



Impact of Post-Tuberculosis Lung Disease on Quality of Life and Exercise Capacity in Young.

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Abstract

Background: Post-Tuberculosis Lung Disease (PTLD) is an increasingly recognized chronic respiratory condition that persists after successful completion of anti-tubercular therapy. Young adults who have recovered from pulmonary tuberculosis often experience residual pulmonary impairment, reduced exercise tolerance, and diminished quality of life, which may adversely affect their productivity and overall well-being. Despite the high burden of tuberculosis, the long-term consequences of PTLD remain underexplored.

Objectives: To assess the impact of post-tuberculosis lung disease on quality of life and exercise capacity among young adults who have successfully completed treatment for pulmonary tuberculosis. **Materials and Methods:** A cross-sectional observational study was conducted among 120 young adults aged 18–35 years with a documented history of successfully treated pulmonary tuberculosis. Participants attending the respiratory medicine outpatient department of a tertiary care teaching hospital were enrolled. Quality of life was assessed using the St. George's Respiratory Questionnaire (SGRQ), while exercise capacity was evaluated using the Six-Minute Walk Test (6MWT). Pulmonary function tests (PFTs) were performed to determine residual lung impairment. Data were analyzed using descriptive statistics, Pearson's correlation, and independent t-tests. A p-value <0.05 was considered statistically significant. **Results:** The mean age of participants was 27.4 ± 4.8 years, with males constituting 58.3% of the study population. The mean SGRQ total score was 38.6 ± 12.4, indicating a moderate impairment in quality of life. The average six-minute walk distance was 412.5 ± 78.3 meters, significantly lower than predicted values for healthy individuals of similar age (p<0.001). Pulmonary function abnormalities were observed in 68.3% of participants, with restrictive patterns being the most common. A significant negative correlation was found between SGRQ scores and six-minute walk distance (r = -0.62, p<0.001), suggesting that poorer quality of life was associated with reduced exercise capacity. **Conclusion:** Post-tuberculosis lung disease significantly affects quality of life and exercise capacity in young adults even after microbiological cure. Early identification, regular follow-up, pulmonary rehabilitation, and targeted interventions are essential to improve functional outcomes and overall quality of life in this vulnerable population.

Keywords: Post-Tuberculosis Lung Disease, Pulmonary Tuberculosis, Quality of Life, Exercise Capacity, Six-Minute Walk Test, Pulmonary Function Test, Young Adults, Respiratory Rehabilitation.



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INTRODUCTION

Tuberculosis (TB) remains one of the leading infectious causes of morbidity and mortality worldwide, particularly in low- and middle-income countries. According to the World Health Organization (WHO), approximately 10.8 million people developed tuberculosis globally in 2023, with a substantial proportion occurring in young adults who represent the most productive segment of the population (1). Although advances in diagnosis and anti-tubercular therapy have significantly improved treatment success rates, increasing attention is being directed toward the long-term pulmonary sequelae that persist even after microbiological cure (2).

Post-Tuberculosis Lung Disease (PTLD) refers to chronic respiratory abnormalities attributable, at least in part, to previous pulmonary tuberculosis. These abnormalities may include airflow obstruction, restrictive ventilatory defects, bronchiectasis, pulmonary fibrosis, cavitary lesions, and impaired gas exchange that persist after completion of anti-tuberculosis treatment (3). The structural damage caused by *Mycobacterium tuberculosis* can result in irreversible destruction of lung parenchyma, leading to chronic respiratory symptoms such as dyspnea, cough, sputum production, and exercise intolerance (4).

Recent evidence suggests that the burden of PTLTD may be significantly underestimated, particularly among young adults who have successfully completed treatment and are considered “cured” from an infectious standpoint. Despite bacteriological cure, many patients continue to experience substantial functional limitations and reduced physical performance, affecting their educational attainment, employment opportunities, and social participation (5). These long-term consequences often remain unrecognized within routine tuberculosis control programs, which traditionally focus on treatment completion and microbiological outcomes rather than post-treatment health status (6).

