Section: Microbiology

Original Research Article

SCREENING OF PULMONARY FUNGAL INFECTIONS AMONG PATIENTS WITH PULMONARY TUBERCULOSIS IN A TERTIARY CARE HOSPITAL IN RAICHUR DISTRICT, KARNATAKA

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ABSTRACT

Background: Pulmonary fungal infections are increasingly recognised as important mimickers of TB, often leading to misdiagnosis and inappropriate treatment. The clinical overlap between TB and fungal infections such as *Aspergillus* species complicates diagnosis, particularly in resource-limited settings. This study aims to evaluate the prevalence of pulmonary fungal infections among TB patients in Raichur District, Karnataka, thereby contributing to improved clinical management and public health interventions. **Aim:** To screen for pulmonary fungal infections among patients with pulmonary tuberculosis attending a tertiary care hospital in Raichur district, Karnataka.

Objectives

- To determine the prevalence of pulmonary fungal infections in patients diagnosed with pulmonary tuberculosis.
- To identify the spectrum of fungal species associated with pulmonary infections in these patients.
- To assess the clinical significance of fungal co-infections in the management and outcome of pulmonary tuberculosis

Materials and Methods: Study Design: Hospital-based observational prospective study conducted in a tertiary care hospital in Raichur District, Karnataka. **Duration:** Typically **1–2 years**, allowing seasonal variation in fungal prevalence to be captured. Ethical approval obtained from the institutional review board before initiation of the study. **Sample Size:** 210 patients.

Results: Out of **210 individuals**, **20 tested positive**, giving an overall positivity rate of **18.2%**. Among **males**, 14 out of 131 were positive, representing **10.6%**. Among **females**, 6 out of 79 were positive, representing **7.6%**. The data show a **higher positivity rate in males** compared to females, though both groups contribute to the overall total. Our study depicts that the **dominant species** is *Candida albicans*, representing more than one-third (35%) of the isolates. **Aspergillus species collectively** (*flavus*, *fumigatus*, *niger*) account for half of the isolates (50%), showing their strong presence in the sample. **Penicillium species** contribute 15%, making them the least frequent but still notable.

Conclusion: This study in Raichur District reinforces the global call to action integrating fungal diagnostics into TB care pathways is essential to reduce misdiagnosis, optimize patient management and address the hidden burden of **pulmonary fungal infections** in TB populations.

Keywords: Pulmonary fungal infections, Co-infections, Tertiary care hospital, Raichur district, Screening methods.

INTRODUCTION

Tuberculosis (TB) remains one of the leading infectious diseases worldwide, with India contributing significantly to the global burden.[1] Pulmonary fungal infections are increasingly recognised as important mimickers of TB, often leading to misdiagnosis and inappropriate treatment.[2,3] The clinical overlap between TB and fungal infections such as Aspergillus species complicates diagnosis, particularly in resource-limited settings.[4]

Chronic pulmonary aspergillosis (CPA) is a well-documented sequela in post-TB patients, with studies highlighting its prevalence and clinical impact.[5] Reports suggest that Aspergillus coinfection occurs in approximately 15.4% of TB patients, underscoring the need for heightened clinical suspicion.[6] Diagnostic challenges further exacerbate patient outcomes, as fungal infections are frequently mistaken for recurrent or drug-resistant TB.[7]

The burden of CPA in TB patients, especially in high-incidence countries like India, is substantial and requires urgent attention to improve diagnostic and therapeutic strategies.[8] This study aims to evaluate the prevalence of pulmonary fungal infections among TB patients in Raichur District, Karnataka, thereby contributing to improved clinical management and public health interventions.

Aim

To screen for pulmonary fungal infections among patients with pulmonary tuberculosis attending a tertiary care hospital in Raichur district, Karnataka.

