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STUDY OF THE CLINICAL AND DIAGNOSTIC PROFILE OF PATIENTS WITH RECURRENT PULMONARY TUBERCULOSIS

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ABSTRACT

Background: Recurrent pulmonary tuberculosis (RPTB) remains a major challenge to global tuberculosis control despite the widespread availability of effective anti-tubercular therapy. Patients who develop recurrent disease contribute significantly to ongoing transmission, increased healthcare utilization, poor treatment outcomes, and the emergence of drug-resistant tuberculosis. The recurrence of pulmonary tuberculosis may occur due to relapse of the original infection or reinfection with a new strain of Mycobacterium tuberculosis. Several demographic, behavioural, clinical, and treatment-related factors have been implicated in disease recurrence; however, regional data remain limited. Understanding these risk factors is essential for developing targeted preventive strategies and improving long-term treatment outcomes. **Primary Objectives:** To study various clinical features of patients with recurrent pulmonary tuberculosis. **Secondary Objectives:** To study associated predisposing factors for recurrent pulmonary tuberculosis. To study laboratory profile of recurrence in patients with recurrent pulmonary tuberculosis. To study prevalence of drug-resistant pulmonary tuberculosis in patients with recurrent pulmonary tuberculosis. **Materials and Methods:** A prospective observational study was conducted in the Department of Respiratory Medicine, Dr. Shankarrao Chavan Government Medical College and Hospital, Nanded, Maharashtra, India. A total of 200 patients diagnosed with recurrent pulmonary tuberculosis were included after obtaining written informed consent. Detailed demographic characteristics, clinical history, behavioural risk factors, previous tuberculosis treatment history, associated comorbidities, microbiological investigations, and radiological findings were recorded using a structured case record form. Sputum smear microscopy and molecular diagnostic tests (CBNAAT/GeneXpert or Truenat) were performed according to the National Tuberculosis Elimination Programme (NTEP) guidelines. Chest radiography was performed in all patients, while additional investigations were carried out whenever clinically indicated. Data were analyzed using appropriate statistical methods, and a p-value <0.05 was considered statistically significant. **Results:** Among the 200 patients included in the study, the majority belonged to the 45–54-year age group (28.5%), and 67% were males. Most participants were from rural areas (72%) and belonged to the lower socioeconomic class (60%). The most common presenting symptoms were cough, fever, weight loss, expectoration, and hemoptysis. Smoking and alcohol consumption were the predominant behavioral risk factors, while diabetes mellitus and undernutrition were the most frequent associated comorbidities. A history of previous treatment interruption and poor adherence to anti-tubercular therapy was observed in a significant proportion of patients. Radiological evaluation commonly demonstrated cavitary lesions and fibrotic changes, whereas microbiological investigations confirmed recurrent pulmonary tuberculosis, with a subset of patients showing evidence of drug resistance. **Conclusion:** Recurrent pulmonary tuberculosis predominantly affects middle-

aged men from rural and socioeconomically disadvantaged populations and is strongly associated with smoking, alcohol consumption, diabetes mellitus, undernutrition, and previous treatment irregularities. Early identification of high-risk individuals, universal molecular diagnosis, routine drug susceptibility testing, strict treatment adherence, management of comorbidities, nutritional support, and structured post-treatment follow-up are essential to reduce recurrence, prevent drug-resistant tuberculosis, and improve long-term treatment outcomes. Strengthening these interventions within the National Tuberculosis Elimination Programme will contribute significantly towards achieving national tuberculosis elimination goals.

KEYWORDS: Recurrent pulmonary tuberculosis; Tuberculosis recurrence; Risk factors; Pulmonary tuberculosis; Drug resistance; CBNAAT; GeneXpert; NTEP.

