIG	LIG	1.92	**< 0.01**	0.91	2.93
		CG	7.21	**< 0.01**	6.20	8.22
	LIG	CG	5.29	**< 0.01**	4.28	6.30
QOL-PF	MIG	LIG	6.13	**< 0.01**	4.69	7.56
		CG	9.21	**< 0.01**	7.77	10.65
	LIG	CG	3.08	**< 0.01**	1.64	4.52
QOL-pain	MIG	LIG	2.46	**< 0.01**	1.14	3.78
		CG	6.00	**< 0.01**	4.68	7.32
	LIG	CG	3.54	**< 0.01**	2.22	4.86
QOL-GH	MIG	LIG	4.25	**< 0.01**	2.68	5.82
		CG	7.46	**< 0.01**	5.89	9.03
	LIG	CG	3.21	**< 0.01**	1.64	4.78
QOL-RP	MIG	LIG	2.38	**< 0.01**	1.07	3.68
		CG	5.54	**< 0.01**	4.24	6.85
	LIG	CG	3.17	**< 0.01**	1.86	4.47
QOL-VT	MIG	LIG	3.54	**< 0.01**	1.52	5.57
		CG	8.08	**< 0.01**	6.06	10.11
	LIG	CG	4.54	**< 0.01**	2.52	6.57
QOL-SF	MIG	LIG	3.33	**< 0.01**	1.81	4.86
		CG	6.46	**< 0.01**	4.93	7.98
	LIG	CG	3.13	**< 0.01**	1.60	4.65
QOL-MH	MIG	LIG	2.33	**< 0.01**	0.82	3.85
		CG	5.71	**< 0.01**	4.19	7.22
	LIG	CG	3.38	**< 0.01**	1.86	4.89
QOL-RE	MIG	LIG	0.21	0.96	-1.64	2.05
		CG	3.88	**< 0.01**	2.03	5.72
	LIG	CG	3.67	**< 0.01**	1.82	5.51
HADS-depression	MIG	LIG	-0.08	0.99	-1.36	1.19
		CG	-2.92	**< 0.01**	-4.19	-1.64
	LIG	CG	-2.83	**< 0.01**	-4.11	-1.56
HADS-anxiety	MIG	LIG	-0.33	0.84	-1.73	1.06
		CG	-2.79	**< 0.01**	-4.19	-1.39
	LIG	CG	-2.46	**< 0.01**	-3.86	-1.06

Bold = significant.

age and sex. For example, the physical, general health, and mental health of older patients were generally lower than those of younger patients[8,37].

This is in line with the findings of Liu et al[38] who found that six weeks of respiratory rehabilitation significantly improved the quality of life in elderly patients with COVID-19[38].

Depression and anxiety are more prevalent after isolation treatment for COVID-19 patients[39]. Regarding psychological status measurement (HAM-DRS HAM-ARS) results revealed improvement in both study groups post-intervention with no significant difference between the exercise groups (LIG and MIG) which indicates

the equal effect of both types of exercises on psychological status (Table IV). A previous study[38] showed that a 6-week respiratory rehabilitation program significantly reduced anxiety levels in elderly patients with COVID-19, as well as significantly improved functional ability which agrees with the current study.

According to López et al[34] study, there is no improvement in the anxiety and depression scale with the concurrent use of strengthening exercises with aerobic. Using a shorter period of treatment (8 weeks) and a different treatment regime could be one of the causes to have contradicting results. Liu et al[38] found a significant improvement in anxiety but not in depression in comparison to the baseline and control group. However, a direct comparison can not be made since different outcomes and interventions (respiratory exercise) were used. A previous narrative review[40] showed that exercise can help to enhance anxiety and depression by regulating neurogenesis, neurotransmitter, cerebral blood flow, and neurotrophic factors.

Clinical Implications

The current study can clinically help in improving the exercise capacity, quality of life, and psychological status of post-discharge COVID-19 older patients which can lead to a decrease in the cost of hospitalization. It also helps to emphasize the effectiveness of presented COVID-19 exercise programs[41-45].

Limitations

Our study had some limitations, it is necessary to confirm these findings with a larger sample size. Additionally, future research should address the possibility of placebo effects contributing to the changes observed in our study. Although we found our intervention to be effective and consistent with our objectives, further research is necessary to reach definitive conclusions.

Conclusions

The current study has shown that both low and moderate-intensity aerobic exercises can help improve exercise capacity, quality of life, and psychological status after COVID-19. Interestingly, moderate-intensity aerobic exercise appeared to be superior to low-intensity aerobic exercise in most outcomes. Further future studies are required to support the findings and investigate longer treatment periods.

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Ethics Approval

This study was conducted following the guidelines of the Helsinki Declaration and was granted from the research Ethical Committee of the University of Hail dated 13/12/2021 (H-2021-236) through research project No. (RG-21058).

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Authors' Contributions

Ahmed Abdelmoniem Ibrahim, Hisham M. Hussein, and Raheela Kanwal contributed substantially to the concept and design of the study. Tolgahan Acar, Mohammad Shahid Ali, and Daria Hussain Shaik performed data collection. Omar W Althomali and Wael Alghamdi were responsible for the interpretation, drafting, and validation of the article. All authors gave their final approval of the version of the article to be published.

Conflict of Interest

The authors declare that they have no conflict of interest to declare.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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