



## CORRELATION OF FUNCTIONAL CAPACITY BETWEEN SIX MINUTE WALK TEST AND SIX MINUTE STEP TEST IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS.

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### ABSTRACT

To find the Correlation of Functional Capacity between Six Minute Walk Test and Six Minute Step Test. Non experimental study design. 20 patients with Chronic Obstructive Pulmonary Disease with age group 30-85 years of both genders, being mild ( $FEV1 \geq 80\%$ ) to moderate ( $FEV1 50-79\%$ ). 20 patients performed Six Minute Walk Test on first day and Six Minute Step Test on second day.: Double Product, Borg Scale, Heart Rate and  $VO_2$  max. Statistical analysis was done by using Independent 't' test and Correlation test which showed there is significant difference between Heart rate ( $p < 0.05$ ), Double Product ( $p < 0.05$ ) and Borg Scale ( $p < 0.05$ ) in both the tests and there is no correlation of  $VO_2$  max ( $p > 0.05$ ) between both the test.: It is concluded that there is no correlation of functional capacity between Six Minute Walk Test and Six Minute Step Test in COPD patients.

**KEYWORDS:** Six Minute Walk Test, Six Minute Step Test, COPD, Functional capacity.



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## INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD), a common preventable and treatable disease, is characterized by airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lungs to noxious particles or gases<sup>1</sup>. It is a major public health problem. Worldwide, COPD affects 329 million people or nearly 5% of the population. In 2011, it ranked as the fourth-leading cause of death, killing over 3 million people. In 2010, almost 24 million adults over the age of 40 in India had COPD. According to Joint Health Surveys Unit 1997, 11 percent of men and 8 percent of women in the whole population have evidence of obstructed airways when specifically tested by Spirometry<sup>2</sup>. The prevalence rate of COPD in Tamil Nadu is 4.1% in males and 2.5% in females<sup>10</sup>. World Health Organization (WHO) defines COPD as a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible. COPD is also known by other names such as Chronic Obstructive Lung Disease (COLD), Chronic Obstructive Airway Disease (COAD), Chronic Airflow Obstruction (CAO) or limitation (CAL)<sup>8-9</sup>. The two different types of COPD are Chronic Bronchitis and Emphysema<sup>1</sup>. Chronic bronchitis is defined as cough and sputum on most days for at least 3 consecutive months for at least 2 successive years. Emphysema is defined as abnormal permanent enlargement of the airspaces distal to the terminal bronchioles accompanied by destruction of their walls. COPD is a combination of airway narrowing, parenchymal destruction and pulmonary vascular thickening<sup>1-2</sup>. These

changes are related to chronic airway inflammation and are more pronounced in the peripheral airways. In COPD, the airways are pulled open wide by thoracic expansion, allowing air to enter during inspiration. During exhalation, the airway narrowing from inflammation, remodeling and excessive secretions, causes premature airway closure, trapping air in the distal airways and airspaces<sup>2-3</sup>. The most common parenchymal changes found in COPD are dilatation and destruction of the respiratory bronchioles<sup>1-3</sup>. The main symptoms are chronic cough, expectoration and exertional dyspnoea and on examination are found to have overinflated chest and poor exercise tolerance. The GOLD classifications are the main method used to describe the severity of chronic obstructive pulmonary disease (COPD)<sup>4-5</sup>. GOLD is short for the Global Initiative for Chronic Obstructive Lung Disease, collaboration between the National Institutes of Health and the World Health Organization<sup>4</sup>. The GOLD system classifies people with COPD based on their degree of airflow limitation (obstruction).<sup>3</sup> There are no previous studies regarding the correlation between six minute walk test and six minute step test in COPD. Six minute walk test is more reliable to find out the functional capacity in COPD patients, hence this study focused on finding the alternative test for finding the functional capacity in COPD patients. The aim of this study is to find the correlation between six Minute Walk Test and Six Minute Step Test on functional capacity in COPD patients. The objective of this study is to correlate the VO<sub>2</sub> max and to compare the behavior of physiological variables such as Heart Rate, Blood Pressure, Double Product and Borg Scale during Six Minute Walk Test and Six Minute Step Test in COPD patients.

### GOLD classification of COPD

Stage I	Mild COPD	FEV <sub>1</sub> /FVC<0.70	FEV <sub>1</sub> ≥80% normal
Stage II	Moderate COPD	FEV <sub>1</sub> /FVC<0.70	FEV <sub>1</sub> 50-79% normal
Stage III	Severe COPD	FEV <sub>1</sub> /FVC<0.70	FEV <sub>1</sub> 30-49% normal
Stage IV	Very Severe COPD	FEV <sub>1</sub> /FVC<0.70	FEV <sub>1</sub> <30% normal, or <50% normal with chronic respiratory failure present.

