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Lower-limb resistive versus aerobic training impact on quality of life in post-COVID-19 patients

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Abstract

Objective

To determine the effect of lower-limb resistive versus aerobic training impact on quality of life (QOL) in post-COVID-19 patients.

Participants and methods

Sixty young volunteer patients participated in this study and randomly divided into two equal groups: group A that received an aerobic exercise program three times per week, group B, which received lower-body-resistance exercises. Both groups were evaluated before and after therapy (6 weeks) through measuring resting heart rate (RHR), peak heart rate (PHR), neutrophil/lymphocyte ratio, one-repetition maximum (1-RM) of selected muscle groups, and QOL assessment using the Short-Form (SF-12) Health Survey Questionnaire.

Results

The results revealed a statistical significant decrease ($P < 0.05$) in RHR, PHR, with a statistical significant increase ($P < 0.05$) in 1-RM for (hip flexors and abductors), and SF-12 Health Survey Questionnaire (physical and mental) within each group, on the other side, there was a statistically nonsignificant difference ($P > 0.05$) in neutrophils/lymphocytes ratio within both groups. Comparing between groups A and B at the end of the study, there was a statistically significant increase in 1-RM for (hip flexors and abductors) in favor of group B. On the other side, there was not a statistically significant difference between them in RHR, PHR, and SF-12 Health Survey Questionnaire (physical and mental).

Conclusion

According to the findings of this study, both aerobic exercise and resistance-training interventions are effective in improving the QOL in post-coronavirus disease 2019 patients, but aerobic training is more effective in decreasing RHR and PHR, in comparison with resistance training, which is more effective in improving muscle strength (1-RM).

Keywords: Aerobic exercise, coronavirus, post-COVID-19, quality of life, resistance training

Introduction

The coronavirus disease 2019 (COVID-19) is referred as newfound COVID-2019 by the WHO. It is an infection of the respiratory tract arising from SARS-COV-2, a coronavirus. COVID-19 first featured in the late December 2019 in Wuhan province of China [1].

The infection spreads through droplets from individuals by coughing or sneezing. Patients can still be infectious as far as the symptoms persist, as well as during clinical recovery [2].

With respect to virology, there is incremental understanding of the SARS-CoV-2 epidemiology, in addition to clinical management. However, there are no drugs to treat against SARS-CoV-2 that havs been officially permitted as a result of a lack of sufficient evidence [3].

COVID-19 is a seriously infectious lung-infection syndrome that provokes respiratory, psychological, and physical

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impairment in the affected patients. Due to the fact that COVID-19 is seriously a highly infectious disease, patients are isolated to restrict the extent of SARS-CoV-2. That way, it leads to a significant decrease in social interactions, which drives patients to feel lonely and also isolated [4,5].

This infection extends via droplets by coughing or sneezing. Patients can still be infectious to the extent that the symptoms continue and even during the clinical recovery. This viral infection spreads via inhaling these particles, as well as by touching the mouth, nose, and eyes following contact with any contaminated surface [2].

COVID-19 has eventually proven more fatal, such as it has globally spread to many more individuals than did the remaining viruses, owing to quick human-to-human transmission and uncharacteristic symptoms at a primitive stage in particular patients [6,7].

Infected people who are asymptomatic are thought to play a significant role in the current pandemic, but their relative impact and number are unknown [8].

The predominant symptoms are cough, fever, headache, sore throat, dyspnea, rhinorrhea, and sputum production. Pneumonia emerges to be the extremely frequent severe manifestation of the infection, which was characterized mainly by cough, dyspnea, fever, and bilateral infiltrates on chest imaging [9]. Accompanied by respiratory symptoms, gastrointestinal symptoms (e.g. diarrhea and nausea) have additionally been reported [9]. Neurological signs and symptoms also have been detected in patients with COVID-19 [10].

Scientists all over the world now are developing several potential vaccines to deal with COVID-19. These vaccines are totally designed to teach the immune system of the body to safely identify and hinder the virus that leads to COVID-19. Numerous different types of promising vaccines for COVID-19 are now in development, including

(1) Weakened or inactivated virus vaccines that use a form of the virus that has been weakened or inactivated, accordingly it does not induce the disease, but still yields an immune response.
(2) Protein-based vaccines that use harmless protein fragments or protein shells that imitate the COVID-19 virus to produce an immune response safely.
(3) Viral vector vaccines that use a safe virus that cannot induce the disease but functions as a platform to yield coronavirus proteins to produce an immune response.
(4) DNA and RNA vaccines: a cutting-edge methodology that uses a genetically engineered DNA or RNA to generate a protein that itself safely provokes an immune response [11].

There is a rising number of patients suffering from long-term symptoms post-COVID infection, which was called 'long hauler' as symptoms of post-COVID or COVID-19 syndrome [12,13].

These patients additionally have symptoms related to other different organs that had been already affected by the COVID-19 virus or any other symptoms with no injury to the organs. The most frequent symptoms are fatigue, noticed in further than half of patients, as well as cognitive dysfunction, noticed in one-third of patients [14].

The symptoms produce disruption of social life at work and at home, that is, they have disorders in participation and activity [15].

Although not much is known about the COVID-19 long-lasting physical consequences, patients who require mechanical ventilation in the critical acute stage of disease can experience critical side effects, causing the known as post-intensive-care syndrome that affects the COVID-19 survivors of all ages. That post-intensive-care syndrome is mainly characterized by long-lasting disability, associated with fatigue, pain, muscle dysfunction, and dyspnea as secondary effects [16].

