International Journal of Health Sciences and Research
Volume 14; Issue: 5; May 2024
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Effectiveness of Six-Minute Walk Test Versus Diaphragmatic Breathing Exercise on Subjects with Chronic Obstructive Pulmonary Disease

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DOI: https://doi.org/10.52403/ijhsr.20240563

ABSTRACT

PURPOSE: The purpose of the study is to find the effectiveness between 6-minute walk test and diaphragmatic breathing exercise on subjects with chronic obstructive pulmonary disease.
METHODS: 25 subjects who were clinically diagnosed of chronic obstructive pulmonary disease were assessed and only 20 were recruited who are willing to be in the study and they were randomly allocated into 2 groups. In group A (n=10) subjects were trained with 6-minute walk test, with duration 3days a week for 4 weeks, where in group B (N=10) subjects were trained with diaphragmatic breathing exercise. The outcome of this intervention was oxygen saturation and dyspnea. This was recorded before and after the session of 4-week intervention.
RESULTS: Statistical analysis of the data reveal that between the group comparison showed there is statistically significant difference in pulse oximetry and modified Borg scale.
CONCLUSION: Both the groups have shown significant improvement in reducing dyspnea and improving strength and endurance of respiratory muscles in subjects with chronic obstructive pulmonary disease. GROUP A showed statistically significant improvement when compared to GROUP B in reducing dyspnea and improving oxygen saturation.

Keywords: Six Minute Walk Test, Diaphragmatic Breathing Exercise, Pulse Oximetry, Modified Borg Scale.

INTRODUCTION

Chronic Obstructive Pulmonary Disease is the internationally preferred term encompassing Chronic bronchitis (airway disease), & Emphysema (alveolar disease).[1]
According to world health organization (WHO), Chronic Obstructive Pulmonary Disease (COPD) state is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases.[2]
According to world health organization (WHO) the incidence rate of chronic obstructive pulmonary disease worldwide was 8.5% to 10%. In India the incidence of chronic obstructive pulmonary disease increased from 28.1 million to 55.3 million by 2016. The incidence of chronic

obstructive pulmonary disease was higher in men (13% to 16%) than in women (5.5% to 7%).[2]The prevalence of chronic obstructive pulmonary disease worldwide has increased 29.2% by 2016.[4] It has been studied extensively by Indian investigators over the last 5 decades. According to NCHM (National Commission on Macroeconomics & Health) estimates in 2006 there were around 17 million chronic obstructive pulmonary disease patients in India. The chronic obstructive pulmonary disease prevalence varied from 3% to 8% amongst Indian males & approximately 2.5% to 4.5% among Indian females.[5] According to the prediction of the World Health Organization, chronic obstructive pulmonary disease will become the third leading cause of mortality.[3] In India three out of five leading cause of mortalities constitute non communicable diseases whereas chronic obstructive pulmonary disease is the second biggest cause of death.[4]

Chronic Obstructive Pulmonary Disease (COPD) is characterized by progressive inflammation in large airways (bronchi), smaller airways (bronchioles), & lung parenchyma (gas exchanging lung).[10,11] The pathological changes in patients with Chronic Obstructive Pulmonary Disease (COPD) are complex and occur in the following four different compartments of the lung: the central, large airways; the small peripheral airways; the lung parenchyma and the pulmonary vasculature. The main pathogenesis is characterized to give rise to the clinical and physiological abnormalities in chronic obstructive pulmonary disease, which are mucus hyper secretion and cilia dysfunction, airflow limitation and hyperinflation, gas exchange abnormalities and pulmonary hypertension and systemic effects.[12] Macrophages, neutrophils, dendritic cells and CD^8+ T-lymphocytes are the key inflammatory cells involved in chronic obstructive pulmonary disease.[13] The normal CD^8+ T-lymphocytes equals to 800/mm3. There was a decrease in the total count of CD^8+ T-lymphocytes in Chronic Obstructive Pulmonary Disease.[14]

