E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.01.583

Research Article

Impact of Delayed Diagnosis on Treatment Outcomes among Pulmonary Tuberculosis Patients in Rural Communities: A Mixed-Methods Study

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Received: 04.03.2026, Revised: 10.06.2026, Accepted: 14.06.2026

ABSTRACT

Background: Pulmonary TB continues to be a significant public health issue, especially in the rural areas where health care services are inadequate. Late diagnosis can worsen the disease, make it infectious for a longer period and have detrimental treatment outcomes. Timely diagnosis of TB is crucial for the control of TB in rural areas; understanding the clinical implications and reasons for delayed diagnosis is vital.

Objective: To assess the impact of delayed diagnosis on treatment outcomes among pulmonary tuberculosis patients in rural communities and to explore patient-related and health-system factors contributing to diagnostic delay.

Methods: The study was a mixed-methods study that took place at Gomal Medical College, DI Khan, between January 2025 and June 2025. The total number of diagnosed pulmonary tuberculosis patients in the rural areas was 85, and was obtained using non-probability consecutive sampling. Socio-demographic data, clinical presentation, delay to diagnosis, treatment adherence, sputum conversion, hospitalisation and final outcome of treatment were quantified. Diagnostic delay was considered to be more than 30 days from symptom onset. The results of treatment were classified as good or bad. The qualitative data was gathered by interviewing patients to explain the reasons for delayed diagnosis. The quantitative data was analysed through frequencies, percentages, mean, standard deviation and Chi-square or Fisher exact test, and the qualitative data was analysed thematically.

Results: Among 85 patients, 52 (61.2%) experienced delayed diagnosis, while 33 (38.8%) were diagnosed without major delay. The mean total diagnostic delay was 47.8 ± 21.6 days. Favorable treatment outcomes were observed in 57 (67.1%) patients, whereas 28 (32.9%) had unfavorable outcomes. Patients with delayed diagnosis had a higher frequency of unfavorable outcomes compared with those diagnosed without delay (42.3% vs. 18.2%, p = 0.021). Delayed diagnosis was also associated with poor adherence, reduced sputum conversion at two months, treatment interruption, and hospitalization. Qualitative findings showed that poor awareness, self-medication, financial hardship, long distance from health facilities, stigma, and limited diagnostic access were major contributors to delay.

Conclusion: Delayed diagnosis was common among pulmonary tuberculosis patients in rural communities and was significantly associated with poorer treatment outcomes. Strengthening rural diagnostic services, improving community awareness, reducing financial barriers, and promoting early referral may help improve treatment success and reduce tuberculosis transmission.

Keywords: Pulmonary Tuberculosis, Diagnostic Delay, Treatment Outcome, Rural Communities, Mixed-Methods Study, Treatment Adherence.

INTRODUCTION

Pulmonary tuberculosis is a significant infectious disease and also remains a high burden on health

care systems, especially in low and middle income countries. Even with the effective diagnostic tools and anti-tuberculous treatment, diagnosis is a great problem in the control of tuberculosis. Early diagnosis and prompt treatment is not only important for better treatment of individual patients, but it is also key for curbing spread within families and communities. If the diagnosis of pulmonary tuberculosis is delayed, patients may be infectious for a longer time, have more advanced disease and have a poorer outcome of treatment (1-3).

In rural areas, diagnostic delay is particularly prevalent, with various social, economic and healthcare-related challenges of rurality contributing to this phenomenon. Limited access to diagnostic facilities and long distances to hospitals, low income and the lack of knowledge of the symptoms of TB are seen in many patients living in rural areas. People may not pay attention to symptoms of chronic cough, fever, weight loss, night sweats, or may use home remedies and over-the-counter drugs to treat them. A range of patients visit informal health care providers or local pharmacies prior to visiting a TB diagnostic centre. Such delays may lead to the progression of the disease and may make it less likely to complete treatment successfully (4-6).

Tuberculosis diagnostic delay may be segmented into patient delay, health-system delay and total delay. Patient Delay: Time between onset of symptoms and first health contact. Health-system delay includes the amount of time from the first time a person is asked for health care until they are diagnosed. The total diagnostic delay is the total time between onset of symptoms and diagnosis. Patient-related and health-system-related delays are both important because they have a direct impact on the stage of the disease at the time of treatment initiation and may also contribute to poor adherence, sputum conversion, hospitalization and mortality (7-9).