Physical activity can improve the strength and endurance of the respiratory and breathing muscles, improving them to be more efficient [17]. Exercise training (ET) enhances the 'health-related-quality-of-life' (HR-QOL) in many patient people. That also boosts and strengthens the immune reaction to viral antigens, reducing the viral infection incidence throughout the lifespan [18].

Muscle weakness is common in patients, and aerobic exercise (AE) has a slight effect on this problem. Various studies proved that not only can resistance training improve muscle strength and QOL, but it can also improve exercise capacity [19]. Strength-training techniques that are commonly used include free weights (e.g. dumbbells, weightlifting, and lead balls) or training with machines for legs and arms [20]. We should encourage patients to perform multijoint exercises in their daily activities. Furthermore, single-joint exercise may be necessary to correct muscular imbalances and strengthen lumbar extensors [21]. Regular training gives beneficial properties on the heart in addition to the entire body. This happens partly as ET improves the work capacity of skeletal muscle and reduces resistance, accordingly it increases the peripheral circulation conductance. Cardiac external modification changes and enhances the ability of the heart's autopump [22].

Patients, materials, and methods

Sixty young adult volunteer patients with a past history of COVID-19, their age ranged from 18 to 35 years, their BMI was less than 35 kg/m^2 referred, and they were selected from the outpatient clinic and the Emergency Department of Al-Mataria Teaching Hospital. They were subdivided into two groups equal in numbers: group A received an AE program in the form of cycle ergometer protocols for 6 weeks and group B received lower-body resistance training using free weights for 6 weeks.

Inclusion criteria

All volunteers with a past history of COVID-19 with mild-to-moderate symptoms and after recovery, their age ranged between 18 and 35 years old (young adults), their oxygen saturation at room air was more than 90%. Their BMI was less than 35 kg/m^2, their sex, male and female patients.

Exclusion criteria

Lack of patient's informed consent, patients with severe symptoms, fever more than 38°, obese patients with BMI more than or equal to 35 kg/m^2, patients with orthopedic or neurological limitations to exercise, patients with multiple comorbidities, patients with past history of pulmonary diseases, and patients with any pathological conditions, such as cardiovascular diseases or hypertension.

Informed consent form was signed by each patient in both groups (A and B). This study was approved by the Ethical Committee of Faculty of Physical Therapy, Cairo University (NO.): P.T.REC/012/002979-(10/11/2020).

Instrumentation

Evaluative equipment

(1) Fingertip pulse oximeter: it was used to assess each patient's oxygen saturation and heart rate for all volunteers in both groups (A and B).
(2) Weight/height scale: It was used to measure the weight and the height of all volunteers in both groups (A and B) to calculate their BMI.
(3) Cycle ergometer (bicycle):
It was used to measure peak heart rate (PHR) from the self-paced graded-exercise testing for each patient required to calculate the target heart rate and prescription of AE program intensity.
(4) Free weights: it was used to evaluate one-repetition maximum (1-RM) for each selected muscle group in both groups (A and B).
(5) The 12-item Short-Form Health Survey (SF-12) Questionnaire: it was used to assess the HR-QOL before and after the study in both groups (A and B).
(6) Blood levels of neutrophils and lymphocytes to detect the neutrophil/lymphocyte ratio (NLR) were measured by using Automated Hematology Analyzer XS series with model number 28B2X100700099, which was made in Japan.

Treatment equipment

(1) Cycle ergometer (bicycle): cycle ergometer was used for AE program application. Its model was 955 Ergo Cycle (stationary bicycle–upright bike).
(2) Free weights: free weights such as dumbbells, sand bags, or any weight can be picked up and moved around to exercise muscles. There were weights in the form of 0.5, 1, 2, 3, 4, and 5 kg.

Procedures of the study

The evaluative procedures

(1) A comprehensive medical history was obtained and recorded in the datasheet for both groups (A and B).
(2) Each patient in both groups (A and B) had their weight and height measured at the start while wearing light clothing and bare feet. BMI was calculated.
(3) The SF-12 Health Survey Questionnaire was used to evaluate the HR-QOL before and after the interventions.
(4) The blood samples were collected before and after the study to measure neutrophils and lymphocytes to detect the NLR.
(5) Self-paced graded exercise testing: this test was done by using a bicycle to measure the PHR for each patient required for calculating the target heart rate and prescription of AE intensity.
(6) 1-RM: it was tested for each muscle group involved in the study for calculating the load and prescription of resistance-training intensity.

Therapeutic procedures

(1) AE (group A):
Patients in group A were given an aerobic program in the form of cycle ergometer protocols for 40 min, which included low-intensity warming-up exercises for 10 min prior to training and a 5–10-min cooldown after training. For 6 weeks, the exercise was done three times a week (on different days) at a moderate effort of 65–75% PHR.
(2) Resistance training (group B):
Patients in group B were trained in lower-body-resistance exercises using free weights (e.g., weight lifting, sand bags). For 6 weeks, the training consisted of three sessions per week (alternating days). Patients began gradual training in the sessions with one set of exercise for a maximum of three sets and 10–15 repetitions at 70% of 1-RM.

Statistical analysis

For the collected data, descriptive statistics was used to calculate the means and SD. The data will be analyzed using inferential statistical analysis; the independent *t* test will be used to compare the mean values of the two groups before and after the end of the interventions, and the dependent *t* test will be used to analyze the within-group changes after the intervention. All statistical tests in this study were conducted with a significance level of *P* value less than 0.05. All statistical calculations were done using the statistical package for the social sciences (SPSS) computer program (IBM Corp, SPSS Statistics Company, Chicago, U.S.A).