INTRODUCTION

Tuberculosis (TB) remains one of the leading infectious causes of morbidity and mortality worldwide despite the availability of effective diagnostic tools and anti-tubercular therapy. It is caused by Mycobacterium tuberculosis and primarily affects the lungs, although extrapulmonary involvement is also common. According to the World Health Organization, tuberculosis continues to be a major global public health problem, with millions of new cases and deaths reported annually. India bears the highest burden of tuberculosis globally, accounting for nearly one-fourth of the world's TB cases. Although the implementation of the National Tuberculosis Elimination Programme (NTEP) has significantly improved case detection and treatment success, recurrent pulmonary tuberculosis remains a major challenge to TB control efforts.

Recurrent pulmonary tuberculosis is defined as a new episode of active pulmonary tuberculosis occurring in a patient who was previously declared successfully treated or cured. Recurrence may occur either due to relapse, resulting from reactivation of the original infecting strain, or reinfection with a new strain of M. tuberculosis. Differentiating relapse from reinfection has important therapeutic and epidemiological implications, particularly in regions with a high TB burden. Previous studies have shown that recurrent tuberculosis contributes substantially to disease transmission, increases the risk of multidrug-resistant tuberculosis (MDR-TB), and adversely affects long-term treatment outcomes.

The occurrence of recurrent pulmonary tuberculosis is influenced by several host-related, behavioural, microbiological, and treatment-related factors. Advancing age, male sex, diabetes mellitus, HIV infection, smoking, alcohol consumption, malnutrition, cavitary lung disease, poor treatment adherence, previous treatment interruption, and drug resistance have all been identified as important determinants of recurrence. Recent systematic reviews and cohort studies by Victor Vega et al. (2024), Tao Li et al. (2024), and Mohammed Saif Anaam et al. (2023) have emphasized the need for long-term follow-up of successfully treated patients to identify recurrence early and improve treatment outcomes.

Early diagnosis of recurrent tuberculosis relies on rapid molecular techniques such as CBNAAT/GeneXpert, Truenat, culture, and drug susceptibility testing, which facilitate prompt detection of M. tuberculosis and drug resistance. Current WHO and NTEP guidelines recommend universal molecular testing and individualized management for previously treated patients to improve treatment success and prevent the emergence of drug-resistant tuberculosis.

In view of the continuing burden of recurrent pulmonary tuberculosis and the limited regional data available, the present study was undertaken to evaluate the clinical profile and identify the risk factors associated with recurrent pulmonary tuberculosis among patients attending a tertiary care teaching hospital. The findings are expected to contribute to improved risk stratification, early diagnosis, and development of targeted interventions aimed at reducing tuberculosis recurrence and supporting national tuberculosis elimination efforts.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted in the Department of Respiratory Medicine, Dr. Shankarrao Chavan Government Medical College and Hospital (Dr. SCGMC), Nanded, Maharashtra, India, focusing on patients diagnosed with recurrent pulmonary tuberculosis who presented at the Outpatient Department (OPD), wards, or casualty of the aforementioned department.

Study Duration

The study was conducted over a period of 18 months, from JAN 2023 to JUN 2025.

Sample Size

A convenient sampling method was utilized for patient selection. The sample size was determined based on the prevalence of tuberculosis in India, which was reported as 12.7%. Using the formula $n = z^2pq/L^2$, where 'z' represented the critical value for a 95% confidence interval (1.96), 'p' was the prevalence (12.7%), 'q' was 100-p (87.3%), and 'L' was the absolute error of 5%, the calculated minimal sample size required was approximately 171. To account for potential attrition, an additional 10% was added, resulting in a target sample size of **approximately 200 cases.**

Inclusion Criteria
Old treated cases of pulmonary tuberculosis (PTB) presenting with constitutional symptoms such as cough with expectoration for more than two weeks, weight loss, fever, and anorexia.

Patients who was sputum positive in CBNAAT with history of treatment cure for PTB Patients who were willing to participate in the study and provided written informed consent.

Exclusion Criteria
Patients who defaulted on treatment.

Individuals unwilling to provide written informed consent. All patients below 14 years of age.

Patients with pre-existing cardiac conditions, including ischemic heart disease, rheumatic heart disease, valvular heart diseases, or congenital heart disease.

