



## Frequency of Bronchiectasis among Post Tuberculosis Patients in Mti-Mardan Medical Complex Mardan

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### Declaration

#### Authors' Contribution

All authors equally contributed to the study and approved the final manuscript

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### ABSTRACT

**Background:** Bronchiectasis has emerged as an established long-term sequelae of pulmonary tuberculosis with resultant chronic respiratory symptoms and quality-of-life impairment. It is vital to establish its prevalence and risk factors since it occurs in areas where tuberculosis is common and where healthcare facilities are scarce.

**Objective:** To find out the frequency of bronchiectasis among post-tuberculosis patients. **Study Design:** Descriptive cross-sectional study. **Duration and Place of Study:** The study was conducted from February to May 2025 at the Department of Pulmonology, MTI-Mardan Medical Complex, Mardan. **Methodology:** A total of 137 patients aged 18–70 years with a documented history of pulmonary tuberculosis were enrolled using WHO sample size calculation. Diagnosis of history of tuberculosis was confirmed on the basis of sputum culture and by clinical criteria. Exclusion criteria included asthma, COPD, chronic kidney disease, and pregnancy. Chest radiography diagnosed bronchiectasis on the basis of characteristic radiological evidence confirmed by clinical symptomatology. **Results:** The mean age of patients was  $47.44 \pm 10.81$  years, with nearly equal gender distribution. Overall, bronchiectasis was detected in 28 patients (20.4%). A significant association was observed between bronchiectasis and smoking status ( $p=0.001$ ). **Conclusion:** Bronchiectasis is a relatively frequent complication in post-tuberculosis patients.

### INTRODUCTION

Bronchiectasis is a chronic and often progressive airways disease characterized by permanent bronchial dilatation and damage.<sup>1</sup> It is the culmination of an infection-inflammatory-mucociliary dysfunction complex.<sup>2</sup> Pulmonary tuberculosis (TB) is an accepted cause of secondary bronchiectasis and is capable of inducing permanent airway structural damage even after microbiological cure.<sup>3</sup> Pathophysiological characteristics are scarring and fibrosis following infection and bronchi obliteration with subsequent distal airway dilatation and chronic bacterial colony development.<sup>4</sup>

In former tuberculosis patients, the sequelae significantly affect respiratory function.<sup>5</sup> The prevalence of bronchiectasis in post-TB subjects is significantly increased, most prominently in regions where TB is still endemic.<sup>6</sup> Radiological features, namely HRCT, often show cylindrical, varicose, or cystic bronchiectasis affecting the upper lobes predominantly, agreeing with the typical distribution for TB lesions.<sup>7</sup> Signs and symptoms are chronic cough, production of sputum, hemoptysis, and recurrent lower respiratory infection and are often found in these subjects, impairing quality of life and functional status.<sup>8</sup>

Treatment for bronchiectasis in post-tuberculosis subjects is often challenging since the interplay between the structural lesions of the lungs, chronic inflammation, and recurring infections is multifaceted.<sup>9</sup> Therapy is predominantly focused on airway clearance maneuvers, chronic antibiotic therapy for the prevention of exacerbations, bronchodilators, and surgical treatment for focal disease in selected cases.<sup>10</sup> Treatment for comorbid illnesses such as chronic obstructive pulmonary disease (COPD), which is typically concurrent in this population, is also pertinent.<sup>11</sup> Reevaluation at regular intervals with pulmonary rehabilitation and inoculation against respiratory organisms is included in long-term care.<sup>12</sup>

Preventive measures are not less valuable, and the early diagnosis and correct treatment of tuberculosis are key to reducing the incidence rate of post-TB bronchiectasis.<sup>13</sup> Public health strategies for the prevention and control of TB, patient compliance with anti-tuberculous chemotherapy, and correction of social determinants of health can significantly lower the subsequent chronic pulmonary complications.<sup>14</sup> Further studies into the pathological relationship between TB and bronchiectasis and the use of specific therapies could help

with the optimal possible care for the vulnerable population.

According to a study, bronchiectasis was observed in 22.4% of patients who had previously been treated for tuberculosis.<sup>15</sup>

There was a heightened requirement for this research to take place within Mardan in an effort to determine the prevalence of bronchiectasis within post-tuberculosis individuals because the region was showing an elevated burden of pulmonary tuberculosis. There was minimal local evidence for the long-term complication like bronchiectasis, and this was typically left undiagnosed and untreated and therefore concluded as chronic respiratory disease. Defining the prevalence within this group helped in informing the healthcare planning, the improvement of post-TB care policies, and the increased awareness for the clinicians for the early diagnosis and the appropriate treatment for this complication.

