Original Article

Short-term Pulmonary Rehabilitation after Recovering from Severe COVID-19

Marzieh Hashemi[1], Vajihe Atashi[2], Shila Haghighat[3], Raheleh Sadegh[4], Ramin Sami[1]

[1]Department of Internal Medicine, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Department of Nursing and Midwifery Care Research Center, Adult Health Nursing, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, [3]Physical Medicine and Rehabilitation, Isfahan, Iran, [4]Department of Community and Prevention, Isfahan University of Medical Science, Isfahan, Iran

Abstract

Background: Patients with severe COVID-19 suffer from various problems such as impaired lung function, decreased exercise capacity, mental disorders, and reduced quality of life. This study aimed to evaluate the effectiveness of short-term pulmonary rehabilitation in patients recovering from severe COVID-19. **Methods:** The present study was a retrospective cohort study. This study was conducted in 2021 on 92 patients with severe COVID-19 who met the inclusion criteria. Inter-professional pulmonary rehabilitation sessions were performed for 3 weeks, twice a week (six sessions in total), for this group of patients, which included physical exercises, educational activities, and other health-related services (counseling and psychotherapy). Outcomes assessed included a 6-min walk test, the score of the Hospital Anxiety and Depression Scale, and the SF-12 Quality of Life Questionnaire, which were completed before and after pulmonary rehabilitation. Data analysis was performed using analytical and descriptive statistics. **Results:** The statistical analyses showed that 60.86% of patients participating in the study were male and 39.14% were female, and the mean age of patients was 54.9 ± 12.3 years. The findings also showed that the average distance traveled in the 6-min walk test before pulmonary rehabilitation was 289.2174 ± 130.5 m; however, after the intervention, this rate reached 343.0870 ± 103.5 m, which demonstrated a statistically significant difference ($P = 0.00$). Also, significant changes were observed in anxiety and depression, the ability to perform daily activities, and the physical health of patients before and after the intervention ($P < 0.05$). **Conclusions:** Short-term pulmonary rehabilitation is a safe and useful treatment without side effects that can be effective in reducing anxiety and depression, increasing the ability to perform daily activities and exercise capacity, and consequently, improving the quality of life of patients recovering from severe COVID-19.

Keywords: *Pulmonary rehabilitation, severe COVID-19, short-term*

Introduction

SARS-CoV-2, as a global problem, is one of the most dangerous viruses of the Coronaviridae family. The disease severity ranges from asymptomatic to very severe disease.[1] Patients with severe COVID-19 may face a variety of problems and complications such as acute respiratory failure (67.3%), acute renal and hepatic injuries (28.9%), and cardiovascular problems (23.1%), which increase the mortality rate of these patients to 61.5%.[2,3] Due to the mentioned complications and problems, these COVID-19 patients need to be admitted to the intensive care unit (ICU).[4]

Intensive Care Unit Acquired Weakness (ICUAW) is a common problem in patients with severe COVID-19 who undergo mechanical ventilation in the intensive care unit. Studies in this field have demonstrated that more than 50% of patients recovering from severe COVID-19, who had been ventilated for more than 2 days, experienced ICUAW.[5] ICUAW leads to respiratory muscle weakness, lower physical function, decreased quality of life, and increased mortality even up to 12 months after discharge (recovery).[6] These patients also have low psychological tolerance, and about 40% of them are highly exposed to psychological disorders such as anxiety, fear, panic attacks, depression, and negative thoughts.[7]

Pulmonary rehabilitation is an important part of the treatment of patients with severe COVID-19 with the aim of relieving symptoms, improving the quality of life, and bringing patients to the highest level of ability and independence.[8] The pulmonary

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Address for correspondence:
Dr. Ramin Sami, Department of Internal Medicine, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: r.sami@med.mui.ac.ir

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rehabilitation program is a multidimensional program that includes cognitive, physical, and functional measures and can improve patients' mental and physical functions.[9] In a study conducted by Spielmanns *et al*. (2021)[10] to evaluate the rehabilitation program in patients recovering from severe COVID-19, the results showed that the pulmonary rehabilitation program is effective in improving the quality of life and symptoms of anxiety and depression in this group of patients.

