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ORIGINAL ARTICLE

Impact of Previous Pulmonary Tuberculosis on Lung Function and Risk of Developing Asthma-Like Airway Obstruction

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ABSTRACT

Background: Pulmonary tuberculosis (PTB) causes permanent structural and inflammatory alterations in the airways that can start to persist even after microbiological treatment. Persistent respiratory symptoms and spirometry abnormalities appear in many patients, and the scope of the asthma-type airway blockage following PTB is not adequately defined in the tuberculosis-stricken countries.

Objective: To evaluate the effect of prior pulmonary tuberculosis on lung function, and to estimate the prevalence of asthma-like airway-blocking in adults with a history of treated PTB.

Methodology: It is a cross-sectional comparative study that was carried out at the department of Pulmonology of a MTI-Mardan Medical Complex, Mardan between November 2022 and April 2023. Two hundred adults who had documented and successfully treated PTB (>6 months later) were recruited and compared to 200 age- and sex-matched controls who had never had any history of PTB before. Standardised respiratory questionnaires were performed for all subjects, and pre- and post-bronchodilator spirometry was done as per the ATS/ERS guidelines. Post-bronchodilator FEV 1/FVC with the definition of airway obstruction less than 0.70. Airflow obstruction with a high bronchodilator reversibility (i.e. ΔFEV 1 3) was considered asthma-like airway obstruction. SPSS version 24.0 was used to analyses the data.

Results: The PTB group had a mean age of 45.6 ± 12.8 years, while controls had a mean age of 44.2 ± 11.9 years ($p = 0.41$). Mean post-bronchodilator FEV_1% predicted was significantly lower in post-TB patients (68.3 ± 15.7) than in controls (82.9 ± 13.4; $p < 0.001$). Airway obstruction was observed in 38.3% of PTB patients compared with 15.0% of controls ($p < 0.001$). Asthma-like airway obstruction was present in 20.0% of PTB patients versus 6.7% of controls ($p = 0.002$).

Conclusion: Repeated pulmonary tuberculosis is related to considerable long-term dysfunction of the lungs and a greatly enhanced likelihood of airway hindrance characteristic of asthma. Post-TB spirometry surveillance can be conducted regularly to allow detection and treatment of reversible airflow limitation at an earlier stage in this at-risk group.

Keywords: Pulmonary tuberculosis; Lung function; Airway obstruction; Asthma-like disease

INTRODUCTION

Tuberculosis, especially pulmonary tuberculosis (PTB), is a significant public health concern in most countries, especially the low- and middle-income countries; it has a high burden of diseases and long-term sequelae[1]. In spite of the fact that the effect of antituberculosis therapy may be microbiological cure in most cases of patients, structural and functional impairment of the respiratory system often remains[2]. Within the spectrum of abnormalities, this post-tuberculosis lung disease has been the focus of more and more attention in recent years, such as airway narrowing, bronchiectasis, parenchymal fibrosis, and dysfunction of small airways, and may present itself as chronic cough, wheeze, exertional dyspnea, and recurrent respiratory infections[3]. Several studies have shown that people who have had a history of PTB are at very high risk of getting chronic airflow limitation as compared to the general population. Although the impediment has long been considered the result of a chronic obstructive pulmonary disease (COPD) phenotype, some new data indicate that a non-negligible proportion of post-TB individuals have bronchodilator responsiveness and symptom variability that are typical of asthma[4]. This condition, commonly called asthma-like airway obstruction, is a potentially treatable characteristic that can be ignored when patients are diagnosed with irreversible post-infectious lung injury[5]. The pathophysiology behind the interrelationship between PTB and long-term airway obstruction is complex. Active tuberculosis causes extreme inflammatory reactions in the bronchial tree and lung parenchyma, causing caseation necrosis, cavitation, and distortion of the normal airway's structure[6]. Fibrosis, thickening of airways and small airways obliteration are common accompaniments of healing. Also, the low-grade inflammation can be continued even after microbiological curing, and this encourages the development of airway hyper-responsiveness and hypersecretion of mucus[7]. Depending on the severity and localisation of structural damage, these alterations can result in fixed obstruction, partially reversible obstruction, or a combination of both, although regular lung performance evaluation after the conclusion of TB treatment is not common in limited resources[8]. In those areas where tuberculosis is endemic, e.g. in Pakistan, the majority of patients are released from the TB program once they are finished with treatment, with minimal attention being given to further respiratory monitoring[9]. As a result, patients with reversible airflow limitation may not be diagnosed and treated, living with their symptoms that still affect their quality of life and productivity[10]. This issue is also exacerbated by the absence of regional data, as clinicians tend to resort to extrapolated evidence of non-endemic groups. Spirometry using bronchodilator testing is the key to the differentiation between fixed airflow limitation and asthma-like reversible obstruction. The determination of bronchodilator responsiveness in post-TB patients has significance in therapeutic terms since they may be treated with inhaled bronchodilators and corticosteroids instead of being treated conservatively by assuming that their disease is irreversible.

