Section: Miscellaneous

Original Research Article

EVALUATING DIAGNOSTIC AND TREATMENT DELAYS IN PULMONARY TUBERCULOSIS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Pulmonary tuberculosis (PTB) remains a major public health problem, and delays in diagnosis and treatment contribute to ongoing transmission, advanced disease, and poor outcomes. This study aimed to evaluate the magnitude, determinants, and programmatic implications of diagnostic and treatment delays among newly diagnosed pulmonary tuberculosis patients. Delays in TB care are especially relevant in high-burden settings where patients often first seek care from informal providers, pharmacies, or multiple healthcare contacts before receiving definitive treatment.

Materials and Methods: This manuscript is a hospital-based cross-sectional analytical study among newly diagnosed PTB patients. A structured interview schedule was used to document symptom onset, first healthcare contact, date of diagnosis, and date of treatment initiation. Delay was categorized as patient delay, diagnostic delay, treatment delay, and total delay according to standard TB care cascade definitions used in the literature and WHO-aligned frameworks. Descriptive statistics, chi-square testing, and multivariable logistic regression were used to identify factors associated with prolonged delays.

Results: The study demonstrated substantial delays across the TB care pathway, with patient delay contributing the largest proportion of total delay, followed by diagnostic delay and then treatment delay, consistent with prior Indian and global evidence. Female sex, lower educational status, initial pharmacy or informal treatment, consultation with multiple providers, and private-sector diagnosis were associated with longer delays. Most patients experienced at least one avoidable barrier in the pathway to care, indicating that both community-level and system-level interventions are needed.

Conclusion: Diagnostic and treatment delays in pulmonary tuberculosis remain common and multifactorial. The findings support strengthening early symptom recognition, referral pathways, frontline provider training, and rapid diagnostic access to reduce infectiousness and improve outcomes. Programmatic TB control should prioritize both patient-oriented awareness and health-system responsiveness to shorten the time from symptom onset to treatment initiation.

Keywords: Pulmonary tuberculosis; diagnostic delay; treatment delay; patient delay; health system delay.

INTRODUCTION

Pulmonary tuberculosis continues to be one of the most important infectious diseases in low- and middle-income countries, despite long-standing control efforts. The major challenge is not only the occurrence of disease but the time taken for affected individuals to be diagnosed and started on treatment.

Delayed recognition and treatment allow prolonged transmission within households and communities, and they also increase the risk of advanced lung involvement, complications, and worse treatment outcomes.[1]

Delay in TB care is typically divided into patient delay, diagnostic delay, and treatment delay. Patient delay refers to the interval between onset of symptoms and first contact with a healthcare provider. Diagnostic delay is the time between first contact and confirmed diagnosis, while treatment delay is the interval between diagnosis and initiation of anti-tuberculosis therapy. These definitions are widely used in TB research because they help identify whether the major barrier lies with patient behavior, provider suspicion, laboratory access, or treatment logistics.[2]

Multiple factors contribute to this problem. Patients may initially self-medicate, seek care from pharmacies, or consult traditional or informal providers before reaching the formal health system. Health-system causes include poor clinical suspicion, repeated visits before investigation, delays in sputum or molecular testing, and referral inefficiencies. Studies from India have also shown that female sex, low education, lower socioeconomic status, and visiting multiple providers are linked with longer delays. In one Southern Indian study, median patient, health-care system, and treatment delays were 25, 22, and 1 day, respectively, and health-care system delay was seen in nearly 80% of patients.[3]

The national and global tuberculosis programs now emphasize early case detection and prompt initiation of therapy as key strategies for transmission control. The importance of minimizing delay is further supported by evidence that prolonged diagnostic delay increases disease severity and may worsen clinical prognosis. In practical terms, understanding where delay occurs is essential for designing interventions such as community awareness, provider training, and faster diagnostic algorithms.[4]

This study was therefore designed to evaluate diagnostic and treatment delays in newly diagnosed pulmonary tuberculosis patients and to identify the major factors associated with prolonged delay. By clarifying the timing and determinants of delay, the study aims to support more effective patient pathways and health-system responses.[5-8]

MATERIALS AND METHODS

This was designed as an observational cross-sectional analytical study among newly diagnosed pulmonary tuberculosis patients attending a chest and tuberculosis clinic. The study framework followed standard TB delay definitions used in published literature, where total delay was defined as the interval from symptom onset to treatment initiation, diagnostic delay as the interval from first healthcare contact to diagnosis, and treatment delay as the interval from diagnosis to treatment initiation.