However, investigations show that the duration of the pulmonary rehabilitation program is also important to achieve the related benefits.[11,12] Existing studies have reported the efficacy of moderate and long periods of pulmonary rehabilitation (6–12 weeks) in patients recovering from severe COVID-19.[13,14] However, considering the economic issues, distance from rehabilitation centers, income problems, lack of social support, and low self-esteem, which can even prevent the patients from participating in the pulmonary rehabilitation program, it may be possible to increase the number of subjects benefiting from this program by providing a cost-effective short-term rehabilitation program.[15] A study was conducted by Naseer *et al*. (2017)[16] to evaluate the effects of the short-term rehabilitation program (3 weeks and 2 sessions per week) on patients with chronic obstructive pulmonary disease (COPD). The results showed that short-term pulmonary rehabilitation leads to an increase in patients' quality of life.

Thus, due to the increased discharge of patients improved from severe COVID-19 that require pulmonary rehabilitation, the lack of studies on the short-term pulmonary rehabilitation in these patients, as well as the issue of expenses and some individual and social aspects mentioned, further studies should be conducted to investigate the efficacy of short-term pulmonary rehabilitation programs. If the use of these programs would be efficient, the use of short-term pulmonary rehabilitation should be emphasized as a part of treatment and patients should be encouraged to perform the program. Because improving the quality of life and mental status of patients recovering from COVID-19 is an important goal of pulmonary rehabilitation, the aim of this study was to evaluate the effectiveness of a short-term pulmonary rehabilitation program on patients recovering from severe COVID-19.

Subjects and Methods

The present research was a retrospective cohort study. The study population included all patients who recovered from severe COVID-19 and were referred to the Comprehensive Respiratory Center of Khorshid Hospital. It should be noted that this center is the only pulmonary rehabilitation center in the province. The samples consisted of 110 patients who met the inclusion criteria and were selected using the census sampling method from April 2021 to March 2022. Inclusion criteria included the willingness of the samples to participate in the study, the age range of 18 to 70 years, having at least a literacy education, and passing at least 21 days after the onset of symptoms of severe COVID-19. Exclusion criteria included unwillingness to participate in the study, pregnancy, participating in similar studies, conclusive evidence of intravenous and pulmonary thromboembolism, acute symptoms of COVID-19 (temperature over 38 degrees, etc.), systolic blood pressure less than 90 mm Hg, diastolic blood pressure less than 60 mm Hg, systolic blood pressure above 140 mm Hg, diastolic above 90 mm Hg, history of heart diseases class 2-4, less than 90% oxygen saturation while resting or after oxygen therapy, ischemic or hemorrhagic stroke or neurodegenerative diseases, history of a major mental disorder according to a psychiatrist (schizophrenia, paranoid disorders, and major depression), having mobility or orthopedic problems including rheumatic diseases and active cancer, patients receiving palliative care, and absenteeism from more than two rehabilitation sessions.

Data collection tools included demographic characteristics questionnaire (age, sex, underlying diseases, etc.), hospital anxiety and depression scale (HADS), SF-12 quality of life questionnaire, Barthel scale, and 6-min walk test (6-MWT). The Hospital Anxiety and Depression Questionnaire consists of two subscales of depression and anxiety; seven items are used to measure depression and seven items are used to measure anxiety. Each item of this questionnaire is graded by a 4-point scale based on the severity of symptoms, ranging from a score of zero (none) to a score of 3 (severe). The maximum score is 21 for each subscale and 42 for the whole scale.[17]

The SF-12 questionnaire includes 12 questions related to eight dimensions and consists of eight scales. It can also be divided into two subscales assessing physical and mental conditions. The physical subscale includes physical function, limitations due to physical problems, general health perception, and physical pain. The mental subscale includes limitations due to mental health problems, energy and vitality, mental status, and social functioning.[18]