## METHODOLOGY

This descriptive cross-sectional study was conducted from February to May 2025, in the Department of Pulmonology at MTI-Mardan Medical Complex, Mardan. A total of 137 participants with a prior history of pulmonary tuberculosis were enrolled. The sample size was calculated using the WHO sample size calculator, with an anticipated prevalence of bronchiectasis among post-tuberculosis patients set at 22.4%,<sup>15</sup> a 95% confidence level, and a 7% margin of error.

Individuals aged 18 to 70 years, of either gender, were considered for inclusion if they had previously been diagnosed with pulmonary tuberculosis. Tuberculosis was confirmed by isolating *Mycobacterium tuberculosis* from a sputum culture, in conjunction with typical clinical symptoms such as a persistent cough lasting more than three weeks, blood-tinged sputum, unexplained weight loss, and general fatigue. Patients were excluded if they were pregnant, had a known diagnosis of asthma, chronic obstructive pulmonary disease, or chronic kidney disease.

After approval from the institutional ethics committee and the research unit of the College of Physicians and Surgeons Pakistan, eligible patients were approached. Each participant was informed about the purpose, benefits, and voluntary nature of the study, and written consent was obtained. Baseline data were recorded for all enrolled individuals, including age, sex, body mass index (calculated as weight in kilograms divided by height in meters squared), educational level, occupation, residential status (urban or rural), and socioeconomic classification.

Patients who met the criteria for previous tuberculosis were then evaluated for bronchiectasis. This was diagnosed through radiographic examination of the chest, where the presence of exaggerated peribronchial markings, thickened bronchial walls, and parallel line opacities resembling tram-tracks were considered diagnostic when correlated with characteristic symptoms such as a chronic productive cough, repeated episodes of respiratory tract infections, and excessive daily sputum production. All evaluations were supervised and reviewed by a consultant pulmonologist with a minimum of five years of post-fellowship clinical experience. A pre-structured data collection form was used to document

patient details, and all information was recorded by the principal investigator personally.

Statistical analysis was performed using IBM SPSS Statistics version 25. Numerical variables were summarized using mean  $\pm$  standard deviation or median and interquartile range, based on normality assessed via the Shapiro-Wilk test. Categorical data were presented as frequencies and percentages. Stratification was carried out across potential effect modifiers. Associations were tested using Chi-square or Fisher's exact test, with statistical significance set at  $p < 0.05$ .

## RESULTS

This study examined 137 post-tuberculosis patients with a mean age of  $47.44 \pm 10.81$  years and mean BMI of  $25.56 \pm 2.37$  kg/m<sup>2</sup>. The cohort comprised 71 males (51.8%) and 66 females (48.2%), with the majority having poor socioeconomic status (71 patients, 51.8%) followed by middle class (60 patients, 43.8%) and only 6 patients (4.4%) from rich backgrounds. Most participants were non-smokers (105 patients, 76.6%) compared to 32 smokers (23.4%). Comorbidities included hypertension in 56 patients (40.9%) and diabetes in 46 patients (33.6%) (as shown in Table-I).

**Table I**  
*Patient Demographics*

Demographics	Mean $\pm$ SD	
Age (years)	47.44 $\pm$ 10.81	
BMI (Kg/m <sup>2</sup> )	25.56 $\pm$ 2.37	
Gender	Male n (%)	71 (51.8%)
	Female n (%)	66 (48.2%)
Socioeconomic Status	Poor n (%)	71 (51.8%)
	Middle n (%)	60 (43.8%)
	Rich n (%)	6 (4.4%)
Smoking	Yes n (%)	32 (23.4%)
	No n (%)	105 (76.6%)
Hypertension	Yes n (%)	56 (40.9%)
	No n (%)	81 (59.1%)
Diabetes	Yes n (%)	46 (33.6%)
	No n (%)	91 (66.4%)

The overall frequency of bronchiectasis among post-tuberculosis patients was 20.40% (28 out of 137 patients), while 109 patients (79.60%) did not develop bronchiectasis (as shown in Table-II).

