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The effect of balance training and conventional pulmonary rehabilitation in patients with moderate chronic obstructive pulmonary disease

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ABSTRACT

The purpose of our study was to determine the added effect of a balance training program to conventional pulmonary rehabilitation on exercise capacity, balance, fall risk and health related quality of life in patients with moderate COPD. A Randomized Control Trial with two groups- Experimental and Control groups. 133 participants were randomly allocated to either the conventional pulmonary rehabilitation group or the combined pulmonary rehabilitation group with balance training. In the present study we found statistically significant improvement in Berg Balance Scale by -22.55%, Timed Up and Go test by -46.46%, Single Leg Stance Test by -51.69%, Activities Balance Confidence Score by 13.89%, Elderly Falls Screening Test by -57.42%, Six-minutes walk test by 3.04%, and St. George respiratory questionnaire total score by -18.16%.It is recommended that implementation of 8 weeks balance training with conventional pulmonary rehabilitation program is beneficial on improving balance, six-minute walk distance and health related quality of life in subjects with moderate COPD.

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is characterized by physical and functional limitations due to systemic changes, secondary to the disease itself and the prolonged use of medications (Celli *et al.*, 2004; Viegi *et al.*, 2007). In India Chronic obstructive pulmonary disease (COPD) constitute nearly 25-30 % of cases data according to chest clinics (Mannino, 2002). Patients with COPD suffer from multiple non-respiratory effects, such as peripheral muscle dysfunction, chronic inflammation, depression, anxiety, and malnutrition (Turato *et al.*, 2001; Rabe *et al.*, 2007). Peripheral muscle

dysfunction in patients with COPD is due to chronic inactivity, nutritional imbalance, prolonged usage of certain drugs, hypoxemia, chronic inflammation and electrolyte disturbances (Wust and Degens, 2007; Maltais *et al.*, 2000; Agustí *et al.*, 2003). Lower limb muscles atrophy, weakness, fatigability, and metabolic inefficiency is commonly seen in COPD and these unfavorable muscle characteristics, dysfunction of lower limb muscles and dyspnea are responsible for the limitation of exercise capacity in COPD (Beauchamp *et al.*, 2009; Alexander, 1994; Butcher *et al.*, 2004).

Balance and mobility are the important elements of activities of daily living and studies have shown that reduced muscle strength and hypoxia impairs balance. Recent studies have shown that there is reduced static and dynamic balance in patients with COPD (Oliveira *et al.*, 2013). Several studies have found that COPD patients have reduced functional balance compared to normal healthy individuals in the same age group (Bhosle *et al.*, 2012). It is important to include balance assessment and training in the management of COPD patients. There is a lack of research on the effects of health-related quality of life (HRQOL) balance training in patients with COPD.

Health-related quality of life includes physical, mental, emotional, and social function domains of health. Any improvement in exercise capacity and physical function may influence and lead to significant improvement in HRQOL (Mahler, 2000; Hu and Meek, 2005). The pulmonary rehabilitation exercise part is regarded as the corner stone of rehabilitation, including upper limb, lower limb, and respiratory muscle conditioning, but balance training is not taken into account in the traditional pulmonary rehabilitation guidelines. Latest findings have found that in subjects with COPD, balance and coordination have declined compared to healthier subjects (Reddy *et al.*, 2020). Pulmonary rehabilitation strategies include patient assessment, exercise training, nutritional intervention, education and psychosocial support (Jacome *et al.*, 2016). The evidence suggests that balance defects in patients with COPD may be associated with an increased risk of falls, decreased exercised capacity, and poor HRQoL. Well-established fall risk factors in patients with COPD is known to be lower limb muscle fatigue and impairments in everyday life activities, whereas other intrinsic risk factors, such as gait and balance difficulties, malnutrition, depression and medicines, were potential risk factors (Rabe *et al.*, 2007).