Smoking is recognized as the most important causative factor for chronic obstructive pulmonary disease.[6] And other causes also play a major role i.e. genetically due to deficiency of alpha-1 antitrypsin & environmental factors like air pollution, occupational exposures such as exposure to coal dust, fumes, chemical. substances and various proteases and oxidants are believed to play crucial roles as well.[6,,8,7,9]

The chronic obstructive pulmonary disease severity is classified into four stages. They are stage 1-mild airflow limitation, stage 2-moderate chronic obstructive pulmonary disease, stage 3-severe chronic obstructive pulmonary disease, and stage 4-very severe chronic obstructive pulmonary disease by FEV1/FEC ratio.[15] The normal value for the FEV1/FVC ratio is 70% according to GOLD (Global Initiative for Chronic Obstructive Lung Disease) and when the FEV1/FVC ratio is <70% that defines as obstruction.[16]

The clinical features for chronic obstructive pulmonary disease are based on clinical symptoms like dyspnea, chronic cough, sputum production, chest tightness or a history of exposure to risk factors.[15]

The diagnostic criteria for chronic obstructive pulmonary disease are physical examination measurement of airflow limitation by spirometry. Bronchodilator reversibility testing. Chest X-ray, Chest CT-Scan in severe cases. Arterial blood gas measurement in advanced chronic obstructive pulmonary disease. Alpha-1 antitrypsin deficiency screening.[15]

The Bronchodilator medications which are central to symptomatic management of chronic obstructive pulmonary disease. And other drugs like glucocorticoids, antibiotics, mucolytic agents, alpha-1 antitrypsin augmentation therapy etc. are used. In severe cases of chronic obstructive pulmonary disease, surgical treatments like bullectomy, lung volume reduction surgery and lung transplantation are done.[2,15]

Rehabilitation improves exercise tolerance, reduce symptoms of dyspnea and increase health related quality of life. Cardiopulmonary exercises like incremental cycle ergometry, 6-minute walk test incremental shuttle walking tests; sit to stand tests, breathing exercise like diaphragmatic breathing exercises, and pursed lip breathing exercise, segmental breathing exercises.[17]

The 6 Minute walk test is a field walking test for patients with respiratory disorders which is very popular.[17]The 6 Minute walk test is safer, easier to administer better tolerated and better reflects the activities of daily living when compared to other walk tests like shuttle walking tests.[18] It is a reliable and valid functional test for assessing exercise tolerance and endurance.[19] The six minute walk test primarily helps to predict mortality in patients with severe Chronic Obstructive Pulmonary Disease.[20]

Breathing techniques aim to relieve symptoms of dyspnea and ameliorate adverse physiological effects by increasing strength and endurance of the respiratory muscles, optimizing the pattern of thoraco-abdominal motion, reducing dynamic hyperinflation of the rib cage and improving gas exchange.[21] Diaphragmatic breathing is widely used in pulmonary rehabilitation of patients with Chronic Obstructive Pulmonary Disease.[22] Diaphragmatic breathing training program mainly improves abdominal motion during natural breathing in patients with chronic obstructive pulmonary disease.[23,24] Pursed lip breathing exercise is a strategy often spontaneously employed by patients with chronic obstructive pulmonary disease during distress situation.[25] Breathing techniques also increases participation in physical and social activities, increases the activities of daily living and improve the overall quality of life.

NEED OF THE STUDY:

Chronic obstructive pulmonary disease is a common chronic pulmonary disorder afflicting 10 to 15% adults over age of 45. Chronic obstructive pulmonary disease is associated with significant economic burden including hospitalization. Hence, the need of the study was to compare the effectiveness of 6-minute walk test and diaphragmatic breathing exercise on reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.

individuals with chronic respiratory diseases.[26]

AIM OF THE STUDY:

The aim of the study was to find the effectiveness of 6 minute walk test and diaphragmatic breathing exercise on reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.