## MATERIALS AND METHODS

20 Subjects who are diagnosed with Mild to Moderate Chronic Obstructive Pulmonary Diseases according to the GOLD guidelines (class I and II) were taken in to the study. Both male and Female, age 30-80 years were included in the study. Subjects with History of Asthma, Inability to perform Six Minute Walk and Step tests, Hypertensive subjects, any other Cardiac, Neurological, Renal and Endocrine diseases, Syncope and Musculoskeletal pain, Presence of Respiratory distress, Severe COPD patient according to GOLD Guidelines were excluded from the study. The patients were assessed for suitability based on inclusion and exclusion criteria by performing pulmonary function test (PFT) as of American Thoracic Society Criteria. All the patients were clearly explained about the procedure and an informed consent was taken. Total sample size was 20. All the 20 patients performed both the tests (Six Minute Walk and Six Minute Step Tests). Six Minute Walk Test was performed on Day 1 and Six Minute Step Test was performed on Day 2. Blood pressure, Heart rate and Rate of perceived shortness of breath of the patients were recorded before and after the tests.

### Procedure

#### Day 1 - Six minute walk test

The Six Minute Walk Test was performed indoor, along a flat, straight, enclosed hospital corridor. The walking course was 30 m in length i.e., 100-ft hallway. The length of the corridor was marked every 3 m and the turnaround points were marked with a help of cone. A starting line, which marks the beginning and end of each 60-m lap, was marked on the floor. Demonstration of the test was given before the patients' starts the walk. The patients were asked to sit in a chair for at least 10 minutes which was located near the starting position before the initiation of test. Patients were instructed to walk from end to end at their own pace, while attempting to cover as much distance as possible in the allotted time of 6 minute. Patients were allowed to stop and rest when in need but were encouraged to proceed with the walk as soon as possible. While walking verbal encouraging commands were given to the patients. The walk was timed and the number of laps covered by the patients at the end of the test was recorded. After the walk, Borg score for Dyspnoea, Heart Rate and Blood Pressure were measured. If the walk was stopped while

performing the test, the reason behind it was noted down. The total distance travelled by the patient was calculated by

$$\text{Number of laps + final partial lap (meters) = Total distance walked in 6 minutes (meters).}$$

**Day 2 - Six minute step test**

The Six Minute Step Test was performed on a high step, measuring 20 cm in height, 80 cm in length and 40 cm in width. The patients were instructed to step up and down (up –up-down-down) i.e. supporting their two feet over the step and then return to the starting position. The patients were asked to repeat this cycle as much as possible. The patients were allowed to use either of their legs to start the test and can alternate when wanted. Demonstration of the test was given before the patients' starts the test. The patients were instructed to maintain a steady four beat cycle, women at rate of 22 steps/min and men at rate of 24 steps/min with metronome setting of 96 beats per minute. Patients were allowed to slow down, stop and even rest in chair when in need but were encouraged to resume climbing as soon as possible. Patients were not allowed to use their arms to help them to step but if the patient feels like losing balance, they could use their arms for regaining balance. The test was timed for 6 minute. At the completion of test, patient's pulse was measured for 15seconds and then converted to beats per minute (15sec x 4). After the step test, Borg score of dyspnoea and blood pressure were measured.

If the climbing of step was stopped while performing the test, the reason behind it was noted down.

OUTCOME MEASURES of the study are MaximumVolume of oxygen uptake Vo2 max ( mL/kg/m), Rating of Perceived shortness of breath by Borg Scale, Heart Rate, Double product (systolic pressure x heart rate)

Calculating VO2 max for six minute walk test and six minute step test:

VO2 max Equation for six minute walk test: (mL/kg/m)  
 $VO2max = (0.03 \times \text{six minute distance, in meters}) + 3.38$   
 VO2 max Equation for six minute step test: (mL/kg/m)  
 VO2 max for Men =  $111.33 - (0.42 \times \text{pulse rate beats/min})$   
 VO2 max for Women =  $65.81 - (0.1847 \times \text{pulse rate beats/min})$

**RESULTS**

**Data analysis**

The collected data were tabulated and analyzed using descriptive and inferential statistics. The data was analyzed using Statistical Package for Social Science (SPSS 16.0) to present the finding of the study. To assess all the parameters, mean and standard deviation were used. Independent t test was used for comparison of Heart Rate, Double Product and Borg scale between the two tests. Pearson's Correlation test was used for correlation of VO2 max between the two tests.