Results

Resting heart rate and peak heart rate

In group A (aerobic training): as shown in Table 1 and Fig. 1, the means of posttreatment resting heart rate (RHR) and PHR were 73.4 and 101.53 showing significant changes ($t = 15.42$ and 18.7 and $P < 0.01$) at posttreatment with percentage of changes = 8.9 and 12.1% for RHR and PHR in order.

While in group B (resistance training): as shown in Table 2 and Fig. 2, the means of posttreatment RHR and PHR were 75.47 and 103.27 showing significant changes ($t = 10.53$ and 19.83 and $P < 0.01$) at posttreatment with percentage of changes = 3.8 and 8.6% for RHR and PHR in order.

Comparison between groups (RHR): as shown in Table 3 and Fig. 3, the independent *t* test showed no significant

Table 1: Mean±SD of resting heart rate and peak heart rate of group A

Group A	RHR (b/m)		PHR (b/m)	
	Pretreatment	Posttreatment	Pretreatment	Posttreatment
Means±SD	80.63±4.9	73.4±3.9	115.5±5.9	101.53±5.1
MD	7.2		13.97	
% of changes	8.9		12.1	
DF	29		29	
t	15.42		18.7	
P	<0.01		<0.01	
S	S		S	

PHR, peak heart rate; RHR, resting heart rate.

Table 2: Mean±SD of resting heart rate and peak heart rate of group B

Group B	RHR (b/m)		PHR (b/m)	
	Pretreatment	Posttreatment	Pretreatment	Posttreatment
Means±SD	78.43±5.06	75.47±4.38	112.9±5.96	103.27±5.97
MD	2.97		9.7	
% of changes	3.8		8.6	
DF	29		29	
t	10.53		19.83	
P	<0.01		<0.01	
S	S		S	

PHR, peak heart rate; RHR, resting heart rate.

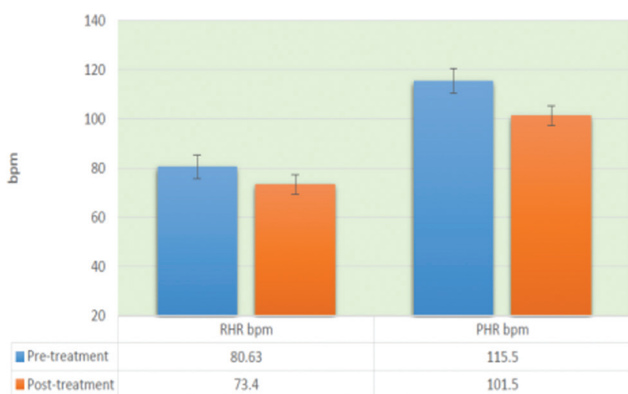

Figure 1: Mean values of RHR and PHR of group A. PHR, peak heart rate; RHR, resting heart rate.

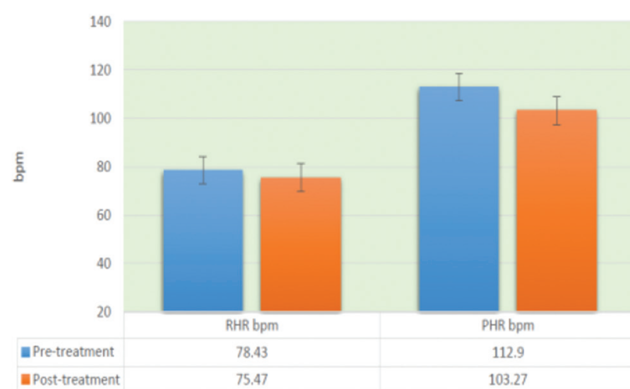

Figure 2: Mean values of RHR and PHR of group B. PHR, peak heart rate; RHR, resting heart rate.

changes (t = 1.703 and P = 0.94) in pretreatment values. Also, there were nonsignificant changes in the posttreatment values (t = 1.939 and P = 0.57).

Comparison between groups (PHR): as shown in Table 4 and Fig. 4, the independent t test showed no significant changes (t = 1.667 and P = 0.101) in pretreatment values. Also, there were nonsignificant changes in the posttreatment values (t = 1.209 and P = 0.232).

Blood neutrophils/lymphocyte ratio

In group A (aerobic training): as shown in Table 5 and Fig. 5, the mean of pretreatment neutrophil/lymphocyte level was 1.78 and posttreatment was 1.68 that shows nonsignificant changes (t = 1.186 and P = 0.245).

While in group B (resistance training): as shown in Table 6 and Fig. 6, the mean of pretreatment neutrophil/lymphocyte level was 1.7 and posttreatment was 1.73 that shows nonsignificant changes (t = 0.213 and P = 0.832).

Comparison between groups: as shown in Table 7 and Fig. 7, the independent t test showed no significant changes (t = 0.242 and P = 0.810) in pretreatment values. Also, there were nonsignificant changes in the posttreatment values (t=−0.378 and P = 0.707).