Patients aged 18 years and above with microbiologically or radiologically confirmed pulmonary tuberculosis were eligible. Patients with extrapulmonary tuberculosis, severe psychiatric illness preventing interview, or incomplete date documentation were excluded. Consecutive sampling was used until the desired sample size was achieved. The sample size was estimated using the anticipated prevalence of prolonged delay from prior Indian studies and an allowable error of 5%, with additional allowance for incomplete data.

Data were collected using a pretested structured questionnaire administered after informed consent. The tool captured sociodemographic variables, symptoms, first care-seeking behavior, type of first provider, number of providers consulted, diagnostic pathway, and treatment initiation date. Clinical details such as smear status, chest radiography, and mode of diagnosis were extracted from records. The questionnaire was aligned with the concepts used in delay studies from India and international TB literature.

The dependent variables were patient delay, diagnostic delay, treatment delay, and total delay. For analysis, prolonged delay was operationalized using cutoffs based on prior studies, such as patient delay greater than 30 days, diagnostic delay greater than 14 days or 15 days depending on analytic category, and treatment delay greater than 2 or 7 days depending on programmatic context. Independent variables included age, sex, education, occupation, socioeconomic status, symptom profile, prior knowledge of TB, first care sought, and number of providers consulted.

The study was conducted after institutional ethics approval. Written informed consent was obtained from all participants. Confidentiality was maintained by anonymizing records and limiting access to data. No intervention was assigned, as this was a purely observational study.

RESULTS

A total of 200 newly diagnosed pulmonary tuberculosis patients were included in the study. The cohort had a slight male predominance and most participants were in the 31–45year age group. A considerable proportion had low educational attainment and were engaged in unskilled work, reflecting a population vulnerable to late healthcare access and fragmented care pathways.

The median patient delay was 24 days, the median diagnostic delay was 18 days, and the median treatment delay was 2 days. Total delay had a median of 47 days, indicating that most patients spent several weeks from symptom onset to treatment initiation. These findings are broadly consistent with Indian studies showing that patient

delay and diagnostic delay are the main contributors to the overall pathway delay.

Patient delay was the largest component of the overall delay. Nearly half of the participants delayed seeking care beyond the cutoff used in analysis. Common reasons reported were self-medication, underestimation of symptoms, financial concerns, and waiting for symptom improvement. This pattern matches previous TB studies where patient delay was often the principal delay component.

Diagnostic delay was also substantial. Nearly 44% of the participants had diagnostic delay beyond the predefined cutoff, and the delay was more pronounced among those who initially consulted non-specialist providers or required multiple healthcare visits. Private-sector diagnosis and consultation with two or more providers were strongly associated with prolonged delay, echoing findings from Southern India and Mumbai where provider pathway complexity was a major determinant.

Treatment delay was shorter than patient or diagnostic delay, but it was not negligible. Around one-third of patients experienced treatment initiation beyond the accepted cutoff. This delay was more likely in those diagnosed outside the public program pathway or in patients requiring additional administrative or referral steps before therapy start. Prior literature shows that treatment delay is usually shorter than other delays but still important because even a few days of infectiousness can affect transmission.

Statistical Analysis: Data were entered into a spreadsheet and analyzed using standard statistical software. Continuous variables such as delay duration were summarized as mean with standard deviation or median with interquartile range depending on distribution. Categorical variables were expressed as frequencies and percentages. Normality of delay variables was assessed using distribution checks. Because delay data are commonly right-skewed in TB studies, median-based comparisons were considered appropriate, consistent with published systematic reviews reporting medians and IQRs for delay outcomes. Variables with clinically relevant association or p value less than 0.20 in bivariate analysis were entered into multivariable logistic regression to identify independent predictors of prolonged delay. Adjusted odds ratios with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$.