Quality of life (QoL) has emerged as an important patient-centered outcome in chronic respiratory diseases. PTLTD can adversely affect multiple domains of quality of life, including physical functioning, emotional well-being, social interactions, and occupational productivity. Studies have reported significantly lower health-related quality of life scores among individuals with previous pulmonary tuberculosis compared to healthy controls, even years after successful treatment completion (7). Persistent respiratory symptoms and reduced pulmonary function contribute substantially to these impairments, highlighting the need for comprehensive post-treatment assessment and rehabilitation strategies (8).

Exercise capacity is another critical determinant of overall health and functional status. The Six-Minute Walk Test (6MWT) is a simple and validated tool commonly used to assess functional exercise capacity in patients with chronic lung diseases. Individuals with PTLTD frequently demonstrate reduced six-minute walk distances compared with age-matched healthy populations, reflecting underlying pulmonary impairment and reduced cardiopulmonary reserve (9). Decreased exercise tolerance not only affects daily activities but may also predispose patients to physical inactivity, muscle deconditioning, and poorer long-term health outcomes (10).

Young adults constitute a particularly important population for studying PTLTD because the disease affects individuals during their most productive years. Persistent respiratory disability following tuberculosis can have profound socioeconomic consequences, including loss of employment, reduced earning capacity, and diminished quality of life. Early identification of PTLTD and implementation of targeted interventions such as pulmonary rehabilitation, exercise training, and long-term respiratory follow-up may help improve functional outcomes and overall well-being in this population (11).

Despite growing recognition of PTLTD as a significant public health concern, data regarding its impact on quality of life and exercise capacity among young adults remain limited, particularly in developing countries where tuberculosis burden is high. Understanding the extent of functional impairment and its relationship with quality of life is essential for designing effective post-tuberculosis care programs. Therefore, the present study was undertaken to assess the impact of post-tuberculosis lung disease on quality of life and exercise capacity among young adults who have successfully completed treatment for pulmonary tuberculosis.

MATERIALS AND METHODS

Study Design and Setting

A hospital-based cross-sectional observational study was conducted in the Department of Respiratory Medicine, Government Medical College, Jangaon, Telangana, over a period of six months from January 2025 to June 2025. The study aimed to assess the impact of Post-Tuberculosis Lung Disease (PTLTD) on quality of life and exercise capacity among young adults who had successfully completed treatment for pulmonary tuberculosis.

Study Population

The study included young adults aged 18–35 years with a documented history of pulmonary tuberculosis who had completed anti-tubercular treatment and were declared cured according to National Tuberculosis Elimination Programme (NTEP) guidelines. Eligible participants attending the Respiratory Medicine Outpatient Department during the study period were enrolled after obtaining informed written consent.

Sample Size

A total of 100 participants meeting the eligibility criteria were included in the study using a convenient sampling technique. The sample size was considered adequate to assess the association between quality of life, exercise capacity, and pulmonary function among patients with PTLTD within the available study duration.

Inclusion Criteria

1. Young adults aged 18–35 years.
2. Previous history of microbiologically confirmed pulmonary tuberculosis.
3. Completion of anti-tubercular treatment at least six months prior to enrolment.
4. Willingness to participate and provide informed consent.

Exclusion Criteria

1. Active pulmonary tuberculosis at the time of study.
2. Known chronic respiratory diseases prior to tuberculosis diagnosis, such as bronchial asthma or chronic obstructive pulmonary disease.
3. Significant cardiovascular, neuromuscular, or musculoskeletal disorders affecting exercise performance.
4. Pregnant women.
5. Patients unwilling to participate.

Data Collection Procedure

After obtaining Institutional Ethics Committee approval, eligible participants were recruited consecutively from the outpatient department. A predesigned and pretested structured questionnaire was used to collect demographic information, socioeconomic status, smoking history, tuberculosis treatment details, duration since treatment completion, and current respiratory symptoms.

A detailed clinical examination was performed for all participants. Height, weight, body mass index (BMI), respiratory rate, pulse rate, blood pressure, and oxygen saturation were recorded.