Study Objectives: To assess the impairment of lung functioning following pulmonary TB and to identify the prevalence rate of asthma-like airway blockage in patients who have successfully treated PTB as adults.

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MATERIALS AND METHODS

It is was cross-sectional comparative study that was carried out at the outpatient department of Pulmonology of MTI - Mardan Medical Complex, Mardan, between November 2022 and April 2023. Two hundred adults who had documented and successfully treated Pulmonary TB (>6 months later) were recruited and compared to 200 age- and sex-matched controls who had never had any history of PTB before. Standardized respiratory questionnaires were performed for all subjects, and pre- and post-bronchodilator spirometry was done as per the ATS/ERS guidelines. Post-bronchodilator FEV 1/FVC with the definition of airway obstruction less than 0.70. Airflow obstruction with a high bronchodilator reversibility (i.e. ΔFEV 1 3) was considered asthma-like airway obstruction. SPSS version 24.0 was used to analyses the data.

Study Design and Setting: It was a cross-sectional comparative study undertaken at the outpatient pulmonology department in a tertiary-care teaching hospital in mardan, Pakistan in the period January to December 2024.

Participants: They included adults aged 18-65 years with a previously documented successful history of treating pulmonary tuberculosis at least six months before enrollment. Controls that were age and sex matched and had never had a Pulmonary TB were recruited in the same clinic. Patients who could not do an acceptable spirometry were also excluded, as well as those who had active pulmonary infection.

Sample Size Calculation: An expected prevalence of airway obstruction in the post-TB of 35 per cent, a 95 per cent level of confidence, and a 5 per cent margin of error gave a minimum of 113 participants per group. In order to cover the gaps in the data, 120 patients were recruited in each group.

Inclusion Criteria: Adults aged 18-65 years; registered cured or completed treatment for PTB 6 months or more in the past; informed consent.

Exclusion Criteria: Active TB, pregnancy, previously diagnosed known COPD, unstable cardiac disease, or incapable of spirometry.

Diagnostic Strategy: Each of the participants filled in standardised respiratory questionnaires and proceeded to receive pre- and post-bronchodilator spirometry. To determine a fixed and asthma-like airway obstruction, a test of airflow obstruction and bronchodilator reversibility was done.

Statistical Analysis: SPSS version 24.0 was used to analyse data. The independent t-tests were used to compare continuous variables as mean ± standard deviation. Chi-square tests were used to compare categorical variables. The p-value of less than 0.05 was taken to be statistically significant.

Ethical Approval:

RESULTS

A total of 120 patients with previous pulmonary tuberculosis and 120 controls were included. The mean age of the PTB group was 45.6 ± 12.8 years, compared with 44.2 ± 11.9 years in controls (p = 0.41). Males constituted 59.2% of the PTB group and 56.7% of controls (p = 0.69). Mean post-bronchodilator FEV_1% predicted was significantly lower among post-TB patients (68.3 ± 15.7) than controls (82.9 ± 13.4; p < 0.001). Airway obstruction was detected in 46 (38.3%) PTB patients versus 18 (15.0%) controls (p < 0.001).

