ORIGINAL RESEARCH ARTICLE

NATIONAL JOURNAL NJMR MEDICAL RESEARCH

Effect of Home Based Versus Hospital Based Pulmonary Rehabilitation Program on Lung Functions in Recovered Covid-19 Patients

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DOI:
10.55489/njmr.150220251059

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Date of Submission: 31/01/2025
Date of Acceptance: 04/03/2025
Date of Publication: 01/04/2025

Funding Support:
None Declare

Conflict of Interest:
The authors have declared that no conflicts of interest exist.

How to cite this article:
Arora H, Jaggi S, Aggarwal D, Sodhi MK, Saini V. Effect of Home Based Versus Hospital Based Pulmonary Rehabilitation Program on Lung Functions in Recovered Covid-19 Patients. Natl J Med Res 2025;15(02):103-108. DOI: 10.55489/njmr.150220251059

ABSTRACT

Background: The COVID-19 pandemic has significantly impacted global public health, with many patients experiencing persistent symptoms and impaired physical functioning even after recovery from the acute phase. Pulmonary rehabilitation may help improve ongoing respiratory symptoms in these individuals. This study compared home-based rehabilitation to hospital-based rehabilitation for post-COVID patients with pulmonary function impairments.

Methods: In a randomized controlled trial, 54 recovered COVID-19 patients were enrolled over 18 months and divided into two groups: Group A (home-based rehabilitation) and Group B (hospital-based rehabilitation). Group A performed exercises at home, while Group B attended two supervised sessions per week for 8 weeks. Spirometry and the 6-Minute Walk Test (6MWTD) were conducted at baseline and after 8 weeks.

Results: Results showed significant improvements in 6MWTD for both groups (Group A: $p < 0.01$, Group B: $p = 0.03$). Group B also showed significant improvement in Forced Vital Capacity (FVC) ($p = 0.04$). However, there were no significant differences in lung function, exercise capacity, or dyspnea grading between the two groups ($p > 0.05$).

Conclusion: Home-based rehabilitation provides similar benefits to hospital-based rehabilitation and is a viable alternative for patients unable to access hospital services.

Keywords: Pulmonary rehabilitation, Telerehabilitation, Post COVID 19, 6 MWTD, mMRC Dyspnoea grading

INTRODUCTION

COVID-19 is a highly contagious respiratory disease which is caused by SARS-CoV-2 virus. Its initial case was detected in Wuhan, China in December 2019, following which it disseminated rapidly to all the geographical regions of the world. WHO announced it a pandemic on 11th March 2020.[1] SARS-CoV-2 belong to the β species of coronaviruses, which are mainly transmitted via respiratory droplets and close contact to the patient. Lung is the most commonly involved organ following COVID-19 infection. Lung involvement can occur in any form within the spectrum ranging from pneumonia to diffuse pulmonary fibrosis. As per studies in post

Publisher: Medsci Publications [www.medscipublications.com] ISSN: 2249 4995 Official website: www.njmr.in

COVID-19 patients, lung impairment is mostly seen in the form of restrictive ventilation defects and compromised diffusion capacity.[2]

The disease presentation may be varied with symptoms ranging from mild fever, sore throat, cough, fatigue and breathing difficulty to rapidly progressing disease and multi systemic involvement. Around 15% of patients manifest as severe form of disease such as pneumonia that requires oxygen support. Only 5% of these patients present with complications such as sepsis, respiratory failure, thromboembolism and multiorgan failure that may require critical care.[3] Despite complete recovery seen in majority of the patients, it has been seen that many patients continue to complain of one or the other symptoms persisting for weeks to months with clinically relevant sequelae. According to recent guidelines, signs and symptoms of COVID-19 persisting for 1 to 3 months after the initial onset of infection are termed as "ongoing symptomatic COVID-19", whereas COVID-19 sequelae that last for more than 3 months are defined by terminologies such as "long-COVID" or "post-COVID- 19 syndrome".[4]

As the battle with the COVID-19 pandemic diminishes, the additional challenge of managing these post Covid sequelae has started to rise. In view of lack of definite treatment of such symptoms, pulmonary rehabilitation seems to be a promising management option in these patients. Pulmonary rehabilitation (PR) is a structured intervention which includes an extensive patient assessment followed by therapies according to every patient's needs that include exercise training, education, psychosocial and behavioral support.[5,6]

In our knowledge, no Indian study has compared the effects of home and hospital-based PR in recovered COVID-19 patients. Hence, this study was conducted to investigate the effects of PR program on lung functions and exercise capacity in recovered COVID-19 patients and if home based rehabilitation program can be a feasible alternative to standard hospital-based program for patients who are not able to access hospital services due to any reason and bring forth improvement in health outcomes in such patients.

