



## Effect of 6 Minute Walk Test on Functional Capacity in Patients with Tuberculosis Sequelae

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### ABSTRACT

**Background:** Sequelae of tuberculosis (TB Sequelae) is defined as the state with various secondary complications after healing of TB, such as chronic respiratory failure (CRF), cor pulmonale or chronic pulmonary inflammation. Consequently, people with pulmonary TB experience impaired gas exchange resulting in a decline in functional capacity. The 6 min walk test is a well-established, valid, and reliable measure of aerobic capacity in older people with cardiac, pulmonary, and peripheral vascular disorders. Till date there is no any research is available on 6 min walk test in 20 – 40 yrs of age group in patients TB Sequelae. The objective of the study was to find out the effect of 6 min. walk test on functional capacity in people with TB Sequelae.

**Methods:** Thirty subjects in an age group of 20-40 years with TB Sequelae were included in the study. A 20 m hospital corridor marked by coloured tape at each end was used. Subjects were instructed to walk from end to end at their self-selected pace, while attempting to cover as much distance as possible in the 6 minutes. The time and distance covered were recorded. The Borg scales for dyspnea and leg fatigue, as well as heart rate were recorded before and immediately after completion of the walk test. The outcome of interest VO<sub>2</sub> Max was calculated by the reference equation from the data collected.

**Results:** There was a significant difference in physical functional capacity between a group of normal 20 – 40 yrs people and those with TB sequelae. In the TB sequelae group, 30.41 % had a VO<sub>2</sub>max below 21 ml/kg/min that resulted in a considerable impact of TB sequelae on cardio respiratory endurance. The functional level of the patients were classified into 10 subjects (FL-2), & 20 subjects (FL-3) via 6 min walk test.

**Conclusion:** Subjects with TB Sequelae had significant decline in functional capacity & cardio-respiratory endurance than normal individuals.

**Key Words:** TB Sequelae, 6 min walk test.

### INTRODUCTION

Tuberculosis is an infectious disease that affects the lungs and results in poor lung compliance secondary to diffuse fibrotic changes to lung tissue.<sup>1</sup> Pulmonary tuberculosis (TB) is a contagious bacterial infection that involves the lungs, but may spread to other organs.<sup>2</sup> Sequelae of tuberculosis (TB sequelae) are defined as the state with various secondary complications after healing of TB, such as chronic respiratory failure (CRF), cor pulmonale or chronic pulmonary inflammation.<sup>3</sup>

In 1988 and 1989, 63 patients with tuberculosis sequelae were demonstrated to have been infected with respiratory pathogenic bacteria by the quantitative sputum culture method (greater than or equal to 10(7)/ml) in Tokyo National Chest Hospital.<sup>4</sup> The male/female ratio of these patients was 3.5, and their average age was 62.5 years. Patients with tuberculosis sequelae were distributed more in the younger age group than others with resembled pulmonary diseases. The man to women ratio was about 2:1.<sup>5</sup>

The sequelae are a pathological status that is caused by many patho-anatomical changes in the healing process of pulmonary tuberculosis and need clinical treatment for many symptoms. The pulmonary tuberculosis sequelae include secondary infection such as aspergillosis, atypical mycobacteriosis and bacterial airway infection. In a broad sense, the sequelae also represent a pathological status with many symptoms after treatment that is caused by injuries in various organs with tuberculosis.<sup>2</sup>

Pathophysiology of TB sequelae is consisted of disturbed pulmonary function, chronic respiratory failure, sleep disorder and pulmonary hypertension. In addition, secondary pulmonary infection with mycosis or non-tuberculous mycobacteriosis (NTM) is difficult to be controlled.<sup>3</sup>

Bacterial infections is one of the most important complications in the patients with pulmonary tuberculosis. In chest X-ray findings, fibrosis and shrinkage of the lung, compensatory pulmonary emphysema, deformity or dilatation of bronchi, bulla formation and residual tuberculous cavities were recognized in 40 to 65% of the cases.<sup>2</sup> Consequently, people with pulmonary TB experience impaired gas exchange resulting in a decline in functional capacity.<sup>1</sup>

“The 6MWT is a useful measure of functional capacity targeted at people with at least moderately severe impairment. The test has been widely used for preoperative and postoperative evaluation and for measuring the response to therapeutic interventions for pulmonary and cardiac disease.”<sup>5</sup> (ATS, 2002). Functional walk tests are typically administered as a means of evaluating functional status, monitoring effectiveness of treatment, and establishing prognosis.<sup>6</sup> Functional walk tests either alone or in combination with other exercise tests have been validated in people with chronic cardiac and pulmonary disease<sup>7,8</sup> chronic obstructive pulmonary diseases and asthma<sup>9</sup>, older adults with chronic heart failure<sup>10</sup>, and in healthy, elderly adults.<sup>6</sup>

Post-tuberculosis patients may have limited exercise tolerance and significant disability which may affect daily activities. Till the date there was no any research on 6-minute walk test in TB sequelae in 20 – 40 yrs of age group. The purpose of the study was to evaluate the physical functional capacity (VO<sub>2</sub>max) in a group of (20 – 40 years) people with pulmonary tuberculosis; compare them to an age-matched healthy group and to develop reference equations that could be used to predict 6-minute walk test (6MWT) distance in adult, healthy people in India.

