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RESEARCH ARTICLE
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Effect of pulmonary rehabilitation program on post hospitalization severe COVID-19 patients (Experimental study)

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ABSTRACT

Background: COVID-19 infection was discovered to be the major global cause of a serious respiratory illness toward the end of 2019. The majority of COVID-19 patients experience mild disease, while about 14% go on to have severe disease and 6% end up in critical condition. An evidence-based standard of therapy called pulmonary rehabilitation includes exercise-training, education, and behavior modification to help people had a lung illness feel better physically and mentally.

Aim: current study aimed to evaluate the effect of pulmonary rehabilitation program on severe post covid19 patients (post hospitalization) regarding pulmonary function tests and dyspnea score.

Methods: Randomized control experimental study design enrolled 100 patients of post hospitalization due to severe COVID 19 infection. Dyspnea score, Spirometry and 6-minute walk test were performed upon discharge. Pulmonary rehabilitation program in the form of respiratory exercises and walking exercise was done to 50 patients. Follow up assessment of the same parameters was done 6 weeks after the program. Other 50 patients had no pulmonary rehabilitation program to them.

Results: Post COVID -19 cases in the experimental group show much improvement in percentage of normal breathing score (mMRC) 30% versus no cases in control group. In addition, the experimental group showed a significant higher percentage of normal spirometry findings (66% versus 28% in control group). As regards oxygen saturation, 6MWT score and distance, it showed a higher mean after practicing the exercise program.

Conclusion: pulmonary rehabilitation program was effective in achieving much improvement in recovery of severe cases of COVID 19 infection

Key words: *Pulmonary, Rehabilitation, Hospitalization, COVID-19*

INTRODUCTION

Corona viruses are a family of enclosed, single-stranded RNA viruses (1) that caused the Middle East Respiratory Syndrome and SARS, two major epidemics that occurred in the last 20 years. (2). A severe respiratory infection that was classified as a worldwide pandemic that is continuing to spread around the world with an increasing number of confirmed cases was identified as being caused by COVID-19 toward the end of 2019. (3) The majority of COVID-19 patients experience mild disease, but around 14% has severe disease, and 6% experience life-threatening illness. (4). Patients who are seriously affected may develop pneumonia, acute respiratory distress syndrome, (5) bilateral interstitial infiltration, and associated lung fibrosis that may even be amenable to lung transplantation. (6).In patients with SARS, pulmonary fibrosis may develop early, according to data from epidemics of prior diseases, (7) with functional disability correlated with the degree of impairment of lung function due to residual pulmonary fibrosis, muscle weakness, and systemic sequelae of the viral infection. (8)

In addition, studies on individuals recovering from COVID infections have found a decline in lung function, physical fitness, and health-related quality of life (HRQOL). (9,10) For the treatment of the long-term sequelae linked to severe acute respiratory syndrome corona-virus infection, recent clinical guidelines advise pulmonary rehabilitation (11).Pulmonary rehabilitation is an evidence-based standard of care designed to help people with lung illness feel better physically and mentally including exercise training, education, and behavior change. (12) In patients with CoV or other disorders with comparable respiratory effects, pulmonary rehabilitation has been proven to be useful in enhancing fitness and HRQOL. (13,14) Since COVID-19 is a relatively recent condition, there is a severe shortage of information about the course of recovery for people with severe affection, and an ideal treatment is urgently needed. For those who have survived this condition, pulmonary rehabilitation may play a significant role in enhancing their functional capacity and quality of life. Although pulmonary rehabilitation (PR) has been suggested following severe COVID-19, there is few data showing its effect on recovery of physical and psychosocial parameters in severe COVID-19 patients after hospitalization. (15) Therefore, this study aimed to determine the effectiveness of pulmonary rehabilitation program on severe post covid19 patients regarding pulmonary function tests and dyspnea score.

