

ORIGINAL RESEARCH

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EFFECT OF UPPER-LIMB AND THORACIC MUSCLE STRENGTH ON 6-MIN WALK DISTANCE IN COPD PATIENTS

D Varalakshmi¹Madhavi .K²P. Sumalatha³

ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is the only cause of death from chronic disease that will increase worldwide until 2020 and it represents a big burden for patients and society. Patients with COPD characteristically show poor exercise performance indicated by a marked reduction in both peak pulmonary O₂ uptake and work rate at peak exercise. The sequelae of exercise intolerance include increased difficulty in performing daily tasks, etc. The objective of the study is to investigate the influence of thoracic and upper limb muscle function on 6-min walk distance (6MWD) in patients with COPD.

Method: Thirty eight COPD patients were included if they fulfilled the criteria for COPD according to the Global Initiative for Chronic Obstructive Lung Disease guidelines. Prospective, cross-sectional design with sample size of 38 patients. All patients performed 6MWD and 1RM exercises.

Results: To study the correlation between variables, Pearson or Spearman coefficients of correlation were used with the level of statistical significance set at 5%. Results of this study suggested for the first time that thoracic muscle strength is a predictor of 6MWD in COPD patients. It also confirms the influence of respiratory muscle strength (Pimax), dyspnea, on the 6MWD of these patients.

Conclusion: It is concluded that peripheral muscle strength, respiratory muscle strength, and the sensation of dyspnea all have an influence on the capacity of COPD patients to perform exercises.

Key Words: COPD, dyspnea, max. Inspiratory pressure, 6MWD, peripheral muscle strength.

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¹Assistant Professor in Physiotherapy, Apollo College of Physiotherapy, Hyderabad.

²Professor & Principal, SVIMS College of Physiotherapy, Tirupati, India.

³Assistant Professor in Physiotherapy, Apollo College of Physiotherapy, Hyderabad.

CORRESPONDING AUTHOR

¹D Varalakshmi, MPT,
Assistant Professor,
Apollo College of Physiotherapy,
Jubilee hills,
Hyderabad, India.
e-mail: vara31.lakshmi@gmail.com

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is the only cause of death from chronic disease that will increase worldwide until 2020 and it represents a big burden for patients and society. COPD frequently leads to significant debilitation. Patients often come to medical attention only after severe damage to the lung's function and become homebound, isolated, and depressed as they seek to avoid the dyspnea produced during activities of daily living¹. There is a growing realization that COPD is a multi-organ- system disease. The most frequent complaint of these unfortunate patients is exercise intolerance². In particular, there is accumulating evidence that the skeletal muscles do not function normally and that this contributes to exercise intolerance and also as an indicator of advanced stages of COPD³. In most patients with COPD, the respiratory muscles are chronically overworked and the limb muscles are chronically under worked. The physical exercise component has therefore become a cornerstone of respiratory rehabilitation. Several studies have shown that physical exercise reverses COPD induced skeletal muscle dysfunction as well as the morphological and metabolic changes of skeletal muscles⁴. The uneven distribution of muscle weakness between upper and lower limbs could be related to differences in accustomed level of activity between the different muscle groups⁵. Compared with lower limb muscles, the upper limb muscles are probably more normally involved in activities of daily living. Furthermore, in COPD, the pectoralis major and the latissimus dorsi muscles may also act as accessory inspiratory muscles, another potential source of stimulation⁶. Patients with COPD characteristically show poor exercise performance indicated by a marked reduction in both peak pulmonary O₂ uptake and work rate at peak exercise.⁷ Muscle changes observed include reductions in type I fibers, atrophy of type I and II fibers, reduced capillarity, and altered metabolic enzyme levels^{7,8}. Numerous factors have been identified as contributing to skeletal muscle changes, including hypoxia, hypercapnia, inflammation, nutrition, deconditioning, and steroid-induced myopathy⁹. Skeletal muscle changes highlight that muscle conditioning may play an integral role in the treatment of this population¹⁰. When the primary respiratory muscles are dysfunctional or cannot meet the ventilatory demand, trapezius, latissimusdorsi, pectoralis major, and serratus anterior muscles

may assume an accessory respiratory function^{11, 12}. Data regarding the influence of these muscles strength on 6MWD is scarce and limited so there is a need to know the importance of strength of these muscles on exercise tolerance. The aim of the study is to investigate the influence of thoracic and upper limb muscle function on 6-min walk distance (6MWD) in patients with COPD.

