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The Impact of Early Pulmonary Rehabilitation on Dyspnea, Quality of Life, and Symptoms in Moderate to Severe COVID-19 Pneumonia Patients

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Abstract

Introduction: COVID-19 pneumonia leads to dyspnea, persistent symptoms and poor quality of life. Inpatient pulmonary rehabilitation (PR) has limited evidence of effectiveness. Therefore, we aimed to determine the effect of a comprehensive inpatient PR program on dyspnea symptoms and quality of life in patients with COVID-19 pneumonia. Methods: A group pretest-posttest design was conducted in patients with COVID-19 pneumonia. Comprehensive PR was administered during hospitalization. Baseline dyspnea index (BDI), Transitional dyspnea score (TDI), Modified Medical Research Council score (mMRC), and St. George's Respiratory Questionnaire (SGRQ) were assessed at baseline, 4th week and 12th week after discharge. Results: In total, 28 patients were included (9 with oxygen supplementation, 19 without oxygen supplementation). The mean BDI at baseline was 7.82 ± 2.13. TDI scores at the 4th and 12th weeks were 5.14 ± 1.90 and 6.61 ± 1.59, respectively, with a significant difference observed between the 4th and 12th weeks ($p < 0.001$). Median mMRC scores at baseline, 4th week, and 12th week were 2(1.25 - 3), 1 (1 - 2) and 1 (0 - 1), respectively, showing a significant improvement between baseline vs 4th week, baseline vs 12th week, and 4th week vs 12th week ($p < 0.001$). The total SGRQ score exhibited a median (IQR) of 11.34 (7.88 - 8.58) at the 4th week and 6.93 (4.43 - 13.03) at the 12th week, demonstrating a statistically significant improvement ($p < 0.001$). No adverse events were reported during inpatient PR. Conclusion: Inpatient PR provides a safe and feasible profile, reduces dyspnea symptoms, and improves the quality of life in patients with moderate to severe COVID-19 pneumonia.

Keywords: Pulmonary rehabilitation, COVID-19, Pneumonia, SAR-CoV-2, Respiratory physiotherapy

Introduction

COVID-19 is a highly infectious respiratory disease caused by SARs-CoV-2 virus, causing a global pandemic. Clinical presentation of COVID-19 varies a range, including mild disease with no evidence of viral pneumonia, moderate cases displaying clinical signs of pneumonia, severe cases featuring severe pneumonia and critical cases involving complications like respiratory failure, acute respiratory distress syndrome, thromboembolism, sepsis, and/or multiorgan failure [1,2]. The possible mechanisms causing hypoxemia are direct lung injury, endothelial dysfunction, thrombosis and collapsed lung tissue, leading to systemic inflammation and multiorgan dysfunction [3].

Individuals who recover from acute COVID-19 may have persistent symptoms such as respiratory symptoms, mental impairment, and cognitive dysfunction. The persistent symptoms are well-recognized as

post-COVID conditions or long-COVID, which affect the patient's quality of life for at least 1 year [4,5]. The pathogenesis of post-COVID conditions consists of long-term tissue damage, immune dysregulation, and autoimmunity. Factors related to post-COVID-19 conditions include multiple symptoms at 1st presentation, severity of illness, and co-morbidity [5].

Patients admitted to the hospital are often bedridden for extended periods, leading to an increased risk of complications associated with immobility. These complications may include a decline in cardiorespiratory endurance, impaired balance, and issues with muscles and joints, ultimately resulting in activity limitations [6].

Pulmonary rehabilitation is a comprehensive intervention and refers to a longitudinal process focused on promoting and optimizing functional status and minimizing the disability resulting from respiratory disease. Pulmonary rehabilitation provides beneficial effects for multiple respiratory diseases. Nevertheless, data on the safety and efficacy of rehabilitation in patients with COVID-19 during hospitalization are sparse. Pulmonary rehabilitation provides beneficial effects for multiple respiratory diseases. Clinical practice guidelines for pulmonary rehabilitation for COVID-19 are based on rationale regarding existing evidence from the previous coronavirus pandemic and other chronic pulmonary diseases [7-10].

