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Effects of creative dance on functional capacity, pulmonary function, balance, and cognition in COPD patients: A randomized controlled trial

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A B S T R A C T

Background: Exercise training is key to the comprehensive management of patients with chronic obstructive pulmonary disease (COPD). Creative dance can be an innovative approach as effective as traditional exercise training.

Objectives: This study aimed to investigate effect of creative dance-based exercise (CDE) training on functional capacity, postural stability and balance, pulmonary and cognitive functions, respiratory and peripheral muscle strength in COPD patients.

Methods: Twenty-four patients with COPD were randomly allocated to either "chest physiotherapy and home-based walking program" (PT) or "CDE alongside home-based chest physiotherapy group" (PT+CDE). Both groups performed chest PT program twice a day for 5 days per week for 8 weeks. PT+CDE group received CDE training 2 days a week for 8 weeks. Primary outcome was six minute walk test (6MWT). Secondary outcomes were postural stability and balance, pulmonary function, maximum inspiratory (MIP) and expiratory (MEP) pressure, peripheral muscle strength, Montreal Cognitive Assessment (MoCA), COPD Assessment Test (CAT), and BODE index. Outcome measures were assessed at baseline and after 8 weeks of training.

Results: Both groups showed statistically significant improvements in 6MWT distance, MIP, MEP, MoCA score, CAT, and BODE index ($p < 0.05$). Only with CDE training was achieved improvements in postural stability and balance scores, pulmonary function, and peripheral muscle strength ($p < 0.05$). The improvements in 6 MWT distance, MEP, MoCA score, and CAT were greater in PT+CDE group ($p < 0.05$).

Conclusion: Use of creative dance training in addition to home-based chest PT program was more effective than chest PT program regarding primary and secondary outcomes in COPD patients.

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the main causes of high mortality and morbidity, a common, preventable, and treatable disorder characterized by progressive and irreversible airflow obstruction and has systemic effects other than respiratory system involvement. Pathophysiological changes in the respiratory system may cause decrease in pulmonary function, peripheral and respiratory muscle strengths, and functional capacity.[1,2] Recent studies have explored decline of cognitive functions and balance highlighted these findings as extrapulmonary features for chronic lung diseases.[3,4]

The importance of multidisciplinary and comprehensive pulmonary rehabilitation (PR) program is emphasized in the management of the disease in the guidelines and individualized exercise training is a key component.[1] A number of studies have reported that different exercise training programs improve symptom management, functional capacity, peripheral and respiratory muscle strengths, and quality of life in the COPD population.[1, 5] However, adherence rate of participation in PR programs in patients with COPD is less than 50%;

Abbreviations: COPD, Chronic obstructive pulmonary disease

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it is reported that the rate of not completing the programs has reached up to 70%.[6] Therefore; there has been an increasing interest for an alternative and innovative approaches to motivate patients to exercise and participate in programs.

Dance is mentioned and recommended as an enjoyable physical activity that can be performed by individuals of all ages for improving health-related physical parameters and psychological well-being, preventing chronic diseases, and to contributing to treatment.[7] Dance, which is a holistic approach, is considered a form of aerobic exercise and can be applied as a group or individual training. Creative dance is a form of dance that offers participants opportunities to create their own movement expressions during movements, lacks standard movement patterns, and does not require prior dance training. Studies have reported enhancement in functional capacity, balance, body awareness, peripheral muscle strength, quality of life, and proprioception in healthy individuals.[8,9]

To the best of our knowledge, despite the potential effects and enjoyable characteristics of creative dance, there is no study that investigates the effect of creative dance in patients with COPD in the literature, and also, a limited number of studies have used dance as an exercise training method in COPD.[10] Thus, this study aimed to investigate the effect of creative dance-based exercise (CDE) training on functional capacity, postural stability, balance, pulmonary and cognitive functions, respiratory and peripheral muscle strength in patients with COPD.

Methods

Study design and subjects

This study was conducted as a prospective and randomized controlled study. Twenty-four patients who met the inclusion criteria among 29 COPD patients referred from the Department of Chest Diseases of a university hospital between March 2019 and January 2021 were included in the study. Criteria for selecting the subjects were as follows: Forced vital capacity (FVC) / forced expiratory volume at 1s (FEV_1) ratio of < 70%, age more than 18 years, and be able to read written and understand spoken language. The subjects who were unable to perform tests or exercises because of diagnosed comorbidities, had an exacerbation in the last 8 weeks, currently continuing or participating in a regular exercise training program within the last 1 year, and were treated with long-term oxygen excluded.