OBJECTIVES OF THE STUDY:

- To assess the effect of 6 minute walk test, diaphragmatic breathing exercise in reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.
- To determine the effectiveness of 6 minute walk test when compared to diaphragmatic breathing exercise in reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease

HYPOTHESIS:

- **EXPERIMENTAL HYPOTHESIS:** 6 Minute walk test is more effective than diaphragmatic breathing exercise in reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.
- **ALTERNATIVE HYPOTHESIS:** Diaphragmatic breathing exercise is more effective than 6-minute walk test in reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.
- **NULL HYPOTHESIS:** There is no difference between 6 minute walk test and diaphragmatic breathing exercise in

reducing dyspnea and improving oxygen saturation in subjects with chronic obstructive pulmonary disease.

MATERIALS & METHODS

This study was proposed to determine the effectiveness of 6 minute walk test and diaphragmatic breathing exercise in subjects with chronic obstructive pulmonary disease.

STUDY DESIGN: Experimental Study.
STUDY SETTING: The study was conducted at department of Pulmonology, STUDY **SUBJECTS:** A total number of 25 subjects both men and women age between 40-60 years suffering with chronic obstructive pulmonary disease are recruited from department of pulmonology and willing to participate in the study general hospital.
SAMPLE SIZE:

GROUP	NO. OF SUBJECTS	TREATMENT
Group A	10	6-minute walk test
Group B	10	Diaphragmatic breathing exercise

STUDY SAMPLING: simple random sampling, (lottery method.)
TREATMENT DURATION: 4 weeks, 3 days/week for 30 minutes.
STUDY PERIOD: 1 year.
MATERIALS USED: Paper, Pen, Measuring tape, Stop watch, Pulse oximetry Modified borgs scale, Data collection chart, Consent form.

INCLUSION CRITERIA:

1. Age limit with 40-60 years.
2. Both Genders were included.
3. Subjects willing to participate voluntarily.
4. According to GOLD criteria stage 1 - mild airflow limitation, and stage 2 – moderate chronic obstructive pulmonary disease (FEV1/FVC < 70%) with shortness of breath.

EXCLUSION CRITERIA:
Acute Exacerbations of chronic obstructive pulmonary disease. Unstable vital signs, Lung surgeries within previous three months, psychological problems, Untreated neoplasia, Arrhythmia, History of cardiovascular diseases, Patients with requirement for supplement oxygen therapy.

OUTCOME MEASURES:
Pulse Oximetry: To measure the oxygen saturation.
Modified Borg Scale: To measure the dyspnea grading.

MEASUREMENT PROCEDURE (DATA COLLECTION)
The study was a pre-test and post-test comparative experimental study. The subjects participating in the study were briefed about nature and duration of study, then informed consent was taken. The initial assessment like Name, Age, Gender, occupation was taken. The subjects were randomly assessed into two equal groups A and B having 10 in A group and 10 in B group. Patients were included after study baseline assessment subjects who fulfill the inclusion criteria. The treatment was

PULSE OXIMETRY:
Pulse oximetry is used to measure the oxygen saturation level in the blood. It is a small, clip-like device that attaches to a body part, like finger, toes or earlobe. It is most commonly put on a finger. It can rapidly detect even small changes in how efficiently oxygen is being carried to the extremities furthest from the heart, including the legs and the arms.

DYSPNEA MODIFIED BORG SCALE:
This scale is used to rate the difficulty of breathing. It is a 0 to 10 rated numerical score where 0 has no difficulty in breathing and progresses through to 10 where the breathing difficulty is maximum. The patients were asked how much difficulty is he/she is experiencing while breathing.

INTERVENTION:

Total 20 subjects with chronic obstructive pulmonary disease, who fulfilled the inclusion criteria were taken by simple random sampling technique. Mode of assessment and about the condition was explained to all the subjects and return informed consent were obtained from them. Before starting the training program pre-test was done and the subjects were divided into two groups. Group A, 6 minute walk test group, and Group B, diaphragmatic breathing exercise group. All the subjects were scheduled to attend the exercise session for 3 days per week with exercise duration 30 minutes for 2 times per day. During training program all the patients were allowed to continue their medications. And patients were counseled about smoking cessation, food habits and conventional physiotherapy was given commonly.