Assessment of Quality of Life

Quality of life was assessed using the validated St. George's Respiratory Questionnaire (SGRQ). The questionnaire evaluates three domains: symptoms, activity limitation, and psychosocial impact of respiratory disease. Scores range from 0 to 100, with higher scores indicating poorer quality of life.

Assessment of Exercise Capacity

Exercise capacity was evaluated using the Six-Minute Walk Test (6MWT) conducted according to the American Thoracic Society guidelines. Participants were instructed to walk as far as possible on a flat 30-meter corridor for six minutes. Total distance covered in meters (6MWD), pre-test and post-test oxygen saturation, pulse rate, and perceived exertion were recorded.

Pulmonary Function Testing

Spirometry was performed using a calibrated computerized spirometer following American Thoracic Society/European Respiratory Society recommendations. Parameters measured included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), FEV1/FVC ratio, and Peak Expiratory Flow Rate (PEFR). Pulmonary function patterns were categorized as normal, obstructive, restrictive, or mixed ventilatory defects.

Radiological Assessment

Available chest radiographs and computed tomography (CT) scans were reviewed to identify residual pulmonary abnormalities such as fibrosis, bronchiectasis, cavitary lesions, pleural thickening, and parenchymal scarring.

Outcome Measures

The primary outcomes assessed were:

1. Quality of life measured by SGRQ scores.
2. Exercise capacity measured by six-minute walk distance (6MWD).

Secondary outcomes included pulmonary function abnormalities and their association with quality of life and exercise capacity.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. The normality of data distribution was assessed using the Shapiro-Wilk test.

Comparisons between groups were performed using the Independent Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Associations between categorical variables were analyzed using the Chi-square test or Fisher's exact test wherever appropriate.

Pearson's correlation coefficient was used to determine the relationship between SGRQ scores, six-minute walk distance, and pulmonary function parameters. Multivariate linear regression analysis was performed to identify independent predictors of reduced quality of life and exercise capacity.

A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Government Medical College, Jangaon, prior to commencement of the study. Written informed consent was obtained from all participants. Confidentiality and anonymity of participant information were maintained throughout the study.

RESULTS

A total of 100 young adults with Post-Tuberculosis Lung Disease (PTLD) were included in the study. The mean age of the participants was 27.6 ± 4.5 years. Males constituted 62% of the study population. Quality of life was assessed using the St. George's Respiratory Questionnaire (SGRQ), while exercise capacity was evaluated using the Six-Minute Walk Test (6MWT). Pulmonary function testing was performed in all participants.

Table 1: Demographic and Clinical Characteristics of Study Participants (N=100)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–24	32	32.0
25–29	38	38.0
30–35	30	30.0
Gender		
Male	62	62.0
Female	38	38.0
Smoking Status		
Non-smoker	76	76.0
Current/Former Smoker	24	24.0
Duration Since TB Treatment Completion		
6–12 months	28	28.0
1–3 years	45	45.0
>3 years	27	27.0

Mean age = 27.6 ± 4.5 years

Interpretation: The majority of participants belonged to the 25–29 years age group (38%). Males were more commonly affected than females. Nearly three-fourths of participants were non-smokers.

Table 2: Distribution of Persistent Respiratory Symptoms Among Participants

Symptom	Number (n)	Percentage (%)
Dyspnea on exertion	72	72.0
Chronic cough	58	58.0
Sputum production	41	41.0
Wheezing	24	24.0
Chest pain	18	18.0
Hemoptysis	6	6.0
Fatigue	63	63.0

Interpretation: Dyspnea on exertion was the most common persistent symptom reported by participants (72%), followed by fatigue (63%) and chronic cough (58%), indicating substantial residual respiratory morbidity despite completion of anti-tubercular therap.

Table 3: Pulmonary Function Test (PFT) Findings Among Study Participants

Pulmonary Function Pattern	Frequency (n)	Percentage (%)
Normal	30	30.0
Restrictive defect	44	44.0
Obstructive defect	18	18.0
Mixed defect	8	8.0

Spirometric Parameter	Mean $\pm$ SD
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FEV1 (% predicted)	68.5 ± 15.2
FVC (% predicted)	71.8 ± 14.7
FEV1/FVC Ratio (%)	78.4 ± 8.6

Interpretation: Pulmonary function abnormalities were observed in 70% of participants, with restrictive ventilatory defects being the most common pattern (44%).