Treatment outcome is an important indicator of tuberculosis program performance. Positive outcomes typically are cure and completion of treatment, and negative outcomes are treatment failure, death, loss to follow-up, or treatment interruption. If the diagnosis is delayed, an individual may experience more serious clinical disease, have a higher bacillary load, have decreased nutritional status, and may be more likely to be unable to complete therapy. The psychological stress and financial burden could also be aggravated by delayed diagnosis, particularly for patients in rural areas who rely on daily income and lack of family support (10).

The quantitative data can illustrate the correlation between the delay in diagnosis and treatment effects, but is not necessarily a complete answer to why patients are late for diagnostic services. Use of a mixed-methods approach is helpful as this combines statistical measurement with patients' lived experiences. Qualitative interviews can be used to explore stigma, fear, financial burden, lack of family support, gender, and the dissatisfaction with health services, in greater depth. This allows a more comprehensive picture of the problem to be obtained and practical solutions to address the issue of early diagnosis are to be identified (11).

There is a need to better understand the impact of delayed diagnosis on pulmonary tuberculosis treatment outcomes in rural communities of Pakistan. Evidence from rural settings can support improvements in community awareness, referral pathways, primary healthcare services, and patient follow-up systems. Therefore, the present study was conducted at Gomal Medical College, DI Khan, to assess the effect of diagnostic delay on treatment outcomes among pulmonary tuberculosis patients from rural communities and to explore the major patient-related and health-system factors responsible for delayed diagnosis.

METHODOLOGY

This mixed-methods study was conducted at Gomal Medical College, DI Khan, from January 2025 to June 2025. The study was designed to assess the impact of delayed diagnosis on treatment outcomes among pulmonary tuberculosis patients living in rural communities. A mixed-methods approach was selected because it allowed both numerical measurement of diagnostic delay and treatment outcomes, as well as exploration of patients' experiences, barriers, and reasons for late diagnosis. The quantitative component evaluated the association between delayed diagnosis and clinical outcomes, while the qualitative component explored social, economic, and health-system factors contributing to diagnostic delay.

A total of 85 diagnosed pulmonary tuberculosis patients were included in the study. The non-probability consecutive sampling technique was used for the selection of patients. The diagnosis

of pulmonary tuberculosis among the adult population during the study period in the rural areas was considered the inclusion criteria. Both males and females were included as patients. Diagnosis of pulmonary tuberculosis was based on the clinical features, sputum smear microscopy, GeneXpert MTB/RIF, chest radiography or clinical decision by the treating physician on the basis of the standard tuberculosis diagnostic criteria. Patients with extrapulmonary TB alone, incomplete medical record, unwillingness to participate, and inability to get reliable information on the period of time for which the symptoms were present were excluded from the study.

The informed consent of the appropriate hospital authorities and tuberculosis care unit were also obtained. All participants received written informed consent after the purpose of the study is explained. Participants were ensured confidentiality of their information and assured that the information would be used solely for research. They were also told that their treatment and follow-up wouldn't be affected if they declined to take part.

Structured questionnaires and patient's medical records were used to collect data. The questionnaire consisted of information about the age, gender, education, occupation, income, residence, distance from healthcare facility, smoking history, previous history of tuberculosis, contacts with known TB patient, and comorbid conditions like diabetes mellitus. Other clinical parameters, including the duration of cough, fever, weight loss, night sweats, hemoptysis, diagnostic method, sputum status and BMI were also documented. Follow up records and patient interviews provided information for treatment related issues such as adherence, sputum conversion, treatment interruption, hospitalization, and final treatment outcome.

The diagnostic delay was assessed into three components. The time from onset of TB-related symptoms until the first visit to any health care provider was defined as patient delay. Health-system delay was defined as the duration from the first health-care visit to the diagnosis of TB. Time to diagnosis of PTB was defined as total diagnostic delay, which was the period between the onset of symptoms and the diagnosis of PTB. Patients were split into 2 groups for analysis: patients diagnosed at a delay and those diagnosed in a timely fashion. If it took over 30 days from symptom onset to diagnosis was delayed diagnosis.

The primary dependent variables for the present study were treatment outcome. The outcomes were divided into two groups: favorable and unfavorable. Favorable treatment outcome was defined as cure or successful completion of treatment. The unfavourable treatment outcome was treatment failure, deaths, loss to follow-up, treatment interruption or absence of sputum conversion during follow-up. Other secondary outcome variables examined included sputum conversion at 2 months, treatment adherence, missed doses, hospitalization, and mortality. The outcomes were compared between early and delayed diagnosis groups.

