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ORIGINAL ARTICLE

Post-Tuberculosis Pulmonary Impairment: Prevalence, Functional Limitation, and Quality of Life in Adult Patients

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Abstract

Background: Tuberculosis (TB) remains a major global health burden, and despite effective treatment, many survivors develop post-tuberculosis pulmonary impairment (PTB-PI). This condition leads to chronic respiratory symptoms, reduced lung function, and poor quality of life. The lack of standardized post-TB care results in neglected morbidity.

Objectives: To determine the prevalence, patterns, functional limitations, and quality of life among adult patients with post-tuberculosis pulmonary impairment.

Materials and Methods: This cross-sectional study was conducted it Dhaka National Medical College, Department of Pulmonology, from January to December 2024, including 156 adults with completed TB treatment. Data were collected through questionnaires, spirometry, and standardized scales (mMRC, SF-36). Descriptive and inferential statistics were performed using SPSS v23. Ethical approval was obtained from the Institutional Review Board, and written informed consent was secured from all participants.

Result: Among 156 patients, mean age was 43.2 years with male predominance (62.8%). Pulmonary impairment was highly prevalent (73.7%), primarily obstructive (36.5%) and restrictive (28.8%) patterns. Most patients (69.2%) reported dispend, with 27.5% experiencing severe functional limitation (mMRC 3-4). Smoking was a major risk factor, with 82.3% of smokers/ex-smokers impaired versus 55.0% of non-smokers. Quality of life was most affected in physical functioning (only 23.1% good) and energy levels (32.0% poor).

Conclusion: This study confirms PTB-PI is highly prevalent and debilitating, necessitating integrated post-TB care within national health programs.

Keywords: Post-Tuberculosis Lung Disease, Post-TB Pulmonary Impairment, Tuberculosis Sequelae, Chronic Lung Disease after TB.

Introduction

Tuberculosis (TB) remains a formidable global health challenge, ranking as the second leading infectious cause of death worldwide after COVID-19.[1] While the global focus has historically been on reducing TB incidence and mortality through effective diagnosis and curative treatment, a critical long-term consequence is increasingly gaining recognition: post-tuberculosis pulmonary impairment (PTB-PI). A significant proportion of patients who successfully complete anti-Tuberculosis therapy are left with permanent structural and functional damage to their lungs, a condition now recognized as a major contributor to chronic respiratory morbidity.[2] The prevalence of PTB-PI is alarmingly high. Recent systematic reviews and cohort studies indicate that between 30% and 80% of pulmonary TB survivors develop some form o residual respiretory impairment, ranging from obstructive and restrictive defects to a mixed pattern on spirometry.[3,4] These impairments are the sequelae of the host's immune response to Mycobacterium tuberculosis, which, while controlling the infection, often results in parenchymal destruction, bronchiectasis, and pleural fibrosis.[5] The severity of PTB-

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PI is influenced by factors such as delays in diagnosis, the extent of cavitary disease at presentation, and smoking status.[6,7] This high prevalence translates into a substantial and growing population of TB survivors living with chronic respiratory symptoms, including persistent dyspnea, chronic cough, and reduced exercise tolerance. The functional limitations imposed by PTB-PI are profound and extend beyond laboratory spirometry values. Patients frequently exhibit significantly reduced exercise capacity, as measured by the six-minute walk test (6MWT), which directly impacts their ability to perform activities of daily living and return to work.[8,9] This loss of functional capacity often leads to socioeconomic decline, creating a vicious cycle of poverty and ill health.[10] Consequently, the culmination of chronic symptoms and functional disability severely diminishes health-related quality of life (HRQoL). Studies utilizing standardized tools like the St. George's Respiratory Questionnaire (SGRQ) and the EQ-5D consistently report significantly worse HRQoL scores among TB survivors compared to the general population, with impair mention physical, psychological, and social domains.[11,12] Despite its significant burden, PTB-PI remains a neglected aspect of TB care. There are no standardized global guidelines for the follow-up, diagnosis, or management of this condition, leading to a large "hidden" population with unmet health care needs.[13,14] As global TB treatment success rates improve, the absolute number of individuals living with the long-term consequences of the disease will continue to rise, placing increasing demands on healthcare systems.[15] Therefore, understanding the local prevalence, specific functional limitations, and the profound impact on the quality of life of adult patients with PTB-PI is not just an academic exercise but a critical public health imperative. This study aims to contribute to this understanding, providing essential data to advocate for integrated post-TB care and rehabilitation services within national TB programs.