MATERIALS AND METHODS

The study was conducted in the Department of Pulmonary, Critical Care and Sleep Medicine, Government Medical College and Hospital (GMCH), Sector-32, Chandigarh during the period December 2020 to May 2022. This was a Randomized Controlled Trial (RCT) in which 54 recovered patients of Covid-19 visiting the post COVID care clinics or pulmonary medicine OPD with pulmonary function impairment were enrolled. The study was conducted after approval from the institute's ethics committee. All recovered patients of COVID-19, of either gender and >18 years of age presenting with pulmonary function impairment as assessed by spirometry and six-minute walk test (6MWT) after at least 1 month of their initial diagnosis were included. Post COVID patients with evidence of any active infection, active COVID-19 illness, severe joint pain, severe cardiac compromise, neurological impairment or any other issues that may hinder effective participation in pulmonary rehabilitation, any other chronic lung pathology that may bias the results and subjects who did not provide consent were not included in the study.

In depth medical history was taken from all subjects followed by systemic examination. Past history about their COVID illness was recorded, particularly any history of hospitalization, any previously diagnosed lung impairment etc. The baseline severity of disease was categorized as mild, moderate and severe based as per the standard criteria.[7] These subjects were randomized to Group A (home-based PR group) and Group B (hospital-based PR group) with 27 subjects in each group according to randomization sequence generated by computer. Allocation concealment was maintained by using brown envelope which was opened by the study investigator only.[8]

Spirometry was done on all the patients at baseline according to guidelines issued by American Thoracic Society (ATS).[9] FEV1 (Forced Expiratory Capacity in 1 second), FVC (Forced Vital Capacity), and FEV_1/FVC were estimated. The exercise capacity of the patient was estimated using 6-MWT.[10] Dyspnea grading was done using the modified medical research council (mMRC) dyspnea scale.[11]

Group A patients were asked to perform set of exercises from their homes which included active range of motion (ROM) exercises, breathing exercises, aerobic reconditioning, home walking program, incentive spirometry and functional rehabilitation if needed. The schedule of exercises and proper technique were explained to them on their maiden visit to the hospital by the investigator. They were routinely followed up telephonically or in Post COVID care clinics once weekly.

Group B patients underwent two sessions of supervised pulmonary rehabilitation per week of 45 minutes to 1-hour duration in the hospital. Each session included upper and lower limb muscle training, strength and endurance training, pursed lip breathing and diaphragmatic breathing. The Blood pressure and SpO_2 were measured before starting training and SpO_2 was measured during the exercise. If SpO_2 fell below 88% exercise was stopped. The exercise training was followed by diet counselling in rehabilitation and education sessions. Patients were referred for psychiatric counselling if found to have anxiety, depression-like symptoms post COVID.

After 8 weeks of the PR program, patients in both arms underwent response assessment in the form of repeat spirometry, 6MWT and dyspnea grading. Changes observed in the above-mentioned parameters in both the groups following PR were analysed using appropriate statistical tests.

Approval of Institutional Ethical Committee: Approved by

Institutional Ethics Core Committee vide letter number GMCH/IEC/2020/549R/114.

RESULTS

The study was conducted in 54 recovered Covid 19 patients at least 1 month after the initial diagnosis with baseline lung function impairment, which were randomized into two groups with 27 patients in either group. Demographic and baseline attributes of the both groups are stated in Table 1. Mean age of the subjects was 50.8 ± 14.7 years. The mean age in both groups was matched at baseline (p value 0.68). Out of 54 study participants, 54% (29) were females and 46% (25) were males. 31% (17) participants suffered from one or more co morbidities. Hypertension was the most prevalent comorbidity overall in both the groups. The 2 groups were comparable at baseline with regard to BMI distribution (p = 0.81) but it was found that overall 42% (23) participants had BMI in the obese category with 48% (13) participants in Group A and 34%(10) participants in Group B respectively.

Mean change in the parameters post PR for 8 weeks and inter group analysis is shown in Table 2.

Table 1: Demographic and baseline attributes of the two groups

Parameter	Study Population (*n*=54)	Group A	Group B	*P*
Age ± SD (Years)	50.8±14.7	51.6±16.2	50.0±13.2	0.68
Gender				
Male	25 (46%)	12 (44%)	13 (48%)	0.78
Female	29 (54%)	15 (56%)	14 (52%)	
BMI (in kg/m^2) (Mean ± SD)	24.6±5.2	24.4 ± 5.8	24.8 ± 4.6	0.81
Smoking Status	17 (32.5%)	10 (37%)	7(25%)	0.38
Comorbidities	17(31%)	8(29%)	9(26%)	0.77
Baseline FEV1 (In %) (Mean±SD)		57.7±15.3	59.6±12.7	0.42
Baseline FVC (In %) (Mean±SD)		57.6±17.4	57.9±12.1	0.93
Baseline FEV1/FVC (In %) (Mean±SD)		78.5±12.8	82.1±12.5	0.32
Baseline 6MWD (In Meters) (Mean±SD)		300.6±73.2	290.3±111.7	0.69
Baseline MMRC dyspnea grade (Mean±SD)		2.30±0.91	2.44±0.8	0.55