A retrospective study shows that early rehabilitation in critically ill patients with COVID-19 is feasible and safe. Furthermore, the long-term effectiveness of pulmonary rehabilitation is needed to highlight the clinical implications [11]. The objective of this study is to prospectively evaluate the safety and impact of dyspnea symptoms of in-hospital pulmonary rehabilitation in patients with COVID-19 pneumonia.

Materials and methods

Study design and population

A group pretest-posttest study was conducted in patients who suffered pneumonia from the SARS-CoV-2 infection. Patients aged 18 to 70 years with good communication and cooperation, COVID-19 pneumonia diagnosed by radiologic evidence of pulmonary infiltration, and confirmation of SARS-CoV-2 infection by real-time polymerase chain reaction were included in this study. Exclusion criteria included patients who: 1) required oxygen supplementation with an oxygen fraction greater than 40 %; 2) had unstable hemodynamics or uncontrolled arrhythmia; 3) had pneumothorax or pneumomediastinum; 4) had deep vein thrombosis or pulmonary artery thromboembolism; 5) had a risk of bleeding; and 6) were pregnant. The eligible patients for this study were screened from a specific cohort ward for COVID-19 infection at Srinagarind Hospital, Khon Kean University, Thailand, between December 2021 and August 2022. Approval for this study was obtained from the Khon Kaen University Ethics Committee for Human Research (HE641539), and registration with the Thai Clinical Trials Registry was completed (TCTR20221227003).

Study procedure

The inpatient early pulmonary rehabilitation (PR) included 4 interventions, specifically positioning management, breathing training, early mobilization, and education. The patients engaged in early pulmonary rehabilitation under supervision and monitoring using a telemonitoring system by the respiratory physical therapist. Positioning, together with breathing training, was suggested to perform every day. Bedside mobilization was conducted 2 - 4 times a week under supervision.

Concerning the positioning management of patients, the selection of the position (e.g., semi-prone, half-lying, upright) was based on the principle of 'Good lung down for promoting oxygenation" (evident of chest X-ray) and the patients' responses such as $SpO_2 \geq 94$ %, heart rate (HR), and rating of perceived breathlessness (RPB) measured by the Borg CR10 scale. The individually selected position was advised to be maintained for at least 2 h in the morning, afternoon, and evening every day, and breathing training was also conducted in this selected position. Reevaluation of positioning selection was done in every visit to the patients, and change or modification was made as appropriate.

Regarding breathing training, with or without device-assisted breathing training, it was performed by the patients. The respiratory physical therapist made the decision to use device-assisted breathing training, taking into consideration the patient's response, including RPB, rating of perceived exertion (RPE), SpO_2, HR, breathing pattern, and the patient's preference. Without assisted breathing training, the slow deep breathing exercise (5 - 10 breath per set, 5 - 10 set per session), pulse lip breathing (5 - 10 breath per set, 5 - 10 set per session) and breathing control as appropriate. For device-assisted breathing training, the BreatheMAX® breathing device was used [12,13]. This device consists of 2 modes: Oscillated incentive

spirometry breathing (OIS) and oscillated positive expiratory pressure breathing (OPEP). The device-assisted breathing training consisted of OIS (inspiratory load setting 2 - 5 cm H_2O) and OPEP (expiratory load setting 4 - 6 cm H_2O). In OIS breathing, the patients were instructed to take a slow deep inspiration through the device (5 - 10 breaths per set, 5 - 10 sets per session). In OPEP breathing, the patients blow through the device with slow and steady expiratory flow rate with inspiratory and expiratory time ratio (I:E) of 1:2 - 3 (5 - 10 breath per set, 5 - 10 set per session). Appropriate breathing control was also emphasized during the device-assisted training. The breathing training was suggested to carry out 3 sessions/day (morning, afternoon and evening) every day.