Materials and Methods

This prospective cross-sectional observational study was conducted at Dhaka National Medical College and the Department of Respiratory Medicine, Dhaka, Bangladesh. The study period extended from January 2024 to December 2024. The study population take of 156 adult patients. Study subjects were selected as per inclusion & exclusion criteria. The study includes adult patients aged 18 years & above who had a documented history of pulmonary tuberculosis and had completed a full course of anti-tubercular treatment at least three months prior to enrollment. Only those who were clinically stable and willing to provide informed consent for participation were selected to ensure reliability of results and minimize on founding factors related to acute illness or treatment effects. After obtaining informed consent, data were collected through a structured questionnaire and clinical assessment. Socio-demographic information, past tuberculosis history, smoking habits, and environmental exposurewere recorded. Each participant underwent a detailed respiratory symptom evaluation and physical examination. Spirometry was performed using a calibrated digital spirometer to assess pulmonary function (FEV1, FVC, and FEV1/FVC ratio). Functional limitation was assessed using the Modified Medical Research Council (mMRC) Dyspnea Scale, and quality of life was evaluated using the SF-36 questionnaire. Data collection was conducted by trained research assistants under the supervision of the principal investigator to ensure consistency and accuracy. All data were entered, cleaned, and analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0. The association between categorical variables was tested using the Chi-square test, and continuous variables were compared using the t-test or ANOVA where applicable. A p-value of <0.05 was considered statistically significant. Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Dhaka National Medical College. All participants were informed about the objectives, benefits, and potential risks of the study, and written informed consent was obtained before enrollment. Confidentiality of personal information was strictly maintained, and participants were given the right to with draw from the study at any stage without any consequence. The study adhered to the principles of the Declaration of Helsinki (2013 revision) for ethical research involving human subjects.

Results

Table-I: Socio-demographic characteristics of the study population (n=156)

Variables	Categories	Frequency(n)	Percentage (%)
Age (years)	18–30	28	17.9
	31–40	44	28.2
	41–50	47	30.1
	>50	37	23.8
Mean±SD (years)		**43.2 ±11.6**	
Gender	Male	98	62.8
	Female	58	37.2
Occupation	Service holder	45	28.8
	Day laborer	36	23.1
	Housewife	34	21.8
	Farmer	26	16.7
	Others	15	9.6

Table-I showed the mean age of the study population was 43.2 ± 11.6 years, with the highest proportion of participants belonging to the 41–50 years age group (30.1%), followed by those aged 31–40 years (28.2%). About17.9% were between 18–30 years, while 23.8% were above 50 years. Out of 156 participants, 98 (62.8%) were males and 58 (37.2%) were females, indicating a male predominance. Regarding occupation, 45 (28.8%) were service holders, 36 (23.1%) were day laborers, 34 (21.8%) were housewives, 26 (16.7%) were farmers, and 15 (9.6%) were involved in other professions. These results suggest that middle-aged, working men were the most affected group. (Table I)

Table-II: Smoking and environment al expo sure history

Variables	Categories	Frequency (n)	Percentage (%)
Smoking Status	Current smoker	64	41.0
	Ex-smoker	29	18.6
	Non-smoker	63	40.4
Duration of Smoking (years)	<5 years	18	11.5
	5–10 years	32	20.5
	>10 years	43	27.6
Biomass Fuel Exposure	Yes	67	42.9
	No	89	57.1