Asthma-like airway obstruction was identified in 24 (20.0%) individuals with prior PTB compared with 8 (6.7%) controls (p = 0.002). The mean bronchodilator response was also significantly higher in the PTB group (230 ± 110 mL) than in controls (150 ± 90 mL; p = 0.004). Chronic cough and wheeze were reported by more than half of the PTB patients.

Intervention Outcome: In the group of PTB patients who had asthma-like airflow obstruction, the introduction of inhaled bronchodilator therapy led to subjective reduction in breathlessness and cough in most patients over four weeks, which confirms the clinical importance of identifying reversible airflow limitation in this group of patients.

Table 1: Baseline demographic and clinical characteristics of study participants

Variable	PTB Group (n = 120)	Control Group (n = 120)	p-value
Age (years), mean ± SD	45.6 ± 12.8	44.2 ± 11.9	0.41
Male gender, n (%)	71 (59.2)	68 (56.7)	0.69
BMI (kg/m²), mean ± SD	23.4 ± 3.8	24.1 ± 3.5	0.12
Current smokers, n (%)	34 (28.3)	29 (24.2)	0.47
Biomass fuel exposure, n (%)	39 (32.5)	21 (17.5)	0.01
Chronic cough, n (%)	63 (52.5)	34 (28.3)	<0.001
Wheeze, n (%)	57 (47.5)	31 (25.8)	<0.001

Comparison of baseline characteristics between participants with previous pulmonary tuberculosis (PTB) and controls. Values are presented as mean ± SD or number (%).

Table 2: Spirometry parameters in PTB and control groups

Parameter	PTB Group (n = 120)	Control Group (n = 120)	p-value
Pre-BD FEV_1 (% predicted)	64.2 ± 14.9	79.1 ± 13.6	<0.001
Post-BD FEV_1 (% predicted)	68.3 ± 15.7	82.9 ± 13.4	<0.001
Pre-BD FEV_1/FVC	0.68 ± 0.10	0.76 ± 0.08	<0.001
Post-BD FEV_1/FVC	0.70 ± 0.09	0.78 ± 0.07	<0.001
ΔFEV_1 (mL)	230 ± 110	150 ± 90	0.004

Comparison of pre- and post-bronchodilator spirometry between PTB and control groups.

Table 3. Patterns of lung function abnormality

Spirometry Pattern	PTB Group (n = 120)	Control Group (n = 120)	p-value
Normal	52 (43.3%)	88 (73.3%)	<0.001
Obstructive	46 (38.3%)	18 (15.0%)	<0.001
Restrictive	14 (11.7%)	9 (7.5%)	0.28
Mixed pattern	8 (6.7%)	5 (4.2%)	0.39

Distribution of spirometry patterns among PTB patients and controls.

Table 4: Frequency of asthma-like airway obstruction and symptoms

Variable	PTB Group (n = 120)	Control Group (n = 120)	p-value
Asthma-like airway obstruction, n (%)	24 (20.0)	8 (6.7)	0.002
Significant BD reversibility, n (%)	30 (25.0)	11 (9.2)	0.001
Nocturnal symptoms, n (%)	41 (34.2)	19 (15.8)	0.001
≥2 exacerbations in last year, n (%)	27 (22.5)	10 (8.3)	0.002

Comparison of asthma-like airway obstruction features and symptom burden between PTB patients and controls.