METHODOLOGY

The study was approved by Institutional Review Board Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati. The study was conducted in SVIMS Hospital, Tirupati. Thirty eight COPD patients were included according to Convenience Sampling and if they fulfilled the criteria for COPD according to the Global Initiative for Chronic Obstructive Lung Disease guidelines and the study design is Prospective, cross-sectional design.

INCLUSIVE CRITERIA

Patients were included in the study only when in a clinically stable condition with no history of infections or exacerbation of respiratory symptoms, no changes in medication within the 2 months preceding the study outset, and no clinical signs of edema.

EXCLUSIVE CRITERIA

- History of cerebrovascular accident.
- Use of immunosuppressive drugs.
- Presence of Neuromuscular disorders.
- History of cardiovascular instability.
- History of pulmonary surgery.
- Hemodynamically unstable patient.
- Wound infection.

PROCEDURE

New protocols of therapy that may benefit patients in pulmonary rehabilitation programs are emerging, and this trend reflects increasing scientific knowledge and technology as well as the gradual emergence and acceptance of this application of rehabilitation. Study group consisted of 30 patients of age ranging from 50 – 76yrs (62.8yrs). All participating patients provided written informed consent.

6MWT

The 6MWT was conducted according to American Thoracic Society guidelines. Patients were instructed to walk, attempting to cover as much ground as possible within 6 min¹². A research assistant timed the walk, and standardized verbal encouragement was given to each patient. Before and after the test, data were obtained for heart

rate, respiratory rate, Borg scale dyspnea score, and BP. The distance covered was measured in meters.

Respiratory Pressures P_{lmax} measured in accordance with Black and Hyatt.

Peripheral Muscle Strength

Peripheral muscle strength was assessed through the determination of the one-repetition maximum (1RM). The agreed convention for 1RM is the heaviest weight that can be lifted throughout the complete range of determined movement. The 1RM was assessed for each of exercises performed on gymnasium equipment. Patients were required to perform the following exercises: bench press (pectorals and triceps), lat pull down (latissimus dorsi, trapezius, rhomboids, pectorals major and biceps)¹⁰. A warm up of 10 repetitions with a light weight was performed prior to the test in order to minimize the effects of learning. The 1RM test was initiated at a weight near the suspected maximum to minimize repetition fatigue. All participants attained the 1RM within four attempts^{11, 12}. Two to 3 min of rest was allowed between repetitions. The Valsalva maneuver was avoided, and the proper exercise performance technique for each muscle group was emphasized.

Pulmonary function tests

Pulmonary function tests were performed with a spirometer according to the criteria set by the American Thoracic Society⁷. Values of FEV₁ are expressed in liters, in percentages of FVC, and as percentages of reference values.

BDI

A modified version of the baseline dyspnea index (BDI) developed by Mahler et al was used to evaluate baseline dyspnea.

DATA ANALYSIS

To study the correlation between variables, Pearson or Spearman coefficients of correlation were used with the level of statistical significance set at 5%. Data were submitted to multiple regression analysis to evaluate independent variables that might be determinants of 6MWD.

RESULTS

Baseline characteristics of the 38 COPD patients tested are shown in Table 1.

Table 1: Baseline Characteristics of the Study Population

Variables	Mean	SD
Age, yr	62.86	8.82
FEV ₁ , % of predicted	57.00	22.14
BDI	1.80	1.14
P _{lmax} , cm H ₂ O	-71.00	25.00
Bench press, 1RM in kg	32.71	8.77
Lat pull down, 1RM in kg	38.00	9.00
6MWD, m	560.00	96.00

Among the group of patients, airflow obstruction was, on average, moderate to severe. In all patients, the sensation of dyspnea on exertion was found to be light to moderate.

Mean P_{lmax} was -71±25 cm H₂O (± SD), Mean 1RM for the lat pull down exercise was greater than that obtained by Taaffe et al in healthy elderly subjects (38±9 kg vs. 35 ± 9 kg) [Table 1], and handgrip strengths were within predicted values obtained for healthy individuals in the various age groups. Mean 6MWD during the study was 560 ± 96 m. Mean male patient distances were 109% of predicted values, compared with 105% of predicted for female patients (Table 1). The 6MWD presented statistically significant positive correlations with BDI score, (r =0.50; p < 0.01), FEV₁, (r=0.33; p < 0.05) P_{lmax}, (r =0.53; p < 0.01), and 1RM (r =0.52; p < 0.02), for all exercises performed. Conversely, 6MWD was found to correlate negatively, to a statistically significant degree, with a sensation of dyspnea at the end of the 6MWT. Multiple regression analysis revealed P_{lmax}, and 1RM in the lat pull down exercise to be predictive of 6MWD. These variables explained 59.8% of the total variance in 6MWD. *Results of Multiple Regression Analysis of the 6MWD and the Independent Determinants*

Table 2: Dependent Variable 6MWD

Determinants	Coefficient	p Value
BDI	41.802	<0.001
P _{lmax}	1.806	0.002
Lat pull down	3.458	0.022

Correlation between 6MWD and peripheral muscle strength variables are presented in Figure 1.