Among all respondents, 64 (41.0%) were current smokers, 29(18.6%) were ex-smokers, and 63 (40.4%) had never smoked. Among the smokers, 18(11.5%) had smoked for less than 5 years, 32 (20.5%) for 5–10 years, and 43 (27.6%) for more than 10 years. Additionally, 67 (42.9%)of the participants reported expo sure to biomass fuel smoke, whereas 89(57.1%) were not exposed. (Table-II)

Table-III: Duration and treatment history of tuberculosis

Variables	Categories	Frequency (n)	Percentage (%)
Number of TB Episodes	One	123	78.8
	Two or more	33	21.2
Treatment Completion	Completed fully	138	88.5
	Defaulted/interrupted	18	11.5
Duration Since TB Cure (years)	<1 year	34	21.8
	1–3 years	58	37.2
	>3 years	64	41.0

A majority of the participants, 123 (78.8%), had a single episode of tuberculosis, while 33 (21.2%)had two or more episodes. Most of them, 138 (88.5%),had completed the full course of anti-tuberculosis treatment, and only 18 (11.5%) had interrupted or defaulted on therapy. Regarding the duration since TB cure, 34 (21.8%) had been cured for less than one year, 58 (37.2%) between one to three years, and 64 (41.0%) for more than three years. (Table III)

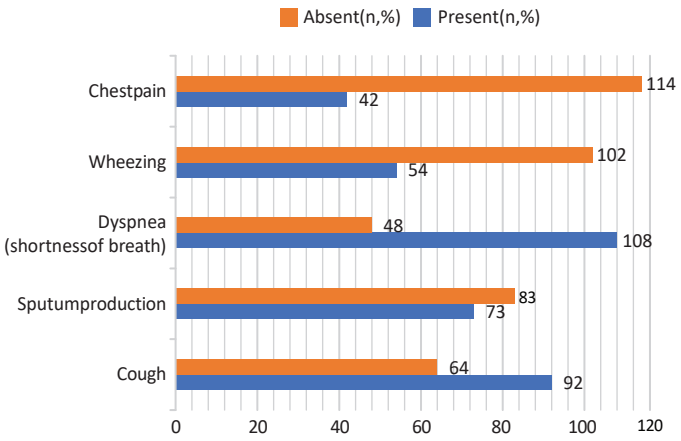

Figure-I: Respiratory Symptoms after TB Treatment

Persistent respiratory symptoms were common among participants. Dyspnea (shortness of breath) was the most frequent symptom, reported by 108(69.2%) patients. Cough was present in 92(59.0%), sputum production in 73(46.8%), wheezing in 54(34.6%), and chest pain in 42 (26.9%) of cases (Fig-I). Although tuberculosis had been microbiologically cured, a large proportion of patients continued to experience significant respiratory discomfort, suggesting irreversible pulmonary changes.

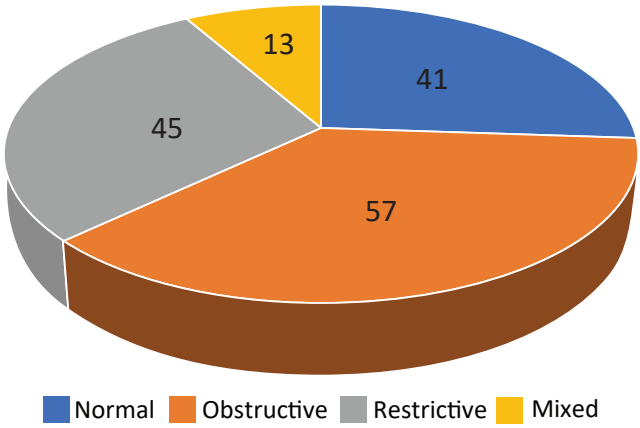

Figure-II: Pulmonary Function Test (PFT) Results

Out of 156 subjects, 41 (26.3%) showed normal spirometry results, while 115 (73.7%) had varying degrees of pulmonary impairment. Among the abnormal patterns, 57 (36.5%) demonstrated an obstructive type, 45(28.8%) had a restrictive pattern, and 13 (8.4%) had a mixed pattern. (Fig-II)