GROUP A (6 MINUTE WALK TEST) :

The 6 minute walk test is a time-limited walk test and frequently used to evaluate the functional status. The 6 minute walk test is a self-placed test and the degree of the therapist encouragement can be crucial in setting walking speed. The 6 minute walk test was done according to American thoracic association guidelines. Subjects were instructed to walk from end to end at the corridor of the hospital which is 30m (100 foot) long at their own pace, while attempting to cover as much distance as possible in the allotted 6 minute without oxygen supplement. The distance walked is recorded . At the end of the 6 minute walk test the total distance covered was recorded. Total duration of the exercise was 30 min . Patients were told to stop once they could walk no more.

GROUP B (DIAPHRAGMATIC BREATHING EXERCISE):

The subjects were instructed to breath normally for 1 min in sitting position. And the following verbal instructions were given during inhalation and exhalation, respectively:" to perform a slow maximal inspiration allowing the air to go to your belly", and "perform a normal expiration without forcing abdominal retraction and pursed lip breathing." Tactile feedback was provided by positioning the patients hands on the abdomen and the other hand on the upper rib cage. If necessary, visual and auditory stimulation was provided to correct uncoordinated respiratory patterns. The duration of the training was 30 minute and both the 6 minute walk test group, diaphragmatic breathing exercise group were trained for 3 days in a week for 4 weeks.

STATISTICAL ANALYSIS

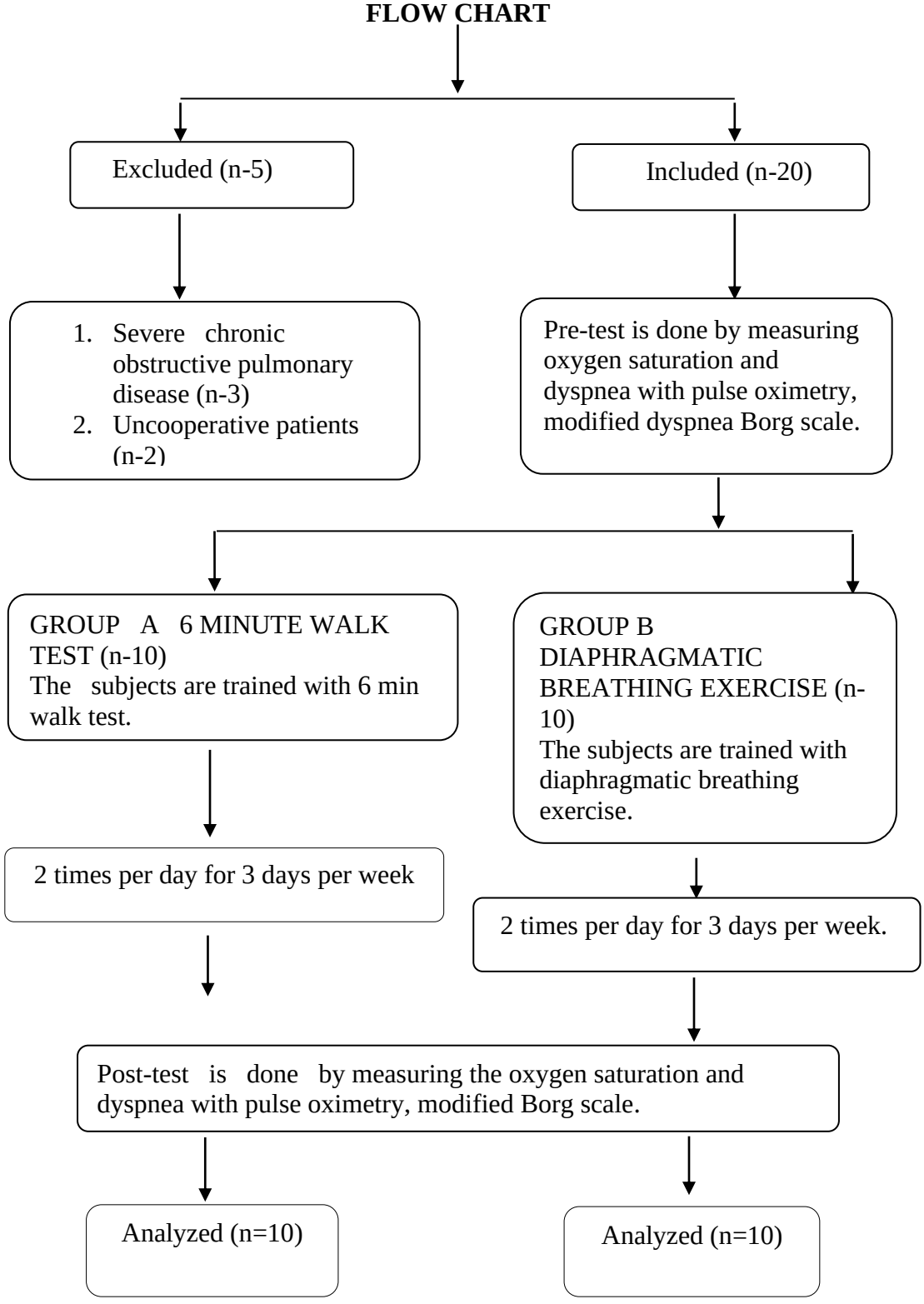
Statistical analysis was performed using MS Excel 2007 and GRAPHPAD software version 20.0. Descriptive statistical data has presented in the form of mean standard deviation and mean difference percentage were calculated and presented.