After the initial assessments, patients were randomized into two groups; either chest physiotherapy and home-based walking programme (PT group) (n=12) or CDE in addition to the PT group' program (PT+CDE group) (n=12) by using a computer-based program. The physiotherapist who assessed the patients was blind to group assignments. Another physiotherapist applied training programs to both groups. Both groups were given a home-based chest PT program for 8 weeks, 5 days a week, twice a day. In addition to the chest PT program, the patients in the CDE group received creative dance-based exercise training for 8 weeks, 2 days a week under the supervision of a physiotherapist who received creative dance instructor training. All evaluations were repeated at the end of eight weeks. Patients were instructed to keep an exercise and physical activity diary. Adherence to chest PT program (%) was defined as the ratio of the completed sessions to total sessions, which was calculated as "(Completed sessions)/(Total sessions = 80 sessions) multiplied by 100". On the other hand, compliance with physical activity recommendation (%) was defined as the ratio of the number of days of completed daily physical activity to the number of total days of the program, which was calculated as "(Number of days of completed daily physical activity recommendation)/ (Number of total days of the program = 56 days) multiplied by 100".

The study was conducted by the tenets of the Declaration of Helsinki and approved by the Ethics Committee of XX (Protocol number: XX), and registered to the ClinicalTrials.gov website (Registration Number: XX). Written informed consent was received from each patient.

Outcome measures

Primary outcome measures

The primary outcome was functional capacity determined by six minute walk test (6MWT).

Secondary outcome measures

The secondary outcomes were postural stability, balance, pulmonary and cognitive functions, respiratory and peripheral muscle strength, COPD Assessment Test (CAT), and BODE index.

The clinical and demographic characteristics of the patients were recorded.

Functional capacity

6MWT was applied by American Thoracic Society (ATS) criteria to determine the functional capacity of the patients.[11] Patients were instructed to walk as fast as possible at their own walking pace without running for 6 minutes in a straight corridor set at 30 m. Before and after the test, oxygen saturation (SpO_2), heart rate, blood pressure, respiratory frequency, dyspnea, and fatigue levels with Modified Borg Scale and leg pain with Visual Analog Scale were evaluated. Walking distance in 6 minutes was recorded as a meter (m).

Postural stability and balance

Postural stability and balance were evaluated with the valid and reliable device Biodex Balance System® (BBS; Biodex Medical Systems, Shirley, New York, United States of America).[12] Patients underwent three tests for BBS: Postural Stability Test (PST), Limits of Stability Test (LoST), and Test of Sensory Integration and Balance (TSIB). In PST; evaluate the ability of the person to maintain the gravity center of the body. Higher stability index results indicate worse postural stability. The purpose of LoST is to evaluate the ability to change and control the body's center of gravity between support surfaces. High scores correlate with good postural control. The purpose of the TSIB is to evaluate how different senses affect the maintenance of balance and how well they can maintain balance when one or more of these senses are eliminated. The test was performed on firm and foam surfaces with eyes open/closed and the oscillation index was calculated for each position. A high oscillation index scores reflect that the amount of oscillation is too much to maintain the balance.[12]

Pulmonary function

Pulmonary function test were performed according to ATS and European Respiratory Society (ERS) guidelines using the COSMED Pony FX (COSMED; Italy) spirometer device.[13] FVC, FEV_1, FEV_1/FVC, peak expiratory flow (PEF) and forced expiratory flow between 25% and 75% (FEF_{25-75}) were measured and expressed as percentages of the predicted values.

Cognitive function

Montreal Cognitive Assessment (MoCA) is a questionnaire developed to evaluate different cognitive functions and mild cognitive impairment. The maximum score that the patient can obtain from the test is 30, a score of 21 or above was considered as no mild cognitive impairment.[14] The test was administered by a physiotherapist who received training on application and scoring rules. The Turkish reliability and validity study of the MoCA was performed by Selekler et al.[15]

Respiratory muscle strength

Maximum inspiratory (MIP) and expiratory (MEP) pressures were measured by ATS/ERS criteria using an electronic, mobile, (MicroRPM, Micro Medical; UK) device.[16] A maximum value of three efforts that vary less than 5% was recorded as cm H_2O for inspiratory and expiratory pressures.[17]

Peripheral muscle strength

The muscle strength of the patients of the dominant extremity of M. Quadriceps was evaluated using a MicroFet 2 hand–held dynamometer (Hogan Health Industries Inc.) by the breaking method. The peak values of the dominant extremity of M. Quadriceps with three consecutive measurements were obtained and the best value was recorded as kg.[18]

COPD Assessment Test (CAT)

The CAT has been developed to inquire about the general health status and symptoms in COPD patients in a short time. In the test, eight questions evaluate the basic symptoms such as dyspnea perception, sputum, cough, and wheezing, as well as fatigue, daily living activities, sleep status, and energy status. Patients are asked to score each question between 0 and 5. A CAT total score of $>$ 20 indicates highly symptomatic.[19] The Turkish version of CAT was shown to be reliable and valid.[20]

BODE index

The BODE index was created to determine the mortality risk in patients with COPD. The BODE index consists of BMI (B), airflow obstruction severity (O), dyspnea perception (D), and exercise capacity (E).[21]