However there is a lack of literature on the beneficial effects of introducing to the traditional pulmonary rehabilitation program a balance training aspect. The objective of our research was to evaluate the impact on the health-related quality of life, balance, and risk of falls in patients with moderate COPD of incorporating a balance training program to a traditional pulmonary rehabilitation programme.

MATERIALS AND METHODS

Ethical Clearance was obtained from Biomedical Research on Human Subjects, 2000, ICMR, New Delhi. Written informed consent was obtained from all the patients included in our study. We included 133 COPD patients who were randomly allocated to the intervention group (conventional pulmonary rehabilitation program with balance training) or the control group (conventional pulmonary rehabilitation program alone.) Medically stable patients with moderate severity COPD (GOLD criteria) were referred for physiotherapy and pulmonary rehabilitation by the consulting pulmonologist. The sample size was calculated based on findings from our pilot study results (Reddy *et al.*, 2020). Patients were randomly assigned to one of the 2 groups by the process of block randomization, with a block size of 4 patients in each group.

The initial screening of the patients included a history of falls and self-reported decline in balance or increased risk of falls in the last five years or recent near fall. After initial screening, patients with acute exacerbation, history of bronchial asthma (defined as a $\geq$ 25% change in FEV1 post-bronchodilator), history of any neuromuscular conditions like stroke, Parkinsonism and multiple sclerosis, a history of any vestibular condition, presence of any musculoskeletal condition that limited mobility such as severe arthritis, low back pain, amputation and history of hearing and cognitive impairment were excluded from our study.

Procedure

Pre-Test: All patients involved in the study were tested for balance, tolerance for exercise, quality of life associated with fitness, and risk of falls. The Berg Balance Scale (BBS) is a responsive and accurate scale for elderly people to assess the risk of falls. BBS is a 14-item scale with each item scored from 0-4 with a maximum score of 56. Good balance performance is indicated by higher BBS scores (Jacome *et al.*, 2016).

The Timed Up and Go Test (TUG) was used to determine the participants' dynamic balance. The patients were asked to get up from a chair, walk for 3 meters and then turn around to return to the starting position. The fall risk was assessed during the test in the presence of a therapist (Mesquita *et al.*,

2016).

Static balance was assessed by the Single leg stance test (SLST), where the patient's ability to stand on one leg without any assistance was recorded in seconds (Crisan *et al.*, 2015). Patients had to demonstrate their confidence in executing 16 specific activities without losing their balance or any sense of uncertainty during Specific Balance Confidence Scale activities (ABC scale) (Beauchamp *et al.*, 2009). SGRQ questionnaire was used to assess the HRQoL (Jones, 2008) which was administered on all the patients before and after the intervention in both the groups.

Balance Training for the Intervention Group

Balance training was included for patients in the intervention group, in addition to the conventional pulmonary rehabilitation programme which was given within the same session. Sixty-six of 68 patients completed both the above treatments as per the prescribed treatment protocol by the therapist. One patient was unable to carry out the exercises due to lower limb injury. Another patient was hospitalized due to fever with arthralgia and was not able to continue the exercises.

Balance Training

The training consisted of 15-20-minute session at a frequency of 3 times per week and for a duration of 8 weeks. The exercise listed below were included

1. Weight shifting: The patient was told to stand up straight with feet apart, change weight to one side and lift the opposite foot from the floor; maintain the position for 30 seconds and repeat on the other side.
2. Stand up and sit down without using hand support
3. Walking in straight line with progression to tandem walking.
4. Single leg standing: Stand with feet hip-width apart.
5. Maintaining equal weight distribution and upright trunk postural alignment while standing on a wobble board.
6. Arm movements were included as a progression in the above exercises

All exercises were performed for 10-15 repetitions, increasing to 15- 20 repetition's and then arm movements were added. On non-treatment days, patients continued these exercises at home having been given the exercises protocol in a printed format in English and local languages. Adherence to the exercises was assessed through regular telephone calls. Patients were also advised to carry out their routine daily activities.