Regarding early mobilization, it commenced with upright positioning, progressed to bedside sitting, then standing, finally advanced to bedside walking on the spot and walking around the ward while continuously monitoring vital signs. Moreover, all the patients were educated in monitoring their vital signs during activities and exercise programs as well as advice about dyspnea management, e.g., pulse lip breathing, and breathing control during activities.

Before discharge, all patients underwent an assessment of the interventions they were currently performing, and a home pulmonary rehabilitation (PR) program was prescribed for them to continue the same program for the first 4 weeks. A follow-up reassessment was conducted at 4th week and modifications or progressions to the PR program were made based on the reassessment. A summary of the PR program is presented in **Table 1**.

Table 1 Summary of PR program.

Interventions	
Positioning management	**Position of sufficient oxygenation response**
Breathing training	***Without device*** Slow deep diaphragmatic breathing Purse lip breathing Breathing control ***With device-assisted (BreatheMAX®)*** OIS breathing OPEP breathing Breathing control
Early mobilization	upright positioning bedside sitting bedside standing bedside walking on the spot walking around the ward
Education	Monitoring of their vital signs Dyspnea management

Outcomes

The primary outcome measure was the transitional dyspnea index (TDI), which consists of 3 components based on its impact compared with the baseline dyspnea index (BDI). The score of TDI ranges from –9 to 9; the lower score indicates deterioration of dyspnea. The secondary outcomes included the modified Medical Research Council scale for dyspnea (mMRC), quality of Life assessment using the St. George's Respiratory Questionnaire (SGRQ) and self-reporting of persistent symptoms. In addition, any adverse events during the pulmonary rehabilitation were also noted. The assessments were done at baseline (1st-time inpatient visit), follow up at 4th week and 12th week of discharge.

Statistical analysis

Descriptive statistics were used to present the patient's demographic characteristics, such as mean and standard deviation, median and interquartile range (IQR) and number and percentage. Subgroup analysis was done based on the requirement of oxygen supplements during hospitalization. Before analysis, the data distribution was assessed using the Shapiro-Wilk test. Depending on the distribution, baseline and follow-up assessments were compared using a paired t-test or Wilcoxon sign rank test. A 1-sample t-test was applied to compare the difference between primary outcomes (TDI) using the MCID set at 1 [14]. All data were analyzed using SPSS version 27 and statistical significance was considered when $p < 0.05$.

Results and discussion

Twenty-nine patients who met the criteria were enrolled in this study. All the patients had completed the inpatient pulmonary rehabilitation program. One patient had a loss to follow up after discharge. Therefore, 28 patients were included in the analysis.

Demographic and baseline characteristics of the patients are shown in **Table 2**. Our patients' median (IQR) age was 53 (40 - 57) years. Nine out of 28 patients required oxygen supplementation: 2 Used low-flow nasal canular, 6 used high-flow nasal canular with FiO_2 less than 0.4 and 1 required non-invasive ventilation with a full-face mask interface. The median (IQR) of the duration of oxygen supplementation was 5 (3 - 6) days.

The mean TDI score, mMRC score, and SGQR score of all participants are presented in **Table 3**. The mean TDI score at the 4th and 12th week was 5.14 ± 1.90 and 6.61 ± 1.60, respectively. A significant improvement in the TDI score was observed between the 4th and 12th weeks ($p < 0.001$). The TDI score at the 4th week also showed a significant difference ($p < 0.001$) according to a 1-sample test (with MCID set at 1, as per Ubolsakka-Jones *et al.* [12]). The median (IQR) of mMRC score was 2 (1.25, 3) at baseline, 1 (1, 2) at the 4th week, and 1 (0, 1) at the 12th week. There was a significant difference in mMRC scores between baseline vs. 4th week ($p < 0.001$), baseline vs. 12th week ($p < 0.001$) and 4th week vs. 12th week ($p = 0.001$). The total SGRQ score showed a median (IQR) of 11.34 (7.88 - 8.58) at the 4th week and 6.93 (4.43 - 13.03) at the 12th week, respectively. A statistically significant improvement was found between the 4th and 12th week ($p < 0.001$).