One-repetition maximum for hip flexors and abductors

In group A (aerobic training): as shown in Table 8 and Fig. 8, the mean values of pretreatment 1-RM for hip flexors and abductors were 3.47 and 3.3 and posttreatment were 3.9 and

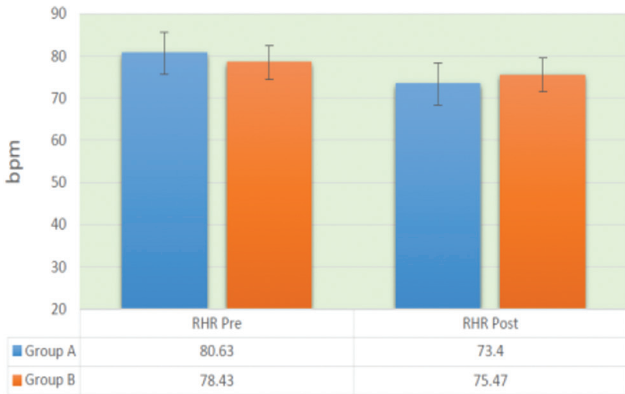

Figure 3: Mean values of RHR of both groups. RHR, resting heart rate.

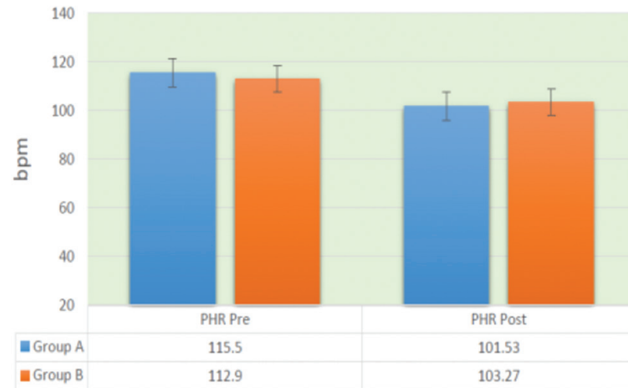

Figure 4: Mean values of PHR of both groups. PHR, peak heart rate.

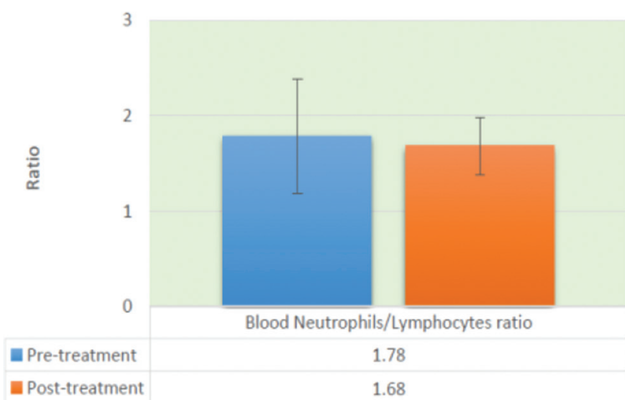

Figure 5: Mean values of neutrophils/lymphocytes of group A.

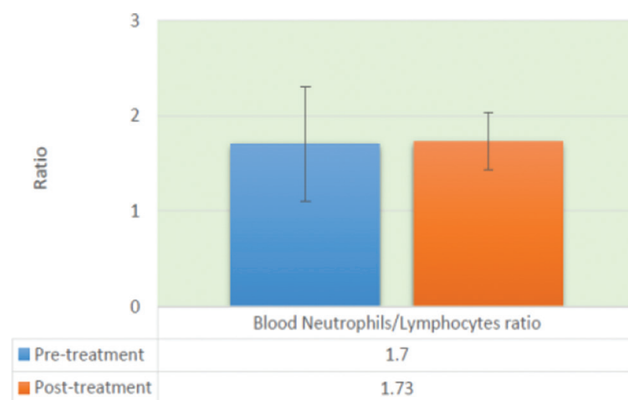

Figure 6: Mean values of neutrophils/lymphocytes of group B.

Table 3: Comparing of resting heart rate between both groups

Independent *t* test	RHR (b/m)			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	80.63±4.9	78.43±5.06	73.4±3.9	75.47±4.38
MD	2.2		2.067	
t	1.703		1.939	
P	0.94		0.57	
S	NS		NS	

RHR, resting heart rate.

Table 4: Comparing of peak heart rate between both groups

Independent *t* test	PHR (b/m)			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	115.5±5.9	112.9±5.96	101.53±5.1	103.27±5.97
MD	2.57		1.73	
t	1.667		1.209	
P	0.101		0.232	
S	NS		NS	

PHR, peak heart rate.

3.8 that show significant increases ($t = 9.355$ and 9.327 and $P < 0.01$) in order with percentage of changes = 12.4 and 15% in order.

While in group B (resistance training): as shown in Table 9 and Fig. 9, the mean values of pretreatment 1-RM for hip flexors and abductors were 3.6 and 3.58 and posttreatment were 5.1 and 4.98 that show significant increases ($t = 20.15$ and 23.08 and $P < 0.01$) in order with percentage of changes = 40.2 and 39.1% in order.

Comparison between groups (hip flexors): as shown in Table 10 and Fig. 10, the independent *t* test showed no significant changes ($t = 0.638$ and $P = 0.526$) in pretreatment values. But there were significant changes in the posttreatment values ($t = 4.516$ and $P < 0.01$) in favor of group B.

While comparison between groups (hip abductors): as shown in Table 11 and Fig. 11, the independent *t* test showed no significant changes ($t = 1.210$ and $P = 0.231$) in pretreatment values. But, there were significant changes in the posttreatment values ($t = 4.968$ and $P < 0.01$) in favor of group B.