In the qualitative part of the study, in-depth interviews were held with selected patients with pulmonary tuberculosis from the rural community. Participants were asked open-ended questions to explore their initial symptoms, first actions when feeling unwell, perceived barriers to care seeking, financial barriers, distance to health facilities, stigma, the support of family and friends, and challenges in accessing services and/or during treatment. Interviews were conducted in the private and comfortable environment. Respondents were asked to answer in writing, and significant patient comments were made. The qualitative data were re-reviewed repeatedly and categorized into various themes, including poor awareness of the symptoms of tuberculosis, self-medication, financial difficulty, long distance to travel, social stigma, gender related barrier, mis diagnosis and limited diagnostic facilities.

Data was entered and analyzed by using the statistical software. Data for quantitative variables (age, patient delay, health-system delay, total diagnostic delay) was reported as mean and standard deviation. Qualitative variables like gender, level of education, symptoms, sputum conversion status, adherence, and treatment outcomes were reported as frequencies and percentages. Association between diagnostic delay and treatment outcomes were analyzed using the chi-square test or Fisher's exact test. A p value < 0.05 was deemed as statistically significant. Qualitative findings were analyzed thematically and supported and explained quantitative findings.

RESULTS

The study included 85 patients of pulmonary TB from villages. The mean age of participants was 39.6 ± 14.2 years, the maximum percentage was found to be 31-45 years. There were a few more males than females. The rural low-income background of the study population was indicated by the majority who were low educated and/or living in low-income households.

Table 1. Socio-Demographic Characteristics of Pulmonary Tuberculosis Patients

Variable	Frequency (n)	Percentage (%)
Age group		
18–30 years	24	28.2
31–45 years	32	37.6
46–60 years	20	23.5
>60 years	9	10.6
Gender		
Male	49	57.6
Female	36	42.4
Education status		
Illiterate	31	36.5
Primary education	24	28.2
Secondary education	21	24.7
Higher education	9	10.6
Monthly income		
Low income	56	65.9
Middle income	24	28.2
High income	5	5.9
Occupation		
Farmer/laborer	34	40.0
Housewife	25	29.4
Unemployed	14	16.5
Other	12	14.1

The presentation of most patients was typical of pulmonary tuberculosis. The most common symptom was cough for more than 2 weeks, followed by weight loss, fever and night sweats. A smaller proportion of patients reported a history of tuberculosis, and some patients had diabetes mellitus.

Table 2. Clinical Characteristics of the Study Participants

Clinical variable	Frequency (n)	Percentage (%)
Cough for more than 2 weeks	78	91.8
Fever	67	78.8
Weight loss	62	72.9
Night sweats	55	64.7
Hemoptysis	18	21.2
Previous history of TB	13	15.3
Contact with known TB patient	29	34.1
Smoking history	27	31.8
Diabetes mellitus	16	18.8
Underweight BMI	38	44.7

There was a high prevalence of diagnostic delay among TB patients in rural areas. Of these 85 patients, 52 patients (61.2%) had delayed diagnosis and 33 (38.8%) had a delayed diagnosis but not significantly. The mean total diagnostic delay was 47.8 ± 21.6 days. Patient

delay was greater than health-system delay. Self-medication, inadequate knowledge of TB symptoms, financial constraints, difficulties in accessing health facilities and treatment at informal health care providers were the most common reasons for delayed treatment.

Table 3. Pattern of Diagnostic Delay among Pulmonary Tuberculosis Patients

Diagnostic delay variable	Mean ± SD / n (%)
Mean patient delay	29.4 ± 15.8 days
Mean health-system delay	18.4 ± 10.6 days
Mean total diagnostic delay	47.8 ± 21.6 days
Diagnosis within 30 days	33 (38.8%)
Delayed diagnosis >30 days	52 (61.2%)
First visit to private clinic/pharmacy	37 (43.5%)
First visit to public health facility	28 (32.9%)
First visit to traditional/informal provider	20 (23.5%)
Three or more healthcare visits before diagnosis	41 (48.2%)
Initial misdiagnosis	36 (42.4%)
Travel distance >10 km	46 (54.1%)
Financial difficulty in reaching care	50 (58.8%)

Treatment outcomes were better among patients who were diagnosed without delay. Total 57 patients (67.1%) had favorable treatment outcome and 28 patients (32.9%) had unfavorable treatment outcome. The bad outcomes occurred more often among patients with a delayed diagnosis than among those diagnosed early. Delayed diagnosis was also linked with lower sputum conversion at 2 months and poor adherence, and higher treatment interruption.