Between the groups: Independent student 't' test was performed to assess the statistical significant difference in mean values between the groups for pulse oximetry and modified Borg scale.

Within the groups: Paired student 't' test was performed to assess the statistical difference within the groups for pulse oximetry and modified Borg scale from pre and post tets values.

The statistical significance was set at $p<0.05$ with 95% confidence intervals.

FLOW CHART



RESULT

The results of this study were analyzed which was based on oxygen saturation and dyspnea measured by pulse oximetry and modified Borg scale.

Comparison was done both within each group as well as in between the two groups. So as to evaluate the intra group and inter group effectiveness of 6 minute walk test and diaphragmatic breathing exercise which are under considerations in the present study During the training period pre - test measurements were taken and post-test

measurements were taken after 4 weeks of intervention with pulse oximetry and modified Borg scale.

Table:1- Analysis of Mean score of pre & post values of SpO2 within Group A:

TEST	N	MEAN SCORE SpO2	Standard Deviation	P - value	Interference
PRE	10	86.20	2.30		
POST	10	88.80	1.55	0.0083	Significant

Table: 2- Analysis of Mean score of pre &post values of Dyspnea within Group A:

Parameters	N	Mean for Dyspnea	Standard Deviation	P – value	Interference
PRE	10	2.300	0.675	0.0002	Significant

Table:3- Analysis of Means of pre &post values SpO2 within Group B:

Test	N	Means of SpO2	Standard Deviation	P - value	Interference
PRE	10	85.40	1.84		
POST	10	86.30	1.95	0.0039	Significant

Table: 4- Analysis of means of pre & post values of Dyspnea within Group B:

Test	N	Means of Dyspnea	Standard Deviation	P - value	Interference
PRE	10	1.50	0.707		
POST	10	0.900	0.459	0.0130	Significant

Table:5- Analysis of means of post values of SpO2 between Group A & Group B:

Parameters	N	Mean	Standard deviation	P – value	Interference
SpO2 of Group A (POST)	10	88.80	1.55		
SpO2 of Group B (POST)	10	86.30	1.95	0.0053	Significant

Table: 6- Analysis of means of post values of Dyspnea between Group A & Group B

Parameters	N	Mean	Standard deviation	P – value	Interference
Dyspnea grading of Group A (POST)	10	1.000	0.577		
Dyspnea grading of Group B (POST)	10	1.500	0.457	0.00456	Significant

DISCUSSION

The results had shown that both 6 minute walk test and diaphragmatic breathing exercise who received the four weeks of therapy has improved significantly on pre and post-test values within the groups and when compared between these groups there is statistical significance noted. So, this study concluded that there is significant difference between 6 minute walk test and diaphragmatic breathing exercise in improving oxygen saturation and reducing dyspnea among chronic obstructive pulmonary disease patients.