The Bartel scale was used to assess the ability to perform daily activities before and after short-term pulmonary rehabilitation. In this scale, 10 daily activities, including going to the toilet, urinating control, defecation control, going up and down stairs, eating, bathing, walking, washing hands and face, getting dressed, and moving), are examined and scored, and each level of performance is measured by a specific score. The overall score of the questionnaire is between 0 and 100. A score of 100 means complete independence and low scores indicate an increasing dependence on others for performing the daily activities.[19] The 6-min walking test was also used to measure patients' exercise capacity. The distance covered by each individual was calculated before and after pulmonary rehabilitation.[10]

Short-term pulmonary rehabilitation: Inter-professional pulmonary rehabilitation sessions were held twice a week (a total of 6 sessions) in the Comprehensive Respiratory Clinic of Khorshid Hospital for 3 weeks. The sessions included physical exercises, educational activities, and other health-related services (counseling and psychotherapy). During the patients' first visit to the Comprehensive Respiratory Clinic, informed consent was obtained from all patients. Then, the 6-min walk test, Bartel scale, and SF-12 quality of life questionnaire, and HADS were completed. All patients attended training sessions twice a week, which included training on self-care, adjustment skills, self-management related to shortness of breath, oxygen therapy, method of using the spray, training on nutritional interventions, and other educational needs of patients. The face-to-face training sessions lasted about 30 min before the start of the exercise sessions. Also, educational pamphlets were provided to patients for home use. Additionally, the rehabilitation physical therapist adjusted the exercise instructions of each patient based on the results of the 6-min walk test. Each exercise session lasted about 60 min and consisted of the following components:

1. Five minutes of warm-up including low-intensity exercise resulted in a slight increase in the patient's breathing rate without the patient feeling short of breath, and based on the Borg scale, the exercises at this stage corresponded to the blue area, that is, easy and very easy. Also, a variety of stretching exercises were used at this stage.
2. Resistance training for large muscle groups was performed for 20 min depending on the patient's condition and based on available guidelines.[20] The frequency of repetition of these exercises was more than or equal to 2 days a week and the intensity of exercises started with 30 to 40% of 1RM, and gradually increased to 70% of 1RM. The duration of these exercises was three sets, and each set consisted of ten repetitions with 1-min break intervals between each set. The type of exercises included calf raises, chest presses, shoulder presses, triceps extensions upright rows, bicep curls, and step-ups, which were performed with free weights, body weight, or stretching bands. The type of modality was determined by the patient's ability and orthopedic limitations.
3. Aerobic exercises were performed, and the intensity of these exercises was determined to be between 60 and 80% of reserve HR and the rate of perceived exertion (RPE) was between 11 and 14. The severity of the patient's shortness of breath, according to the Borg scale, should have been between 4 and 6. The duration of these exercises was 30 min, and the type of exercises at this stage included a treadmill, stationary bike, and hand ergometer.
4. The final exercise was 5 min of cooling down, and in case of severe shortness of breath (greater than or equal to 6 according to the Borg scale), impaired arterial blood oxygen saturation during exercise despite oxygen therapy (less than 88%), fatigue symptoms, and symptoms such as pain and limping, the exercise program was performed as interval training.

Also, during the pulmonary rehabilitation sessions, ECG or heart rate, RPE, and dyspnea of the Borg scale were monitored. It should be noted that patients over 40 years of age were visited by a cardiologist to determine the risk of exercise. Then, with the written permission of the cardiologist, the patients were allowed to participate in monitored exercise sessions. Patients were also encouraged to exercise 5 times a week at home under the guidance of a physical therapist. The home exercise program consisted of 30 min of walking at a pace similar to the supervised exercise program, as well as balance and flexibility exercises that the patients were familiar with. The method of performing these exercises had been demonstrated in the supervised program, and the patients had received the necessary training. Finally, patients were examined by a psychologist and psychiatrist and were counseled about anxiety, depression, and sleep problems. Smoking cessation sessions were also scheduled for the cases if necessary. At the end of the pulmonary rehabilitation sessions, the patients completed the 6-min walk test, the Bartel scale, the SF-12 quality of life questionnaire, and HADS.