For patients who did not require oxygenation supplementation, the mean TDI scores were 5.68 ± 1.53 and 6.89 ± 1.52 at the 4th and 12th week, respectively. The 1-sample t-test indicated a significant difference in the TDI score at the 4th week ($p = 0.003$) (with MCID set at 1 according to Ubolsakka-Jones *et al.* [12]). Additionally, a significant improvement in the TDI score was observed between the 4th and 12th weeks in non-oxygenation therapy patients ($p = 0.02$). The mMRC score had a median (IQR) of 2 (1, 2), 1 (1, 1) and 1 (0, 1) at baseline, 4th and 12th week for non-oxygenation therapy patients. There were significant differences in mMRC scores between baseline vs. 4th week ($p = 0.002$), baseline vs. 12th week ($p < 0.001$), and 4th vs. 12th week ($p = 0.008$). The total SGRQ score showed a median (IQR) of 10.97 (6.73 - 4.88) at the 4th week and 6.34 (4.20 - 9.32) at the 12th week for non-oxygen supplementation patients. A statistically significant improvement was found between the 4th and 12th week ($p < 0.001$).

For patients requiring oxygen supplementation, the mean TDI scores at the 4th and 12th week were 4 ± 2.18 and 6 ± 1.66, respectively. A significant improvement was observed through the 1-sample t-test at the 4th week for the TDI score ($p < 0.001$) (with MCID set at 1 according to Ubolsakka-Jones *et al.* [12]). Similarly, a significant improvement in the TDI score for oxygenation therapy patients was noted between the 4th and 12th weeks ($p = 0.012$). The mMRC scores had a median (IQR) of 3 (2.5), 2 (0.5, 2), and 1 (0.5, 2) at baseline, 4th and 12th week for patients on oxygenation therapy. There were significant differences in mMRC scores between baseline vs. 4th week ($p = 0.016$), baseline vs. 12th week ($p = 0.007$) and 4th week vs. 12th week ($p = 0.046$). The total SGRQ score showed a median (IQR) of 10.97 (6.73 - 4.88) at the 4th week and 6.34 (4.20 - 9.32) at the 12th week for patients on oxygen supplementation. A statistically significant improvement was found between the 4th and 12th week ($p = 0.008$).

The data on self-reported symptoms is displayed in **Figure 1**. At baseline, the majority of symptoms were cough (89 %), fever (82 %), and dyspnea (75 %). The most common symptoms at both the 4th and 12th week were cough, dyspnea, and phlegm production. A significant reduction in self-reported symptoms was observed when comparing baseline to the 4th week, baseline to the 12th and 4th week to the 12th week.

Table 2 Demographic and baseline characteristics of the patients.

Characteristics	**Total (n = 28)**	**Non-oxygen supplementation (n = 19)**	**Oxygen supplementation (n = 9)**
Age, years	53 (40 - 57)	48 (38 - 57)	56 (52 - 59)
Female, n (%)	12 (42.9 %)	9 (47.4 %)	3 (33.3 %)
BMI, $kg.m^{-2}$	26.9 (24.5 - 30.9)	27.1 (23.6 - 31.2)	26.8 (25 - 29.2)
Smoking status			
Never/current/former	16/11/1	12/7/0	4/4/1