Table 4. Treatment Outcomes According to Diagnostic Delay

Treatment outcome	No delay n=33	Delayed diagnosis n=52	Total n=85	p-value
Favorable outcome	27 (81.8%)	30 (57.7%)	57 (67.1%)	0.021
Unfavorable outcome	6 (18.2%)	22 (42.3%)	28 (32.9%)	0.021
Sputum conversion at 2 months	28 (84.8%)	32 (61.5%)	60 (70.6%)	0.019
Good treatment adherence	30 (90.9%)	35 (67.3%)	65 (76.5%)	0.012
Treatment interruption	4 (12.1%)	17 (32.7%)	21 (24.7%)	0.034
Hospitalization during treatment	5 (15.2%)	18 (34.6%)	23 (27.1%)	0.049
Mortality	1 (3.0%)	6 (11.5%)	7 (8.2%)	0.167

Patients diagnosed late, with low adherence, underweight BMI, diabetes mellitus and with a long distance from the nearest health facility were at higher risk of unfavourable treatment outcomes. There was no association between early weight gain and age at treatment initiation, but there was a statistically significant association between diagnostic delay and poor treatment outcome.

Table 5. Factors Associated with Unfavorable Treatment Outcome

Factor	Favorable outcome n=57	Unfavorable outcome n=28	p-value
Delayed diagnosis	30 (52.6%)	22 (78.6%)	0.021
Poor treatment adherence	8 (14.0%)	12 (42.9%)	0.003
Underweight BMI	20 (35.1%)	18 (64.3%)	0.011
Diabetes mellitus	7 (12.3%)	9 (32.1%)	0.026
Travel distance >10 km	25 (43.9%)	21 (75.0%)	0.007
Initial misdiagnosis	18 (31.6%)	18 (64.3%)	0.004

Low monthly income	34 (59.6%)	22 (78.6%)	0.084

The qualitative data reinforced the quantitative data and gave a deeper insight into the reasons for the delay in diagnosis in the rural community. Patients frequently initially describe a cough and fever as a "seasonal illness." A large proportion of people relied on home remedies or purchased medicines from local pharmacies prior to seeking the services of a trained health worker. In addition, financial difficulties, poor transport, fear of stigma and poor access to diagnostic services were significant factors in the late diagnosis.

Table 6. Qualitative Themes Related to Delayed Diagnosis

Main theme	Sub-themes identified
Poor awareness of TB symptoms	Cough ignored, symptoms considered seasonal, lack of knowledge about TB transmission
Financial barriers	Cost of transport, consultation charges, loss of daily wages
Health-seeking delay	Self-medication, use of home remedies, preference for informal providers
Health-system barriers	Delayed referral, limited diagnostic facilities, repeated visits before testing
Social stigma	Fear of isolation, hiding symptoms, concern about family reputation
Gender-related barriers	Women depending on family permission, restricted mobility
Treatment-related concerns	Fear of long treatment, side effects, difficulty attending follow-up visits

Overall, the findings showed that delayed diagnosis was frequent among pulmonary tuberculosis patients living in rural communities. Patients with diagnostic delay had poorer treatment outcomes, reduced early sputum conversion, lower adherence, and more treatment interruptions compared with those diagnosed earlier. Qualitative findings further revealed that lack of awareness, poverty, distance from health facilities, stigma, and weak referral pathways were major reasons for delayed diagnosis.

