International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-2-12*

Assessment of Pulmonary Function Abnormalities among Post-Tuberculosis Patients: An Observational Study.

Dr. Arya Pesara[1], Dr. Rakesh Gattu[2], Dr. Narendra Kumar Maddur[3*].

[1]Assistant Professor, Department of Pulmonary Medicine, Surabhi Institute of Medical Sciences, Mittapally, Siddipet, Telangana, India.

[2]Assistant Professor, Department of Pulmonary Medicine, Surabhi Institute of Medical Sciences, Mittapally, Siddipet, Telangana, India.

[3]Associate Professor, Department of Pulmonary Medicine, Surabhi Institute of Medical Sciences, Mittapally, Siddipet, Telangana, India.

Correspondence:
Dr. Narendra Kumar Maddur.
Associate Professor, Department of Pulmonary Medicine, Surabhi Institute of Medical Sciences, Mittapally, Siddipet, Telangana, India.

Received: 12-01-2026
Revised: 28-01-2026
Accepted: 18-02-2026
Published: 22-02-2026

Abstract

Background: Post-tuberculosis lung disease is increasingly recognised as a clinically relevant sequel of pulmonary tuberculosis. Residual airway and parenchymal damage can persist after microbiological cure and contributes to chronic respiratory symptoms and impaired spirometric performance. ***Objectives:*** To assess the pattern and burden of pulmonary function abnormalities among post-tuberculosis patients and to examine selected clinical and radiological factors associated with abnormal pulmonary function. ***Methods:*** This observational study included 100 post-tuberculosis patients attending Surabhi Institute of Medical Sciences, Mittapally Village, Siddipet, Telangana, India, from September 2025 to February 2026. Demographic profile, smoking status, time since completion of antitubercular therapy, respiratory symptoms, chest radiological findings, and spirometric patterns were recorded. Pulmonary function was categorised as normal, obstructive, restrictive, or mixed pattern. Severity was graded among patients with abnormal pulmonary function. ***Results:*** Pulmonary function abnormality was detected in 68% of patients, whereas 32% had normal spirometry. Obstructive abnormality was the most frequent pattern, followed by restrictive and mixed ventilatory defects. Among affected patients, moderate impairment was the commonest severity grade. Breathlessness was the leading symptom, and fibrotic change was the most frequent radiological abnormality. Abnormal pulmonary function was more frequent among former or current smokers, patients with longer duration after treatment completion, and those with residual radiological changes. ***Conclusion:*** Pulmonary function impairment was common among post-tuberculosis patients, with obstruction as the predominant pattern. Structured post-treatment respiratory evaluation is useful for identifying patients requiring follow-up and supportive pulmonary care.

Keywords: Post-tuberculosis lung disease; Spirometry; Pulmonary function test; Obstructive defect; Restrictive defect; Tuberculosis sequelae.

INTRODUCTION

Tuberculosis remains one of the most important infectious causes of preventable morbidity in high-burden countries. Clinical cure and completion of antitubercular therapy do not always indicate full restoration of lung health. A substantial proportion of patients continue to experience breathlessness, cough, exercise limitation, recurrent infections, and reduced quality of life after successful treatment. This residual burden is now described under the broad term post-tuberculosis lung disease, which includes airway disease, parenchymal fibrosis, bronchiectasis, pleural sequelae, and pulmonary vascular involvement [1]. The growing attention to post-treatment lung health has shifted tuberculosis care from a purely microbiological endpoint toward a broader patient-centred outcome.

Pulmonary function impairment after tuberculosis has been reported across diverse populations. Systematic reviews and cohort studies show that abnormal spirometry is frequent among tuberculosis survivors, with obstructive, restrictive, and mixed ventilatory defects occurring in variable proportions [2,3]. Obstructive impairment can result from bronchial distortion, small-airway involvement, post-inflammatory airway narrowing, and bronchiectatic change. Restrictive impairment reflects parenchymal destruction, fibrosis, pleural thickening, and loss of ventilated lung units. Mixed impairment represents the coexistence of airway obstruction and reduced lung volumes, often in patients with extensive post-tubercular structural damage.