Characteristics	Total (n = 28)	Non-oxygen supplementation (n = 19)	Oxygen supplementation (n = 9)
Duration			
Between the 1st symptom to admission days (days)	3 (2 - 4)	3 (2 - 4)	3 (2 - 8)
Hospital stays (days)	9 (7 - 11)	8 (7 - 10)	13 (8.5 - 26)
Hospital admission to the 1st PR session (days)	3.5 (2 - 5.7)	3 (2 - 4)	7 (3.5 - 9.5)
Comorbidities prior to COVID-19, n (%)			
Coronary heart disease	4 (14.3 %)	1 (5.3 %)	3 (33.3 %)
Stroke	1 (4.8 %)	1 (5.3 %)	-
Hypertension	14 (50 %)	9 (47.4 %)	5 (55.6 %)
Diabetes	11 (39.3 %)	6 (31.6 %)	5 (55.6 %)
Chronic kidney disease	8 (28.6 %)	4 (21.1 %)	4 (44.4 %)
Asthma	1 (3.6 %)	1 (5.3 %)	-
Post kidney transplant	3 (10.7 %)	1 (5.3 %)	2 (22.2 %)
ROX index	21.0 (17.4 - 13.5)	22.8 (20.7 - 23.5)	26.8 (25 - 29.2)
CRP, mg. L^{-1}	18.0 (8.5 - 53.4)	12.3 (5.6 - 24.5)	56.7 (22.3 - 99.2)
Radiologic parameter, n (%)			
Ground-glass opacity	23 (82.1 %)	16 (84.2 %)	7 (77.8 %)
Consolidation	4 (14.3 %)	1 (5.3 %)	3 (33.3 %)
Reticulation	9 (32.1 %)	6 (31.6 %)	3 (33.3 %)
Diffuse abnormalities	3 (10.7 %)	-	3 (33.3 %)
Multifocal abnormalities	16 (57.1 %)	12 (63.2 %)	4 (44.4 %)
Focal abnormalities	7 (25 %)	6 (31.6 %)	1 (11.1 %)
Severity of pneumonia (WHO Ordinal scale)			
Moderate pneumonia (WHO Ordinal scale 3 or 4), n (%)	21 (75 %)	19 (100 %)	2 (22.2 %)
Severe pneumonia (WHO Ordinal scale 5), n (%)	7 (25 %)	-	7 (77.8 %)

Note: Data are presented as number with percentage, median with interquartile range (IQR). BMI: Body Mass Index; COVID-19: Coronavirus disease 2019; COPD: Chronic obstructive pulmonary disease; ROX index: Respiratory rate-oxygenation ratio; CRP: C-reactive protein; PR: Pulmonary rehabilitation.

Table 3 The comparison of TDI, mMRC and SGQR at baseline, 4th and 12th week.

Parameters	Total (n = 28)			Non-oxygen supplementation (n = 19)			Oxygen supplementation (n = 9)		
	Baseline	4th week	12th week	Baseline	4th week	12th week	Baseline	4th week	12th week
BDI	7.82 ± 2.13	N/A	N/A	8.53 ± 1.61	N/A	N/A	6.33 ± 2.40	N/A	N/A
TDI	N/A	5.14 ± 1.90	6.61 ± 1.60*	N/A	5.68 ± 1.53	6.89 ± 1.52*	N/A	4 ± 2.18	6 ± 1.66*
mMRC	2 (1.25,3)	1 (1,2)#	1 (0,1)b,*	2 (1,2)	1(1,1)#	1 (0,1)b,*	3 (2.5)	2 (0.5,2)#	1 (0.5,2) b, *
SGQR									