Table-IV: Functional Limitation (Modified Medical Research Council Dyspnea Scale)

Grade	Description	Frequency (n)	Percentage (%)
Grade0	No dyspnea except with strenuous exercise	29	18.6
Grade1	Dyspnea when hurrying on level ground	46	29.5
Grade2	Walks slower due to breathless ness	38	24.4
Grade3	Stops for breath after walking100yards	25	16.0
Grade4	Too breath less to leave the house	18	11.5

Based on the mMRC dyspnea grading, 29(18.6%) patients had no significant dyspnea (Grade 0), 46(29.5%) experienced breath lessens when hurrying or walking uphill (Grade1), and 38(24.4%) walked slower than peers due to breathlessness (Grade 2). Additionally, 25 (16.0%) had to stop after walking 100 yards (Grade3), and 18(11.5%) were to breathless to leave the house (Grade4). Altogether, 43 (27.5%) participants had severe functional limitation (Grades 3–4), reflecting the lasting impact of post-TB pulmonary damage on daily activities. (Table-IV)

Table-V: Quality of Life Assessment (SF-36D omains)

Domain	Good (n, %)	Moderate (n,%)	Poor (n,%)
Physical Functioning	36 (23.1)	71 (45.5)	49 (31.4)
Role Limitation due to Physical Health	48 (30.8)	64 (41.0)	44 (28.2)
Energy/Fatigue	29 (18.6)	77 (49.4)	50 (32.0)
Emotional Wellbeing	57 (36.5)	66 (42.3)	33 (21.2)
Social Functioning	61 (39.1)	68 (43.6)	27 (17.3)

Quality of life analysis showed that physical and energy-related domains were most affected. Only 36 (23.1%) participants had good physical functioning, while 71 (45.5%) reported moderate and 49 (31.4%) reported poor performance. Role limitation due to physical health was good in 48(30.8%), moderate in 64(41.0%), and poor in 44(28.2%). Energy/fatigue levels were rated as good in 29(18.6%), moderate in 77(49.4%), and poor in 50(32.0%). In contrast, emotional well being was better preserved, with 57(36.5%) good and 66(42.3%) moderate scores. Similarly, social functioning was good in 61(39.1%) and moderate in 68(43.6%). (Table-V)

Table-VI: Association between Smoking Status and Pulmonary Impairment

Smoking Status	Impairment Present (n, %)	No Impairment (n,%)	Total
Smoker/Ex-smoker	79 (82.3)	17 (17.7)	96
Non-smoker	33 (55.0)	27 (45.0)	60
Total	**112 (71.8)**	**44 (28.2)**	**156**

Among smokers and ex-smokers (n=96), 79 (82.3%) exhibited pulmonary impairment compared to 33 (55.0%) of non-smokers (n=60). Only 17 (17.7%) smokers showed no impairment, whereas 27 (45.0%) non-smokers maintained normal lung function. Overall, pulmonary impairment was present in 112 (71.8%) of the total participants. (Table -VI)

Discussion

This study provides a comprehensive analysis of the demographic, clinical, and functional characteristics of 156 adult patients with post-tuberculosis pulmonary impairment (PTB-PI). Our findings reveal significant health burden in a predominantly middle-aged, male, working-class population, with a high prevalence of persistent respiratory symptoms, abnormal lung function, and compromised quality of life. The mean age of our cohort was 43.2 years, with the highest proportion of participants (30.1%) in the 41-50 year age group, and a male predominance of 62.8%. This identifies working-age men as the most affected group, which is consistent with the general epidemiology of active TB. A recent systematic review highlighted that men have a higher risk of TB infection and disease, potentially due to greater exposure risks, smoking rates, and health-seeking behavior delays, which could also influence long-term outcomes.[16] The high proportion of participants engaged in physically demanding occupations (e.g.,23.1% day labourers, 16.7% farmers) underscores the socioeconomic vulnerability of this group and suggests that PTB-PI can severely impact an individual's earning capacity. A critical finding was the high prevalence of pulmonary impairment, with 73.7% (115/156) of participants showing abnormal spirometry. This aligns with a growing body of global evidence. A recent meta-analysis found a pooled prevalence of PTB-PI to be 68.5%, with obstructive lung disease being the most common pattern, closely mirroring our finding of 36.5%(57/156) for obstruction.[17] This persistent damage is a direct consequence of the lung destruction caused by the host's inflammatory response to Mycobacterium tuberculosis. Our data revealed that dyspnea was the most frequent persistent symptom, affecting 69.2% (108/156) of patients. Importantly, 27.5% (43/156) of participants experienced severe functional limitation (mMRC Grades 3-4). This high level of disability translates directly into a reduced capacity for work. A recent prospective cohort study demonstrated that patients with PTB-PI had a significantly lower mean six-minute walk distance

