



Original Article

Combined effect of pulmonary rehabilitation and music therapy in patients with chronic obstructive pulmonary disease

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Abstract. [Purpose] We aimed to analyze parameters of pulmonary function and physiological, psychological, and physical factors in patients with chronic obstructive pulmonary disease (COPD) receiving pulmonary rehabilitation (PR) and music therapy (MT). [Participants and Methods] This randomized crossover comparative study included in-patients diagnosed with COPD and a ratio of forced expiratory volume measured at the first second and forced vital capacity (FEV1/FVC) of <70% after administration of a bronchodilator. Patients were randomly divided into two groups that received either PR only or MT and PR (n=13 each). The PR program included conditioning, respiratory muscle training, and endurance training, whereas the MT program included vocal, singing, and breathing exercises using a keyboard harmonica. The programs lasted 8 weeks, in which pre- and post-intervention data were compared every 4 weeks. [Results] The FEV1/FVC in the MT group improved after the intervention. Expiratory volume control was obtained better with feedback by sound than with expiration practice. In the MT and PR program, it was easier to adjust the timing and volume of breathing, obtain expiratory volume control, and, thus, improve FEV1/FVC than in conventional practice. [Conclusion] Combining MT with PR improves parameters of pulmonary function in patients with COPD. Music therapy is a novel approach that, in combination with PR, may be used in COPD management.

Key words: Chronic obstructive pulmonary disease, Music therapy, Pulmonary rehabilitation

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INTRODUCTION

In patients with chronic obstructive pulmonary disease (COPD), activities of daily living are restricted owing to depression and anxiety associated with dyspnea¹. Depression occurs in 48.6% of patients, and its prevalence increases with an increase in body mass index, airway obstruction, dyspnea, and exercise tolerance (BODE index)². Depression and anxiety decrease the quality of life (QOL) of patients with COPD and are associated with mortality³, and a decreased exercise tolerance leads to a higher risk of hospitalization and readmission, further increasing mortality⁴.

Pulmonary rehabilitation (PR) improves exercise tolerance, health-related QOL (HRQOL), and dyspnea, and also reduces depression and anxiety, as evidenced in the Global Initiative for Chronic Obstructive Lung Disease⁵. It increases exercise

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endurance and, according to HRQOL, significantly improves dyspnea⁶. Regarding the differences in effectiveness between exercise therapy and a combination of exercise therapy and psychosocial intervention, a combined intervention has a greater effect on shortness of breath, anxiety, depression, HRQOL, and exercise tolerance⁷. Music therapy (MT) can improve depression and anxiety in patients and has a beneficial effect compared with conventional treatments alone⁸. A meta-analysis comparing preoperative, intraoperative, and postoperative effects of MT showed a decrease in postoperative pain and anxiety, a decreased use of analgesics, and an increase in patient satisfaction⁹. In a study examining the effects of singing on patients with cystic fibrosis, an increase in maximum expiratory pressure (an index of respiratory muscle strength) was observed in the singing group¹⁰. Passive music therapy for asthmatic patients, with the combined effect of MT and PR, seems to improve their respiratory efficiency due to their effect on their mental state¹¹. In a systematic review of 415 patients with COPD receiving MT, auditory stimulation using music reduced dyspnea and improved exercise tolerance¹². Singing, listening, and playing a musical instrument have shown positive effects on the QOL and improvements in physiological indicators such as forced expiratory volume in one second (FEV_{1,0}) and forced vital capacity¹³. In the singing instruction program, the Short Form-36, a validated HRQOL tool, showed improved physical condition, anxiety score, breath-holding times, and shuttle walking¹⁴. MT deliberately uses music to recover mental and physical disabilities, maintain and improve functions, improve QOL, and transform behaviors. MT for COPD includes pursed-mouth and abdominal breathing, vocal therapy through singing, respiratory control vocalization, and whistle performance as active MT.

There are many previous studies in which clinical effects of PR and MT alone have been observed, but there are few reports showing the combined effects of PR and MT. Considering that PR and MT can have a positive clinical effect on patients with COPD, we hypothesized that a combination of PR and MT could improve parameters of pulmonary function, and the physiological, psychological and physical factors of COPD.

The purpose of this study was to assess improvements in parameters of lung function, physiological, psychological and physical factors in patients with COPD receiving PR and MT.