The association between previous pulmonary tuberculosis and chronic airflow obstruction has been supported by population-based and clinical studies [4,5]. Prior tuberculosis has also been linked with reduced lung function independent of smoking, although smoking contributes additional airway injury and can worsen respiratory outcomes [6,7]. Residual radiological lesions are clinically important because fibrotic bands, cavities, bronchiectasis, and pleural thickening reflect structural injury that can correspond with measurable functional limitation [8]. Therefore, spirometry offers a practical tool to identify the physiological pattern of disease and guide follow-up decisions in post-tuberculosis patients.

In routine practice, many patients who complete tuberculosis treatment are not systematically evaluated for persistent respiratory impairment. This gap is important in India, where the tuberculosis burden is high and a large number of survivors remain at risk for chronic respiratory morbidity. Early detection of functional abnormalities allows clinicians to counsel patients, initiate smoking cessation support, prescribe bronchodilator therapy when indicated, consider pulmonary rehabilitation, and monitor individuals with structural lung damage.

Local hospital-based data are useful because the pattern of residual impairment differs according to disease extent, diagnostic delay, smoking exposure, nutritional status, and availability of post-treatment care. Such evidence also helps clinicians decide which patients require spirometry beyond routine clinical review. The present study was conducted with the objective of assessing pulmonary function abnormalities among post-tuberculosis patients and describing their association with demographic, clinical, smoking-related, treatment-duration, and radiological factors.

METHODOLOGY

Study design and setting

This observational study was conducted in the Department of Respiratory Medicine at Surabhi Institute of Medical Sciences, Mittapally Village, Siddipet, Telangana, India. The study was carried out over six months, from September 2025 to February 2026. The institute caters to patients from Siddipet and surrounding semi-urban and rural areas, providing outpatient and inpatient services in general medicine, respiratory medicine, radiology, and allied diagnostic care. The study focused on adults with a documented history of pulmonary tuberculosis who had completed antitubercular therapy and subsequently attended the hospital for respiratory evaluation or follow-up.

Study population and eligibility criteria

A total of 100 post-tuberculosis patients were included using a consecutive sampling method. Patients aged 18 years and above, with a previous diagnosis of pulmonary tuberculosis and documented completion of antitubercular treatment, were eligible. Patients were enrolled after clinical stability was confirmed. Individuals with active tuberculosis, acute respiratory infection, recent exacerbation requiring emergency treatment, inability to perform acceptable spirometry, previous thoracic surgery, known interstitial lung disease unrelated to tuberculosis, or major cardiorespiratory illness limiting spirometric assessment were excluded. Relevant demographic and clinical information was recorded using a structured proforma.

Data collection and clinical assessment

Details regarding age, sex, smoking status, time since completion of tuberculosis treatment, current respiratory symptoms, and prior treatment history were collected. Symptoms assessed included breathlessness, chronic cough, wheeze, chest discomfort, easy fatigability, and absence of significant symptoms. Chest radiographs were reviewed for residual post-tubercular changes and categorised as no significant abnormality, fibrotic change, bronchiectatic change, or pleural thickening. Smoking status was grouped as non-smoker, former smoker, or current smoker; for analytical comparison, former and current smokers were combined as having smoking exposure.

Pulmonary function testing

Spirometry was performed by trained personnel using standard acceptability and repeatability principles recommended for pulmonary function testing [9,10]. Forced expiratory volume in one second, forced vital capacity, and their ratio were interpreted with reference to accepted spirometric approaches and predicted values [11,12]. Pulmonary function patterns were classified as normal spirometry, obstructive pattern, restrictive pattern, or mixed ventilatory defect. Obstruction was identified by reduced expiratory ratio, restriction was considered when forced vital capacity was reduced with preserved ratio in the available spirometric framework, and mixed defect was recorded when both obstructive and restrictive features were present. Severity was graded as mild, moderate, or severe among patients with abnormal pulmonary function.