Conventional Pulmonary Rehabilitation

The conventional pulmonary rehabilitation program was given for both groups for 60 minutes with adequate rest periods in each session, at a frequency of 3 days a week, for a duration of 8 weeks as per the guidelines given by the American College of Chest Physicians (ACCP). Borg's rating of perceived exertion scale was used to monitor the endurance and strength training exercises. The supervised endurance exercise training was given in the form of walking 3 times in a week. A Borg score of 5–6 for dyspnea or fatigue was set as a target for the exercise. The progression in the walking was made by increasing the distance based on RPE. Upper extremity strength testing involved biceps, triceps, and deltoid exercises; lower extremity training included quadriceps, hamstrings, hip flexors, hip extensors, and free weight hip abductors. The resistance applied was based on the patient's ability to complete 10-15 repetitions. The exercises were progressed by increasing resistance and number of sets. Patients received 5-10 minutes of breathing exercises including diaphragmatic, pursed lip and segmental breathing exercises. The program also included relaxation techniques, education for self-management and psychological support.

Data Analysis

The data obtained was coded and entered in Windows IBM SPSS Statistics, Version 25.0.0. Armonk, NY: IBM Corp and the normality evaluation was performed. Descriptive statistical analysis was conducted and shown as mean $\pm$ SD. Significance was assessed at 5 % level of significance with p-value was set at 0.05. In order to compare the variables for within group results, a Paired t-test and Wilcoxon signed rank test were used. Using Independent's and Mann Whitney U tests, similarities were examined between group comparisons.

RESULTS AND DISCUSSION

Table 1 shows that there was no significant difference in mean age between the intervention and control group. The Table 2 describes the means of variables measured for balance evaluation using Berg Balance Scale, Timed Up and Go Test, Single limb Stance time, and Activities Balance Confidence Score, Elderly Falls Screening Test, and the variable measured for COPD condition improvements

Table 1: Basic Characteristics of participants

Basic Characteristics of the subjects d studied	Experimental Group	Control Group
Number of participants studied (n)	66	62
Age in years (Mean± SD)	52.53± 3.98	52.10± 4.59
Gender n (%)	Male: 52 (78.78%) Female: 14 (21.21%)	Male: 51(82.25%) Female: 11 (17.74%)
FEV 1, % predicted	67.2 ± 22.3	69.6 ± 23.7
BBS-Berg Balance Scale	40.12± 1.67	40.00± 1.70
Six minutes test	302.95± 15.49	309.68± 15.83

Table 2: Pre- Intervention Comparative Analysis means of BBS. TUG, SLST, ABC, Six minutes test, EFST, St. George questionnaire between Experimental and Control group

	Experimental Group – Pre Mean±SD (min-max)	Control Group – Pre Mean±SD (min-max)	Percentage of difference	Significance P-value	95% Confidence interval	
					Lower	Upper
BBS-Berg Balance Scale	40.12± 1.67 (37- 44)	40.00± 1.70 (36- 44)	-26.79%	p=0.696(NS)	-0.491	0.733
TUG-Timed Up and Go Test in sec	16.86± 1.18 (15- 19)	16.27±1.07 (15 - 19)	15.58%	p=0.004**	0.192	0.986
Single limb Stance time (SLST) in sec	16.18± 1.74 (12 - 19)	16.03±1.62 (13-19)	-51.05%	p=0.618 (NS)	-0.442	0.741
Activities Balance Confidence Score	78.55±2.25 (75 – 83)	79.37± 2.22 (75-83)	13.16%	p=0.039**	-1.610	-.041
Elderly Falls Screening Test	2.14± 0.34 (2-3)	2.29± 0.45 (2 - 3)	-61.40%	p=0.033**	-.295	-.013
Six minutes test	302.95± 15.49 (280– 330)	309.68± 15.83 (285-340)	24.39%	p=0.017**	-12.203	-1.242
St. George: Symptoms	70.57± 10.11 (55.41– 85.84)	67.39± 12.98 (50.29– 95.03)	-1.34%	p=0.123 (NS)	-.873	7.243
St. George: Activity Score	60.75± 12.63 (35.80– 85.66)	58.72± 11.80 (36.47– 85.66)	-9.46%	p=0.350 (NS)	-2.254	6.312
St. George: Impact score	43.36± 18.06 (13.03–89.86)	39.72± 19.72 (13.03–90.42)	-30.89%	p=0.278 (NS)	-2.968	10.253
St. George: Total score	53.15± 13.85 (27.61–87.50)	50.07± 14.77 (26.32–86.82)	-19.28%	p=0.226 (NS)	-1.929	8.086