## MATERIALS

2 plastic chairs: to mark the turn around points.  
A chair that can be easily moved along the walking course.  
Sphygmomanometer: used to measure blood pressure.  
Borg scale: used to assess rate of perceived exertion.  
Weighing Machine: used to measure weight of patient.  
Measuring tape: used to measure the height of patient.  
Stopwatch: used to measure the time for 6 MWD test.<sup>5</sup>

## METHODOLOGY

**Study Design of study:** Cross sectional

**Sample selection:** Purposive sampling.

**Sample Size:** 30 patients with TB sequelae between 20-40 yrs of age

**Study Setting:** YCR Hospital, MIMS Medical College, Nagar Parishad Hospital, Latur.

**Study Duration:** 6 months.

## SELECTION CRITERIA

Inclusion criteria:

30 Subjects within 20 – 40 years of age group.  
Both male and female included  
Tuberculosis patient on DOTS regimen.  
Subjects with TB Sequelae confirmed on sputum examination & chest x-ray findings.

Exclusion criteria:

Persons with Coronary Artery Disease,  
Abdominal surgeries,  
History of fracture (spine, hip, arthritis, backpain),  
Acute injury on the day of the functional assessment,  
Renal disease,  
Peripheral vascular disease,  
Myocardial Infarction,  
Cardiac surgeries,  
Lower limb weakness and deformities.<sup>1</sup>

## PROCEDURE

**Prior to test:** The participants were asked to wear Comfortable clothing, Appropriate shoes, Patients were told to use their usual walking aids during the test (cane, walker, etc.), A light meal was acceptable before the tests. Patients were told not to exercise vigorously within 2 hours of beginning the test.

Written consent was taken from the participants and the procedure was explained. Baseline assessment that is height, weight, BMI, heart rate was taken. Subjects were instructed to walk 20m distance from end to end at their self-selected pace, while attempting to cover as much distance as possible in the 6 minutes.

The time and distance covered were recorded. The Borg scales for dyspnea and leg fatigue, as well as heart rate were recorded before and immediately after completion of the walk test.

From the collected data, the distance covered in meters.

### After Test:

From the reference equation given below, 6 Min Walk Distance was measured for each patient.

Reference equations for six-minute walk distance in 20 – 40 yrs of age group: -

**For males:-**

$$6mwd = 867 - (5.71 * \text{age}) + (1.03 * \text{height}).$$

**For females:-**

$$6mwd = 525 - (2.86 * \text{age}) + (2.71 * \text{height}) - (6.22 * \text{BMI})$$

(Age in years, Height in centimetres, Weight in kilograms, BMI in kg/m<sup>2</sup>, Distance in meters)

After measuring the 6 Min Walk Distance, from the equations given below, the functional level was measured via VO<sub>2</sub> Max<sup>17</sup>

$$\text{VO}_2 \text{ Max} = 0.006 * \text{distance (feet)} + 3.38$$

Using these VO<sub>2</sub>max values, subjects were classified into functional levels (FL). The FL are as follows: FL-4 ≤ 3.5 ml/kg/min; FL-3 between 3.6 and 10.5 ml/kg/min; FL-2 between 10.6 and 21 ml/kg/min; FL-1 ≥ 21 ml/kg/min<sup>1</sup>.

**DATA ANALYSIS**

Table 1: Age wise distribution of TB patients.

Sr.No.	Age Group	No. of TB Patients	Percentage
1	20-22	05	16.67
2	23-25	05	16.67
3	26-28	00	0.00
4	29-31	04	13.33
5	32-34	00	0.00
6	35-37	05	16.67
7	38-40	11	36.66
Total		30	100