**Table 1**  
**Comparison of heart rate between six minute walk test**  
**And six minute step test in COPDpatients**

Groups	N	Mean	Std.deviation	Std.error mean	P Value
Heart rate Walk test	20	81.70	1.867	0.417	0.000
Step test	20	90.60	3.648	0.816	

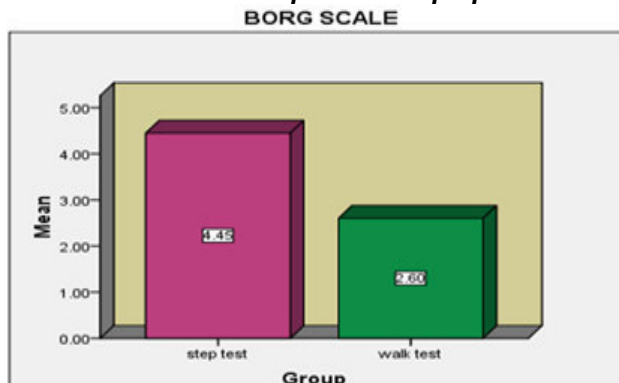
*In this table, there is significant difference in Heart Rate between the Six Minute Walk and Six Minute StepTests in COPD patients, since the p <0.05.*

**Table 2**  
**Comparison of double product between six minute walk test**  
**and six minute step tests in copd patients.**

Groups	N	Mean	Std.deviation	Std.error mean	P Value
Double Product Walk test	20	11.800	302.937	291.346	0.000
Step test	20	13.700	1318.415	294.807	

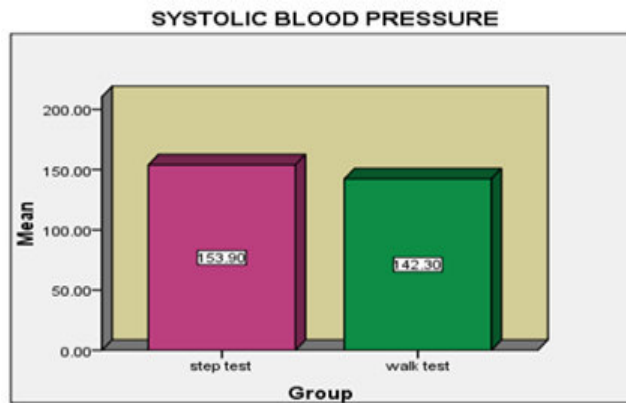
*In this table, there is significant difference in Double Product between Six Minute Walk and Six Minute Step Test in COPD patients since, p <0.05.*

**Graph 1**  
**Comparison of borg scale between six minute walk test**  
**and six minute step test in copd patients**



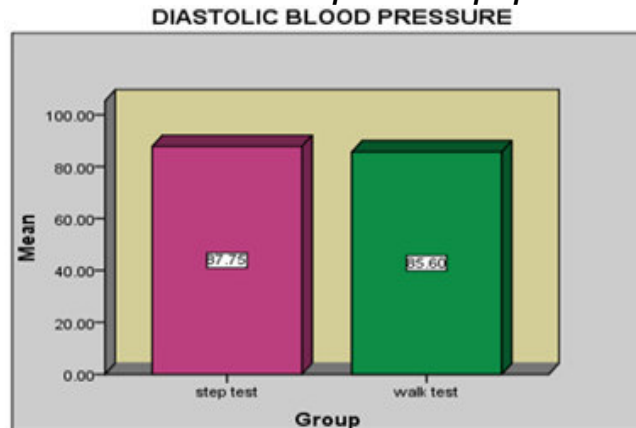
*In this graph, there is significant difference in Borg Scale between Six Minute Walk and Six Minute Step Tests in COPD patients, since p <0.05.*

**Graph 2**  
**Comparison of systolic blood pressure between six minute walk test and six minute step test in copd patients.**



In this Graph, there is significant difference in Systolic Blood Pressure between Six Minute Walk Test and Six Minute Step Test in COPD patients, since  $p < 0.05$ .

**Graph 3**  
**Comparison of diastolic blood pressure between six minute walk test and six minute step test in copd patients.**



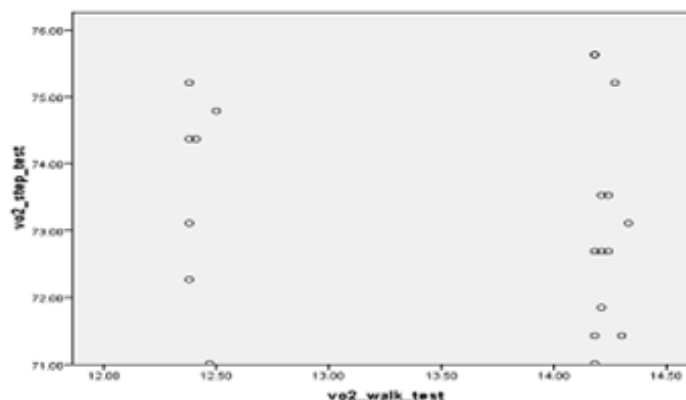
In this Graph, there is no significant difference in Diastolic Blood Pressure between Six Minute Walk Test and Six Minute Step Test in COPD patients, since  $p > 0.05$ .