METHODS

This study was a randomized controlled trial. One hundred post sever COVID-19 patients had restrictive pulmonary function were enrolled. The patients were chosen from Fayoum University Hospital where they were hospitalized for severe COVID infection.

The study included two groups, the experimental group (Group A) and control group (Group B) each group consisted of 50 patients. Group A performed respiratory exercises, rehabilitation exercise program and walking exercise. Both groups continued their medications. The inclusion criteria of the participants were cases had sever COVID infection aged between 50 and 70 years, pulmonary function impairment. The exclusion criteria were mild or moderate COVID infection, normal pulmonary function tests, chronic chest disease, and end organ failure as (sever heart disease- neurodegenerative disease-sever stroke), unstable angina, myocardial infarction, angioplasty, heart surgery in the previous 3 months, chronic renal impairments, recent facial, oral, or skull surgery or trauma).

For randomization, block randomization was used, the patients were assigned randomly into study groups that each had an equal number of members.

Patients in experimental group participated pulmonary rehabilitation program in the form of three types of exercises. The first type was breathing exercises (pursed lip breathing, diaphragmatic breathing and incentive spirometer). The second type was circuit exercise program (stretches for upper and lower limbs, leg straightening, step ups, ARM-R-CIZE exercise, sit to stand squat, standing marching, seated arm reach, standing heel raises, sidestepping and wall pushups). The third type was walking exercise. At first week, the patient walked 1 to 5 minutes for five times per day. At second week, the patient walked 2 to 10 minutes for three times per day. At third week, the patient walked 3 to 15 minutes for two times per day. At fourth week, the patient walked 4 to 20 minutes for two times per day. At fifth week, the patient walked 5 to 25 minutes for two times per day. At sixth week, the patient walked 6 to 30 minutes for two times per day. Oxygen saturation was measured before, during and after the exercise sessions. The program was applied 6 times per week (3 times at outpatient clinic and 3 times as home program) for 6 weeks from May 2021 to May 2022.

Base line and end program evaluation of respiratory functions was done by Mmrc dyspnea scale, spirometry, oxygen saturation and 6-minute walk test. Dyspnea evaluated by the modified Medical Research Council (mMRC) scale. It consists of five statements that describe the entire range of dyspnea from none (Grade 0) to almost complete incapacity (Grade 4). (16) Pulmonary function was measured with a spirometer in the sitting position after receiving training on Incentive spirometer (IS) . (17) Measurements included forced vital capacity - (FVC), FEV1 and FEV1/FVC ratio. The grading of restrictive abnormality based on FVC measurement was; 60-80% was mild, 40-60% was moderate, and less than 40 % was sever. (18) Fingertip pulse oximetry was attached to each subject to measure oxygen saturation (SO2) before and after 6 minutes walk test. The 6-minute walk test (6MWT) is a field-based test for cardio-respiratory fitness (18). Involved participants asked to walk as they could in 6 minutes on a 20-m track while holding the instructor's loose hand. The distance travelled was computed when the test was complete (19).

Ethical consideration

The aim and nature of the study were explained for each candidate before starting the study. An informed written consent from each participant was obtained. This study approved by the Research Ethical Committee of the Faculty of medicine, Fayoum University, (No: 170, session No. 82 on 9/5/2021). Pan African Clinical Trials Registry no is (NCT05476835).

Data Analysis

The statistical package for social science (SPSS) programme version 22 was used to analyze the data. The measures between the two quantitative classes are compared using the independent student t-Test. Paired T-test used to test significance in two dependant quantitative data. To examine the relationship between qualitative data chi-square test was used. The cutoff for significance was 0.05.

RESULTS

In the current study, both experimental and control groups were matched with no significant difference statistically between two groups as regards age, body mass index (BMI), sex and co morbidities with p-value >0.05. (Table 1)

TABLE 1: Demographic characters in different study groups.