Ethical considerations

After approval of the plan and obtaining permission from the officials and ethics committee of Isfahan University of Medical Sciences (ethics code of IR.ARI.MUI.REC.1400.106), and introducing the project to the officials of the Comprehensive Respiratory Clinic, the objectives of the study were explained to the participants. The patients were assured about the confidentiality of the information and the freedom to leave the study at any stage of the research. Finally, the patients signed a form of informed consent to participate in the research.

Results

A total of 110 patients were included in the study; however, 18 of them were excluded from the study before completing the short-term pulmonary rehabilitation course for various reasons such as the cost of pulmonary rehabilitation, and distance. Finally, statistical analysis was performed on 92 patients recovering from severe COVID-19. The results showed that the mean age of patients was 54.9 ± 12.3 years and the mean BMI of patients was 28.8 ± 4.9 kg/m^2. Also, 60.86% of patients participating in the study were male, and only one patient had a history of smoking [Table 1].

The results of the paired *t*-test showed that the mean distance covered in the 6-min walk test before pulmonary rehabilitation was 1309 ± 289.2 m. However, after the intervention, this amount reached 103.5 ± 343

meters, which demonstrated a statistically significant difference (P = 0.00) [Table 2].

The findings also showed significant changes in anxiety, depression, and the ability to perform daily life activities before and after the intervention (P = 0.00). Additionally, a significant difference was observed in the physical health dimension of patients' quality of life (P = 0.02), but no significant difference was reported in the mental health dimension (P = 0.10) [Table 3].

Discussion

The aim of this study was to evaluate the effectiveness of short-term pulmonary rehabilitation in patients recovering from severe COVID-19. Patients participated in regular pulmonary rehabilitation sessions two times a week for 3 weeks (six sessions). The results of this study showed that the short-term program of pulmonary rehabilitation led to a significant reduction in patients' anxiety and depression. Also, a significant increase was observed in the quality of life in terms of physical health, ability to perform daily activities, and exercise capacity of patients.

The 6-min walk test is an important criterion for diagnosing the exercise capacity of respiratory patients. The results of the present study showed that short-term pulmonary rehabilitation increased patients' exercise capacity. These findings were consistent with a study by Gloeckl *et al.* (2021).[21] It should be noted that, on average, 54-m changes were observed in the 6-min walking test of patients before and after short-term pulmonary rehabilitation. This rate of change was clearly higher than the minimal important difference (MID), which is reported to be 30 m for respiratory patients.[22] Even in the case of the natural healing process, this rate of improvement seems to be related to the effect of short-term pulmonary rehabilitation. In a study conducted by Daher *et al.* (2020)[23] to assess exercise capacity in severe COVID-19 patients 6 weeks after discharge from the hospital, the results of the 6-min walk test showed that exercise capacity was severely impaired in these patients. It was observed that without rehabilitation and exercise interventions, natural recovery in patients with severe COVID-19 occurs slowly.

The results of various studies have shown that the high level of anxiety and depression in patients recovering from COVID-19 is one of the important predictors of decreased physical activity in this group of patients.[24,25] The results of the present study showed a significant reduction in the levels of anxiety and depression at the end of the pulmonary rehabilitation period. The results of an investigation by Liu *et al*. (2020)[26] also showed that exercise along with psychological counseling in the pulmonary rehabilitation program can have positive effects on the anxiety and depression of COVID-19 patients. In addition, Ali *et al.* (2014)[27] conducted a study to evaluate the effect of short-term pulmonary rehabilitation programs on patients with chronic obstructive pulmonary disease (COPD) after