Generally, peripheral muscle weakness is a result of chronic inactivity and muscle deconditioning in patients with chronic obstructive pulmonary disease and may play a role in the reduction of functional capacity. Additionally, in these patients , dyspnea and lower limb muscular weakness may be accompanied by cardiorespiratory limitation. Age and dyspnea are the strongest and most consistent correlates of impaired exercise performance in patients with chronic airway obstruction. It has been reported that perceived breathlessness is correlated with walking distance in patients with chronic obstructive pulmonary disease. Due to these symptoms it is difficult for chronic obstructive pulmonary disease patients to perform daily living activities which urged me to conduct this study on chronic obstructive pulmonary disease subjects, whose recovery can be prudent for their family and their social life

However, regular exercise has been associated with reduced risk of hospitalization for exacerbated chronic obstructive pulmonary disease and mortality among the patients with chronic obstructive pulmonary disease.

For patients with chronic obstructive pulmonary disease who expend extra energy just to breath, walking regularly can improve the body's ability to utilize oxygen. Walking a low impact exercise places minimum stress on the joints and is generally an easy exercise for chronic obstructive pulmonary disease patients to perform.

Pulmonary rehabilitation including exercise training (6 minute walk test and diaphragmatic breathing exercise) for at least 4 weeks has been shown to improve shortness of breath, and to improve the quality of life, and strategies for coping with chronic obstructive pulmonary disease.

S.Ozalevli.et.al(2006) the purpose of the study is to know the functional status of chronic obstructive pulmonary disease patients. The 6 minute walk test is used for chronic obstructive pulmonary disease patients and found that it depends on age, quality of life, severity of dyspnea and peripheral muscle strength. It is determined that FEV1 is a poor predictor of symptoms and disability in chronic obstructive pulmonary disease patients. Thus, exercise test must be performed in these patients in order to assess their disability, because this information cannot be derived from traditional functional findings. It is known that 6minute walk test determines the strength of lower extremity muscles. Age and dyspnea are the strongest and most consistent correlates of impaired exercise performance in patients with chronic airway obstruction. It has been reported that perceived breathlessness is correlated with walking distance in patients with chronic obstructive pulmonary disease. This study found that 6minute walk test provides independent information regarding the functional status of chronic obstructive pulmonary disease patients and correlates with the changes in dyspnea severity and quality of life. This study showed that the arm muscles are active during walking exercise in some patients with chronic obstructive pulmonary disease and this might be a source of reflex impulses to the respiratory centers, leading to dis-synchronous breathing and consequently impairing gas exchange. Similarly, it was found that encouragement significantly increased the distance walked in 6 minute walk test.[27]

Reshma RajendraKolase.et.al(2011) this study suggested that significant oxygen desaturation was found at the end of the test. Individuals with chronic obstructive pulmonary disease found were to have incidents of large desaturation after walking exercises either walking at a constant speed and resistance or walking with increment. Oxygen desaturation as a fall in SpO2 OF >4% below resting value that persists for at least the last 3 minute of the exercise test. This 4% fall was defined as a fall of 2% to account for potential inaccuracy of oximetry plus another fall of 2% account for the right shift of the hemoglobin saturation curve induced by exercise metabolic acidosis. Hence, implication of our findings is that a field walking test is used for identifying those who may benefit from oxygen therapy during walking, is often the assessment upon which the prescription of ambulatory oxygen is based, and ambulatory oxygen should be considered if a patient shows desaturation on exercise and an improvement in exercise performance and/or dyspnea with oxygen and is motivated to use it.[1]