SD: standard deviation; BMI: body mass Index; 6MWD: 6 Minute Walk Distance

Table 2: Parameters post PR for 8 weeks and inter group analysis

Parameters	Follow up (8 weeks)	*P*	Mean Change	*P*
FEV1 (in %) (Mean±SD)				
Group A	60.6±15.6	0.08	2.9±8.5	0.79
Group B	63.9±13.5	0.07	4.3±10.7	
FVC (In %) (Mean±SD)				
Group A	60.1±16.5	0.14	2.5±8.6	0.67
Group B	61.5±12.6	0.04	3.6±8.7	
FEV1/FVC (In %) (Mean±SD)				
Group A	77.1±19.1	0.57	-1.4±13.1	0.92
Group B	83.1±10.4	0.28	1.1±5.3	
6 MWD (in %) (Mean±SD)				
Group A	321.1±66.5	<0.01	20.5±32.1	0.77
Group B	308.0±107.3	0.03	17.7±40.5	
MMRC Dyspnoea grade				
Group A			0.26±0.76	0.76
Group B			0.19±0.68	

SD, standard deviation; 6MWD, 6 Minute Walk Distance

Lung function and exercise capacity assessment was done using spirometry parameters [FEV_1 (%), FVC (%) and FEV_1/FVC (%)] and 6MWTD respectively. The current study showed that 6MWTD improvement was statistically significant in both the groups when compared from baseline at the end of 8 weeks. The mean 6MWTD at baseline evaluation was found to be comparable between both the study groups (P>0.05). The present study depicted more increase in 6-MWTD in Group A (20.52 ± 32.19) meters after PR with p value<0.01 as compared to Group B where there was increase in 6MWTD of 17.70 ± 40.57 meters with p value 0.03. Also, only Group B (Hospital based rehabilitation) participants demonstrated significant improvement in FVC after 8 weeks with p value of 0.04 and mean change of 3.67 ±8.78 %. However, no statistically significant change was noted in exercise capacity and lung functions after 8 weeks of PR when compared in both the groups (6MWTD: p = 0.77, FEV_1: p =0.79, FVC: p =0.67, FEV_1/FVC: p =0.92) highlighting comparable effects of pulmonary rehabilitation on lung functions in Group A participants with respect to Group B participants. Baseline mMRC dyspnea grading was comparable between the two groups with p value 0.55. On inter group analysis of mMRC dyspnea grade, statistically significant difference was not appreciated (p=0.76), highlighting com-

parable reduction in dyspnea grade in both the groups post rehabilitation.

DISCUSSION

This study was conducted to compare the effects of home versus hospital-based PR on pulmonary function and exercise capacity in recovered COVID-19 patients.

The mean age of study participants was similar to as observed in previously done studies.[12,13] The female predominance seen in the present study is in contrast to the various studies where males were more in number as study participants (58.1% by Guan et al, 73% by Huang et al and 54.3 % by Wang et al).[14-16] Although, the data regarding higher risk of Covid-19 infection in males is still not adequate but it is well documented that males have almost three times higher risk of developing severe disease, which was also reflected in the present study with 56% male participants having a severe disease.[17] The difference in gender distribution in our study may have been due a small study sample size. Hypertension was the most prevalent comorbidity overall in both the groups which was in consensus with a study done by Richardson et al in New York City[18]) A study conducted in China found out that patients with cardiovascular and metabolic diseases may face a greater risk of progressing into severe disease and causing much more impairment of lung functions and exercise capacity.[15] Also, association of disease severity with obesity is documented in various studies, which was highlighted in the present study with Group A having more number of participants with severe disease (9) as compared to Group B(7).[14] Hence, it becomes imperative to screen all COVID 19 patients for presence of comorbidities for a better disease outcome.

Lung function assessment was done using spirometry parameters [FEV_1 (%), FVC (%) and FEV_1/FVC (%)]. In the present study, only FVC (%) lung function parameter in Group B patients with a p value=0.04 and mean change of 3.67 ±8.78 % showed statistically significant difference. This was in consensus with a similar prospective cohort study done by Gloeckl et al in patients having Covid-19 infection with mild to critical disease, who were given 3-week inpatient pulmonary rehabilitation. The study demonstrated statistically significant improvement in FVC, mild and moderate disease patients showed 7.7% increase with p=0.002; severe and critical disease patients showed 11.3% increase with p<0.001).[4] However, no other lung function parameters in both the groups showed significant improvement. A possible reason can be that exercises included in pulmonary rehabilitation programme did not sufficiently target the lung function whereas they were focused more on physical strength and endurance. The disparity observed in change of lung function parameters amongst various studies can be explained by the variable designs and the intensity with which PR is given. The initiating point of PR from the time after discharge from hospital and the baseline severity of COVID- 19 infection with other factors like age, BMI, smoking status and comorbidities at baseline can also lead to the variations observed in lung function parameters.