PARTICIPANTS AND METHODS

We included patients who were hospitalized and diagnosed with COPD. Patients with less than 70% of the FEV_{1,0}/forced vital capacity ratio (FEV_{1,0}%) after bronchodilator administration were included. Patients with other airflow disorders, severe comorbidities, neuropathy, advanced dementia, severe mental illness, or unstable heart disease were excluded. Patients were randomly divided into a PR only intervention group and an MT combination group using a random number table. Of the 21 patients, data were analyzed from thirteen patients. The reasons for exclusion were that patients were discharged from hospital. Thirteen patients were included in the PR only group and thirteen in the MT combination group. This study was performed with the approval of the Tokyo Chidori Hospital Ethics Committee, the Shimousa Hospital Ethics Committee, and the Tokyo Metropolitan University Arakawa Campus Research Safety Ethics Committee.

These studies were conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All included patients provided written informed consent.

This was a randomized crossover comparative study. Randomized controlled trials help improve the functioning of patients with COPD affected by PR and MT. Randomization offers one important advantage over all other methodologies. It equalizes known and unknown prognostic factors between treatment groups. The sample size analysis was calculated using G*Power¹⁵) (version 3.1.9.2, Heinrich Heine University, Düsseldorf, Germany), and a sample size of 24 was needed to detect a medium effect size ($f=0.25$) with 0.80 power ($1-\beta$) at the 0.05 significance level. The PR program lasted 40 minutes and consisted of conditioning (breathing instruction, thoracic range of motion exercise, and stretching), respiratory muscle training (abdominal breathing using weights, abdominal drawing, and inspiratory and expiratory muscle training), strength training (of lower and upper limbs and trunk), and endurance training (walking, stepping up and down, bicycle ergometer, and treadmill) for 10 minutes each. The MT program lasted 20 minutes. Vocalization practice was performed with the aim of increasing voice volume, expanding range, and extending the duration of vocalizations. The practice first used a song with a short breath interval, and then the timing was adjusted. Exhalation practice with the keyboard harmonica aimed to maintain exhalation over three beats per note, gradually increasing the number of beats. The level of difficulty increased from simple songs with favorite music to Japanese ballads and popular songs that varied greatly in length. The exhalation duration was measured regularly, and the timing of breathing and the number of sounds were set individually. The load was set to a modified Borg scale of 4–5. The patients had the impression that they were able to continue or enjoy the training by adjusting to their favorite music. For the study procedures, the PR group performed 40 minutes of the PR program and 20 minutes of leisure activities while sitting (handicraft, reading, or watching television), whereas the combination group participated in 40 minutes of the PR program and 20 minutes of the MT program. After four weeks, the patients in each group were exposed to a different intervention. Patients completed a total of eight weeks of the program and compared pre- and post-intervention data between the four weeks of each section.

Evaluation items included age, body mass index, spirometry results, modified British Medical Research Council score, Self-rating Depression Scale score, State-Trait Anxiety Inventory result, COPD Assessment Test result, General Self-Efficacy Scale score¹⁶), 6-minute walk distance (6MWD), and the Nagasaki University Respiratory Activities of Daily Living score¹⁷).

Pulmonary function tests were performed three times using a spirometer (AS-307; Minato Medical Science, Osaka, Japan)

according to the respiratory function test guidelines of the Japanese Respiratory Society. The best results were used.

Statistical analysis was performed using a Student's t-test to compare basic attributes between the two groups. Outcomes before and after the intervention were analyzed using a two-way repeated measures analysis of variance. A Tukey's simple main effect test was performed using different combinations including group and time course. SPSS (version 26; IBM, Armonk, NY, USA) was used for calculations, and the significance level was set to 5%.

RESULTS

No significant differences were found in basic patient characteristics (Table 1). In the two-way analysis of variance, interaction was observed for FEV_{1.0}% (Table 2). The simple main effect test showed a significant improvement in FEV_{1.0}% in the MT group after the intervention (Table 2). The modified British Medical Research Council score, 6MWD, and the Nagasaki University Respiratory Activities of Daily Living score showed significant main effect with time (Table 2). No significant differences were observed in scores of the Self-rating Depression Scale, State-Trait Anxiety Inventory, COPD Assessment Test, and General Self-Efficacy Scale (Table 2).