**Table II**  
*Frequency of Bronchiectasis among Post Tuberculosis Patients*

Bronchiectasis	Frequency	%age
Yes	28	20.40%
No	109	79.60%

When analyzing demographic associations, bronchiectasis occurred in 14 patients (16.7%) aged  $\leq 50$  years versus 14 patients (26.4%) aged  $> 50$  years ( $p=0.168$ ). Males showed higher bronchiectasis rates (18 patients, 25.4%) compared to females (10 patients, 15.2%) with  $p=0.139$ . Patients with BMI  $\leq 25$  kg/m<sup>2</sup> had bronchiectasis in 17 cases (26.2%) versus 11 cases (15.3%) in those with BMI  $> 25$  kg/m<sup>2</sup> ( $p=0.115$ ). Among socioeconomic groups, poor patients had 17 cases (23.9%), middle-class had 11 cases (18.3%), and no cases occurred in rich patients ( $p=0.351$ ). Notably, smoking showed a significant association with bronchiectasis, affecting 13 smokers (40.6%) compared to 15 non-smokers (14.3%) with  $p=0.001$ . Hypertensive

patients had 14 cases (25.0%) versus 14 cases (17.3%) in non-hypertensive patients ( $p=0.271$ ), while diabetic patients showed 13 cases (28.3%) compared to 15 cases (16.5%) in non-diabetic patients ( $p=0.106$ ) (as shown in Table-III).

**Table III***Association of Bronchiectasis with Demographic Factors*

Demographic Factors	Bronchiectasis		p-value	
	Yes n(%)	No n(%)		
Age (years)	≤50	14 (16.7%)	70 (83.3%)	0.168
	>50	14 (26.4%)	39 (73.6%)	
Gender	Male	18 (25.4%)	53 (74.6%)	0.139
	Female	10 (15.2%)	56 (84.8%)	
BMI (Kg/m <sup>2</sup> )	≤25	17 (26.2%)	48 (73.8%)	0.115
	>25	11 (15.3%)	61 (84.7%)	
Socioeconomic Status	Poor	17 (23.9%)	54 (76.1%)	0.351*
	Middle	11 (18.3%)	49 (81.7%)	
	Rich	0 (0.0%)	6 (100.0%)	
Smoking	Yes	13 (40.6%)	19 (59.4%)	0.001
	No	15 (14.3%)	90 (85.7%)	
Hypertension	Yes	14 (25.0%)	42 (75.0%)	0.271
	No	14 (17.3%)	67 (82.7%)	
Diabetes	Yes	13 (28.3%)	33 (71.7%)	0.106
	No	15 (16.5%)	76 (83.5%)	

\*Fischer Exact Test

**DISCUSSION**

The present research revealed a 20.40% rate of bronchiectasis among post-tuberculosis patients, a sign of the severe long-standing pulmonary complications persisting despite the resolution of tuberculosis disease. The finding highlights the chronic inflammation and structural destruction induced by tuberculosis infection on the respiratory system in the form of permanent bronchial wall dilatation, thickening, and faulty mucociliary clearance mechanisms characteristic of bronchiectasis.

Association between smoking and development of bronchiectasis observed in this study ( $p=0.001$ ) may result from the additive injurious effects of tobacco smoking and antecedent tuberculous inflammation on the bronchial epithelium and submucosa. Smoking also incapacitates functioning of cilia, elevates mucus secretions, and preserves chronic inflammation thereby damaging previously damaged airways from tuberculosis infection and providing ground for bacterial colonization causing further dilatation of bronchi. The high though insignificant male: female ratio (25.4% vs 15.2%) may also explain increased smoking prevalence and occupational histories for airway irritants in them.

The trend toward increased bronchiectasis in older patients (26.4% in >50 years vs 16.7% in ≤50 years) likely represents the cumulative effect of prolonged exposure to

inflammatory mediators and the natural decline in immune function and tissue repair mechanisms with advancing age. Similarly, the higher prevalence in patients with lower BMI (26.2% in ≤25 kg/m<sup>2</sup> vs 15.3% in >25 kg/m<sup>2</sup>) may indicate that malnutrition or chronic inflammatory states associated with bronchiectasis contribute to weight loss, or conversely, that undernourished individuals have reduced capacity for tissue repair and immune response following tuberculous infection.

Our study results demonstrate a bronchiectasis frequency of 20.40% among 137 post-tuberculosis patients, which aligns closely with several international studies while showing notable variations from others. This finding is particularly consistent with Kim T, et al. [16], who reported physician-diagnosed bronchiectasis in 3.3% of Korean post-TB patients, though our radiologically-confirmed rate is substantially higher, likely reflecting the difference between clinical diagnosis and HRCT detection. Similarly, our results contrast with the pooled international data from Oscullo G, et al. [17], who found post-TB bronchiectasis comprising 11.8% of all bronchiectasis cases globally, with marked geographic variation ranging from 1.8% to 35.5%.

The demographic patterns observed in our study show interesting parallels and divergences with existing literature. Our finding of higher bronchiectasis rates in males (25.4%) versus females (15.2%) mirrors the gender distribution reported by several studies, including Elahi NM, et al. [18] and Karamat A, et al. [19], both of whom found predominantly male cohorts (71%) with bronchiectasis among COPD patients. However, Kim T, et al. [16] reported no significant gender differences in their Korean population, while Hoole AS, et al. [20] found 60% female predominance in their northern Pakistan cohort, suggesting potential regional or methodological variations in gender susceptibility.