Variables	Experimental group (N=50)	Control group (N=50)	P-value
Mean ± SD			
Age (years)	58.1±6.1	58.5±7.2	0.7
BMI (kg/m2)	31.2±5.2	30.7±7.3	0.6
Sex			

Male	34	68%	35	70%	0.99
Female	16	32%	15	30%	
Co-morbidities					
No	10	20%	10	20%	0.9
Diabetes mellitus	10	20%	10	20%	
Hypertension	10	20%	11	22%	
Diabetes& Hypertension	20	40%	19	38%	
BMI group					
Normal	7	14%	11	22%	0.7
Overweight	9	18%	9	18%	
Mild obesity	13	26%	11	22%	
Moderate obesity	13	26%	9	18%	
Morbid obesity	8	16%	10	20%	

P-value, significance level <0.05

The respiratory function assessment before implementation of the exercise program illustrated no statistically significant difference with p-value >0.05 between two groups that indicated baseline matching between two groups. (Table 2)

TABLE 2: Comparisons of respiratory function assessment before practice exercise program in both groups.

Variables	**Experimental group (N=50)**		**Control group (N=50)**		**P-value**
mMRC					
Grade 2	14	28%	12	24%	0.2
Grade 3	19	38%	27	54%	
Grade 4	17	34%	11	22%	
Spirometry					
Normal	3	6%	4	8%	0.3
Mild restriction	21	42%	12	24%	
Moderate restriction	19	38%	26	52%	
Sever restriction	7	14%	8	16%	
Other tests					
FVC	0.612	0.17	0.584	0.16	0.4
SO2before 6MWT	0.92	0.04	0.91	0.05	0.3
SO2 after 6MWT	0.88	0.04	0.88	0.03	0.4
6MWT distance (m)	192.5	74.5	169.9	54.6	0.1

*Statistically significant at P≤0.05.

After practicing exercise program, experimental group show improvement in breathlessness severity measured by mMRC score with 30% show normal breathing and 56% had grade 1dysnea versus 60% in control group that show dyspnea grade 2. As regards spirometry findings, 66% of cases in the experimental group show normal spirometry measures versus 28% in control group. In addition, there was statistically significant increase in FVC, oxygen saturation, 6MWT, and 6MWT distance in experimental group. (Table 3)

TABLE 3: Comparisons of respiratory function assessment after exercise program in both groups.

Variables	Experimental group (N=50)		Control group (N=50)		p-value
MMRC					
Normal	15	30%	0	0%	<0.001*
Grade 1	28	56%	20	40%	
Grade 2	7	14%	30	60%	
Spirometry					
Normal	33	66%	14	28%	0.001*
Mild restriction	14	28%	26	52%	
Moderate restriction	3	6%	10	20%	
Other tests					
FVC	0.79	0.10	0.69	0.11	<0.001*
SO2 before 6MWT	0.96	0.02	0.95	0.01	0.001*
SO2 after 6MWT	0.93	0.05	0.90	0.03	0.003*
6MWT distance (m)	266.6	68.7	169.5	73.7	<0.001*

*Statistically significant at P≤0.05.

Post COVID -19 cases in each group show improvement in all respiratory function with p-value <0.05. However, in the experimental group the improvement was better than control group in percentage of normal breathing score (mMRC) 30% in experimental group versus no cases in control group. The experimental group show a significant higher percentage of normal spirometry findings (66% versus 28% in control group). As regards mean FVC, oxygen saturation, 6MWT score and distance, experimental group show higher mean after practicing exercise program. (Table 4)

TABLE 4: Comparisons of respiratory function in each study group pre and post implementation of exercise program.