**Statistically Significant difference p<0.05; NS- Not significant

Table 3: Analysis of means of BBS. TUG, SLST, ABC, Six minutes test, EFST, St. George questionnaire-Pre and post measurements with in the experimental group

Experimental Group	Pre Mean±SD (min-max)	Post Mean±SD (min-max)	Percentage of Change	p-value	95% Confidence interval	
					Lower	Upper
BBS-Berg Balance Scale	40.12± 1.67 (37- 44)	46.10± 1.38 (43- 48)	14.90%	p=0.000**	-6.080	-5.405
TUG-Timed Up and Go Test in sec	16.86± 1.18 (15- 19)	12.60± 0.78 (12-15)	-25.26%	p=0.000**	3.225	-5.482
Single limb Stance time (SLST) in sec	16.18± 1.74 (12 - 19)	23.50± 1.65 (19- 26)	45.24%	p=0.000**	-6.682	-5.985
Activities Balance Confidence Score (ABC)	78.55±2.25 (75 – 83)	85.60± 1.64 (83- 90)	8.97%	p=0.000**	-8.326	-7.219
Elderly Falls Screening Test	2.14± 0.34 (2-3)	0.80± 0.45 (0- 1)	-62.61%	p=0.000**	1.725	1.972
Six minutes test	302.95± 15.49 (280– 330)	371.80± 15.09 (340- 400)	12.82%	p=0.000**	-78.569	-71.976
St. George: Symptoms	70.57± 10.11 (55.41– 85.84)	50.12± 7.63 (35.00- 68.60)	-28.97%	p=0.000**	18.549	22.348
St. George: Activity Score	60.75± 12.63 (35.80– 85.66)	32.05± 9.26 (12.12- 53.62)	-47.24%	p=0.000**	25.930	31.463
St. George: Impact score	43.36± 18.06 (13.03– 89.86)	17.14± 9.45 (1.63- 46.66)	-60.47%	p=0.000**	22.913	29.527
St. George: Total score	53.15± 13.85 (27.61– 87.50)	27.13± 7.63 (11.63- 45.90)	-48.95%	p=0.000**	23.555	28.472

Table 4: Analysis of means of BBS. TUG, SLST, ABC, Six minutes test, EFST, St. George questionnaire-Pre and post measurements with in the Control group