Short-Form-12 Health Survey Questionnaire

Physical: in group A (aerobic training): as shown in Table 12 and Fig. 12, the mean of pretreatment SF-12 physical score was 35.4 and posttreatment was 88.8 that shows

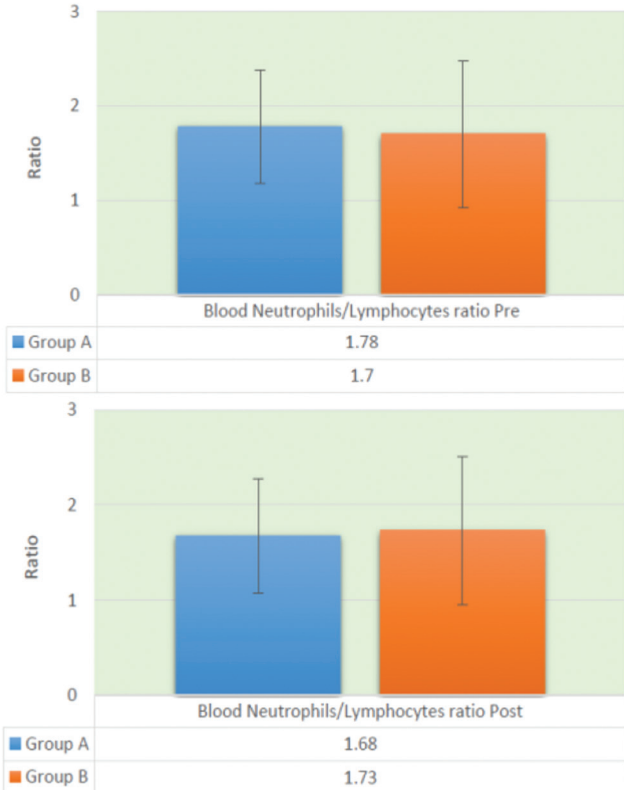

Figure 7: Mean values of neutrophils/lymphocytes of both groups.

Table 5: Mean±SD of neutrophils/lymphocytes of group A

Group A	Neutrophils/lymphocytes	
	Pretreatment	Posttreatment
Means±SD	1.78±0.6	1.68±0.3
MD	0.1	
DF	29	
t	1.186	
P	0.245	
S	NS	

Table 6: Mean±SD of neutrophils/lymphocytes of group B

Group B	Neutrophils/lymphocytes	
	Pretreatment	Posttreatment
Means±SD	1.7±0.78	1.73±0.54
MD	0.15	
DF	29	
t	0.213	
P	0.832	
S	NS	

significant increases ($t = 26.29$ and $P < 0.01$) at posttreatment with percentage of changes = 152%.

While in group B (resistance training): as shown in Table 13 and Fig. 13, the mean of pretreatment SF-12 physical score was 37.97 and posttreatment was 81.3 that shows

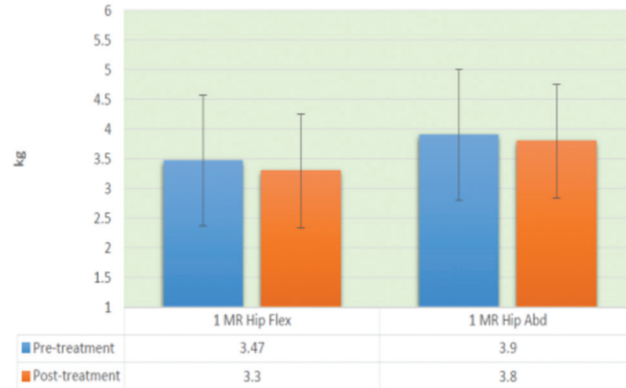

Figure 8: Mean values of 1-RM for hip flexors and abductors of group A. 1-RM, one-repetition maximum.

significant increases ($t = 12.92$ and $P < 0.01$) at posttreatment with percentage of changes = 114%.

Comparison between groups: as shown in Table 14 and Fig. 14, the independent *t* test showed no significant changes ($t = 0.762$ and $P = 0.449$) in pretreatment values. But, there were significant changes in the posttreatment values ($t = 2.623$ and $P = 0.011$) in favor of group A.

Mental: in group A (aerobic training): as shown in Table 15 and Fig. 15, the mean of pretreatment SF-12 mental score was 36.5 and posttreatment was 85.3 that shows significant increases ($t = 20.57$ and $P < 0.01$) at posttreatment with percentage of changes = 133.6%.

While in group B (resistance training): as shown in Table 16 and Fig. 16, the mean of pretreatment SF-12 mental score was 40.18 and posttreatment was 81.6 that shows significant increases ($t = 19.75$ and $P < 0.01$) at posttreatment with percentage of changes = 102.5%.

Comparison between groups: as shown in Table 17 and Fig. 17, the independent *t* test showed no significant changes ($t = 1.119$ and $P = 0.268$) in pretreatment values. Also, there were no significant changes in the posttreatment values ($t = 1.819$ and $P = 0.074$).

Discussion

This study was conducted to determine the effect of lower-limb resistive versus aerobic training impact on the QOL in post-COVID-19 patients.

In both groups (A and B), there were statistically significant decreases in RHR, PHR, with a statistically significant increase in 1-RM for (hip flexors and abductors), and SF-12 Health Survey Questionnaire (physical and mental) with no significant difference in NLR.

Comparison between both groups (A and B): Before starting, there was not a statistically significant difference between them at all measured parameters. At the end of the study, there was a statistically significant increase in 1-RM for (hip flexors and abductors) in favor of group B. On the other side, there was not a statistically significant difference between them in RHR, PHR, and SF-12 Health Survey Questionnaire (physical and mental).