Interventions

Patients in both groups underwent a home-based chest PT program. The program consisted of diaphragmatic, chest, and bilateral segmental breathing exercises, incentive spirometer (IS) with Triflo®, the teaching of breathing control, relaxation of body positions, and coughing techniques. All breathing exercises were combined with pursed lip breathing. Exercises were applied as 2 sets with 5 repetitions, twice a day, 5 days a week, for 8 weeks by all patients. Patients using inhaled bronchodilators performed their exercises following medical treatment. The first session was performed under the supervision of a physiotherapist. In addition to the chest PT program; a minimum of 30 minutes on 5 days of moderate-intensity aerobic physical activity such as walking, cycling, swimming was recommended to each patient considering their interests to promote physical activity participation.[22]

The creative dance sessions comprised three main phases, namely, warm-up (10 minutes), the main phase consisting of locomotor and non-locomotor movements combined with elements of dance (25 minutes), and cool down (10 minutes). Modified Borg Scale (MBS) was used to prescribe exercise intensity for patients.[23] Perceived dyspnea and fatigue rating of 4–6 on the Modified Borg Scale was determined to be appropriate.[24]

The warm-up consisted of Brain Dance standing version to prepare both body and nervous system for action. The Brain Dance is based on eight developmental movement patterns (breath, tactile, core-distal, head-tail, upper-lower, body-side, cross-lateral patterns, and vestibular system) in the first year of life to evolve the central nervous system. Planning movement patterns in normal developmental stages at any age, in any position, or at any time as exercise can support the increase of oxygenation of the brain and the reorganization of the central nervous system. In the main phase; the exercises and movement concepts were varied for each session, following the book "Creative Dance for All Ages" written by Anne Green Gilbert who is the founder of creative dance. Creative dance focuses to compose own movement opportunities and expressing feelings rather than repeating an observed movement with the elements of dance which include body parts (head, neck, arms, hip, legs) movement (locomotor, non-locomotor), space (size, level, direction, pathway), time (tempo, rhythm) and force (energy). (Fig. 1) These dance elements were incorporated into sessions on weekly different themes. Themes and images given by the leader emphasize the creation of movement expressions that stimulate various abilities (flexibility, strength, balance, agility, coordination, and imagination). Finally, in the cool-down phase; the Brain Dance sitting version was used for breathing and stretching.[25] All dance sessions were planned and implemented as individuals.

Statistical analysis and sample size

SPSS v.26 (SPSS Inc., USA) program was used for data analysis. The normality of the distribution of data was analyzed using The Shapiro-Wilk Test. Categorical variables were compared between groups using Chi-square Test. Paired Sample T-test or Independent Samples T-test was used for intragroup comparisons and Wilcoxon or Mann-Whitney U test was used for between-groups comparisons depending on the distribution properties of the data. The statistical significance level was accepted as $p < 0.05$ for all analyzes. 95% confidence intervals (95% CI) were calculated and expressed as mean difference (MD) [(95% CI)] for each variable to estimate the statistical inference. The effect size (Cohen's d) were calculated, and Cohen's d results represent 0.8 large, 0.5 medium, and 0.2 small effect.[26]

The sample size was calculated using the G*Power 3.1 (Universitaet Dusseldorf, Germany).[27] Kaltsatou et al.[28] reported that the experimental group achieved a significant enhancement via dance therapy in 6MWT from 227.1 ± 106.2 meters to 328.4 ± 35.9 meters which has an effect size of 1.08 with the highest standard deviation among all variables. Since we did not find a study in which dance was performed in the COPD population or in chronic respiratory system diseases common with our primary outcome measure (6 minute walk test) for determining the sample size; the study which dance therapy was applied in patients with schizophrenia who were in the same age group as the patients in our study was selected. We estimated that a minimum of 12 patients should be included in each group to detect such an improvement in 6MWT via CDE with a 95% confidence level and 80% power in our study.

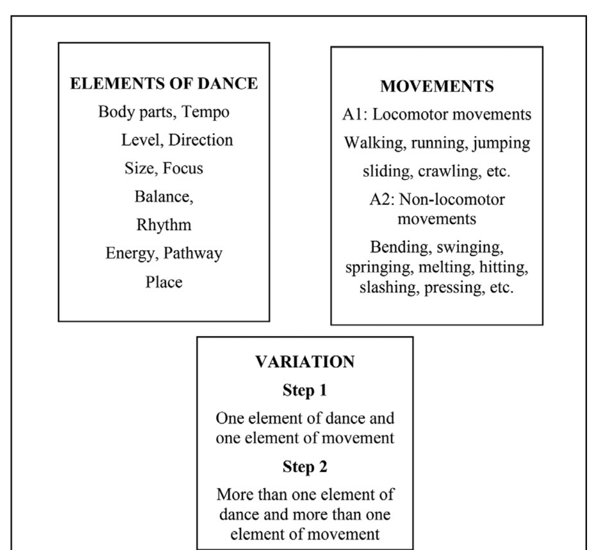

Fig. 1. Movement concept of creative dance.