	Control Group – Pre Mean±SD (min-max)	Control Group – Post Mean±SD (min-max)	Percentage Change	p-value	95% Confidence interval	
					Lower	Upper
BBS-Berg Balance Scale	40.00± 1.70 (36- 44)	44.76± 1.07 (40- 48)	11.9%	p=0.000**	-5.134	-4.383
TUG-Timed Up and Go Test in sec	16.27±1.07 (15 - 19)	14.40± 0.81 (13-16)	-11.49%	p=0.000**	1.653	2.089
Single limb Stance time (SLST) in sec	16.03±1.62 (13-19)	20.40± 1.48 (17- 24)	27.26%	p=0.000**	-5.070	-4.414
Activities Balance Confidence Score (ABC)	79.37± 2.22 (75-83)	82.31± 1.85 (80- 85)	3.70%	p=0.000**	-3.187	-2.684
Elderly Falls Screening Test	2.29± 0.45 (2 - 3)	.97± 0.25 (0- 2)	-57.64%	p=0.000**	1.194	1.451
Six minutes test	309.68± 15.83 (285-340)	371.37± 13.15 (340- 400)	19.92%	p=0.000**	-64.945	-58.442
St. George: Symptoms	67.39± 12.98 (50.29– 95.03)	52.66± 11.26 (36.82-85.92)	-21.85%	p=0.000**	12.290	17.156
St. George: Activity Score	58.72± 11.80 (36.47– 85.66)	41.77±8.18 (23.53-60.26)	-28.86%	p=0.000**	14.397	19.499
St. George: Impact score	39.72± 19.72 (13.03–90.42)	28.00± 15.89 (3.62- 61.16)	-29.50%	p=0.000**	9.725	13.701
St. George: Total score	50.07± 14.77 (26.32–86.82)	36.27± 11.00 (16.25-59.38)	-27.56%	p=0.000**	12.163	15.436

measurements such as Six minute's walk test, and St. George respiratory questionnaire components- Symptoms, Activity, impact and total score were compared between the Experimental and control group shown that there is a statistically significant difference ($p<0.05$) between the groups in the pre-means of Timed Up and Go Test, Activities Balance Confidence Score, Elderly Falls Screening Test, and Six minutes' walk test.

There is no statistically significant difference in means of BBS, Single limb Stance time, St. George respiratory questionnaire components- Symptoms, Activity, impact and total score.

Table 3 describes the means of variables measured for balance evaluation using Berg Balance Scale, Timed Up and Go Test, Single limb Stance time, and Activities Balance Confidence Score, Elderly Falls Screening Test, and the variable measured for COPD condition improvements measurements such as Six minutes test, and St. George respiratory questionnaire components- Symptoms, Activity, impact and total score were compared between the Experimental and control group shown that there is a statistically significant difference ($p<0.05$) in means of Berg Balance Scale, Timed Up and Go Test, Single limb Stance time, and Activities Balance Confidence Score, Elderly Falls Screening Test, Six minutes test, and St. George respiratory questionnaire components- impact, and total score between the groups with large effect size.

Table 5: Post-intervention comparative analysis of means of BBS. TUG, SLST, ABC, Six minutes test, EFST, St. George questionnaire between Experimental and Control group

	Experimental Group – Post (Mean±SD) min-max	Control Group – Post (Mean±SD) min-max	Percentage difference	p-value	95% Confidence interval	
					Lower	Upper
BBS-Berg Balance Scale	46.10± 1.38 (43- 48)	44.76± 1.07 (40- 48)	-22.55%	p=0.000**	0.564	3.526
TUG-Timed Up and Go Test in sec	12.60± 0.78 (12-15)	14.40± 0.81 (13-16)	-46.46%	p=0.000**	-1.304	-.745
Single limb Stance time (SLST) in sec	23.50± 1.65 (19- 26)	20.40± 1.48 (17- 24)	-52.69%	p=0.000**	1.189	2.293
Activities Balance Confidence Score (ABC)	85.60± 1.64 (83- 90)	82.31± 1.85 (80- 85)	13.89%	p=0.000**	3.400	4.624
Elderly Falls Screening Test (EFST)	0.80± 0.45 (0- 1)	0.97± 0.25 (0- 2)	-57.42%	p=0.000**	-0.810	-0.550
Six minutes test	371.80± 15.09 (340- 400)	371.37± 13.15 (340- 400)	3.04%	p=0.007**	1.890	11.823
St. George: Symptoms	50.12± 7.63 (35.00- 68.60)	52.66± 11.26 (36.82- 85.92)	-12.20%	p=0.136 (NS)	-5.887	0.806
St. George: Activity Score	32.05± 9.26 (12.12- 53.62)	41.77±8.18 (23.53- 60.26)	-13.68%	p=0.000**	-12.784	2.207
St. George: Impact score	17.14± 9.45 (1.63- 46.66)	28.00± 15.89 (3.62- 61.16)	-18.86%	p=0.000**	-15.407	-6.654
St. George: Total score	27.13± 7.63 (11.63- 45.90)	36.27± 11.00 (16.25- 59.38)	-18.16%	p=0.000**	-12.431	-5.839

There is no statistically significant difference in St. George respiratory questionnaire components-Symptoms between the groups with small effect size.