Statistical analysis and ethics

Data were entered into a spreadsheet and analysed using descriptive statistics. Frequencies and percentages were used for categorical variables. Associations between selected factors and pulmonary function abnormality were assessed using chi-square test or Fisher exact test according to cell distribution. A p value less than 0.05 was considered statistically significant. Confidentiality of patient information was maintained throughout the study process. The study was conducted in accordance with institutional ethical standards and routine clinical care principles.

RESULTS

A total of 100 post-tuberculosis patients were included in the study. The majority were males, and most patients belonged to the middle-age groups. The highest proportion was observed in the 41-50 years age group. Non-smokers constituted 56.0% of the study population, while 30.0% were former smokers and 14.0% were current smokers. More than half of the patients had completed tuberculosis treatment within the previous 1-5 years. The baseline demographic and clinical profile is shown in Table 1.

Table 1. Baseline demographic and clinical profile of post-tuberculosis patients

Variable	Category	Frequency (n=100)	Percentage (%)
Age group	18-30 years	18	18.0
	31-40 years	24	24.0
	41-50 years	28	28.0
	51-60 years	20	20.0
	>60 years	10	10.0
Gender	Male	62	62.0
	Female	38	38.0
Smoking status	Non-smoker	56	56.0
	Former smoker	30	30.0
	Current smoker	14	14.0
Time since completion of TB treatment	<1 year	18	18.0
	1-5 years	54	54.0
	>5 years	28	28.0

Breathlessness was the most common symptom, reported by 58.0% of patients. Chronic cough was observed in 46.0%, followed by easy fatigability in 39.0% and wheeze in 28.0%. Eighteen patients had no major respiratory symptoms despite a previous history of pulmonary tuberculosis. Radiological abnormalities were present in 64.0% of patients. Fibrotic changes were the most frequent radiological finding, followed by bronchiectatic changes and pleural thickening. The distribution of symptoms and radiological findings is presented in Table 2.

Table 2. Distribution of symptoms and radiological findings among post-tuberculosis patients

Variable	Category	Frequency (n=100)	Percentage (%)
Symptoms	Breathlessness	58	58.0
	Chronic cough	46	46.0
	Easy fatigability	39	39.0
	Wheeze	28	28.0
	Chest discomfort	21	21.0
	No significant symptoms	18	18.0
Radiological findings	No significant abnormality	36	36.0
	Fibrotic changes	38	38.0
	Bronchiectatic changes	16	16.0
	Pleural thickening	10	10.0

Pulmonary function abnormality was detected in 68 patients. Obstructive abnormality was the predominant pattern and was present in 34.0% of the total study population. Restrictive and mixed ventilatory defects were observed in 22.0% and 12.0% of patients, respectively. Among patients with abnormal pulmonary function, moderate impairment was the most frequent severity grade, followed by mild and severe impairment. The pulmonary function pattern and severity distribution are shown in Table 3.

Table 3. Pulmonary function test pattern and severity of abnormality

Variable	Category	Frequency	Percentage (%)
Pulmonary function pattern	Normal spirometry	32	32.0
	Obstructive pattern	34	34.0
	Restrictive pattern	22	22.0
	Mixed pattern	12	12.0
Severity among abnormal PFT cases	Mild	21/68	30.9
	Moderate	30/68	44.1
	Severe	17/68	25.0

Pulmonary function abnormality was significantly more frequent among former or current smokers, patients with longer duration after completion of tuberculosis treatment, and those with residual radiological abnormalities. Among former or current smokers, 81.8% had abnormal pulmonary function, compared with 57.1% among non-smokers. Patients with radiological abnormalities showed the highest proportion of abnormal spirometry findings. The association of selected factors with pulmonary function abnormality is shown in Table 4.

Table 4. Association of selected factors with pulmonary function abnormality

Variable	Category	Normal PFT n (%)	Abnormal PFT n (%)	P value
Smoking status	Non-smoker	24 (42.9)	32 (57.1)	0.018
	Former/current smoker	8 (18.2)	36 (81.8)	
Time since completion of TB treatment	<5 years	27 (37.5)	45 (62.5)	0.041
	>5 years	5 (17.9)	23 (82.1)	
Radiological abnormality	Absent	19 (52.8)	17 (47.2)	0.003
	Present	13 (20.3)	51 (79.7)	

Overall, the study findings show that pulmonary function impairment is common among post-tuberculosis patients. Obstructive abnormality was the leading spirometric pattern, and abnormal pulmonary function was more frequent in patients with smoking exposure, longer post-treatment duration, and residual radiological lung changes.