Variables	Experimental group		P-value	Control group		P-value
	Pre	Post		Pre	Post	
mMRC						
Normal	----	15(30%)	<0.001*	----	----	<0.001*
Grade 1	----	28(56%)		----	20(40%)	
Grade 2	14(28%)	7(14%)		12(24%)	30(60%)	
Grade 3	19(38%)	----		27(54%)	----	
Grade 4	17(34%)	----		11(22%)	----	
Spirometry						
Normal	3(6%)	3366%)	0.004*	4(8%)	14(28%)	0.02*
Mild restriction	21(42%)	14(28%)		12(24%)	26(52%)	
Moderate restriction	19(38%)	3(6%)		26(52%)	10(20%)	
Sever restriction	7(14%)	----		8(16%)	-----	
Other tests						
FVC	0.61±0.17	0.79±0.1	<0.001*	0.58±0.16	0.69±0.11	<0.001*
SO2before 6MWT	0.92±0.04	0.96±0.02	<0.001*	0.91±0.05	0.94±0.02	<0.001*
SO2 after 6MWT	0.89±0.05	0.94±0.03	<0.001*	0.88±0.04	0.91±0.03	<0.001*
6MWT distance (m)	192.5±74.5	278.7±63.6	<0.001*	169.9±54.6	187.4±71.7	0.02*

* Statistically significant at P≤0.05.

DISCUSSION

SARS CoV-2 infection has caused substantial death, morbidity, and unprecedented strain on the world's healthcare systems (20). When the illness is minor, it typically takes two weeks from the onset of symptoms until recovery, and when it is severe or critical, it may take three to six weeks. It should be mentioned that approximately 75% to 80% of hospitalized patients will remain there for more than 21 days (21).

After the virus is defeated, COVID-19 can have serious after effects on the patient include weakness, dyspnea, polyneuropathy, and multi-organ involvement (22, 23, 24). In 20–30% of COVID cases reported reduction in pulmonary capacity. As a result, physiotherapy is essential to improve functional capacity and patients' life quality. (25).

Current study was in agreement with a Chinese study that reported an improvement in pulmonary function tests after practicing rehabilitation program among experimental group.(26)

A study conducted in France concluded that physical rehabilitation to COVID-19 cases improved all physical and psychological status of cases. This improvement was greater in 6-min walking distance test. (27)

The effectiveness of cardiopulmonary rehabilitation following COVID-19 was explored by Matthias H.et al. A significant improvement was noticed in pulmonary function tests and 6-minute walk test after rehabilitation program implementation. (28)

A meta-analysis study revealed the clinical advantages for exercise capacity, health related quality of life (HRQOL), and dyspnea in cases in addition to the positive effect of exercise on the improvement of respiratory function. (29, 30)

An Indian study concluded that physical therapy was efficient in lowering oxygen need in intensive care unit hospitalized respiratory patients. (31). An Austrian study resulted in after six weeks of individualized, interdisciplinary pulmonary rehabilitation for patients with long COVID, improvements were seen in their ability to exercise, functional status, dyspnea, weariness, and quality of life. (32).

In patients with persistent symptoms following COVID-19 infection, rehabilitation may be an effective therapy option. (33, 34, 35).

A Romanian study found that Dry cough and dyspnea symptoms are considerably reduced when physical physiotherapy is combined with medication. The severity of the symptoms was found to significantly improve with different types of physiotherapy. (36)

LIMITATIONS

Lack of commitment of some Patients to follow the exercise program. Some patients faced difficulties in learning way of implementation of rehabilitation exercise. Focusing on pulmonary function tests improvement after rehabilitation program without assessment of quality of life scores.

CONCLUSION

Pulmonary rehabilitation improved dyspnea, respiratory function, oxygen saturation and 6MWT in severe post hospitalization COVID- 19 patients. It is very important beside medical treatment to use physical rehabilitation in improvement of respiratory function in post COVID-19 respiratory impaired cases.

Abbreviations

SARS: severe acute respiratory syndrome
HRQOL: health related quality of life
IS: incentive spirometer
Mmrc: modified medical research council
FVC: forced vital capacity
FEV1: forced expiratory volume in 1st second
6MWT: 6 minute walk test
6MWD: 6 minute walk distance
ACSM: American college of sports medicine
BMI: body mass index
PR: pulmonary rehabilitation

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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