So, in addition, this study comes along with da Silveira *et al.* [23], who studied 'the physical exercise as a tool to help the immune system against COVID-19' and showed that physical activity reinforces the immune system, suggesting a benefit in response to viral infectious diseases. Accordingly, consistent training of tolerable intensity is recommended as a supplementary tool in strengthening and organizing the resistance of the immune system against COVID-19.

Also, this study outcomes in conformity with Mohamed and Alawna [24], who studied 'the role of increasing the aerobic capacity on improving the function of immune and respiratory systems in patients with coronavirus (COVID-19)' and reported that improving aerobic capacity is indicated because it has the potential to improve respiratory and immunological systems, which could help with COVID-19 prevention. COVID-19 morbidity and mortality rates could be reduced as a result of this. Furthermore, increasing people's aerobic capacity during the lockdown period is strongly advised in order to reduce COVID-19 risk factors and increase respiratory and immune system performance in the face of COVID-19 to allow for greater body functioning. As a result, patients with mild pulmonary symptoms and all people should adhere to a routine of 10–30 min of mild-to-moderate AE performance.

In addition, this study showed a significant decrease in RHR and PHR, this decrease comes in coordination with Reimers *et al.* [25], who studied the effects of exercise on the RHR and concluded that exercise – especially AE and yoga—decreases

Table 7: Comparing of neutrophils/lymphocytes between both groups

Independent *t* test	Blood neutrophil/lymphocyte level			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	1.78±0.6	1.7±0.78	1.68±0.3	1.73±0.54
MD	0.08		−0.05	
t	0.242		−0.378	
P	0.810		0.707	
S	NS		NS	

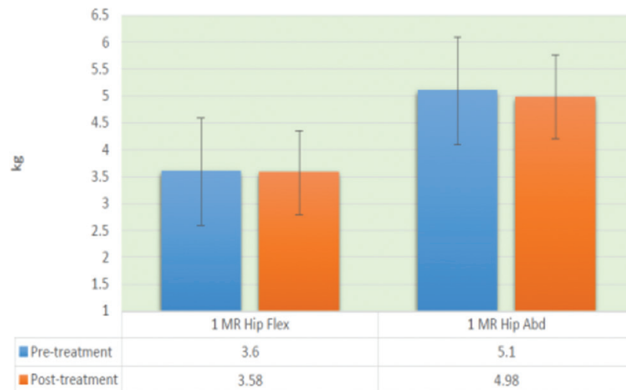

Figure 9: Mean values of 1-RM for hip flexors and abductors of group B. 1-RM, one-repetition maximum.

Table 8: Mean±SD of one-repetition maximum for hip flexors and abductors of group A

Group A	1-RM for hip flexors		1-RM for hip abductors	
	Pretreatment	Posttreatment	Pretreatment	Posttreatment
Means±SD	3.47±1.13	3.9±1.1	3.3±0.9	3.8±0.98
MD	0.43		0.5	
% of changes	12.4		15	
DF	29		29	
t	9.355		9.327	
P	<0.01		<0.01	
S	S		S	

1-RM, one-repetition maximum.

Table 9: Mean±SD of one-repetition maximum for hip flexors and abductors of group B

Group B	1-RM for hip flexors		1-RM for hip abductors	
	Pretreatment	Posttreatment	Pretreatment	Posttreatment
Means±SD	3.6±0.89	5.1±0.92	3.58±0.78	4.98±0.84
MD	1.45		1.4	
% of changes	40.2		39.1	
DF	29		29	
t	20.15		23.08	
P	<0.01		<0.01	
S	S		S	

1-RM, one-repetition maximum.

Table 10: Comparing of one-repetition maximum for hip flexors between both groups

Independent *t* test	1-RM for hip flexors			
	Pretreatment		Posttreatment	
Group	Group A	Group B	Group A	Group B
Means±SD	3.47±1.13	3.6±0.89	3.9±1.1	5.1±0.92
MD	0.17		1.18	
t	0.638		4.516	
P	0.526		<0.01	
S	NS		S	

1-RM, one-repetition maximum

Table 11: Comparing of one-repetition maximum for hip abductors between both groups

Independent *t* test	1-RM for hip abductors			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	3.3±0.9	3.58±0.78	3.8±0.98	4.98±0.84
MD	0.27		1.17	
t	1.210		4.968	
P	0.231		<0.01	
S	NS		S	

1-RM, one-repetition maximum.

Table 12: Mean±SD of Short-Form-12 physical score of group A

Group A	Short-Form-12 physical scores	
	Pretreatment	Posttreatment
Means±SD	35.4±12.04	88.8±8.6
MD	53.38	
% of changes	152	
DF	29	
t	26.29	
P	<0.01	
S	S	

Table 13: Mean±SD of Short-Form-12 physical score of group B

Group B	Short-Form-12 physical scores	
	Pretreatment	Posttreatment
Means±SD	37.97±14.14	81.3±13.02
MD	43.3	
% of changes	114	
DF	29	
t	12.92	
P	<0.01	
S	S	

RHR. This effect may assist in a decrease in all-cause mortality as a result of regular exercise or sports.