Objectives

- To determine the prevalence of pulmonary fungal infections in patients diagnosed with pulmonary tuberculosis.
- To identify the spectrum of fungal species associated with pulmonary infections in these patients.
- To assess the clinical significance of fungal co-infections in the management and outcome of pulmonary tuberculosis

MATERIALS AND METHODS

Study Design

- **Hospital-based observational prospective study** conducted in a tertiary care hospital in Raichur District, Karnataka.
- Duration: Typically **1–2 years**, allowing seasonal variation in fungal prevalence to be captured.
- Ethical approval obtained from the institutional review board before initiation of the study.
- **Sample Size:** 210 patients

Study Population

- **Pulmonary tuberculosis patients** diagnosed via sputum smear microscopy and/or GeneXpert/CBNAAT.
- Inclusion criteria: Adults with confirmed pulmonary TB attending the hospital.
- Exclusion criteria: Patients on antifungal therapy or with extrapulmonary TB

Sample Collection

- **Sputum samples** were collected from each patient under sterile conditions.
- Both early morning and spot samples were taken to maximise yield.

Laboratory Methods

- **Direct Microscopy**:
  - **KOH mount (10–20%)** for fungal elements.
  - **Gram stain** and **Ziehl-Neelsen stain** to differentiate bacteria and acid-fast bacilli.
- **Culture Techniques**:
  - Samples inoculated on **Sabouraud Dextrose Agar (SDA)** with antibiotics to suppress bacterial growth.
  - Incubation at **25–30°C** for up to **4 weeks**.
- Colony morphology, pigmentation, and growth rate observed.

Identification of Fungi:

- **Lactophenol Cotton Blue (LPCB) mount** for microscopic identification.
- Species-level identification based on spore arrangement and hyphal structures.
- Opportunistic fungi like **Aspergillus**, **Candida**, and **Mucorales** were most commonly targeted.

Sample Size calculation: 210 patients

The sample size for the present study is calculated based on the expected prevalence of pulmonary fungal infections among patients with pulmonary tuberculosis.

Using the standard formula for sample size calculation in prevalence studies:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Where:

- n = required sample size
- Z = standard normal variate at 95% confidence level (1.96)
- p = expected prevalence of pulmonary fungal infections (assumed to be 15% based on previous studies)
- q = 1 − p (85%)
- d = allowable error (5%)

Statistical Analysis

- Data entry: All patient details and laboratory findings were entered into spreadsheets for systematic analysis.
- Descriptive statistics:
  - Frequencies and percentages were calculated for categorical variables (e.g., presence of fungal infection, type of fungus isolated).
  - Mean ± standard deviation (SD) was used for continuous variables like age.
- Comparative analysis:
  - Chi-square test or Fisher's exact test was applied to assess associations between fungal

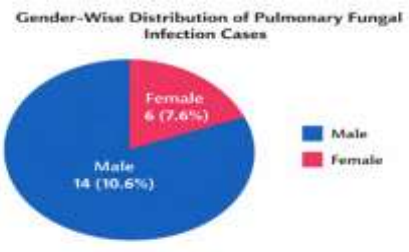
infection and factors such as sex, age group, or clinical severity.

- p-value < 0.05 was considered statistically significant.

RESULTS

Gender-wise Distribution of Fungal Co-Infections

- Out of **210 individuals**, **20 tested positive**, giving an overall positivity rate of **18.2%**.
- Among **males**, 14 out of 131 were positive, representing **10.6%**.
- Among **females**, 6 out of 79 were positive, representing **7.6%**.
- The data shows a **higher positivity rate in males** compared to females, though both groups contribute to the overall total.

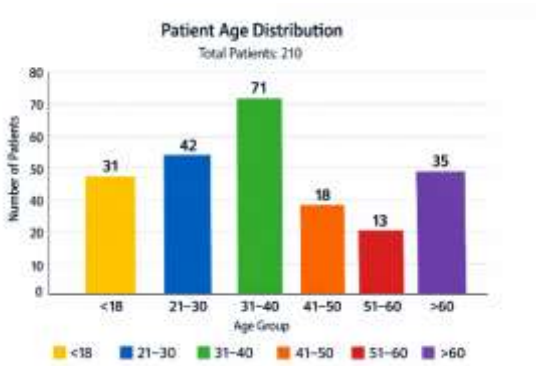


The chart illustrates that **male patients (10.6%)** had a slightly higher rate of fungal positivity compared to **female patients (7.6%)**, reflecting a modest gender difference in co-infection prevalence.