DISCUSSION

The purpose of this study was to assess improvements in parameters of lung function, physiological, psychological and physical factors in patients with COPD receiving MT and PR. Patients completed a total of eight weeks of the program and

Table 1. Basic participant characteristics

	PR-only group (n=13) mean ± SD	MT combination group (n=13) mean ± SD	p value
Age (years)		72.8 ± 12.9	-
BMI (kg/m ²)		21.2 ± 5.1	-
FEV _{1.0} %	58.2 ± 10.2	52.8 ± 11.3	0.12
%FEV _{1.0}	45.9 ± 15.4	39.3 ± 14.1	0.13
GOLD stage: n	II: 5, III: 6, IV: 2	II: 5, III: 4, IV: 4	

PR: pulmonary rehabilitation; MT: music therapy; SD: standard deviation; BMI: body mass index; FEV_{1.0}: forced expiratory volume in one second; FEV_{1.0}%; FEV_{1.0}/FVC ratio; %FEV_{1.0}: percent predicted forced expiratory volume in one second; GOLD: Global Initiative for Chronic Obstructive Lung Disease.

Table 2. Two-way ANOVA results before and after the intervention

Period	PR-only group (n=13)		MT combination group (n=13)		Main effect (p value)		Interaction (p value)
	Before	After	Before	After	Between groups	Time	
FVC [L]	1.93 ± 0.5	1.92 ± 0.5	1.85 ± 0.5	1.98 ± 0.5	0.97	0.71	0.67
FEV _{1.0} [L]	1.11 ± 0.4	0.98 ± 0.3	0.93 ± 0.3	1.29 ± 0.5	0.61	0.36	0.05
FEV _{1.0} %	58.27 ± 10.2	55.69 ± 10.8	52.84 ± 11.3	64.94 ± 11.6	0.55	0.14	0.02*
%FEV _{1.0}	45.94 ± 17.7	40.70 ± 14.8	39.31 ± 14.1	52.09 ± 19.0	0.62	0.43	0.06
PEF [L/s]	2.02 ± 1.1	1.85 ± 1.0	1.53 ± 0.8	2.47 ± 1.2	0.83	0.23	0.08
mMRC	1.76 ± 1.0	1.38 ± 0.8	2.00 ± 1.0	1.23 ± 0.8	0.88	0.04*	0.49
SDS	41.07 ± 10.9	39.61 ± 9.8	39.07 ± 10.2	37.07 ± 9.4	0.55	0.44	0.92
STAI [State]	38.76 ± 10.5	42.46 ± 9.1	39.61 ± 9.6	37.69 ± 11.8	0.51	0.76	0.35
STAI [Trait]	41.07 ± 13.4	40.15 ± 12.3	40.38 ± 10.6	38.92 ± 13.5	0.79	0.74	0.94
CAT	9.00 ± 7.0	9.76 ± 8.2	11.23 ± 7.1	8.30 ± 6.8	0.85	0.61	0.38
GSES	8.30 ± 4.3	7.69 ± 4.8	8.92 ± 4.4	8.15 ± 5.0	0.69	0.61	0.95
6MWD [m]	252.60 ± 67.1	291.25 ± 73.4	233.05 ± 75.9	306.30 ± 63.0	0.92	0.02*	0.46
NRADL	78.92 ± 7.2	84.30 ± 8.0	78.15 ± 9.1	83.84 ± 6.8	0.78	0.01*	0.94

Results presented as mean ± standard deviation. PR: pulmonary rehabilitation; MT: music therapy; FVC: forced vital capacity; FEV_{1.0}: forced expiratory volume in one second; FEV_{1.0}%: FEV_{1.0}/FVC ratio; %FEV_{1.0}: percent predicted forced expiratory volume in one second; PEF: peak expiratory flow; mMRC: modified British Medical Research Council score; SDS: Self-rating Depression Scale; STAI: State-Trait Anxiety Inventory; CAT: COPD Assessment Test; GSES: General Self-Efficacy Scale; 6MWD: 6-minute walk distance; NRADL: Nagasaki University Respiratory Activities of Daily Living score.

pre- and post-intervention data were compared after four weeks of each intervention. A two-way analysis of variance showed that FEV_{1.0}% had a significant interaction effect. The simple main effect test showed a significant improvement in FEV_{1.0}% in the MT group after the intervention.