Results

Twenty-nine COPD patients were assessed for eligibility; a total of five patients were excluded for not meeting the inclusion criteria or refusing to participate. Twelve patients for each group were included in the study and a total of 24 patients completed the study with no drop-outs (Fig. 2). The demographic and clinical characteristics of the patients are shown in Table 1. No significant difference was found between the two groups' demographic and clinical data. Compliance with physical activity recommendation (%) was 86.33±11.19 in the PT+CDE group, 88.10 ± 13.21% in the PT group, with no between groups difference ($p = 0.297$). Adherence to chest PT program (%) was 89.10 ± 13.81 in the PT+CDE group, 87.33 ± 13.17 in the PT group, with no between groups difference ($p = 0.285$).

Tables 2 and 3 summarize the effects of training on each outcome. Groups were similar in terms of baseline values. Both groups had a high adherence rate (%100).

6MWT distance, respiratory muscle strength, MoCA score, CAT, and BODE index significantly improved in both groups after the training ($p < 0.05$). Pulmonary function, postural stability and balance scores, and peripheral muscle strength were significantly increased only in the PT+CDE group ($p < 0.05$). There were no significant differences in changes in BODE index and MIP value between the two groups ($p > 0.05$). The improvements in CAT, MEP, 6 MWT distance and MoCA score were greater in the PT+CDE group compared with the PT group ($p < 0.05$). Between-group effect sizes were large for 6 MWT distance ($d = 1.053$), all postural stability and balance scores except the LOST/Right ($d = 0.551$) and CTSIB/Composite score ($d = 0.583$), pulmonary function test parameters, MEP ($d = 1.001$), the strength of the M. Quadriceps ($d = 3.356$) MoCA score ($d = 1.357$), and CAT ($d = 0.928$). Although between-group differences were not found to be statistically significant, a medium and small effects were detected related to the effect size of MIP value and BODE index ($d = 0.592$; $d = 0.476$).

Table 1
Demographic and clinical characteristics of the patients.

	PT+CDE Group ($n = 12$)	PT Group ($n = 12$)	p
Age (year)	65.17±6.35	64.75±8.49	0.893
Gender			
Female	2 (16.7%)	2 (16.7%)	1
Male	10(83.3%)	10(83.3%)	
Disease duration (year)	10±8.57	10.67±9.21	0.856
GOLD stage			
I			
II	3(25%)	6(50%)	
III	5(41.66%)	4(33.33%)	0.411
IV	4(33.33%)	2(16.66%)	
mMRC	1.67±0.98	1.83±0.57	0.432
Body composition			
BMI (kg/m^2)	25.14±3.73	25.94±4.26	0.631
Muscle mass (kg)	46.8±8.5	47.9±7.6	0.518
Fat mass (kg)	21.8±10.1	24.5±8.46	0.245
Resting metabolic rate (kcal)	1935±259	1969±444	0.485
Smoking history (pack-years)	36.42±9.60	32.67±18.96	0.547
Number of exacerbation in past year			
0	6 (50%)	7 (58.3%)	
1	3 (25%)	4 (33.3%)	0.485
≥2	3 (25%)	1 (8.33%)	
Oxygen support / NIV device	0	0	1
Compliance with physical activity recommendation	86.33±11.19%	88.10±13.21%	0.297
Adherence to chest PT program	89.10 ± 13.81%	87.33 ± 13.17%	0.285

Data are presented as mean ± standard deviation or n (%).
GOLD: Global Initiative for Chronic Obstructive Lung Disease; mMRC: Modified Medical Research
Council Scale; NIV: noninvasive mechanical ventilation; cm: centimeter; kg: kilogram; BMI: Body mass index; kcal: kilocalories.