Exercise capacity was estimated using six-minute walk test (6MWT). The present study showed more increase in 6-MWD in Group A (20.52 $\pm$ 32.19) meters after PR with p value<0.01 as compared to Group B where there was increase in 6MWD of 17.70 ± 40.57 meters with p value 0.03. The increase in Group A was higher as opposed to Group B which can be attributable to the fact that daily PR sessions were taken by Group A patients at home whereas twice weekly sessions were received by Group B patients in the hospital.

The present study findings of 6MWD correspond to the similar results published from Switzerland (Betschart et al), probably because of the same PR settings.[19] Present study corroborates with the results of previous studies emphasizing upon utility of pulmonary rehabilitation in improvement of exercise capacity as determined by 6MWD in Post COVID-19 patients. However, variation in its improvement in this study as compared to similar available literature can be due to variation in age of subjects, timing, duration and components of PR given to the patients. There are chances of recovery of lung function while study is ongoing and acute phase of disease has subsided which will lead to variation in results. There is lack of treatment control group in current study which impedes the evaluation of effect size of PR on 6-MWTD.

Dyspnea is the commonest problem faced by patients with chronic respiratory diseases. In such patients, to reduce the grade of dyspnea is an important objective of PR programmes. Baseline mMRC dyspnea grading was comparable between the two groups with p value 0.55. On inter group analysis of mMRC dyspnea grade, statistically significant difference was not observed (p=0.76), highlighting comparable reduction in dyspnea grade in both the groups post rehabilitation. In a similar study done in Italy to assess feasibility of telerehabilitation in survivors of COVID-19 pneumonia, the decrease in barthal index dyspnoea was 6.5 points above the MCID.[20] Another study conducted in Vienna to investigate the outcome of a PR programme on various primary and secondary end points related to lung functions in post covid patients showed statistically significant improvement in dyspnea grading(p value <0.001).[21] The variable effect of pulmonary rehabilitation on dyspnea grade can be explained by use of different designs of PR program and different assessment tools used to grade perception of dyspnea. Measuring dyspnea can be difficult as its perception varies with every patient. Thus, standard tools should be developed for future research which should also take into account the type of PR and its short term and long-term effects.

PR has been validated as a useful intervention in patients of respiratory illnesses such as COPD (Chronic Obstructive Pulmonary Disease), bronchiectasis and DPLD (Diffuse Parenchymal Lung Disease).[22] Current

study gives us valuable insight to the beneficial effects of this intervention in the patients with post-COVID-19 sequalae. However, few people are not able to attend the sessions in hospital due to various factors such as travel and transport. Such scenarios have led to the emergence of telemedicine and telerehabilitation where patient can get his treatment and pulmonary rehabilitation sessions from a faraway place with the help of communication and technology thus preventing any delay in their management. The present study has demonstrated the similar effects of PR on lung functions and exercise capacity in both the groups thus indicating towards the efficacy of the home-based PR in such patients. This study did not limit the findings only to critically ill patients but patients with mild to moderate disease were also included.

A key drawback of this study was limited sample size and study dropouts or lost to follow up subjects. Randomization for research purpose via computer generated system to either home based or hospital-based rehabilitation might have presented difficulties to patients who were not able to access pulmonary rehabilitation in hospital due to older age or any other reason. Another shortcoming of the study was that it had no control group; however, it can be explained by the fact that it might have been unethical to leave out any patients of the rehabilitation services who presented with post covid sequelae.

CONCLUSION

The data analyzed from the current study indicates that outcome of a structured, supervised PR program on lung functions and exercise capacity in post covid patients is similar in home based and hospital-based settings. Hence, we recommend home based PR as a viable alternative to hospital-based PR in patients who are not able to access the hospital services due to any reason. Even in low resource settings, it is a feasible, safe and beneficial option to improve lung functions and exercise capacity in patients with persistent sequelae post COVID-19 infection.

However, new strategies are continuously needed to be adapted and developed to cater need of this challenging population. To provide robust evidence on the effectiveness of exercise interventions, further larger randomized controlled trials should be conducted in this patient population.

Author Contribution: HA and SJ: Contributed to study conception, design, data collection, analysis, and manuscript preparation. **DA, MKS and VS**: Contributed to study conception, design, data analysis, and manuscript preparation.

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