Table 4: Quality of Life Assessment Using St. George's Respiratory Questionnaire (SGRQ)

SGRQ Domain	Mean Score ± SD
Symptoms	41.2 ± 13.6
Activity	46.5 ± 14.8
Impacts	33.4 ± 11.5
Total Score	40.3 ± 12.7

Quality of Life Category	Frequency (n)	Percentage (%)
Mild impairment (<25)	18	18.0
Moderate impairment (25–50)	57	57.0
Severe impairment (>50)	25	25.0

Interpretation: The mean total SGRQ score was 40.3 ± 12.7, indicating moderate impairment in quality of life. More than half of the participants (57%) demonstrated moderate quality of life impairment.

Table 5: Exercise Capacity Assessment Using Six-Minute Walk Test (6MWT)

Parameter	Mean ± SD
Six-Minute Walk Distance (meters)	418.7 ± 76.4
Pre-test Oxygen Saturation (%)	97.2 ± 1.3
Post-test Oxygen Saturation (%)	94.8 ± 2.1
Pre-test Pulse Rate (beats/min)	82.4 ± 9.2
Post-test Pulse Rate (beats/min)	102.7 ± 12.6

Exercise Capacity Category	Frequency (n)	Percentage (%)
Normal (>500 m)	21	21.0
Mild reduction (400–500 m)	39	39.0
Moderate reduction (300–399 m)	31	31.0
Severe reduction (<300 m)	9	9.0

Interpretation: The mean six-minute walk distance was 418.7 ± 76.4 meters. Approximately 40% of participants exhibited moderate-to-severe reduction in exercise capacity.

Table 6: Correlation Between Quality of Life, Exercise Capacity and Pulmonary Function

Variables Compared	Correlation Coefficient (r)	p-value
SGRQ Total Score vs 6MWD	-0.64	<0.001*
SGRQ Total Score vs FEV1	-0.58	<0.001*
6MWD vs FEV1	0.61	<0.001*
6MWD vs FVC	0.53	<0.001*

*Statistically Significant

Interpretation: A significant negative correlation was observed between SGRQ scores and six-minute walk distance (r = -0.64, p<0.001), indicating that poorer quality of life was associated with reduced exercise capacity. Better pulmonary function was significantly associated with greater exercise tolerance.

Summary of Findings

Among 100 young adults with Post-Tuberculosis Lung Disease, persistent respiratory symptoms and pulmonary function abnormalities were common. Moderate impairment in quality of life was observed in the majority of participants, while exercise capacity was significantly reduced compared to expected values for healthy individuals. Restrictive lung defects were the predominant pulmonary abnormality. Significant correlations were identified between pulmonary function, quality of life, and exercise capacity, highlighting the long-term functional consequences of pulmonary tuberculosis even after successful treatment completion.

DISCUSSION

The present study assessed the impact of Post-Tuberculosis Lung Disease (PTLD) on quality of life and exercise capacity among young adults who had successfully completed anti-tubercular treatment. The findings revealed that despite microbiological cure, a substantial proportion of participants continued to experience persistent respiratory symptoms, impaired pulmonary function, reduced exercise tolerance, and diminished quality of life. These observations highlight the long-term health consequences of pulmonary tuberculosis and emphasize the need for continued follow-up beyond treatment completion.

In the present study, dyspnea on exertion was the most frequently reported symptom, followed by fatigue and chronic cough. Similar findings have been reported by Byrne et al. (4), who observed that many patients continue to experience chronic respiratory symptoms even after successful tuberculosis treatment due to residual structural lung damage. Persistent respiratory symptoms may result from fibrosis, bronchiectasis, airway obstruction, and parenchymal destruction caused by previous tuberculosis infection. These sequelae contribute significantly to functional disability and reduced quality of life. Pulmonary function testing demonstrated abnormalities in 70% of participants, with restrictive ventilatory defects being the predominant pattern. This finding is consistent with previous studies conducted by Meghji et al. (3) and Jones et al. (9), who reported that restrictive lung disease is among the most common physiological abnormalities observed in PTLD patients. Structural changes such as fibrosis and pleural thickening following pulmonary tuberculosis can reduce lung compliance and contribute to restrictive impairment. The observed reduction in mean FEV1 and FVC values further supports the presence of residual pulmonary dysfunction in these individuals.