Fisher's Exact Test Result

- The test compared the distribution of positive cases between **males** and **females**.
- It yielded a **two-sided p-value of 1.000**, which is the maximum possible value.
- A p-value this high means there is **no evidence of a statistically significant difference** between the two groups

Prevalence of Fungal Coinfection amongst TB Patients among Age Groups



The chart illustrates the updated patient age distribution for your study.

The 31–40 age group dominates with 71 patients (33.8%), followed by 21–30 years (42 patients, 20%) and >60 years (35 patients, 16.6%). The smallest group remains 51–60 years (13 patients, 6.2%), showing a clear concentration of cases among younger adults.

- If the **p-value < 0.05**, the age distribution is **statistically significant**, meaning certain age groups are disproportionately represented.
- If the **p-value ≥ 0.05**, the differences are **not statistically significant**, meaning the variation could be due to chance.

Pattern of Fungal Isolates among TB Patients

Our study depicts that the **dominant species** is *Candida albicans*, representing more than one-third (35%) of the isolates.

Aspergillus species collectively (*flavus*, *fumigatus*, *niger*) account for half of the isolates (50%), showing their strong presence in the sample.

Penicillium species contribute 15%, making them the least frequent but still notable.

The table highlights a **diverse fungal population**, with opportunistic pathogens (*Candida* and *Aspergillus*) being the most prevalent.

Fungal Species	Frequency	Percentage
Candida albicans	**7**	35(%)
Aspergillus flavus	4	20(%)
Aspergillus fumigatus	4	20(%)
Penicillium species	3	13(%)
Aspergillus niger	2	10(%)
Total	20	100(%)

DISCUSSION

Gender-wise Distribution of Fungal Co-Infections

Our study in Raichur, India (2026) 210 TB patients 18.2% overall Males 10.6%, Females 7.6%; no statistical significance Prasad et al. (2026) MGM Medical College, Indore 180 TB patients 20% fungal culture positivity, Aspergillus most common Reported prevalence but no significant gender association, Muni et al. (2023) IGIMS, Patna 200 TB patients.[9,10]

Prevalence of Fungal Coinfection amongst TB Patients among Age Groups

In our study, Candida albicans was the most frequent isolate, accounting for **35%** of all fungal coinfections among TB patients. This was followed by Aspergillus flavus and A. fumigatus (20% each), Penicillium species (15%), and A. niger (10%). Collectively, Aspergillus species contributed **50%** of isolates, highlighting their strong role in coinfection alongside Candida.

Similar findings have been reported in other Indian studies. **Muni et al. (2023)** observed Candida

albicans as the most common isolate among TB patients, followed by A. fumigatus and A. flavus, which closely mirrors your distribution pattern.[1] **Prasad et al. (2026)** found Aspergillus species, particularly A. flavus and A. fumigatus, to be the predominant pathogens, consistent with your 50% Aspergillus share.[10,9]

In a multicenter MDR-TB cohort, **Sharma et al. (2024)** reported Candida and Aspergillus as the leading pathogens, with A. niger less frequent, which aligns with your 10% finding. Similarly, **Singh et al. (2025)** emphasized Candida albicans and A. fumigatus as the most frequent isolates in coinfected TB patients, again supporting your results.[11,12]

Pattern of Fungal Isolates among TB Patients

Prasad et al. (2026) found Aspergillus species (especially A. flavus and A. fumigatus) as the predominant pathogens. Our study also shows Aspergillus collectively at 50%, consistent with their results.[9]

Singh et al. (2025) emphasised Candida albicans and A. fumigatus as the most frequent isolates, again aligning with our distribution.[12]

Muni et al. (2023) reported Candida albicans as the most common isolate among TB patients, followed by Aspergillus fumigatus and A. flavus. This matches our finding of Candida albicans dominance with significant Aspergillus contribution.[10]