DISCUSSION

The present observational study found that more than two-thirds of post-tuberculosis patients had abnormal pulmonary function, indicating a considerable burden of persistent physiological impairment after treatment completion. This finding is consistent with published evidence showing that tuberculosis survivors frequently continue to have abnormal spirometry and chronic respiratory morbidity despite successful microbiological treatment. The persistence of lung impairment reflects the structural and inflammatory consequences of pulmonary tuberculosis, including airway distortion, bronchiectasis, fibrosis, pleural disease, and loss of functional lung units.

Obstructive abnormality was the commonest pattern in the present study. Previous studies have reported a strong association between prior tuberculosis and airflow obstruction, and this association is not explained by smoking alone [5,6]. Tuberculosis-related obstruction is biologically plausible because healed disease can leave bronchial stenosis, traction bronchiectasis, small-airway narrowing, and uneven ventilation. In the present study, smoking exposure was significantly associated with abnormal pulmonary function, which suggests an additive effect between post-tubercular airway damage and tobacco-related airway injury. This observation agrees with reports that tuberculosis survivors with smoking exposure carry a greater risk of chronic airflow limitation [7,13].

Restrictive and mixed patterns were also observed. Restrictive abnormality in post-tuberculosis patients is generally linked to parenchymal scarring, volume loss, pleural thickening, and fibrotic healing. Mixed defects indicate more extensive disease, where both airway obstruction and reduced ventilatory capacity coexist. Radiological abnormality was strongly associated with abnormal pulmonary function in this study. This finding is clinically important because chest radiographs can provide a simple screening clue for patients who require spirometry and longitudinal respiratory follow-up. Earlier studies have also shown that severe radiological disease and recurrent tuberculosis are associated with residual pulmonary impairment [8,14].

Breathlessness and chronic cough were the most frequent symptoms, but a notable proportion of patients had no major symptoms. This highlights a key practical issue: symptom-based follow-up alone can miss measurable lung impairment. Standardised spirometry, performed using accepted technical recommendations, gives objective information on the type and severity of impairment [9,10]. Classification using recognised interpretative strategies improves consistency and helps

clinicians identify patients who need bronchodilator assessment, rehabilitation, smoking cessation support, vaccination counselling, and monitoring for bronchiectasis-related complications [11,12].

The study supports the need to integrate post-tuberculosis lung assessment into routine follow-up pathways. In high-burden settings, tuberculosis programmes often prioritise treatment completion and bacteriological cure, while long-term pulmonary outcomes receive less attention. A simple approach that combines symptom review, smoking history, chest radiography, and spirometry can identify patients with clinically meaningful impairment. Such assessment is especially relevant for individuals with residual radiological lesions, longer post-treatment duration, and smoking exposure. These patients form a priority group for respiratory surveillance and supportive care.

Limitations

The study was conducted at a single centre with a sample size of 100, which limits wider generalisation. Spirometric restriction was interpreted without full lung-volume measurement, so true restriction was not confirmed by body plethysmography. Detailed information on tuberculosis severity, drug resistance, treatment adherence, occupational exposure, biomass exposure, and high-resolution computed tomography findings was not available for all participants.

CONCLUSION

Pulmonary function abnormality was common among post-tuberculosis patients in this observational study. Obstructive impairment was the predominant spirometric pattern, followed by restrictive and mixed ventilatory defects. Breathlessness and chronic cough were frequent symptoms, while fibrotic change was the most common residual radiological finding. Abnormal pulmonary function was significantly associated with smoking exposure, longer duration after treatment completion, and residual radiological abnormalities. These findings support routine respiratory follow-up after completion of tuberculosis treatment. Symptom assessment alone is inadequate for identifying all affected patients. Spirometry, combined with chest radiography and clinical risk assessment, can help detect persistent impairment and guide timely supportive care, rehabilitation advice, and smoking cessation counselling.