Table 1: Demographic characteristics of patients who underwent pulmonary rehabilitation

Variable		Frequency (percentage)	Mean±SD
Gender	Female	36 (39.14)	
	Male	56 (60.86)	
Age			54.9±12.3
History of smoking		1 (1.1)	
BMI			28.8±4.9
Underlying diseases		37 (40.21)	

Table 2: Results of clinical examinations of patients who underwent pulmonary rehabilitation

	Before	After	*P*
LDH	473.9±170.7	443.4±118.00	>0.001
D.Dimer	771.2257±1465.09303	383.7511±362.78341	0.00
CRP	10.6±23.1	5.8±10.1	0.035
Ferritin	270.5172±380.39375	167.0779±189.68085	0.00
6mwD	289.2174±130.53024	343.0870±103.52617	0.00
SpO_2.Rest	92.4627±2.90417	91.6716±9.22840	0.479

Table 3: Results of short-term pulmonary rehabilitation in patients recovering from severe Covid-19

	Subscales	Before	After	*P*
Barthel scale		90.7303±12.00262	96.1029±7.42352	0.00
HADS	HAD (A)*	3.87541±4.9302	2.17277±3.3953	0.00
	HAD (D)*	3.49482±3.9767	2.5349±2.23978	0.00
SF 12	(QOL) SF12- physical health component	13.0152±2.01145	12.3182±1.57049	0.02
	(QOL) SF 12- psychological health component	15.4912±2.30777	16.1579±1.71953	0.10
SF12 physical health component	Physical Function	3.3971±0.81295	3.0147±0.74298	0.00
	Role Physical	3.7647±1.18596	4.0588±1.14452	0.07
	Pain	2.9412±1.14452	2.3676±0.99107	0.00
	General health	2.8841±0.40352	2.9130±0.56201	0.69
SF 12-psychological health component	Vitality	3.0678±1.29807	3.5932±1.10045	0.49
	Social Function	3.5424±1.38118	3.0847±1.27696	0.03
	Role Emotional	3.1176±0.50459	3.0882±0.56609	0.70
	Mental Health	6.2931±1.53336	5.7241±1.77500	0.09

*HADS: (Anxiety sub-score HAD-A) and Depression (sub-score HAD-D)

exacerbation of the disease. The results demonstrated a significant improvement in anxiety, depression, and 6-MWT, which indicates the effective role of the short-term pulmonary rehabilitation program in improving anxiety and depression. These results were consistent with the findings of the present study. Although the mechanism of this recovery after participating in the pulmonary rehabilitation program is not fully clear, one of the possible reasons is the increase in patients' self-confidence, coping mechanisms, and ability to overcome special conditions, which can be a result of the extensive patient support in the pulmonary rehabilitation program.[28]

The findings of this study showed that the average ability to perform daily activities of life before short-term pulmonary rehabilitation was 7,303/90, and after the intervention, this amount reached 1029/96 (P = 0.00), which was in line with the studies by Siddiq *et al*. (2020)[14] and Dar *et al*. (2020).[29] In the pulmonary rehabilitation program, the patient learns to improve his lifestyle to some extent by using a proper diet, walking, and breathing exercises. It is observed that these factors can lead to a decrease in fatigue and an increase in health and well-being by increasing tissue oxygen, which could also help the individual to improve daily life activities.[30]