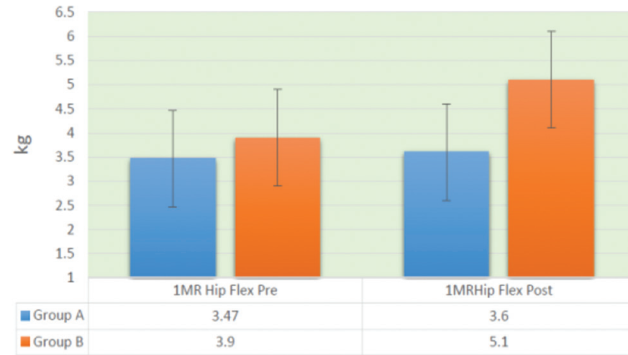

Figure 10: Mean values of 1-RM for hip flexors of both groups. 1-RM, one-repetition maximum.

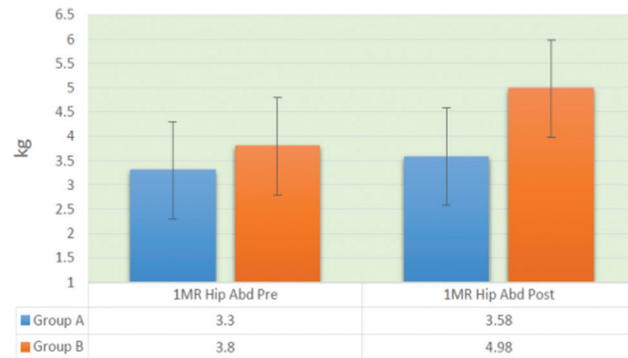

Figure 11: Mean values of 1-RM for hip abductors of both groups. 1-RM, one-repetition maximum.

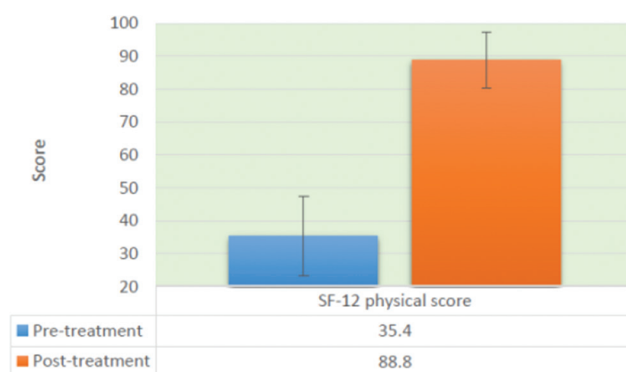

Figure 12: Mean values of SF-12 physical score of group A. SF-12, Short-Form-12.

Also, this study showed a significant increase in 1-RM and SF-12 Health Survey Questionnaire (physical and mental), this increases was in accordance with Giuliano *et al.* [26], who studied 'the effects of resistance training on muscle strength, QOL and aerobic capacity in patients with chronic heart failure' and concluded that individual interventions such as resistance training can improve muscle strength, aerobic capacity, and HR-QOL in patients with chronic heart failure and may offer an alternate methodology, mainly for those who are unable to contribute to AE. The resistance training outcome on muscle

Table 14: Comparing of Short-Form-12 physical score between both groups

Independent *t* test	Short-Form-12 physical scores			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	35.4±12.04	37.97±14.14	88.8±8.6	81.3±13.02
MD	2.58		7.47	
t	0.762		2.623	
P	0.449		0.011	
S	NS		S	

Table 15: Mean±SD of Short-Form-12 mental scores of group A

Group A	Short-Form-12 mental scores	
	Pretreatment	Posttreatment
Means±SD	36.5±12.3	85.3±8.1
MD	48.79	
% of changes	133.6	
DF	29	
t	20.57	
P	<0.01	
S	S	

Table 16: Mean±SD of Short-Form-12 mental scores of group B

Group B	SF-12 mental scores	
	Pretreatment	Posttreatment
Means±SD	40.18±12.9	81.6±7.7
MD	41.42	
% of changes	102.5	
DF	29	
t	19.75	
P	<0.01	
S	S	

Table 17: Comparing of Short-Form-12 mental scores between both groups

Independent *t* test	Short-Form-12 mental score			
	Pretreatment		Posttreatment	
Groups	Group A	Group B	Group A	Group B
Means±SD	36.5±12.3	40.18±12.9	85.3±8.1	81.6±7.7
MD	3.257		3.727	
t	1.119		1.819	
P	0.268		0.074	
S	NS		NS	

strength is most pronounced throughout slow-organized movements, rather than throughout rapid movements.

Furthermore, the outcomes of this study come in agreement with Canuto *et al.* [27], who studied 'aerobic versus

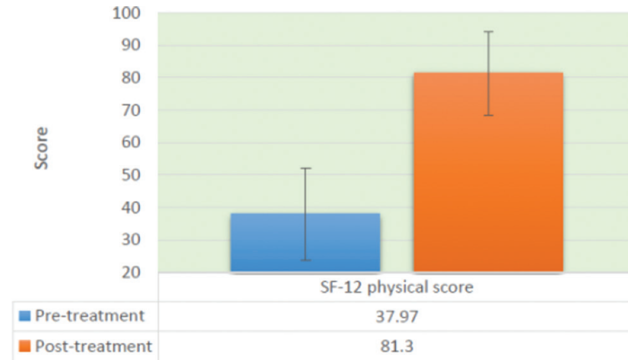

Figure 13: Mean values of SF-12 physical score of group B. SF-12, Short-Form-12.