Marcelo Fernandes et.al (2011) this study showed that diaphragmatic breathing altered the respiratory patterns, increasing the tidal volume and reducing the respiratory frequency. This technique resulted in increases in VE and in gas exchange, as shown in the reduction in VD/VT and VE/VCO2 and the increase in SpO2. During the exercise, the displacement was predominantly abdominal with some patients showing asynchronous thoracoabdominal

movement and a greater sensation of perceived exertion. In the present study, the technique was used with low dyspnea ratings and thoracoabdominal coordination in several patients. This study believed that preserved respiratory muscle strength and adaptive mechanisms in the diaphragm, such as muscle remodeling, change in the fiber composition, reduction in the number of sarcometers in series, and maintenance of diaphragmatic excursion efficiency, contributing to a suitable balance between developed work and reserve of strength. Abnormalities in the coordination between the thorax and abdomen are related to an increase in the respiratory muscle load and are considered precursors of muscle fatigue. This study reported that diaphragmatic breathing may not be the best choice as a ventilatory strategy for chronic obstructive pulmonary disease patients with hyperinflation and mechanical inefficiency of the diaphragm. In conclusion diaphragmatic breathing is a ventilatory strategy able to promote an increase in pulmonary ventilation in chronic obstructive pulmonary disease patients with preserved respiratory mechanics. Thus , the inclusion of diaphragmatic breathing as a ventilatory strategy in a self-management program may produce positive effects in these patients.[29]

Wellington P. Yamaguti.et.al(2012) this study randomized control trail was designed to investigate the isolated effects of a short-term diaphragmatic breathing in patients with chronic obstructive pulmonary disease. It demonstrated an improvement in abdominal motion as well as an increase in diaphragmatic mobility and leads to benefits in dyspnea symptoms and exercise tolerance. These results support the hypothesis that diaphragmatic breathing can induce a modification in habitual breathing patterns and increase diaphragmatic excursion, there by relieving symptoms and improving the functional capacity of patients with patients with chronic obstructive pulmonary disease. Diaphragmatic dysfunction is an important consequence of respiratory alterations in patients with chronic obstructive pulmonary disease. The study reveals that patients who participated in diaphragmatic breathing had higher abdominal motion and higher diaphragmatic mobility after the training as well as reduction in dyspnea symptoms. The new contribution of this study lies in the fact that diaphragmatic breathing not only improves respiratory mechanics but also impacts functional outcomes.[23]

In this study we have taken a therapy session of 30 minute, which is a therapist friendly approach for inpatient treatment program and even cost effective and time saving procedure for both the patient and therapist.

I have taken oxygen saturation and dyspnea as an outcome measures. I have observed improvement in the post test values of both the 6 minute walk test group and diaphragmatic breathing exercise group.

The result of present study shows that there is significant difference between 6 minute walk test and diaphragmatic breathing exercise statistically.

Limitations:

- The study did not include long term follow up.
- This study sample size was relatively small to detect the differences between 6 minute walk test and diaphragmatic breathing exercise groups.

Recommendations:

- Follow up programs can be included to assess the short term and long term effects of treatment.
- Further study can be done to check the effects of these techniques on other conditions.

- Effects of these trainings on other stages of chronic obstructive pulmonary disease can be studied.
- Further study should include more measurement tools.

CONCLUSION

In conclusion, in patients with chronic obstructive pulmonary disease 4-week 6 minute walk test and diaphragmatic breathing exercise resulted in significant improvements in exercise performance. The results had shown that both 6minute walk test group and diaphragmatic breathing exercise group has improved significantly on post- tests values within the groups but when compared between the groups six minute walk test showed statistically significant improvement than diaphragmatic breathing exercise group in improving oxygen saturation and reducing dyspnea. among mild and moderate chronic obstructive pulmonary disease subjects.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Chintamalla Rishita, Kusuma Kilani. Effectiveness of six-minute walk test versus diaphragmatic breathing exercise on subjects with chronic obstructive pulmonary disease. *Int J Health Sci Res.* 2024; 14(5):483-493. DOI: *10.52403/ijhsr.20240563*

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