Table 4 shows that the improvement in Berg Balance Scale, Timed Up and Go Test, Single limb Stance time, Activities Balance Confidence Score, Elderly Falls Screening Test, Six minutes test, and St. George respiratory questionnaire after conventional pulmonary rehabilitation with balance training is statistically significant ($p<0.05$).

The percentage of change in outcome measures in experimental group for BBS is 14.90%, TUG is -25.26%, SLST is 45.24%, ASBS is 8.97%, EFST is -62.61%, Six minutes-walk test is 12.82%, St. George: Symptoms is -28.97%, St. George: Activity Score is -47.24%, St. George: Impact score is -60.47% and St. George: Total score is -48.95%.

There is also an improvement in all these measures within the control group after conventional pul-

monary rehabilitation.

The percentage of change in outcome measures in control group for BBS is 11.9%, TUG is -11.49 %, SLST is 27.26%, ASBS is 3.70%, EFST is -57.64%, Six minutes-walk test is 12.82%, St. George: Symptoms is -12.20%, St. George: Activity Score is -13.68%, St. George: Impact score is -18.86% and St. George: Total score is -18.16%.

Table 5 shown that there is a statistically significant difference ($p<0.05$) between the Experimental and control group in means of Berg Balance Scale, Timed Up and Go Test, Single limb Stance time, and Activities Balance Confidence Score, Elderly Falls Screening Test, Six minutes test, and St. George respiratory questionnaire.

There is no statistically significant difference in St. George respiratory questionnaire components-Symptoms between the groups. The percentage of difference between the groups for BBS is -22.55%, TUG is -46.46%, SLST is -51.69%, ASBS is 13.89%, EFST is -57.42%, Six minutes-walk test is 3.04%, St. George: Symptoms is -12.20%, St. George: Activity Score is -13.68%, St. George: Impact score is -18.86% and St. George: Total score is -18.16%.

Eight weeks of balance training with pulmonary rehabilitation shows there is a significant improvement of health related quality of life, balance, falls and exercise tolerance in patients with moderate COPD patients thus, the study shows that the addition of balance training in pulmonary rehabilitation may help to achieve greater benefits by reducing the risk of falls in moderate COPD patients.

The improvement in health related quality of life, balance and exercise tolerance in both the groups could be because of effect of pulmonary rehabilitation program. Previous studies have shown the effect of pulmonary rehabilitation on improvement of various outcome measures in patients with COPD. Exercise based pulmonary rehabilitation induces biochemical and structural changes in the muscles so that the exercise tolerance is improved (Casaburi *et al.*, 1996).

In a study conducted by Stav et al , an increase in exercise endurance time was observed with pulmonary rehabilitation over a period of 6 months (Stav *et al.*, 2009). After the pulmonary rehabilitation program, the dyspnea severity, the maximum heart rate achieved in 6MWT significantly improved. After the recovery program, a major impact of individualized exercise on dyspnea peak and high heart rate was seen in 6MWT.

Firstly, this can be explained by better physical conditions and a very strong response to exercise, which supports a reduced sensation of dyspnea (Palange *et al.*, 1995).

Secondly, certain physiological improvements, such as enhanced cardiac tolerance, decreased production of lactic acid and lowered exercise metabolic costs (Antonucci *et al.*, 2003).