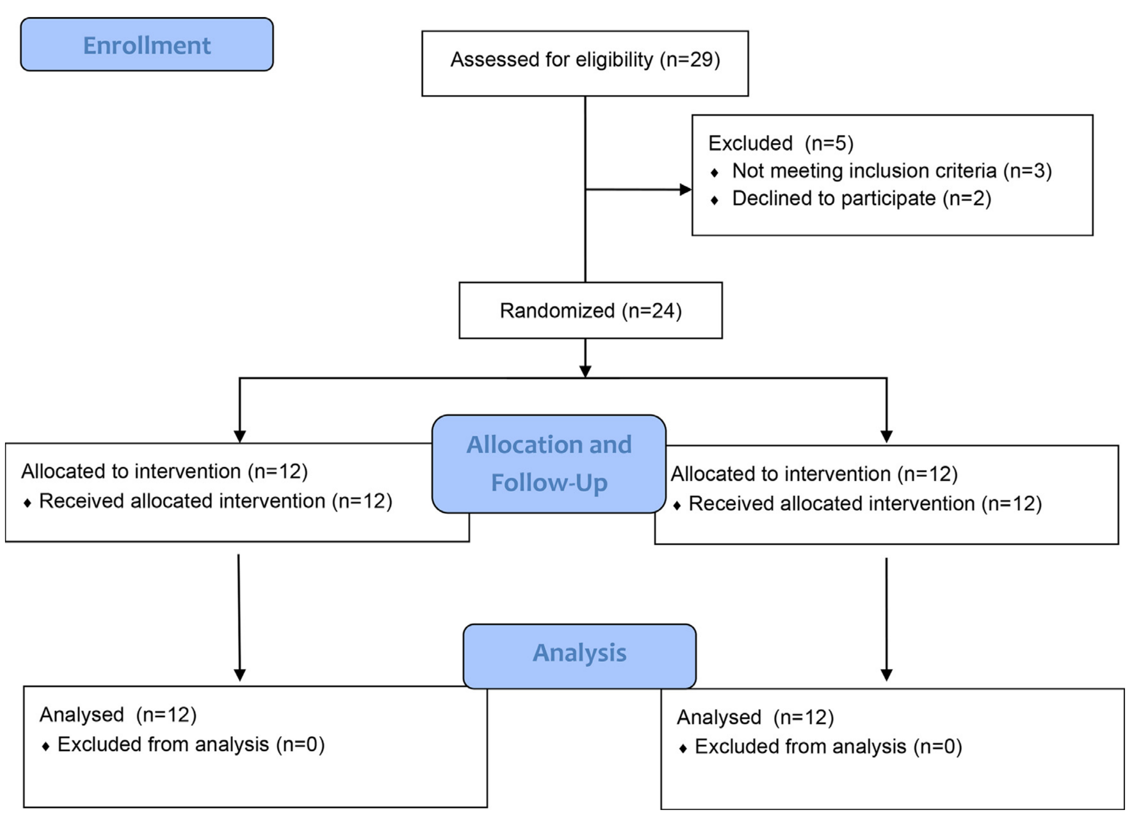

Fig. 2. Flow chart.

Table 2
Effects of training on functional capacity, postural stability, and balance. (In PDF version, the appereance of the Table 2 and 3 seen divided and the lines seem cramped. But when I want to edit the tables; Since it looks horizontal, there is no problem. I could not decide whether this appereance is appropriate for the publication.)

Outcomes	PT+CDE Group (n=12)	PT Group (n=12)	Between-group difference	Between-group difference p-value	Effect size (Cohen's d)
6MWT distance (m)					
Baseline	468.8 ± 98.7	439,2 ± 111,7			
Post-intervention	508.2 ± 104.1	456,7 ± 111,6			
With-in group change	39.4 (25.8, 52.9)[a]	17.5 (7.8, 27.1)[a]	21.9 (4.3, 39.5)[a]	**0.017** [a]	1.053
PST/Overall					
Baseline	0.5 ± 0.4	0.5 ± 0.2			
Post-intervention	0.4 ± 0.3	0.6 ± 0.2			
With-in group change	-0.1 (-0.1, -0.04)[a]	0.1 (-0.05, 0.1)	0.2 (0.03, 0.2)[a]	**0.012** [a]	1.092
PST/Anterior/posterior					
Baseline	0.4 ± 0.3	0.3 ± 0.1			
Post-intervention	0.3 ± 0.2	0.4 ± 0.1			
With-in group change	-0.1 (-0.1, -0.03)[a]	0.1 (-0.07, 0.1)	0.2 (0.003, 0.2) [a]	**0.038**	0.874
PST/Medial/lateral					
Baseline	0.25 ± 0.1	0.24 ± 0.1			
Post-intervention	0.20 ± 0.1	0.28 ± 0.1			
With-in group change	-0.05 (-0.08, -0.01)[a]	0.04 (-0.01, 0.09)	0.09 (0.02, 0.1) [a]	**0.012** [a]	1.091
LOST/Overall score					
Baseline	34.5 ± 11.7	33.6 ± 13.7			
Post-intervention	44.6 ± 11.3	37.2 ± 14.3			
With-in group change	10.1 (4.5, 15.6)[a]	3.6 (-4.1, 5.2)	6.5 (1.8, 17.1)[a]	**0.018** [a]	1.048
LOST/Forward					
Baseline	44.5 ± 13.6	50.6 ± 20.8			
Post-intervention	56.3 ± 14.7	49.1 ± 20.6			
With-in group change	11.8 (5.9, 17.6)[a]	-1.5 (-9.2, 6.2)	13.3 (3.0, 23.5)[a]	**0.013** [a]	1.102
LOST/Backward					
Baseline	35.8 ± 17.6	35.8 ± 19.1			
Post-intervention	49.5 ± 20.0	36.2 ± 15.3			
With-in group change	13.7 (8.7, 18.5)[a]	0.4 (-4.7, 5.5)	13.3 (5.6, 20.80)[a]	**0.001** [a]	1.485
LOST/Left					
Baseline	42.4 ± 13.3	43.2 ± 19.4			
Post-intervention	55.1 ± 7.9	42.9 ± 19.3			
With-in group change	12.7 (6.3, 19.1)[a]	-0.3 (-4.7, 4.1)	13.0 (4.8, 21.3)[a]	**0.003** [a]	1.342
LOST/Right					
Baseline	44.7 ± 18.1	47.6 ± 17.8			
Post-intervention	53.0 ± 16.7	48.6 ± 17.0			
With-in group change	8.3 (0.9, 15.7)[a]	1.0 (-6.6, 8.6)	7.3 (-3.9, 18.5)[a]	**0.047** [a]	0.551
CTSIB/Composite score					
Baseline	1.7 ± 0.8	1.9 ± 0.9			
Post-intervention	1.1 ± 0.7	1.8 ± 0.8			
With-in group change	-0.6 (-1.0, -0.1)[a]	-0.1 (-0.6, 0.4)	0.5 (-0.2, 1.2) [a]	**0.001** [a]	0.583