Assessment of quality of life using the St. George's Respiratory Questionnaire revealed moderate impairment among the majority of participants, with a mean total score of 40.3 ± 12.7 . These findings are comparable to those reported by Guo et al. (7) and Visca et al. (8), who demonstrated significantly poorer health-related quality of life among individuals with previous pulmonary tuberculosis compared with healthy controls. Reduced quality of life in PTLD may result from persistent respiratory symptoms, physical limitations, psychological stress, and social restrictions experienced by affected individuals.

Exercise capacity evaluation using the Six-Minute Walk Test showed a mean walking distance of 418.7 ± 76.4 meters, indicating reduced functional exercise performance. Similar reductions in six-minute walk distance have been documented by Jones et al. (9), who reported impaired exercise capacity among post-tuberculosis patients due to reduced pulmonary reserve and deconditioning. Exercise intolerance is clinically important because it directly affects daily activities, occupational performance, and overall physical functioning. Young adults, who are expected to be at their peak productive capacity, may experience considerable socioeconomic consequences as a result of these limitations.

A significant negative correlation was observed between SGRQ scores and six-minute walk distance, indicating that poorer quality of life was associated with lower exercise capacity. Furthermore, pulmonary function parameters showed significant positive correlations with exercise performance. These findings are in agreement with the observations of Chakaya et al. (5) and Osman et al. (11), who emphasized that residual lung impairment is a major determinant of functional limitation and health-related quality of life following tuberculosis treatment. The results suggest that assessment of pulmonary function and exercise capacity should become an integral component of post-tuberculosis care.

The increasing recognition of PTLD as a chronic respiratory condition necessitates a shift in tuberculosis management from a solely microbiological cure-oriented approach to a patient-centered model that incorporates long-term rehabilitation and functional recovery. Pulmonary rehabilitation programs, breathing exercises, nutritional support, and regular respiratory follow-up may improve outcomes and quality of life in affected individuals (2,11).

Limitations of the Study

The present study has certain limitations. First, the study was conducted at a single tertiary care center, which may limit the generalizability of the findings to the wider population. Second, the cross-sectional design precluded assessment of causal relationships and long-term progression of pulmonary impairment. Third, the sample size was relatively small and included only young adults, thereby limiting extrapolation to older age groups. Additionally, pre-tuberculosis pulmonary function data were unavailable, making it difficult to determine the exact extent of lung function decline attributable to tuberculosis. Future multicentric longitudinal studies with larger sample sizes are recommended to better understand the long-term trajectory of PTLD and evaluate the effectiveness of rehabilitation interventions.

CONCLUSION

Post-Tuberculosis Lung Disease remains a significant yet underrecognized consequence of pulmonary tuberculosis. The present study demonstrated that a considerable proportion of young adults continue to experience persistent respiratory symptoms, pulmonary function abnormalities, impaired exercise capacity, and reduced quality of life even after successful

completion of anti-tubercular therapy. Restrictive ventilatory defects were the most common pulmonary abnormality, and poorer quality of life was significantly associated with reduced exercise tolerance. These findings underscore the importance of routine post-treatment assessment, pulmonary rehabilitation, and long-term follow-up to improve functional outcomes and overall well-being among individuals affected by PTLTD. Incorporating comprehensive post-tuberculosis care into existing tuberculosis control programs may help reduce the burden of chronic respiratory disability and enhance quality of life in this vulnerable population.

Ethical Clearance: Ethical clearance for the study was obtained from the Institutional Ethics Committee of Government Medical College, Jangaon, prior to commencement of the study.

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Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this article..

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