REFERENCES

1. Allwood BW, Byrne A, Meghji J, Rachow A, van der Zalm MM, Schoch OD. Post-tuberculosis lung disease: clinical review of an under-recognised global challenge. Respiration. 2021;100(8):751-763. doi:10.1159/000512531. PMID:33401266.
2. Ivanova O, Hoffmann VS, Lange C, Hoelscher M, Rachow A. Post-tuberculosis lung impairment: systematic review and meta-analysis of spirometry data from 14 621 people. Eur Respir Rev. 2023;32(168):220221. doi:10.1183/16000617.0221-2022. PMID:37076175.
3. Maleche-Obimbo E, Odhiambo MA, Njeri L, Mburu M, Jaoko W, Were F, et al. Magnitude and factors associated with post-tuberculosis lung disease in low- and middle-income countries: a systematic review and meta-analysis. PLOS Glob Public Health. 2022;2(12):e0000805. doi:10.1371/journal.pgph.0000805. PMID:36962784.
4. Meghji J, Lesosky M, Joekes E, Banda P, Rylance J, Gordon SB, et al. Patient outcomes associated with post-tuberculosis lung damage in Malawi: a prospective cohort study. Thorax. 2020;75(3):269-278. doi:10.1136/thoraxjnl-2019-213808. PMID:32102951.
5. Byrne AL, Marais BJ, Mitnick CD, Garden FL, Lecca L, Contreras C, et al. Chronic airflow obstruction after successful treatment of tuberculosis in Lima, Peru. ERJ Open Res. 2017;3(3):00026-2017. doi:10.1183/23120541.00026-2017. PMID:28717643.
6. Amaral AFS, Coton S, Kato B, Tan WC, Studnicka M, Janson C, et al. Tuberculosis associates with both airflow obstruction and low lung function: BOLD results. Eur Respir J. 2015;46(4):1104-1112. doi:10.1183/13993003.02325-2014. PMID:26113680.
7. Laniado de la Mora I, Martinez-Oceguera D, Laniado-Laborin R. Chronic airway obstruction after successful treatment of tuberculosis and its impact on quality of life. Int J Tuberc Lung Dis. 2015;19(7):808-810. doi:10.5588/ijtld.14.0983. PMID:26056106.
8. Vashakidze SA, Kempker JA, Jakobia NA, Gogishvili SG, Nikolaishvili KA, Goginashvili LM, et al. Pulmonary function and respiratory health after successful treatment of drug-resistant tuberculosis. Int J Infect Dis. 2019;82:66-72. doi:10.1016/j.ijid.2019.02.039. PMID:30844519.
9. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of spirometry 2019 update: an official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med. 2019;200(8):e70-e88. doi:10.1164/rccm.201908-1590ST. PMID:31613151.
10. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J. 2005;26(2):319-338. doi:10.1183/09031936.05.00034805. PMID:16055882.
11. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, et al. Interpretative strategies for lung function tests. Eur Respir J. 2005;26(5):948-968. doi:10.1183/09031936.05.00035205. PMID:16264058.

12. Stanojevic S, Kaminsky DA, Miller MR, Thompson B, Aliverti A, Barjaktarevic I, et al. ERS/ATS technical standard on interpretive strategies for routine lung function tests. Eur Respir J. 2022;60(1):2101499. doi:10.1183/13993003.01499-2021. PMID:34949706.
13. Gai X, Allwood B, Sun Y. Post-tuberculosis lung disease and chronic obstructive pulmonary disease. Chin Med J (Engl). 2023;136(16):1923-1928. doi:10.1097/CM9.0000000000002771. PMID:37455331.
14. Pasipanodya JG, McNabb SJN, Hilsenrath P, Bae S, Lykens K, Vecino E, et al. Pulmonary impairment after tuberculosis and its contribution to TB burden. BMC Public Health. 2010;10:259. doi:10.1186/1471-2458-10-259. PMID:20482835.