6MWT: Six minute walk test; PST: Postural stability test; LOST: Limits of stability test; CTSIB: Clinical test of sensory integration of balance; m: meter. Outcome values at baseline and post-intervention are mean ± standard deviation. Values for with-in group change and between-group change scores are mean (%95 confidence interval).

[a] Statistically significant differences ($p < 0.05$)

Discussion

This study set out with the aim of assessing the effect of creative dance-based exercise training on functional capacity, postural stability, balance, pulmonary and cognitive functions, respiratory and peripheral muscle strength in patients with COPD. To our knowledge, this is first randomized controlled study that creative dance has been used as an exercise training method in COPD patients. The most important clinically relevant findings were that only CDE training achieved improvement in postural stability and balance scores, pulmonary function, and peripheral muscle strength in patients with COPD. Besides, 6MWT distance, respiratory muscle strength, MoCA score, CAT, and BODE index were ameliorated in both groups. When comparing the two groups; the improvements in 6 MWT distance, MEP, MoCA, and CAT score were greater in the PT+CDE group.

Patients in the PT+CDE group showed a mean increase in 6 MWT distance of 39.41 m which was found both statistically and clinically significant. When between-group improvements in the distance were compared, the difference was significantly greater in the PT +CDE group. In the PT group, the increase of 17 m was statistically but not clinically significant. It is not surprising to achieve further improvements in the 6 MWT distance of the PT+CDE group in our study since dance is an aerobic effort. Besides; improvement of 6 MWT distance and its relationship with traditional exercise training in patients with COPD already have been known and reported in the literature.[5,29] In a review, an increase of 30 m in 6 MWT was accepted as the minimum clinically important difference for COPD patients, and it was stated that with an average increase of 43.9 m (32.6–55.2 m) was achieved as a result of 38 different studies that included the results of aerobic exercise interventions. In the present study, in which dance was applied as an aerobic exercise method, a similar effective result was achieved and an increase of 39.41 m was obtained.[29] In addition, similar improvements were obtained in studies which use different exercise training parallel to our method were applied in terms of duration and frequency in COPD patients (Δ6 MWT: 31m, 45 m respectively).[30,31] Similarly, in a study reported by Wshah et al.[10] which used various dance forms for 8 weeks in patients with COPD, a significant increase was found in 6 MWT distance. Our finding also supports previous studies which showed positive effects of dance on functional capacity in different chronic diseases.[32,33] Authors explained dance as an alternative form of exercise in chronic diseases due to its effectiveness both as conventional aerobic exercises and enjoyable activity. We think that setting out the target exercise intensity as moderate-high with MBS at 4-6 levels may have contributed to the results. Many personal barriers affect participation in physical activity in individuals. Intrinsic motivation, enjoyment of exercise or activity, and having fun are key factors of attendance rate in physical activity and exercise programs. The fact

Table 3
Effects of training on pulmonary function and other secondary outcome measures.