In patients with COPD, airway obstruction and FEV_{1.0} reduction clearly progress because diaphragm function is reduced during exertion due to dynamic lung hyperinflation as a result of airflow restriction, and it is not possible to inhale sufficiently compared to respiratory movement inhalation. As a result, lung expansion occurred because of air trapping¹⁸). FEV_{1.0} is significantly correlated with tidal volume and minute ventilation during maximum exercise, and a decrease in FEV_{1.0} reflects a decrease in ventilation capacity. The limit of one's ventilation capacity exceeds minute ventilation requirements, causing dyspnea¹⁹).

In the MT group, the peak expiratory flow increased from 1.53 L/s to 2.47 L/s, and FEV_{1.0} increased from 0.93 L to 1.29 L. FEV_{1.0}% showed a significant improvement from 52.84% to 64.94%, showing an interaction effect. As chest wall compliance and lung elasticity decrease, more respiratory muscles are engaged. Respiratory muscle strengthening helps minimize the physical changes related to chest wall compliance. In previous studies, peak expiratory flow improved with expiratory strength training²⁰). In response to sound feedback, expiratory volume control was easier to obtain than by expiration practice, and long-term breathing exercises using singing and the keyboard harmonica, combined with increased airway pressure and abdominal breathing functions, improved the functions of the intercostal muscles and diaphragm. Previous studies have reported that acoustic rhythms are related to motor rhythms and highlight a pull-in synchronization phenomenon²¹). The volume changes according to the expiratory volume under sound feedback making it easier to adjust the timing and volume of breathing and to obtain expiratory volume control compared with the conventional exhalation practice at the threshold, improving FEV_{1.0}%. Using concomitant MT enabled the continuation of the monotonous exhalation practice and made it possible to suppress air trapping and reduce lung hyperinflation. Improved FEV_{1.0} and ventilation capacities led to reductions in dyspnea (the modified British Medical Research Council score improved from 2.00 to 1.23) as 6MWD improved in the MT group from 233 m to 306 m.

Classified the 6MWD of COPD patients into three groups: 350 m or more, 250–349 m, and 249 m or less, thereafter examining the survival rate of each group²²). As a result, the survival rates nine years after the start of the survey were 66%, 46%, and 26% in the 350 m or more, 250–349 m, and 249 m or less groups, respectively. It was reported that the survival rate decreased as the walking distance shortened. In addition, Examined 6MWD results and survival rates and reported that those who had an improved 6MWD after respiratory rehabilitation had higher survival rates²³). Therefore, promoting more efficient improvement of 6MWD is expected to lead to improvement of survival rate. This study suggests that PR alone may help improve dyspnea and physical scores, but the addition of MT was more effective at improving 6MWD, indicating effective treatment. In this study, there were no significant differences in depression and anxiety, which were expected to improve. Zung²⁴) set the cut-off value for the Self-rating Depression Scale to 40 points, considering 40–47 points reflective of mild depression, 48–55 points reflective of moderate depression, and 56 or more points reflective of severe depression. The cut-off value of the State-Trait Anxiety Inventory, is 45 points and 55 or more points reflects high anxiety²⁵). The Self-rating Depression Scale score before intervention was mean 41.07 points in the PR group and 39.07 points in the MT group. The State Anxiety Inventory score was 41.07 points in the PR group and 40.38 points in the MT group, and the Trait Anxiety Inventory score was 41.07 points in the PR group and 40.38 points in the MT group. The reason improvement was not observed after the intervention maybe that the patients' depression and anxiety levels were low before the intervention.

To conclude, combining MT with PR improved parameters of pulmonary function in patients with COPD. The use of music for therapy is a novel approach that in combination with PR could be useful for treating COPD in patients.

This study did not assess 6MWD changes and viability, thus further studies are needed to track, investigate, and clarify this information. A limitation of this study is the limited statistical power due to the small sample size. Therefore, it is important to be cautious when interpreting these results, and further study with increased sample size is required.

Conference presentation

A summary of this study was presented at the International Conference on Nursing 2019, Rome, Italy. 24th October 2019.

Trial registration

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Funding and Conflict of interest

None.

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