Parameters	Total (n = 28)			Non-oxygen supplementation (n = 19)			Oxygen supplementation (n = 9)		
	Baseline	4th week	12th week	Baseline	4th week	12th week	Baseline	4th week	12th week
Total	N/A	11.34 (7.88 - 8.58)	6.93* (4.43 - 13.03)	N/A	10.97 (6.73 - 4.88)	6.34* (4.20 - 9.32)	N/A	18.86 (8.66 - 45.39)	13.54* (4.02 - 17.21)
Symptoms	N/A	17.04 (11.10 - 26.01)	10.88* (6.32 - 15.54)	N/A	15.31 (10.57 - 26.01)	10.88* (6.32 - 15.12)	N/A	22.48 (17.30 - 48.06)	10.88* (8.44 - 22.38)
Activity	N/A	20.30 (11.16 - 30.99)	11.91* (5.25 - 22)	N/A	17.37 (11.16 -29.49)	11.86* (5.25 - 17.37)	N/A	23.53 (14.29-63.32)	17.12* (5.58 - 32.49)
Impact	N/A	3.99 (1.64 - 8.75)	0.81* (0 - 5.21)	N/A	3.55 (0 - 7.35)	0* (0 - 3.32)	N/A	8.78 (2.85 - 30.61)	3.14* (0 - 15.30)

Note: Data are presented as mean with standard deviation (SD) and median with interquartile range (IQR).
BDI: Baseline dyspnea index; TDI: Transitional dyspnea index, mMRC: Modified Medical Research Council scale for dyspnea; SGQR: St. George's Respiratory Questionnaire; N/A: Not applicable or not available.
$^{\#}p < 0.05$ between baseline versus 4th week, by Wilcoxon singed rank test.
$^{\beta}p < 0.05$ between baseline versus 12th week, by Wilcoxon singed rank test.
$^{*}p < 0.05$ between 4th week versus 12th week, by paired t-test for TDI and Wilcoxon singed rank test for mMRC & SGRQ.

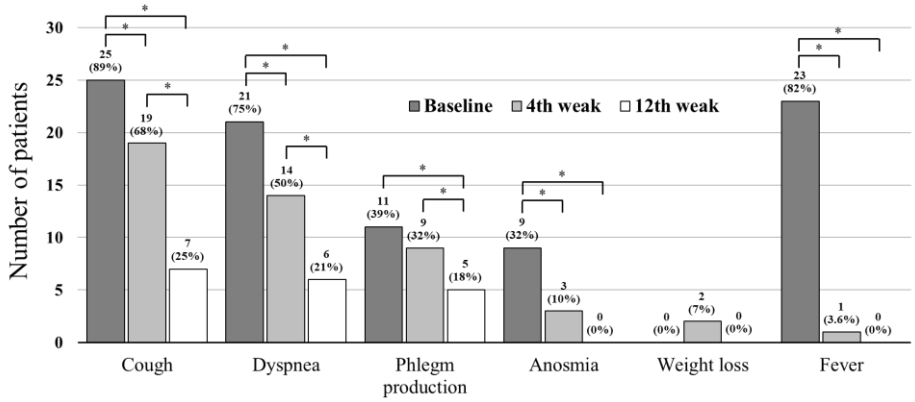

Figure 1 Self-reported remaining symptoms among patients with COVID-19 pneumonia (n = 28)
Data are presented as numbers and percent. $^{*}p$-value < 0.05 by Pearson Chi^2.

Discussion

Our study illustrated the impact of early pulmonary rehabilitation of moderate to severe COVID-19 pneumonia, beginning with inpatients in isolation wards and extending for 12 weeks post-discharge. The findings revealed improvements in dyspnea, quality of life and overall symptoms in these patients.

Dyspnea is among the most common symptoms observed in both acute and post-COVID pneumonia cases [15]. In our study, we utilized the TDI and mMRC scores to assess the dyspnea symptoms in our patients. Both scores demonstrated improvements in dyspnea at the 4th and 12th weeks compared to baseline, as well as at the 12th week compared to the 4th week regardless of oxygen therapy.

The majority of non-critical COVID-19 pneumonia survivors exhibited impaired lung diffusion capacity, measured 6 weeks post-discharge by DLCO [16]. Additionally, higher regional ventilation inhomogeneity, potentially linked to dyspnea, was reported in post-COVID patients [17]. Both factors may contribute to dyspnea in post-COVID patients. Therefore, the observed improvement in dyspnea in our study may be attributed to enhancements in lung diffusion capacity and a reduction in ventilation inhomogeneity.