In older adults, the relationship between muscle fatigue and postural dysfunction is well known (Puente-Maestu *et al.*, 2000). The minor balance changes found in this analysis are likely to have been attributed to the strength training aspect of PR, albeit low-intensity.

It is well known that the postural stability is influenced by muscle weakness in elderly individuals (Orr, 2010). An improvement observed in our study is most likely to have occurred because of strength training component of Pulmonary Rehabilitation. M.A. Spruit et al found that the effect of resistance training is not superior to endurance training on skeletal muscles in COPD patients (Spruit *et al.*, 2013).

The addition of balance training to conventional Pulmonary Rehabilitation in the present study improved the balance and also HRQoL In COPD Patients. Wajdi Mkacher et al., examined the effect of pulmonary rehabilitation program on balance in patients with COPD and compared this with healthy subjects. This study found significant improvement in posture and balance after 12 weeks of training in COPD (Mkacher, 2014) several studies earlier have shown the effect of balance training with pulmonary rehabilitation on various balance related outcome measures Beauchamp *et al.* (2013); Horlings *et al.* (2008).

It is likely that the minimal improvement observed in balance in this study is due to the low intensity strength training component of PR. The higher intensity strength training in combination with targeted balance training is likely to have optimal effects on fall risk and balance (Hess and Woollacott, 2005).

The improvements in the outcome variables are difficult to understand in the absence of the minimum clinically meaningful difference (MCID) values reported. However, minimal detectable change (MDC) scores were reported for static and dynamic balance assessment among community-dwelling older adults with balance impairment in previous studies (Mkacher *et al.*, 2015).

The MCID for commonly used balance assessment scales in patients with COPD undergoing pulmonary rehabilitation were reported in a study conducted by Beauchamp M K et al., (2016). The MCID ranges for

various balance assessment scales were published in the previous studies (Marques *et al.*, 2015; de Castro *et al.*, 2016).

The improvements observed our study were below the MCID minimal range published in the previous studies, indicating that the improvement was not clinically significant between groups (Beauchamp *et al.*, 2016).

So, the addition of balance training did not have clinical significance. This could be due to the short duration of the training program used in our study. A longer duration program in future studies is recommended to achieve clinically significant results for balance and HRQoL. Mkacher W et al., (2015) examined the effect of long duration balance training as part of Pulmonary Rehabilitation program in COPD patients. They concluded that adding balance training to pulmonary rehabilitation program has a significant effect on balance in COPD patients (Hess and Woollacott, 2005).Marques A et al., (2015) found significant improvement in functional balance after adding balance training in PR in patients with COPD (Mkacher *et al.*, 2015).

The greater percentage of improvement is found the experimental group compared with control group; this could be because of adding balance training along with pulmonary rehabilitation. Most of the earlier studies have found the effect of pulmonary rehabilitation over a period of 3 to 6 months, whereas the 8 weeks duration of training in the present study had positive effect on outcomes.

Even four weeks of intensive PR program produced significant health benefits through improved exercise capacity and HRQoL in a study conducted by Skumlien et al. (Skumlien and Skogedal, 2007). The eight weeks of balance training with pulmonary rehabilitation given in experimental group found there is a significant effect on improvement of health-related quality of life, balance, falls and exercise tolerance in moderate COPD subjects, in the present study.

CONCLUSIONS

The study concludes that Pulmonary Rehabilitation with or without balance training for subjects with moderate COPD found statistically and clinically significant effect on improving balance, exercise capacity, Elderly Falls Screening Test score, and Health related quality of life. However, the greater percentage of improvement in balance, elderly falls screening test, exercise capacity and health related quality of life found in experimental group who received Pulmonary Rehabilitation with balance training than control group who received only Pulmonary Rehabilitation without balance training. The improvement in COPD symptoms in both the groups found that there is no statistically significant difference in St. George respiratory questionnaire components- Symptoms between the groups with small effect size.

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Conflict of interest

The authors declare that they have no conflict of interest for this study.

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