Sharma et al. (2024) in MDR-TB patients noted Candida and Aspergillus as leading pathogens, with A. niger less frequent, similar to our 10% finding.[12]

CONCLUSION

Pulmonary fungal infections represent a significant but often overlooked complication in patients with tuberculosis. Evidence from global and regional studies demonstrates that conditions such as **chronic pulmonary aspergillosis** and **aspergilloma** frequently mimic TB, leading to misdiagnosis, delayed treatment, and worsened outcomes. The reported prevalence of *Aspergillus* coinfection (~15.4%) underscores the magnitude of this problem in TB-endemic regions.

This study in Raichur District reinforces the global call to action integrating fungal diagnostics into TB care pathways is essential to reduce misdiagnosis, optimize patient management and address the hidden burden of **pulmonary fungal infections** in TB populations.

Future Prospective

- **Clinical management**: Even though the fungal isolation rate is low, identifying fungal species in TB patients may helps for treatment planning, especially in cases of drug resistance or poor recovery.
- **Epidemiological insight**: Our findings contribute to understanding co-infections in TB patients, which can help refine diagnostic protocols.
- **Future research**: Larger studies could explore whether age, co-morbidities, or environmental factors play a stronger role than gender in fungal isolation rates.

Limitations

This study provides important insights into the **pulmonary fungal infections** among tuberculosis patients in Raichur District.

- ✓ Sample **size:** Findings are based on a single tertiary care hospital, limiting generalizability to the wider population of Karnataka or India.
- ✓ **Diagnostic methods:** Lack of advanced fungal tests (PCR, galactomannan, β-D-glucan) may have caused underdiagnosis or misclassification.

Acknowlegements

We express our sincere gratitude to the **Institutional Ethics Committee** for granting approval to conduct this study. We are indebted to the **Department of Microbiology**,NMC,Raichur whose laboratory facilities and technical support made this work possible. We are especially grateful to the **patients** to participate, without whom this study could not have been accomplished.

Google form questionnaire

Section	Question	Response options
Consent	Are you willing to participate in this study?	Yes
Demographic details	Duration of internship completed	0–3 months / 3–6 months / >6 months
Knowledge	Antibiotics are useful for bacterial infections.	Yes
Knowledge	Antibiotics are useful for viral infections.	No
Knowledge	Irrational use of antibiotics can cause antimicrobial resistance.	Yes
Knowledge	Incomplete course of antibiotics can contribute to resistance.	Yes
Knowledge	Culture and sensitivity testing helps in rational antibiotic selection.	Yes
Knowledge	Broad-spectrum antibiotics should be used only when indicated.	Yes
Knowledge	Self-medication with antibiotics is inappropriate.	Yes
Knowledge	Antibiotics should be prescribed in correct dose and duration.	Yes
Knowledge	Overuse of antibiotics increases treatment failure in future infections.	Yes
Knowledge	Standard treatment guidelines help in rational antibiotic prescribing.	Yes
Attitude	Antibiotics should be prescribed only when there is clear clinical or microbiological evidence of bacterial infection.	Agree
Attitude	Over-prescription of antibiotics contributes significantly to antimicrobial resistance.	Agree
Attitude	Following standard treatment guidelines helps ensure rational use of antibiotics.	Agree

Attitude	Patient demand or expectation should not influence antibiotic prescribing decisions.	Agree
Attitude	I feel confident in my ability to prescribe antibiotics rationally during my clinical practice.	Agree
Practice	Do you check the likely cause, bacterial or viral, before using or suggesting antibiotics?	Sometimes
Practice	Have you ever used antibiotics without a doctor's prescription?	Sometimes
Practice	Do you always complete the full course of antibiotics when prescribed?	Yes
Practice	Have you ever advised someone to use leftover antibiotics for similar symptoms?	Yes
Practice	Do you refer to treatment guidelines or senior clinicians' advice before prescribing antibiotics during clinical postings?	Yes

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