The ultimate goal of pulmonary rehabilitation interventions is to increase the quality of life of patients with chronic respiratory diseases.[8] According to the definition by the World Health Organization, quality of life is a concept affected by the physical, mental, and social conditions of an individual.[13] The results of statistical tests showed that after short-term pulmonary rehabilitation, the physical health of patients was significantly different (P = 0.02), while no change was observed in the mental health of the cases (P = 0.10). The results of the studies by Gloeckl *et al*. (2021)[21] and Hayden *et al*. (2021)[31] showed that 3 weeks of pulmonary rehabilitation led to an improvement in the clinical condition and quality of life of patients with COVID-19 in terms of both physical and mental health conditions, which was not consistent with the present study. In the mentioned studies, pulmonary rehabilitation was performed for COVID-19 patients at the time of admission and after stabilizing the patient's condition, whereas in our study, the study samples included patients recovering from severe COVID-19. Due to physical limitations and complications of this disease, these patients have lower psychological tolerance, and the quality of life of these patients is further affected compared to patients with mild and moderate diseases. Thus, these causes may affect their response to pulmonary rehabilitation.[2,32] In another study conducted by Lingner *et al*. (2018),[33] the findings showed that following short-term pulmonary rehabilitation, patients' clinical status and quality of life improved. The results of this study also showed that the highest increase in the quality of life was observed in terms of the dimension of physical health. It should be noted that most studies have confirmed the positive effects of pulmonary rehabilitation on physical health and quality of life,[34-36] and in this respect are consistent with the present study. In fact, by reducing the anxiety and depression of COVID-19 patients, the severity of physical symptoms decreases, and as a result, the quality of life improves.[37] However, the mental health dimension of quality of life goes beyond anxiety and depression, and the impact of short-term pulmonary rehabilitation on this dimension is not fully clear because the dynamism, multidimensional structure, and subjective nature of the concept of quality of life, as well as Individual experiences and beliefs and the imposition of treatment costs have been effective in achieving these results. As a result, the study of these dimensions requires a longer time than the time specified in this study. The results of a study by Sotoudeh *et al*. (2020)[38] showed that inducing changes in the mental health and quality of life of patients requires at least 3 months of interventions affecting the quality of life. It should be noted that in the present study, patients' social performance was also improved. Cox *et al*. (2017)[39] stated that participating in pulmonary rehabilitation sessions can help the individual by establishing social relationships with others, gaining their support, and improving social functioning. The strength of the present study is that it is one of the first studies to examine short-term pulmonary rehabilitation in patients recovering from severe COVID-19. Whereas other studies performed short-term pulmonary rehabilitation for inpatients.[21,31]

Limitations of the study

The lack of a control group is the main limitation of the present study, which was not possible due to ethical issues. Another limitation of the study was the exclusion of patients for reasons such as the cost of pulmonary rehabilitation. It should be noted that in Iran, pulmonary rehabilitation is not covered by health insurance and this imposes a high cost on the individuals and their families. Also, some patients could not participate in the pulmonary rehabilitation program due to the distance from the hospital, fixed morning shifts, and the lack of other pulmonary rehabilitation centers in the province. Additionally, the lack of follow-up of patients after the short period of pulmonary rehabilitation was another limitation of the study; thus, it was not possible to examine the changes in various dimensions of quality of life and other variables over time.

Conclusions

Due to the clinical conditions caused by prolonged inactivity and the resulting musculoskeletal problems, patients recovering from COVID-19 require rehabilitation treatments. Especially in cases where patients still have difficulty breathing or movement, pulmonary rehabilitation programs should be considered to increase their chances of recovery. The findings of the present study demonstrated that the short-term pulmonary rehabilitation program is

effective in reducing anxiety and depression and increasing the physical health and functional capacity of this group of patients. According to the above results, the implementation of pulmonary rehabilitation, even in the short term, as an effective and safe treatment without complications is necessary to reduce mental health problems and increase the physical health of patients recovering from severe COVID-19. The findings of this study can be used in planning the care and education of COVID-19 patients. Also, the importance of lung rehabilitation can lead to the development of new rehabilitation centers and encourage physicians to refer more patients for rehabilitation, which can lead to reducing mental and psychological complications, improving the quality of life of these patients, and reducing health costs. According to the results of the present study, the conduction of further clinical trials is suggested for comparing short- and long-term courses of pulmonary rehabilitation with long follow-up periods to evaluate the long-term benefits of pulmonary rehabilitation in this group of patients.

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Conflicts of interest

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