DISCUSSION

Results of this study suggested for the first time that thoracic muscle strength is a predictor of 6MWD in COPD patients. It also confirms the influence of respiratory muscle strength (Pimax), dyspnea, on the 6MWD of these patients. Multiple regression analysis revealed that Pimax, BDI and 1RM in the lat pull down exercise were responsible for 59.8% of the total 6MWD variance. The influence of thoracic muscle strength on 6MWD found in the present study has not been previously described in the literature. Hamilton et al estimated the influence of thoracic and upper limb muscle strength on the maximal exercise capacity of patients with respiratory disease; however, the authors did not evaluate 6MWD. The influence of thoracic muscle strength on 6MWD might be explained by the large number of accessory respiratory muscles involved in performing the lat pull down exercise. Muscles necessary to carry out the exercise include the latissimus dorsi, trapezius, rhomboids, pectorals major, and biceps. Some of these muscles may assume an accessory respiratory function when the primary respiratory muscles are dysfunctional or cannot meet the ventilatory demand. It has been suggested that improved accessory respiratory muscle function is the mechanism responsible for the increased ventilatory capacity observed in COPD patients performing the 6MWT with the aid of a rollator. In our patients, the baseline sensation of dyspnea, as evaluated by the BDI, was also determined to be a predictor of 6MWD, as has been previously demonstrated.

CONCLUSION

In conclusion, the results of this study showed the importance of the skeletal musculature in exercise capacity in COPD patients. Peripheral muscle strength, respiratory muscle strength, and the sensation of dyspnea all have an influence on the capacity of COPD patients to perform exercises. Therefore, there is a real need to develop treatment strategies that are aimed at interrupting the deconditioning-dyspnea cycle in these patients.

REFERENCES

1. Enright PL, Sherrill DL. Reference equations for the six minute walk in healthy adults. *Am J Respir Crit Care Med*. 1998; 158(5):1384-1387.
2. American Thoracic Society statement. Guidelines for six minute walking test. *Am J Respir Crit Care Med* 2002; 166:111-117.
3. Pinto-Plata VM, Cote C, Cabral H, et al. The 6-min walk distance: change over time and value as a predictor of survival in severe COPD. *Eur Respir J* 2004; 23(1):28-33.
4. Oga T, Nishimura K, Tsukino M, et al. Relationship between different indices of exercise capacity and clinical measures in patients with chronic obstructive pulmonary disease. *Heart Lung* 2002; 31(5):374-378.
5. Gosselink R, Troosters T, Decramer M. Peripheral muscle weakness contributes to exercise limitation in COPD. *Am J Respir Crit Care Med* 1996; 153(3):976-980.
6. Kim HC, Mofarrahi M, Hussain SN. Skeletal muscle dysfunction in chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2008;3(4):637-58.
7. Moxham J. Respiratory muscle testing. *Monaldi Arch Chest Dis*. 1996;51(6):483-8.
8. Epstein SK. An overview of respiratory muscle function. *Clin Chest Med*. 1994;15(4):619-39.
9. Hamilton AL, Killian KJ, Summers E, et al. Muscle strength, symptom intensity, and exercise capacity in patients with cardiopulmonary disorders. *Am J Respir Crit Care Med* 1995; 152 (6 Pt 1):2021-2031.
10. Bernard S, Leblanc P, Whitton F, et al. Peripheral muscle weakness in patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 1998; 158(2):629-34.
11. Serres I, Gautier V, Varray A, et al. Impaired skeletal muscle endurance related to physical activity and altered lung function in COPD patients. *Chest* 1998; 113(4):900-905.
12. Serres I, Hayot M, Pre' faut C, et al. Skeletal muscle abnormalities in patients with COPD: contribution to exercise intolerance. *Med Sci Sports Exerc* 1998; 30(7):1019-1027.

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