(367 meters) compared to healthy controls, objectively quantifying the functional limitation our study captures through dyspnea grading.[18] The quality of life analysis further elucidated the multifaceted impact of PTB-PI. In our cohort, physical and energy domains were most affected, with only 23.1% (36/156) reporting good physical functioning and 32.0% (50/156) reporting poor energy levels. A 2024 study using the SGRQ questionnaire also found the "activity" domain score to be severely impacted (mean score 58.2), reflecting the direct burden of breathlessness and fatigue on patients' lives, consistent with our findings.[19] Our analysis identified a strong association between smoking and pulmonary impairment, with 82.3% (79/96) of smokers/ex-smokers showing abnormal spirometry compared to 55.0% (33/60)of non-smokers. A recent longitudinal study provided compelling evidence that current smoking at TB diagnosis was an independent predictor for obstructive lung disease (Adjusted Odds Ratio 2.1,95%CI1.4-3.0), reinforcing the role of tobacco smoke in amplifying lung damage.[20] A substantial proportion (42.9%, 67/156) of our participants reported exposure to biomass fuel smoke. The synergistic damaging effect of TB and biomass smoke is increasingly recognized. A recent cross-sectional analysis found that such exposure was significantly associated with a higher risk of restrictive lung disease (OR 1.8, 95% CI 1.2- 2.7) in PTB patients, suggesting a shared pathway of airway inflammation and fibrosis.[21] The fact that 21.2% (33/156) of our cohort had experienced multiple TB episodes is another significant finding. A 2024 analysis confirmed that a history of previous TB was a strong predictor for severe COPD post-TB (Hazard Ratio 2.5, 95% CI 1.9-3.3), indicating a cumulative injurious effect on the lung parenchyma with each episode.[22] The high burden of disease observed, despite 88.5% (138/156) of patients completing treatment, underscores a critical limitation of the current TB care paradigm. There is an urgent need fora shift towards holistic, patient-centered care that includes post-TB follow-up. A recent clinical practice guideline strongly recommends structured follow-up for at least 12 months after treatment completion to screen for and manage PTB-PI.[23] The development of PTB-PI is rooted in complex immunopathology. Recent research has shed light on the dysregulated immune responses that lead to fibrosis. A 2024 review highlighted that levels of specific pro-fibrotic mediators like TGF-ß remain elevated in many patients after cure, providing a biological basis for the irreversible changes we see clinically.[24]

Conclusion

In conclusion, our study, with its detailed numerical findings, adds to the compelling evidence that PTB-PI is a highly prevalent and debilitating condition. It disproportionately affects economically productive individuals, leading to significant functional limitation and reduced quality of life. Key modifiable risk factors like smoking and biomass exposure, along with clinical factors like TB recurrence, highlight potential intervention points. Moving forward, national TB programs must integrate post-TB care services to address this neglected consequence of the TB epidemic.

Limitations of the Study

This study was conducted in a single tertiary care hospital with a relatively small sample size, which may limit the generalizability of the findings to the broader population. The cross-sectional design prevents assessment of long-term changes in pulmonary function over time.

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