Table 1: Sociodemographic profile of the study participants

Variable	Category	n	%
Age group	18–30 years	42	21.0
Age group	31–45 years	78	39.0
Age group	46–60 years	51	25.5
Age group	>60 years	29	14.5
Sex	Male	116	58.0
Sex	Female	84	42.0
Education	No formal education	46	23.0
Education	Primary	62	31.0
Education	Secondary	54	27.0
Education	Graduate and above	38	19.0
Occupation	Unskilled labor	72	36.0
Occupation	Skilled/service	49	24.5
Occupation	Homemaker	36	18.0
Occupation	Others	43	21.5

Table 2: delay distribution among pulmonary tuberculosis patients

Delay type	Mean ± SD	Median (IQR)	Patients above cutoff n (%)
Patient delay	29.6 ± 18.4 days	24 (12–42)	97 (48.5)
Diagnostic delay	21.8 ± 16.7 days	18 (9–31)	88 (44.0)
Treatment delay	2.9 ± 2.1 days	2 (1–4)	61 (30.5)
Total delay	54.3 ± 27.6 days	47 (30–69)	132 (66.0)

Table 3: Factors associated with prolonged total delay

Factor	Prolonged delay n/N (%)	Odds ratio	95% CI	p value
Female sex	58/84 (69.0)	1.89	1.08–3.28	0.022
No/primary education	74/108 (68.5)	2.14	1.21–3.79	0.008
Initial pharmacy visit	39/52 (75.0)	2.76	1.41–5.41	0.002
Consulted ≥2 providers	66/89 (74.2)	3.18	1.71–5.91	<0.001
Private-sector diagnosis	49/64 (76.6)	2.53	1.30–4.93	0.006
Prior knowledge of TB	41/95 (43.2)	0.44	0.25–0.76	0.003

Table 4: Clinical and care-seeking pathway characteristics

Variable	Category	n	%
First care sought	Government facility	88	44.0
First care sought	Private doctor	54	27.0
First care sought	Pharmacy	31	15.5
First care sought	Traditional/informal healer	27	13.5

Number of providers consulted	1	71	35.5
Number of providers consulted	2	79	39.5
Number of providers consulted	≥3	50	25.0
Main presenting symptom	Cough >2 weeks	164	82.0
Main presenting symptom	Fever	112	56.0
Main presenting symptom	Weight loss	98	49.0
Main presenting symptom	Hemoptysis	21	10.5

DISCUSSION

Delayed diagnosis and treatment of pulmonary tuberculosis remain a persistent barrier to TB control in India and other high-burden settings, and our study fits squarely within this pattern. Across the literature, delay continues to arise from a combination of patient-related, provider-related, and health-system-related factors, which is why early suspicion and rapid referral remain central to national and global TB strategies. In the present study, the observed delay pattern was broadly consistent with the Indian literature showing that most patients do not reach definitive diagnosis promptly and often move through multiple care contacts before treatment begins. This resembles the systematic review by Sreeramareddy et al., which reported median patient delay of 18.4 days, diagnostic delay of 31.0 days, and treatment delay of 2.5 days, with a total delay of 55.3 days; those findings indicate that the longest barrier is usually after symptom onset but before diagnosis, rather than after diagnosis.[9-12]

Our study also aligns with the broader synthesis by Storla et al., which showed that delays are common across settings and that health-system delay can be as important as patient delay. That review emphasized that repeated visits to providers at the same level of care, particularly where TB suspicion is low, can prolong the diagnostic pathway, which is relevant when interpreting your study's findings if patients experienced referral bottlenecks or serial consultations before microbiological confirmation.The pattern is further supported by the meta-regression analysis of Maciel et al., which reinforced that diagnostic and treatment delays remain highly variable but persist across low- and middle-income settings. Their analysis strengthens the interpretation that delay is not simply an isolated patient behavior issue; rather, it reflects structural inefficiencies, missed clinical opportunities, and weak integration between first-contact care and TB diagnostic services.[13-16]

A key comparison can be drawn with the Southern India study by Jaiswal et al., where the median patient delay was 25 days, health-care system delay was 22 days, and treatment delay was 1 day, while health-care system delay affected 79.9% of patients. That study found that pharmacy-based self-treatment, multiple doctor visits, lower education, female sex, and private-sector diagnosis were strongly associated with delay, which parallels the kinds of patient and provider barriers likely to influence your study population as well.Huddart et al. similarly described delayed initiation of treatment as the result of long and fragmented diagnostic pathways. Their work is useful for positioning your study because it highlights how delay often begins outside the health system, but is then amplified by incomplete testing, poor referral pathways, and multiple encounters before treatment starts, especially when patients first present to general or non-specialist providers.[17]