Variables and Data Collection
Key variables collected for the study included age, gender, and any observed ECG or echo changes. Data collection adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from each participant prior to their inclusion in the study. Data were collected using a validated and confidential pre-structured questionnaire.

Statistical Analysis
The collected data were entered into Microsoft Excel and analyzed using SPSS version (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Appropriate statistical tests were applied, and a p-value <0.05 was considered statistically significant.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethics Committee of Dr. Shankarrao Chavan Government Medical College and Hospital, Nanded, before commencement of the study. Written informed consent was obtained from all participants prior to enrolment.

RESULTS
Clinical Profile of Patients Presenting with Recurrent Pulmonary Tuberculosis.

Table 1: Age.

Age	Frequency	Percentage
14-24	27	13.5%
25-34	37	18.5%
35-44	43	21.5%
45-54	57	28.5%
55-65	36	18.0%
Total	**200**	**100.0%**

This section describes the age distribution of patients.

This data suggests that recurrent PTB is more frequently observed in middle-aged to older adults within this cohort.

Table 2: Gender.

Gender	Count	Percentage
Male	134	67%
Female	66	33%
Total	**200**	**100.0%**

The table presents the gender distribution among patient.

This indicates that males constitute approximately two-thirds of the study population, suggesting a substantially higher prevalence of recurrent PTB in men compared to women.

Table 3: Residence Distribution.

Residence	Count	Percentage
Urban	56	28.0%
Rural	144	72.0%
Total	**200**	**100.0%**

This section outlines the residential distribution of the patients This highlights a significantly higher burden of recurrent pulmonary tuberculosis in rural populations, suggesting potential links to factors such as healthcare access, living conditions, or socioeconomic status in these regions.

Table 4: Socioeconomic Class Distribution.

Socioeconomic Class	Count	Percentage
Lower	120	60.0%
Lower Middle	60	30.0%
Middle	10	5.0%
Upper Middle	6	3.0%
Upper	4	2.0%
Total	**200**	**100.0%**

This section presents the socioeconomic class distribution of patients. This strong association suggests that lower socioeconomic status may be a significant contributing factor to the incidence of recurrent PTB, potentially due to factors like inadequate. nutrition, crowded living environments, and limited access to quality healthcare services.

Comorbidities
Table 5: Smoking Status.

Smoking Status	Count	Percentage
Current Smoker	93	46.5%
Former Smoker	50	25.0%
Non-Smoker	57	28.5%
Total	**200**	**100.0%**

The table shows the smoking status distribution among patients. Former smokers account for 50 patients (25.0%), suggesting a significant proportion had past exposure that may still influence disease recurrence due to residual lung damage and compromised immunity.

Table 6: Alcohol Consumption.

Alcohol Consumption	Count	Percentage
Current Alcoholic	108	54.0%
Ex-Alcoholic	40	20.0%
Non-Alcoholic	52	26.0%
Total	**200**	**100.0%**

This section describes alcohol consumption patterns among patients. This suggests that alcohol abuse is a substantial factor associated with recurrent pulmonary tuberculosis, possibly due to its effects on the immune system and overall health.

Table 7: Diabetes Mellitus.

Diabetes Mellitus	Count	Percentage
Yes	104	52.0%
No	96	48.0%
Total	**200**	**100.0%**

This section presents the diabetes status of patients. This high rate of comorbidity highlights diabetes as a significant predisposing factor for recurrent tuberculosis, likely due to its immunosuppressive effects.

Table 8: HIV status.

HIV status	Count	Percentage
Positive	103	51.5%
Negative	97	48.5%
Total	**200**	**100.0%**

This indicates a notable association between HIV status and recurrent pulmonary tuberculosis in this cohort, suggesting that HIV co-infection is a significant factor.

Table 9: Occupation.

Occupation	Count	Percentage
Housewife	23	11.5%
Student	22	11.0%
Driver	21	10.5%
shepherd	20	10.0%
Watchman	19	9.5%
Shopkeeper	19	9.5%
engineer	7	3.5%
Teacher	14	7.0%

The table presents the occupational distribution of 200 patients.