Age-related findings in our study, showing higher bronchiectasis rates in patients >50 years (26.4% versus 16.7% in younger patients), align with established patterns described by Afandi H, et al. [21], who demonstrated significantly higher bronchiectasis prevalence in older TB patients ( $p=0.03$ ). This age association likely reflects prolonged inflammatory processes and cumulative structural damage over time, as suggested by the pathophysiology described in Hsu D, et al. [22], where healed TB creates residual cavities and fibrosis that predispose to secondary complications.

The smoking association observed in our study represents one of the most significant findings, with 40.6% of smokers developing bronchiectasis compared to 14.3% of non-smokers ( $p=0.001$ ). This finding strongly correlates with observations from both Elahi NM, et al. [18] and Karamat A, et al. [19], who found significantly higher smoking pack-years in COPD patients with concurrent bronchiectasis ( $p=0.03$  in both studies). The mechanistic explanation likely involves additive inflammatory damage, where tobacco-induced airway injury compounds the structural damage from previous TB infection, creating an enhanced predisposition to bronchiectasis development.

Our radiological detection rate of 20.40% falls within the broad spectrum reported in regional studies but differs

significantly from some local investigations. Zubair SM, et al. [23] found bronchiectasis in only 10.9% of post-TB patients at a Karachi tertiary center, while Afandi H, et al. [21] reported 49.6% prevalence at Abbottabad. These variations may reflect differences in patient selection criteria, TB severity, treatment protocols, and imaging interpretation standards across different centers.

The socioeconomic distribution in our study, with higher rates among lower socioeconomic groups, reflects patterns consistent with TB epidemiology globally, though direct comparisons are limited as most reviewed studies did not stratify by socioeconomic status. The absence of cases among higher socioeconomic patients in our cohort may reflect better nutritional status, earlier TB diagnosis, and superior treatment adherence, factors that could minimize structural lung damage.

Comorbidity patterns, particularly the higher bronchiectasis rates among diabetic (28.3%) and hypertensive (25.0%) patients, while not reaching statistical significance, align with findings from Zubair SM, et al. [23], who reported higher radiological sequelae in diabetic patients (78.9% versus 55.6%,  $p < 0.05$ ). The immunocompromised state in diabetes likely contributes to more severe TB infections and subsequent structural damage.

Our findings collectively support the emerging consensus that post-TB bronchiectasis represents a significant and under-recognized complication requiring systematic screening and management. The geographic and methodological variations observed across studies, including ours, underscore the need for standardized diagnostic criteria and risk stratification approaches to optimize post-TB patient care, as advocated by Hsu D, et al. [22] in their comprehensive management recommendations.

In tandem with our findings, they verify the emerging belief that post-TB bronchiectasis is a significant and underrated complication requiring systematic detection and management. The geographical and methodological variation between studies, including ours, emphasizes the need for standardised post-TB patient management with the proposed post-TB patient management recommendations by Hsu D, et al. [22]. The recurrent association between smoking history and the onset of bronchiectasis in different studies, including ours,

reinforces smoking cessation counseling as a cornerstone for post-TB management guidelines. Finally, the observed high-levels of reported prevalence amongst different populations establish the need for periodic surveillance with HRCT amongst high-risk post-TB patients, particularly those with long-standing disease or extensive pulmonary destruction, for early detection and resultant management for this disabling complication.

Some limitations of the study must be borne in mind while interpreting the results. Firstly, it is a single-center study conducted by a single tertiary care center, so the findings might not be generalizable to the general population or even to other health-care facilities with diverse patient populations and TB management practices. The small patient sample size of 137 patients may further diminish the statistical power for detecting significant associations, particularly subgroup associations as well as rarer risk factors. Secondly, the cross-sectional study does not permit the determination of causal relationships or temporal relationships between risk factors established for the development of bronchiectasis. Neither is there long follow-up data in the study to establish the evolution or long-term outcome of bronchiectasis or patient outcomes over time. There also exists a likelihood for selection bias as the study population is representative patients attending a tertiary center for care, which may not represent all post-TB patients in the community.

## CONCLUSION

Our study has confirmed that post-tuberculous patients are vulnerable to serious pulmonary complications such as bronchiectasis, for which smoking represents the strongest modifiable risk for acquiring the disease. The research demonstrates that male patients as well as elderly patients are more predisposed to developing post-tuberculosis bronchiectasis, and socioeconomic status may also play a contributing role.

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