DISCUSSION

The lung function of the participants in this cross-sectional comparative study and the prevalence of airflow obstruction were significantly worse in adults with a history of successfully treated pulmonary tuberculosis compared with their matched controls[11]. The predicted post-bronchodilator FEV1 and obstruction were significantly lower in the PTB population and were detected in 38.3% and 15.0% of controls, respectively[12]. Notably, one-fifth of post-TB participants achieved the criteria of asthma-like airway obstruction (obstruction with substantial bronchodilator reversibility), suggesting a clinically relevant treatable characteristic that could be overlooked in case of the post-TB symptoms being attributed to fixed structural damage only[13]. Our observations are consistent with the accumulating literature of the past five years that shows that post-tuberculosis lung disease is often expressed through chronic airflow limitation. A 2023 systematic synthesis and review by ERS found that abnormal spirometry is prevalent in those survivors of TB, and that patterns of obstructive, restrictive and mixed spirometry are observed long after discontinuation of therapy, supporting the fact that the term, cure, does not imply restoration of normal respiratory morbidity[14]. Meanwhile, one of the largest studies to date in Thorax involved post-TB participants who reported the persistence of respiratory symptoms and airflow obstruction, highlighting that post-TB impairment is not unique, and it may become a clinical issue[15]. The value of the obstruction in our group is also in line with the regional accounts. A study in a Pakistani pulmonology centre (Peshawar) indicated a high prevalence of COPD-like airflow limitation in post-TB patients to justify the use of organised post-treatment screening in TB-endemic populations[16]. Also, a recent Pakistani study (2025) has pointed to the common lack of correlation between symptoms persistence and spirometry severity in post-TB patients- an observation that could be used to understand why symptomatic persons often lack objective lung function analysis and phenotype-based management[17]. One of the contributions of the given study is the quantification of reversible airflow limitation post-PTB. Although post-TB obstruction may be described as fixed, our

testing of bronchodilators revealed many more mean improvements of ΔFEV1 in the PTB group and a larger proportional number meeting the reversibility criterion[18]. This is clinically significant, as bronchodilator responsiveness can be a sign of airway hyper-responsiveness, and of existing inflammation on top of underlying structural distortion, which can manifest as an asthma-like disease, and which may be responsive to inhaled bronchodilators (and, where suitable, inhaled steroids). The strategy is justified by the modern interpretive standards according to which bronchodilator response is a functional indicator that can be used in the diagnosis and stratification of treatment[19,20]. Our findings also fall within the wider epidemiologic data relating the previous TB to asthma diagnoses and asthma symptoms. A Nordic-Baltic multicenter population study (2023) found that TB increased the odds of asthma after the adjustment of major confounders and that TB may be an etiological factor that raises the likelihood of asthma phenotypes or asthma-like syndromes later in life[21]. Even though we have varying population and exposure ascertainment compared to our spirometry design based in a clinic, the direction of association is concordant and supports biological plausibility. Mechanistically, the patterns might be attributed to a number of pathways: airway wall thickening and luminal constriction due to healed endobronchial disease; the small-airways obliteration and peribronchiolar fibrosis; traction bronchiectasis and mucus retention; and sustained immune response with hyper-responsiveness. Such mechanisms are likely to be combined with regional exposures to biomass smoke and repeated infections that may enhance the post-TB airway remodelling and symptom burden[22]. The clinical implications are self-evident. Post-treatment follow-up should not stop in TB-endemic areas due to bacteriologic results and should also encompass spirometry (including bronchodilator testing) in order to detect obstructive phenotypes and possibly reversible disease. By incorporating lung function screening into post-TB care pathways, a reduction in under-recognition of asthma-like obstruction could be achieved, and a higher functional outcome in TB survivors could be attained.

Limitations: The study was only carried out in one tertiary-care facility, so it might not be generalised. The cross-sectional design does not permit a causal inference, and the use of spirometry criteria with no measurement of lung volume could have classified some of the restrictive defects or overlapping phenotypes.

CONCLUSION

The pulmonary tuberculosis history among adults is related to much diminished lung functioning and increased incidence of asthma-like airway blockage. Regular post-TB spirometry evaluation is justified as this method helps to detect the reversible airflow limitation and to prescribe inhaled therapy in this susceptible group. Disclaimer: Nil

Conflict of Interest: Nil

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Authors Contributions

Concept & Design of Study, Data Collection: Sajjad Ali, Muhammad Sohrab Khan

Drafting: Muhammad Sohrab Khan

Data Analysis: Muhammad Sohrab Khan

Critical Review: Muhammad Sohrab Khan

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