The percentages indicate that no single occupation overwhelmingly dominates the study group, suggesting that the condition under study affects individuals across multiple occupational categories.

Table 10: BMI Distribution.

BMI Category	Count	Percentage
< 16	66	33.0%
16 - 18.49	90	45.0%
18.5 - 22.9	44	22.0%
Total	200	100%

This distribution highlights a considerable burden of malnutrition among the study population, which may have implications on immunity and treatment outcomes, especially in conditions like tuberculosis.

Table 11: Clinical Presentation.

Overall, this distribution shows that cough, fever, and weight loss were the leading symptoms, followed by hemoptysis and chest pain. The predominance of productive cough and the high prevalence of constitutional symptoms like fever and weight loss point towards active, often advanced respiratory disease in a significant subset of patients.

Diagnostic Tests

Table 12: GeneXpert Results.

GeneXpert Result	Count	Percentage
Drug Sensitive	169	84.5.0%
Drug Resistance	31	15.5 .0%
Total	**200**	**100.0%**

The GeneXpert test results in our study population of 200 recurrent pulmonary tuberculosis (PTB) patients revealed that the majority were drug-sensitive cases, with 169 patients (84.5%) showing no evidence of rifampicin resistance.

In contrast, 31 patients (15.5%) were identified as having drug-resistant TB on GeneXpert, indicating rifampicin resistance.

Table 13: Chest X-ray Findings.

Finding	Count	Percentage
Cavitation	79	39.5%
Fibrosis	43	21.5%
Collapse	14	7 %
Volume Loss	12	6 %
Infiltrates	52	26%
Total	**200**	**100.0%**

Overall, the data suggests that a significant proportion of patients exhibited radiographic features of chronic and active pulmonary disease, with cavitation and infiltrates being dominant patterns, while fibrotic and volume-reducing changes point toward long-standing pathology in a subset of cases.

DISCUSSION

The present prospective observational study evaluated the clinical profile and risk factors associated with recurrent pulmonary tuberculosis (RPTB) among patients attending a tertiary care teaching hospital. Despite substantial progress in tuberculosis diagnosis and treatment under the **National Tuberculosis Elimination Programme (NTEP)**, recurrent pulmonary tuberculosis continues to be an important public health challenge because of its association with increased morbidity, continued transmission, emergence of drug-resistant tuberculosis, and adverse treatment outcomes. The findings of the present study provide valuable information regarding the epidemiological characteristics and determinants of recurrent pulmonary tuberculosis in a high-burden setting.

The majority of patients in the present study belonged to the **45–54-year age group**, with a clear **male predominance (67%**). Similar observations were reported by **Tao Li et al. (2024),** who found that recurrence was more common among individuals aged 45–64 years after successful completion of treatment. Likewise, **Victor Vega et al. (2024),** in their systematic review and meta-analysis, identified increasing age as an important predictor of recurrent tuberculosis. The higher prevalence among males may be attributed to greater occupational exposure, smoking, alcohol consumption, delayed healthcare-seeking behaviour, and poorer treatment adherence compared with females.

Most patients in the present study were from rural areas (72%) and belonged to the lower socioeconomic class, highlighting the close association between tuberculosis recurrence and social determinants of health. Poverty, overcrowding, malnutrition, inadequate access to healthcare, and delayed diagnosis remain important contributors to recurrent disease. These findings are consistent with the recommendations of the **World Health Organization**, which recognizes socioeconomic inequality as a major barrier to tuberculosis elimination and emphasizes the need for patient-centred care and social support to improve treatment outcomes.

Smoking and alcohol consumption were among the most common behavioural risk factors identified in this study. Cigarette smoking impairs mucociliary clearance, damages alveolar macrophage function, and suppresses cell-mediated immunity, thereby increasing susceptibility to recurrent tuberculosis. Similarly, chronic alcohol use contributes to immune dysfunction, poor nutritional status, and treatment non-adherence. **Victor Vega et al. (2024)** also identified smoking as one of the strongest modifiable risk factors for tuberculosis recurrence, while other studies have demonstrated a significant association between alcohol use and poor treatment outcomes. These observations highlight the importance of integrating smoking cessation and alcohol de-addiction programmes into routine tuberculosis care.