Outcomes	PT+CDE Group (n=12)	PT Group (n=12)	Between-group difference	Between-group difference p-value	Effect size (Cohen's d)
FVC (predicted %)					
Baseline	59.1 ± 17.0	71.0 ± 19.5			
Post-intervention	65.5 ± 16.9	72.5 ± 18.5			
With-in group change	6.4 (3.3, 9.3)[a]	1.5 (-1.3, 4.4)	4.9 (0.3, 9.1)[a]	**0.036** [a]	0.911
FEV_1 (predicted %)					
Baseline	38.0 ± 11.1	48.5 ± 17.7			
Post-intervention	43.7 ± 12.5	48.5 ± 16.8			
With-in group change	5.7 (3.6, 7.7)[a]	0.0 (-3.4, 3.4)	5.7 (1.3, 9.9)[a]	**0.012** [a]	1.113
FEV_1/FVC (%)					
Baseline	50.7 ± 7.2	52.4 ± 8.9			
Post-intervention	53.1 ± 7.0	51.1 ± 8.5			
With-in group change	2.4 (1.3, 3.4)[a]	-1.3 (-3.4, 0.8)	3.7 (1.1, 6.1)[a]	**0.006** [a]	1.230
PEF (predicted %)					
Baseline	36.0 ± 15.1	42.3 ± 11.8			
Post-intervention	46.2 ± 18.8	44.0 ± 18.0			
With-in group change	10.2 (4.8, 15.6)[a]	1.7 (-7.4, 10.7)	8.5 (-2.5, 19.7)[a]	**0.039** [a]	0.650
FEF_{25-75} (predicted %)					
Baseline	21.1 ± 8.3	22.2 ± 9.5			
Post-intervention	24.1 ± 9.2	22.0 ± 10.3			
With-in group change	3.0 (1.0, 4.9)[a]	-0.2 (-1.9, 1.4)	3.2 (0.4, 6.0)[a]	**0.024** [a]	0.988
MIP (cmH_2O)					
Baseline	69.6 ± 23.1	84.5 ± 20.1			
Post-intervention	79.2 ± 23.4	90.0 ± 18.1			
With-in group change	9.6 (5.0, 14.0)[a]	5.5 (2.5, 8.5)[a]	4.1 (-1.7, 9.7)	**0.161** [a]	0.592
MEP (cmH_2O)					
Baseline	91.5 ± 43.7	75.3 ± 31.0			
Post-intervention	114.9 ± 47.4	84.3 ± 36.9			
With-in group change	23.4 (14.2, 32.3)[a]	9.0 (1.9, 16.0)[a]	14.4 (2.2, 26.4)[a]	**0.023** [a]	1.001
M. Quadriceps (kg)					
Baseline	39.5 ± 4.7	37.9 ± 2.4			
Post-intervention	44.6 ± 5.1	38.6 ± 2.3			
With-in group change	5.1 (2.7, 7,4)[a]	0.7 (-0.3, 1.7)	4.4 (3.6, 5.1) [a]	**0.001** [a]	3.356
MoCA score					
Baseline	19.9 ± 5.2	16.1 ± 4.4			
Post-intervention	23.0 ± 4.5	17.5 ± 4.5			
With-in group change	3.1 (2.9, 3.4)[a]	1.4 (0.2, 2.3)[a]	1.7 (0.6, 2.9)[a]	**0.014** [a]	1.357
CAT					
Baseline	14.3 ±6.7	15.5 ± 5.5			
Post-intervention	8.3 ± 6.1	12.5 ± 6.5			
With-in group change	-6.0 (-7.3, -4.6)[a]	-3.0 (-5.2, -0.7)[a]	3.0 (0.2, 5.7)[a]	**0.033** [a]	0.928
BODE index					
Baseline	3.0 ± 1.3	2.7 ±1.9			
Post-intervention	2.1 ± 1.1	2.2 ± 2.0			
With-in group change	-0.9 (-1.3, -0.3)[a]	-0.5 (-0.7, -0.2)[a]	0.4 (-0.2, 0.9)	**0.256** [a]	0.476

FVC: Forced vital capacity; FEV_1: forced expiratory volume at 1second; PEF: peak expiratory flow; FEF_{25-75}: forced expiratory flow between 25% and 75%; MIP: Maximal inspiratory pressure; MEP: Maximal expiratory pressure; MoCA: Montreal Cognitive Assessment; CAT: COPD Assessment Test; kg: kilogram. Outcome values at baseline and post-intervention are mean ± standard deviation. Values for with-in group change and between-group change scores are mean (%95 confidence interval).

[a] Statistically significant differences ($p < 0.05$).

that none of our patients dropped out of the program shows that they found the process enjoyable. In the literature, physical activity level and respiratory muscle strength have been related to functional capacity.[2,34] Although we did not apply a structured physical exercise program to PT group, patients in this group showed high compliance with physical activity recommendations. Furthermore; improvements in MIP and MEP values were observed in both groups. Functional capacity may also benefit from these gains for PT and PT+CDE groups.

Much of the current literature showed that creative dance is an enjoyable and interesting activity and plays a role in improving balance in elderly people.[8,9] The results were associated with weight-bearing in different positions, coordinating the movement, using different sensory systems, and sudden change of center of gravity like perturbation training during the exercises. Owing to these components are similar to balance exercises, patients in the PT+CDE group showed meaningful improvements in postural stability and balance scores. Similarly, Wshah et al.[10] which used various dance forms for 8 weeks in patients with COPD, achieved significant improvement in Balance Evaluation Systems Test (BESTest) and Activities-Specific Balance Confidence. They found similar augmentation in BESTest scores to another study[35] which was performed a conventional PR program including aerobic and breathing exercises. Studies confirm that balance is associated with functional capacity, peripheral muscle strength, and cognitive function in patients with COPD.[4,36] In the light of these findings, the further increase in 6 MWT distance, peripheral muscle strength, and MoCA score may be attributed to improvement in postural stability and balance in the PT+CDE group.

What is not yet clear is the impact of PR programs on pulmonary function in patients with COPD. Janyacharoen et al.[37] which used Thai dance in menopausal women showed a significant augmentation in FEV_1, FVC, and PEF values. This result was explained by the authors that Thai dance protocol may be equivalent to an aerobic exercise protocol and increase chest expansion as a result of arm and chest movements. Angane and Navare[38] reported that enhancement of pulmonary function is related to changes in aerobic enzyme activity and oxidative capacity of respiratory muscles during aerobic exercise may increase respiratory muscle strength due to increment in respiratory rate and depth, oxygen consumption, and diffusion capacity. Improvement of respiratory muscle strength and the aerobic effect of supervised CDE training may have resulted in greater effective gains in pulmonary function in the PT+CDE group.