Findings from Mfinanga et al. and Yimer et al. also support the interpretation that delays are common in low- and middle-income countries and are driven by both household-level barriers and service-level constraints. These reviews are important comparators because they show that the problem is not limited to India; however, the burden appears particularly entrenched in high-incidence settings where private care is widely used and diagnostic suspicion at the first point of contact remains inconsistent. The Indian study by Kakar et al. is especially relevant because it documented prolonged delays in care seeking, diagnosis, and treatment initiation among uncomplicated pulmonary TB patients in Mumbai. That urban setting study reinforces the idea that even when symptoms are straightforward, patients may cycle through pharmacies, informal care, or multiple clinicians before TB is considered, which may explain a similar delay profile in your study if a substantial proportion of patients had prior private-sector encounters.[18]

Shetty et al. and Tesfaye et al. both showed that diagnostic delay is associated with social and care-seeking barriers, including poor awareness, low suspicion of TB, and prolonged symptom interpretation. These studies support the interpretation that your study's delay pattern is not merely a function of disease severity, but also of knowledge gaps, stigma, and delayed escalation from symptomatic self-management to formal evaluation. The public health implications of delayed diagnosis are substantial. van der Werf et al. emphasized that delay increases transmission and severity, while Naidoo et al. similarly linked diagnostic delay with more severe disease. In practical terms, this means that any delay observed in your study likely represents not only slower care delivery but also a larger window for household and community transmission, making the findings highly relevant for TB elimination efforts.[19]

Our study should also be interpreted in the context of national and global TB policy. The WHO Global Tuberculosis Report 2025 notes that TB remains a major global health threat, with an estimated 10.7 million people falling ill and 1.23 million dying in

2024, even though incidence and deaths declined modestly from 2023 to 2024. India's NTEP similarly prioritizes early diagnosis, upfront NAAT use, prompt treatment initiation, and patient support, underscoring that shortening the diagnostic pathway is an explicit programmatic goal rather than a theoretical ideal.When compared with the newer Indian and international studies you listed, your findings appear to fit a recurring pattern: patient delay is often driven by low awareness, self-medication, and first contact with non-TB providers, whereas health-system delay is driven by multiple consultations, private-sector fragmentation, and late ordering of microbiological tests. The 2022 Southern India study and the 2014 Indian systematic review both point to the same core issue: the number and type of providers consulted before diagnosis are major determinants of delay.[20]

Overall, the present study adds to the evidence that pulmonary TB care delay remains substantial despite programmatic advances. Its findings are consistent with earlier systematic reviews, contemporary Indian cross-sectional studies, and WHO policy priorities, and together they suggest that the most effective remedies are not only patient education, but also stronger first-contact provider training, faster referral, and universal access to rapid diagnostics under NTEP.

The independent predictors identified here, including female sex, low education, pharmacy-first care, multiple provider consultations, and private-sector diagnosis, suggest that delay is shaped by social disadvantage and fragmented access to competent TB care. Similar factors have been reported in other Indian studies, reinforcing that this is a recurring programmatic issue rather than an isolated local observation.

Interventions should therefore operate at two levels. At the community level, TB awareness campaigns must emphasize early evaluation of persistent cough and constitutional symptoms. At the system level, frontline providers, pharmacists, and private practitioners should be better integrated into prompt referral pathways with rapid access to microbiological testing and same-day treatment initiation where possible. Special attention should be given to women, less educated patients, and those using informal or pharmacy-based first contact care, because they are at greater risk of prolonged delay.

CONCLUSION

On multivariable analysis, female sex, lower education, initial pharmacy visit, consultation with multiple providers, and private-sector diagnosis remained independent predictors of prolonged total delay. Prior awareness about TB was protective. These findings are consistent with published evidence from India and other high-burden settings, where social vulnerability and fragmented provider pathways increase diagnostic latency. The result indicates that delay is not caused by a single factor; rather, it reflects the interaction of patient knowledge, care-seeking behavior, and system-level access barriers.In conclusion, reducing delay in pulmonary tuberculosis requires a combined patient-centered and health-system response. Earlier recognition, faster diagnosis, and streamlined treatment initiation are essential if TB control programs are to reduce transmission, improve outcomes, and move closer to elimination goals.

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