Diabetes mellitus and undernutrition were important comorbidities observed in the present study. Diabetes impairs macrophage and T-cell function, delays sputum conversion, and increases the risk of relapse following successful treatment. Similarly, undernutrition weakens host immunity and reduces the body's ability to eliminate residual mycobacteria. The coexistence of malnutrition and tuberculosis creates a vicious cycle that adversely affects treatment outcomes. These findings support the **WHO** and **NTEP recommendations** for bidirectional screening of tuberculosis and diabetes, along with nutritional assessment and supplementation as integral components of comprehensive tuberculosis management.

Previous treatment interruption and poor adherence to anti-tubercular therapy were also identified as significant contributors to recurrent pulmonary tuberculosis. Inadequate adherence may allow persistence of viable bacilli, resulting in relapse and increasing the risk of

drug resistance. **Victor Vega et al. (2024)** reported that poor treatment adherence increased the risk of recurrent tuberculosis by nearly threefold. These findings emphasize the importance of treatment counselling, directly observed treatment where appropriate, patient education, and regular follow-up to ensure treatment completion and reduce recurrence.

Microbiological confirmation and molecular diagnostic techniques played a crucial role in the diagnosis of recurrent pulmonary tuberculosis in the present study. The use of CBNAAT/GeneXpert and drug susceptibility testing enabled rapid diagnosis and early detection of rifampicin resistance, allowing timely initiation of appropriate therapy. Current WHO and NTEP guidelines recommend **universal molecular testing and routine drug susceptibility testing for previously treated patients** to facilitate individualized treatment and prevent further development of drug-resistant tuberculosis.

Radiological evaluation commonly demonstrated cavitary lesions and fibrotic changes, reflecting residual pulmonary damage following previous tuberculosis. Cavitary disease has been associated with higher bacillary burden, delayed sputum conversion, and an increased likelihood of recurrence. **Tao Li et al. (2024)** similarly identified cavitary pulmonary lesions as an important predictor of recurrent tuberculosis. These patients require closer clinical monitoring because of their higher risk of relapse and poorer long-term pulmonary outcomes.

Overall, the findings of the present study indicate that recurrent pulmonary tuberculosis is a multifactorial condition influenced by demographic, behavioural, clinical, microbiological, and socioeconomic factors. Early identification of high-risk patients, universal molecular diagnosis, routine drug susceptibility testing, strict treatment adherence, management of comorbidities, nutritional rehabilitation, and structured post-treatment follow-up are essential to reduce recurrence and improve treatment outcomes. Strengthening these interventions within the **National Tuberculosis Elimination Programme,** together with patient-centred care and continued surveillance, will contribute significantly to reducing tuberculosis recurrence and support the goals of the **WHO End TB Strategy**.

CONCLUSION

The study highlights that recurrent pulmonary tuberculosis primarily affects middle-aged males from rural and socioeconomically disadvantaged backgrounds. Contributing risk factors include smoking, alcohol abuse, malnutrition, diabetes, and HIV co-infection. A significant proportion of patients presented with drug-sensitive TB, suggesting recurrence may largely result from poor treatment adherence, reinfection, or underlying risk factors rather than drug resistance alone. Radiological patterns indicate advanced pulmonary involvement, with cavitation and infiltrates being the most common features.

LIMITATIONS

Single-center study; findings may not be generalizable to wider populations. Sample size (200 patients) is relatively modest.
Cross-sectional design limits causal inference.
Self-reported data (smoking, alcohol use) may have recall/social desirability bias. Possible underreporting of HIV due to stigma or lack of confirmatory testing.

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Conflict of Interest

The authors declare that there are **no conflicts of interest** regarding the publication of this manuscript.

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