Graph 1: Age wise distribution of TB patients

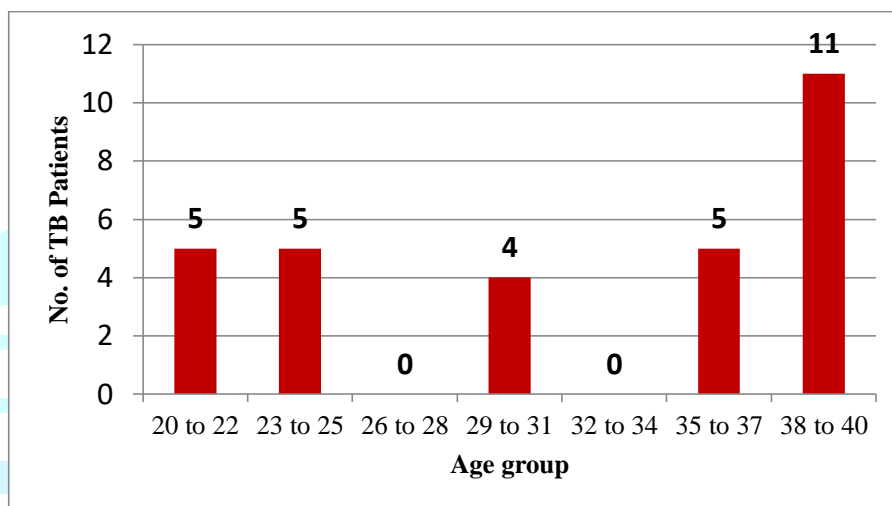


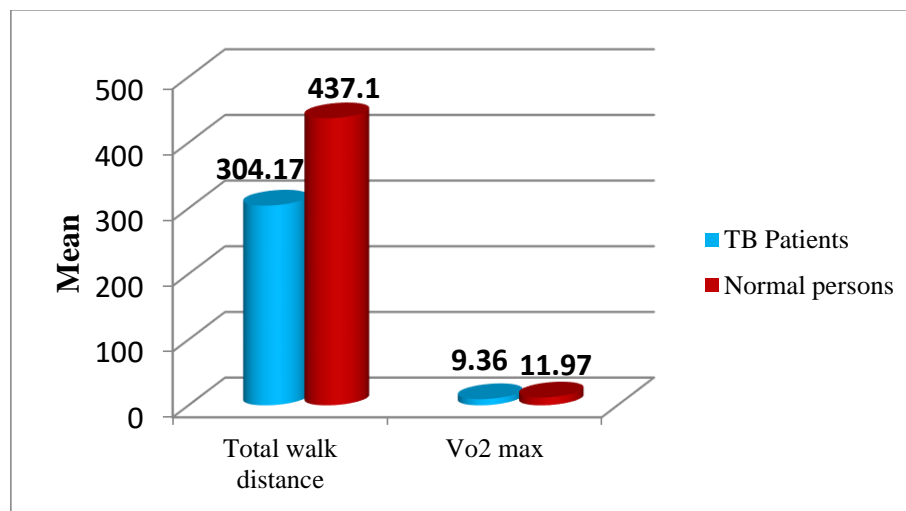
Table 2: Sex wise distribution of TB patients.

Sr. No.	Sex	No. of TB Patients	Percentage
1	Male	24	80
2	female	06	20
Total		30	100

Table 3: Comparison of total walk distance and Vo2 Max in TB patients and normal persons

Sr. No.	Parameter	TB Patients		Normal Persons		t58 value	p value	Significance
		Mean	SD	Mean	SD			
1	Total walk Distance	304.17	120.52	437.10	162.11	3.60	0.0007	Highly Significant
2	Vo <sub>2</sub> Max	9.36	2.37	11.97	3.19	3.60	0.0007	Highly Significant

Graph 2: Comparison of total walk distance and vo2 max in TB patients and normal persons



## RESULTS

Statistical analysis of the age, sex, 6 min walk distance (6MWD), & VO<sub>2</sub> max was carried out to find the degree of significance between them. The statistical tests used for the analysis of the results were as follows:

i) Paired sample t-test.

Descriptive statistical analysis (mean, standard deviation) was carried for the measurements in this study. 30 out of 30 subjects enrolled in the study were included for final analysis.

Table 1 shows age wise distribution of the patients with TB sequelae. Most of the patients i.e 36.66 % were found in the 38-40 yrs of age group (n=11). 16.67 % of the patients were found in the 20-22 yrs, 23-25 yrs & 35- 37 yrs of age group respectively (n=5). 13.33% of the patients were found in 29 – 31 yrs of age group (n=4). The findings in the table (1) are depicted in graph (1).

Table 2 shows sex wise distribution of the patients with TB sequelae. More prevalence of Tb sequelae was noted in male subjects (n= 24, 80 %) as compared to female subjects (n= 6, 20 %). The findings in the table (2) are depicted in graph (2).

Table 3 shows the comparison of total walked distance and VO<sub>2</sub> Max in patients with TB sequelae and normal persons. The mean total walk distance on 6 MWD test was found to be lowered in patients with TB sequelae (304.17 ± 120.52) as compared to normal individuals (437.10 ± 162.11). Similarly; the mean VO<sub>2</sub> max was deteriorated in patients with TB Sequelae (9.36 ± 2.37) compared to normal individuals (11.97 ± 3.19).