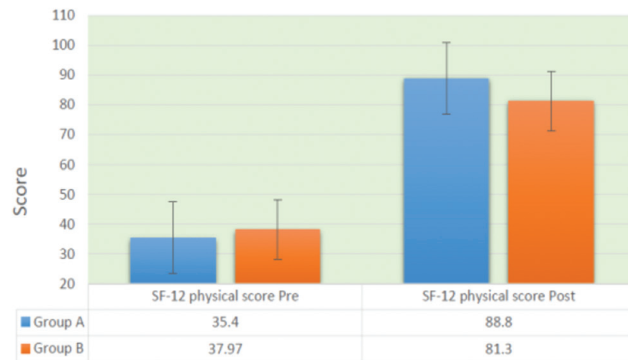

Figure 14: Mean values of SF-12 physical score of both groups. SF-12, Short-Form-12.

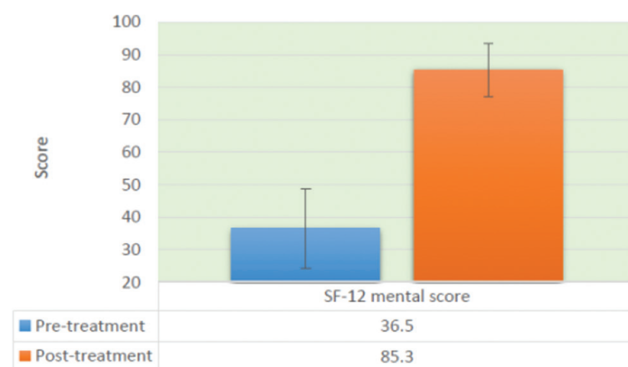

Figure 15: Mean values of SF-12 mental scores of group A. SF-12, Short-Form-12.

resistance training effects on HR-QOL, body composition and function of older adults' and reported that 8 months of moderate-to-vigorous-exercise training that is unrelated to the type of exercise (resistance or aerobic) is a successful intervention to reduce body fat, perfecting general functional capacity, and refining PCS of HR-QOL in community-dwelling elderly people. Additionally, it was confirmed that functional capacity changes prompted by training are definitely associated with variations in some domains of HR-QOL. With the number of elderly people on the rise, a public health strategy based on

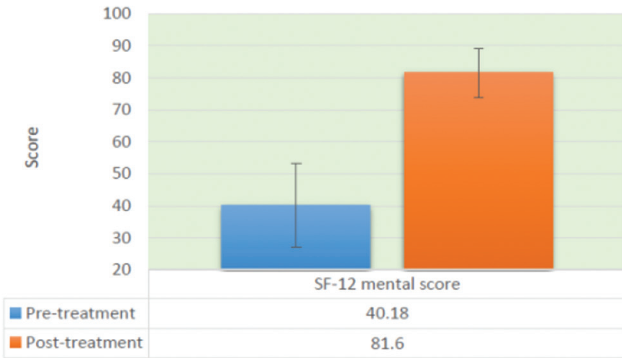

Figure 16: Mean values of SF-12 mental scores of group B. SF-12, Short-Form-12.

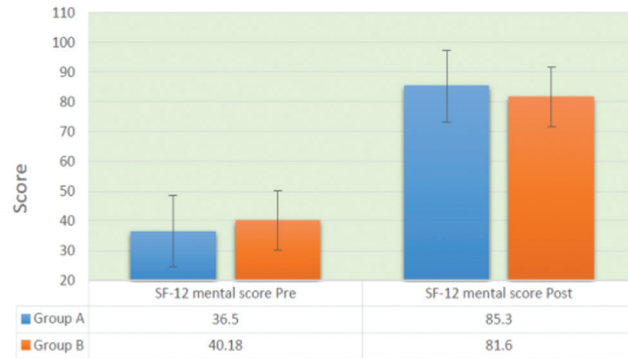

Figure 17: Mean values of SF-12 mental scores of both groups. SF-12, Short-Form-12.

the distribution of resistance and/or AE programs appears to be critical in order to avoid an increase in the number of disabled older people living with poor HR-QOL.

The consequences of this study showed a nonsignificant difference in NLR in relation with exercise training that comes in disagreement with Azam *et al.* [28], who studied 'the NLR and exercise intensity are associated with cardiac troponin levels after prolonged cycling' and discovered that both NLR and exercise intensity are associated with postexercise levels of cardiac-troponin I, showing that inflammatory variables, in addition to exercise intensity, may have a role in the volume of exercise-induced cardiac-troponin I release.

Also, the outcomes of this study come in disagreement with Ali *et al.* [29], who studied 'the effects of intensity and duration of exercise on differential leukocyte count' and concluded that high-intensity, short-duration exercise has a greater impact on neutrophil count. The fact that lymphocyte counts increased 30 min after exercise shows that low-intensity, long-duration exercise is more effective at reinforcing acquired immunity.

Furthermore, the results of this study come in agreement with Iepsen *et al.* [30], who studied 'the effect of resistance training versus endurance training in COPD' and reported that there were no clinically significant differences in the positive benefits of resistance training versus endurance training in COPD patients. As an alternative to ET, they recommend routine resistance training for COPD patients; nevertheless, healthcare practitioners should consider patient preferences when making clinical decisions about physical training as part of pulmonary rehabilitation. As a result, they suggest that patients who are unable or unwilling to participate in ET may benefit from resistance training in terms of physical function and QOL.

So, according to the findings of this study, both AE and resistance-training interventions are effective in improving the QOL in post-COVID-19 patients, but aerobic training is more effective in decreasing RHR and PHR, in comparison with resistance training, which is more effective in improving muscle strength (1-RM).

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Nil.

Conflicts of interest

There are no conflicts of interest.

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