An interesting finding is that MIP and MEP values increased in both groups in our study despite no specific and resistant inspiratory muscle training has been applied for inspiratory muscles. This result may be explained by neural adaptation effect that an increasing number of motor units are involved in contraction as a result of repeated exposures of the muscles to the same task. Neural adaptation improves the neuromuscular recruitment pattern and consequently increases muscle strength.[39] In our study, repeatedly maximum inspiratory and expiratory maneuvers were implemented during the exercises in the chest PT program by the patients in both groups and this may have induced the effect of neural adaptation both for MIP and MEP values. Besides, IS may also have contributed to the increase in MIP. Paiva et al.[40] achieved to improve MIP value with IS and they assumed IS may encourage the respiratory muscles to work more intensely by holding each breath for as long as possible. In the previous study of Nakamura[41]; the increase in MEP value was greater in the COPD group in which aerobic exercise training was performed. The authors stated that since they did not specifically target respiratory muscle training in their studies; improvement may be attributed due to the aerobic exercise protocols that require the activity of all body muscles. Similarly, we assume that combined exercises targeting all body parts in CDE play a role in increasing expiratory muscle strength.

Although a limited number of studies have shown effect of aerobic exercise on peripheral muscle strength in patients with COPD,[42,43] this issue is unclear, since the majority of PR programs were performed aerobic exercises combined with strengthening exercises. The speculated physiological mechanisms underlying these results are the increased oxygen-carrying capacity, capillary density, and mitochondrial and oxidative enzyme activity of the muscle.[43] The present study has demonstrated, for the first time, augmentation on peripheral muscle strength in the PT+CDE group similar to the studies which performed traditional aerobic exercise mentioned above. On the other hand, these gains may have also occurred due to allowing various patterns of movement, using different body parts, and components of dance elements during exercises with creative dance.

In the present study; 41.66% of the patients in the PT+CDE group and 58.33% of the patients in the PT group presented mild cognitive impairment. This finding is similar to the result of 56.7% of patients with COPD reported by a previous study.[3] As far as we know; although there is no study in the literature investigating the effect of dance on cognitive functions in COPD, several studies have revealed this impact in different populations by various forms of dance.[44,45] Authors have explained the influence of dance on cognitive function by several possible factors such as multisensory (auditory, visual, tactile) input in an activity, different movement patterns according to the theme, following the music, focus on remembering dance steps, and learning choreography. We assumed that the improvisation of the movement patterns of the patients with creative dance also provides further benefits. Considering the present results, it supported our hypothesis that CDE, which is an aerobic exercise, provided further improvement in cognitive functions in the PT+CDE group.

Several studies have indicated that both CAT score and BODE index are responsive to PR programs.[46,47] Harrison et al.[48] achieved a significant improvement in the CAT score with dance-based exercise training in patients with chronic breathlessness. Authors have speculated that dance can be an acceptable approach that provides both physical and psychosocial benefits. This may explain our result that supervised and enjoyable CDE training is more effective on both pulmonary and extrapulmonary symptoms and the quality of life. To the present results, Rubi et al.[49] has demonstrated a significant decrease in traditional aerobic training programs in BODE index. Although the PT group did not perform any aerobic training, surprisingly BODE index significantly decreased. This may be attributed to implementing a comprehensive chest PT program consisting of several modalities and the high adherence to the recommendation to engage in aerobic exercise for 30 minutes, five days per week.

Study strengths and limitations

The major strengths of our study are randomized allocation and high adherence of patients, and the presence of a blind outcome assessors for training allocation. On the other hand, the limitation of the study is the lack of a control group that did not perform any PT program. Because the effect of chest PT is well known in patients with COPD; we thought that it would not be ethical to not perform this training. Secondly; prevalence rates of elevated depressive symptoms have been reported in COPD patients. Although dance is known to be an entertainment mind-motor approach, we did not use any depression and anxiety scale to determine the effect of dance. With the lack of literature on the use of dance for pulmonary rehabilitation, the future undertaking of certain research directions may be imperative to establish its efficacy. Further studies with larger sample sizes are expected to be conducted in the future to validate the results.

Conclusion

To the best of our knowledge, the present study is the first in the literature to evaluate the effect of CDE on functional capacity, postural stability, balance, pulmonary and cognitive functions, respiratory and peripheral muscle strengths in patients with COPD. The results of this trial demonstrate that CDE in addition to chest PT could be safe and useful for functional capacity, postural stability, balance, pulmonary and cognitive functions, and respiratory and peripheral muscle strengths in patients with COPD. In summary, we suggest that CDE which has a variety of exercises that appeal to individuals of all ages should be provided as an option in pulmonary rehabilitation programs for those that would find it more enjoyable or motivating compared to other forms of aerobic exercise.

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Declaration of Competing Interest

The authors declare no conflicts of interest.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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