The t58 value of total walk distance & VO<sub>2</sub> max was found to be 3.60 respectively. There was highly significant difference within group for total walk distance & VO<sub>2</sub> max respectively (p <0.07- paired t test). The findings in the table (3) are depicted in graph (3).

Table 4 shows baseline characteristics of other parameters. Mean age, height, weight, BMI, Heart rate was found to be 31.83 ± 7.94, 156.50 ± 8.09, 44.67 ± 7.34, 18.35 ± 3.43, 84.90 ± 8.01 respectively.

## DISCUSSION

The result obtained from this study showed that functional capacity via 6 MWD & cardio-respiratory endurance via VO<sub>2</sub> Max was significantly lowered in patients with TB sequelae compared to normal individuals.

There was a significant difference in physical functional capacity between a group of normal 20 – 40 yrs people and those with TB sequelae. In the TB sequelae group, 30.41 % had a VO<sub>2</sub>max below 21 ml/kg/min that resulted in a considerable impact of TB sequelae on cardio respiratory endurance. The functional level of the patients was classified into 10 subjects (FL-2), & 20 subjects (FL-3).

In the present study; the 6MWD was intended to account for vo<sub>2</sub> max that can be calculated as the 0.006 \* distance walk (feet) + 3.38. Consequently, it seems logical to include force (body weight) as well as walk distance, when assessing an individual's ability to ambulate.<sup>11</sup>

Several studies have shown a relationship between functional capacity and cardio respiratory endurance in different diseases. S. Sivaranjini calculated the walk work to evaluate the functional capacity. They revealed that the sequelae from pulmonary tuberculosis have considerable impact on functional capacity in older people.<sup>1</sup>

Carter et al also noticed a significant 6 min walk work in comparison to using only the 6MWD for the same individuals with improved sensitivity and specificity for the 6MW work calculation in comparison to the performance of the 6MWD. Therefore, the calculation and reporting of 6MW work appears to be a viable option for measuring functional capacity and provides the rationale for why we used the 6MW work calculation to determine VO<sub>2</sub>max in our subjects. Indeed, the BMI and the 6MWD of the subjects in the TB sequelae group was significantly lower than that of the normal subjects and our findings indicate that BMI is correlated to 6MWD. This implies that the body weight of a subject directly affects the work required to perform the walk.<sup>18</sup>

The 6MWT has been validated by high correlations of workload, heart rate, and oxygen saturation when compared to standard bicycle ergometry and treadmill exercise tests.<sup>19</sup> A significant learning effect is observed when the test is performed on two successive days, with a mean 15% improvement in distance covered,<sup>20</sup> but this effect was not important when determining cross sectional correlations or when using the results as a baseline predictor of future events.

The average 6MWD was  $613 \pm 93$  m in a healthy, older population<sup>12</sup> and was  $659 \pm 62$  m in Caucasian healthy subjects.<sup>16</sup> In contrast, the results of our study indicate that in the older, normal Indian population, the average 6MWD was lower. In comparison, the TB sequelae group had an average 6MWD that was even lower.

Although they did not directly measure oxygen saturation levels in our subjects, exercise hypoxia<sup>21</sup> may have also played a role in the decreased 6MWD observed in the group with TB sequelae. Future studies should examine oxygen saturation as a possible contributor to the prediction of VO<sub>2</sub>max in this patient population.

In the present study; the 6 min walk distance was declined in female patients than male patients. This is in accordance with American Thoracic society guidelines.

To summarize, the functional capacity was found to be lowered via 6 min walk test while functional endurance was decreased via VO<sub>2</sub> max in subjects with TB sequelae compared to normal individuals.

## CONCLUSION

Subjects with TB Sequelae had significant decline in functional capacity & cardio-respiratory endurance than normal individuals. The reference equations for 6MWD derived in this study computes the predicted 6MWD in an Indian population without TB.

## LIMITATIONS

The main limitation in this study was sample size, as a very large sample size is necessary for deriving highly predictive reference equations.

## SUGGESTION

- Future studies on the possible mechanism of the effects of TB sequelae on functional capacity & cardio-respiratory endurance are also needed.
- Long-term follow-up should be taken in future.
- Future studies should consider using rate pressure product, heart rate, and Borg's rating of perceived exertion to predict VO<sub>2</sub>max.
- Caution should be used when applying our reference equations to 20 -40 yrs people who have characteristics such as age, height, weight, BMI, and also inclusion and exclusion criteria that fall outside our cohort.
- A larger 6MWD may be expected from persons who have previously performed the 6MWT and when non standardized encouragement is provided.

## ABBREVIATIONS:

BMI = Body Mass Index

6MWD = 6-Minute Walk Distance.

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