A previous prospective observational cohort study conducted by Gloeckl *et al*. [18], focusing on post-acute mild to critical COVID-19 patients, reported a significant improvement in exercise capacity after a 3-week pulmonary rehabilitation program. Existing evidence suggests a negative correlation between dyspnea and exercise capacity in post-COVID-19 patients [19]. In other words, as dyspnea improves, exercise capacity tends to increase. Therefore, our findings of improvement in dyspnea align with and support the results of the aforementioned study.

The SGRQ is a measure of quality of life and comprises 3 components: Symptoms, activity and impact. A higher score on the SGRQ indicates poorer health [20]. Our study observed a reduction in SGRQ scores, irrespective of their need for oxygen supplementation, after the 12th week of our PR program. This

suggests that our early PR program, initiated during inpatient rehabilitation, improves the quality of life for post-COVID patients.

Mundy *et al.* [21] investigated the outcomes of early mobilization conducted in patients admitted for community-acquired pneumonia. The findings revealed a decrease in hospitalization duration and associated expenses, with no reported adverse incidents [21]. Our early inpatient mobilization within the PR program similarly demonstrated no adverse events during the study. Therefore, it is reasonable to affirm that the PR program, incorporating early mobilization, is safe for both inpatient acute-COVID and post-COVID pneumonia patients.

Cough, fatigue, and dyspnea are the most common persistent symptoms reported among patients who survive acute COVID-19. These symptoms can remain or even emerge 12 months after discharge from the hospital [22,23]. In our study, cough and dyspnea were the most common persistent symptoms reported among patients in baseline and remained the most prevalent symptoms at both the 4^{th} and 12^{th} week assessments. A noteworthy finding was the substantial reduction in self-reported symptoms after the PR program, as indicated by comparisons between baseline and the 4^{th} week, baseline and the 12^{th} week, as well as the 4^{th} and 12^{th} week. These comparisons highlight the effectiveness of the PR intervention in alleviating patient-reported symptoms over the course of the study. Similarly, patients' reported respiratory symptoms were also improved after an 8-week program in 6 - 8 weeks post-hospital discharged COVID patients [24].

Our findings emphasize the additional benefits of pulmonary rehabilitation in reducing dyspnea symptoms and improving quality of life. It is important to note that our study was designed as a single-arm prospective study, introducing the possibility that the observed improvement in symptoms could be attributed to the natural convalescence of COVID-19. In a 1-year follow-up study conducted by Scaramuzzo *et al.*, approximately 45 % of patients with post-COVID-19 pneumonia experienced new-onset dyspnea [17]. Notably, in contrast, none of the patients in our study reported new or worsening dyspnea symptoms following our early pulmonary rehabilitation program. This suggests that the relief in dyspnea observed in our study is likely a consequence of the effects of PR rather than the natural convalescence of COVID-19.

The absence of available data hindered our study's sample size calculation. However, a post hoc power analysis, based on the mean and standard deviation of the improvements in TDI compared with the MCID, indicated a larger effect size of 2.18 at 4^{th} week and 3.51 at 12^{th} week. These values suggest that the sample size in our study is sufficient to draw meaningful conclusions.

We acknowledge the limitations of our study. Firstly, our study was a single-arm prospective design without a control group because of ethical concerns during the COVID-19 pandemic. Accordingly, we could not demonstrate the effect of inpatient rehabilitation on the reduction of hospital stays. Secondly, according to the infectious control policy, we could not assess the exercise capacity due to the limitation of the facility in our institution.

Conclusions

Initiating an early pulmonary rehabilitation program, starting from inpatient, is safe and can improve dyspnea, quality of life and patients' reported symptoms in patients with moderate to severe COVID-19 pneumonia. Therefore, implementing a pulmonary rehabilitation program can be considered soon after admission.

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