**Table 3**  
**Correlation of vo2 max between six minute walk test and six minute step test in copd patients.**

Groups	N	Mean	Std.deviation	P Value
VO2 max Walk test	20	13.5905	0.8868	0.507
Step test	20	73.2780	1.53201	

In this table, there is no correlation between VO2 Max values of Six Minute Walk and Six Minute Step Tests in COPD patients, since  $p > 0.05$ .

**Graph 4**  
**Correlation of vo2 max between six minute walk test and six minute step test in copd patients.**



In this Graph, there is no correlation between VO2 Max values of Six Minute Walk and Six Minute Step Tests in COPD patients, since  $p > 0.05$ .

## DISCUSSION

This particular study was carried out in order to find out the correlation between Six Minute Walk and Six Minute Step Tests on functional capacity in COPD patients. The six minute walk test has been used extensively throughout the world to evaluate the functional capacity and dyspnoea sensation in many patient groups and has withstood the test of time<sup>18-23-24</sup>. The six minute step test is not used worldwide but it can be used in assessing functional capacity. According to Ferrazza, et al, the use of the six minute step test to assess patients with COPD makes it possible to quantify the limitation to exercise involving the legs alone, as well as allowing quantification of functional capacity<sup>20</sup>. It was observed that all patients assessed in this study completed the test properly, without need of supplemental oxygen. The rest time taken by the patients during Six Minute Walk test was comparatively very less than rest time taken during Six Minute Step test, because patients become tired and breathless. Rabinovich R.A recommended considering the weight and height of the patients, as well as the height of the step, because, unlike in the six minute walk test in which there is only a horizontal component in the work performed, in the step test there is addition of vertical displacement, which tends to increase the demand level of the test<sup>21</sup>. According to Table 1, Table 2, Graph 1, Heart Rate, Double Product and Borg Scale values showed a marked difference in Six Minute Walk and Six Minute Step Tests. This is because the physiological process of Six Minute Walk and Six Minute Step Tests differs from each other. According to Table 3, there was no correlation between VO<sub>2</sub> max in six Minute Walk test and six Minute Step test. The VO<sub>2</sub> max of Six Minute Step test was found to be more than Six Minute Walk test. This is probably due to the fact that step climbing requires muscle work against gravity. The demand for oxygen requirement was found to be more in six minute step test than six minute walk test.<sup>27</sup> According to Dal Corso S, et al, VO<sub>2</sub> max has been shown to be high during step tests in comparison with the values obtained during other field tests in patients with COPD<sup>22</sup>. The direct method of calculating VO<sub>2</sub> max is by performing an ergometric test with progressive loads and analyzing the exhaled oxygen and carbon dioxide fractions during effort as well as the pulmonary ventilation. Thus due to unavailability of direct method, indirect method of calculating VO<sub>2</sub>

max was used. There is correlation between the direct and indirect method but the direct method proves to be more reliable and accurate<sup>19</sup>. According to Graph 2 and Graph 3, there is difference in systolic pressure and no difference in diastolic pressure. This is because, the diastolic blood pressure is determined by the overall vascular resistance. During aerobic exercises, redistribution of blood occurs to the areas of demand (working muscles) while maintaining adequate blood flows to areas of high demand (brain, kidney). As a result there is decrease in vascular resistance or no increase. Hence the diastolic pressure decreases or remains same during heavy aerobic exercises. The systolic blood pressure increases due to increase in heart rate and diastolic pressure decreases as a result of decreased vascular resistance during aerobic exercises. Six Minute Walk and Six Minute Step tests, both are sub maximal tests. As Step test requires more oxygen and energy to perform the test, so it can be avoided in severe cases of COPD and can be used in mild to moderate cases of COPD. As Six Minute walk test is a self paced less energy consumption test it can be used in all the cases of COPD. This study can be further done by using Direct method of measuring vo<sub>2</sub> max, large sample and in severe COPD Patients. The limitation of the study was though female patients were supposed to be included in the study only male patients were available during the study; hence all the 20 patients were male. Hence according to statistical analysis there was significant difference in physiological process of both the test and there is no correlation in VO<sub>2</sub> max between the tests.

## CONCLUSION

This study concluded that there is no correlation between Six Minute Walk Test and Six Minute Step Test in functional capacity of COPD patients. The physiological process of Heart Rate, Double product, Systolic Blood Pressure and Rate of Perceived Shortness of Breath was found to be different between Six Minute Walk Test and Six Minute Step Test of COPD patients

## CONFLICT OF INTEREST

Conflict of interest declared none.

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