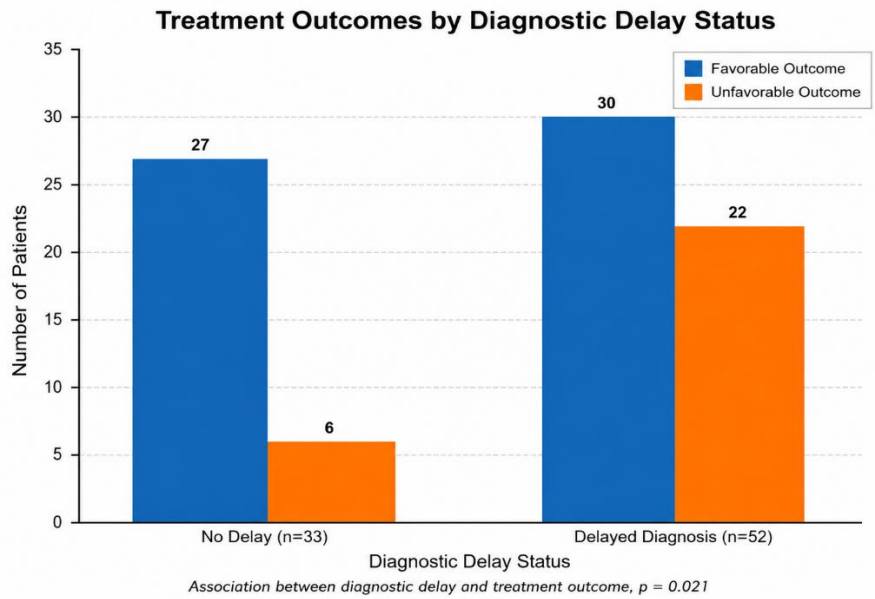

Figure 1. Treatment Outcomes among Pulmonary Tuberculosis Patients

According To Diagnostic Delay Status

Patients with delayed diagnosis had a lower frequency of favorable treatment outcomes and a higher frequency of unfavorable outcomes compared with those diagnosed without delay. A statistically significant association was observed

between diagnostic delay and treatment outcome ($p = 0.021$).

DISCUSSION

The present study assessed the impact of delayed diagnosis on treatment outcomes among pulmonary tuberculosis patients from rural communities. The findings showed that diagnostic delay was common, as 52 out of 85 patients experienced delayed diagnosis. This indicates that many pulmonary tuberculosis patients in rural areas do not reach diagnostic services at an early stage of illness. The mean total diagnostic delay was also considerable, suggesting that both patient-related and health-system-related factors contributed to late detection. In rural communities, symptoms such as cough, fever, night sweats, and weight loss are often ignored in the early phase or treated with home remedies and over-the-counter medicines. This delay allows the disease to progress and may also increase the risk of transmission within households and the wider community (12, 13).

Patient-related delay was greater than health-system delay, indicating that delayed care-seeking was an important factor in delayed diagnosis in this study. Most patients first went to pharmacies, informal providers or private clinics before they could be diagnosed with TB at a TB facility. This may be attributed to low educational status, financial constraints, and a lack of knowledge about tuberculosis symptoms as well as long distances to the diagnostic centers. Transport cost, loss of wages and availability of nearby health facilities are a major limitation for formal consultation in rural areas. These barriers are particularly significant among low-income families, where the need for medical attention might be delayed until symptoms are severe (14-16).

Delayed diagnosis was significantly related to poor treatment outcomes. Those diagnosed late had a lower rate of good outcomes than those diagnosed promptly. Likewise, the delayed diagnosis was linked to poorer treatment adherence, treatment interruption, less sputum conversion at 2 months and increased hospitalisation. This is suggestive that a late diagnosis may be associated with a more advanced disease stage at the time of treatment. Patients with advanced disease may need more time to recover, may have more intense symptoms, and may have more challenges to treatment completion. Another potential risk of delayed diagnosis is that it may cause physical and nutritional weakness, which can affect the patient's treatment and cause complications (17). Nonadherence was another significant factor that was correlated with poor outcomes. It is important to complete and regular TB treatment for drug resistance prevention and cure in TB care. More patients with delayed diagnosis treated by interruption in the current study. This might be due to the fact that patients who present late for care are likely to already be impacted by financial difficulties, health problems, and lack of family support. Inadequate understanding that follow-up is necessary for completion of treatment and fear of side effects of anti-tuberculosis medications may also lead to missed doses. Thus, the improvement of diagnosis alone may not be enough; patients require continuous counseling, follow-up support and community-based treatment supervision (18).

The qualitative findings reinforced the understanding for the reasons for delayed diagnosis. The patients mentioned they did not know the symptoms of TB, did not like to be stigmatized, did not have enough funds, depended on the informal treatment, and did not have access to diagnostic facilities. Social stigma was a significant barrier: some patients worried about rejection by family members, neighbours or employers. Women in rural areas may have more disadvantages because they may need to get permission, support and transportation from family members to access health facilities. This study highlights that diagnostic delay is a social and economic problem as well as a medical problem. To minimize delay, it is essential to implement health education, raise awareness of the community, strengthen referral networks, and decentralize TB diagnostic services (19, 20).

The results of this study have important public health implications. Pulmonary TB can be successfully treated if identified early, reduce the severity of the disease and limit community transmission if identified early. All rural health workers, lady health workers and primary care providers must be trained to recognize early signs of possible TB and promptly refer to a sputum testing or GeneXpert. It is recommended to highlight at community level that cough for over two weeks, fever, weight loss and night sweats should be evaluated by the health services early.

Enhancing rural health centers' diagnostic capacity and minimizing out-of-pocket costs can also help to increase timely diagnosis and completion of treatment.

There were some limitations in this study. The sample size was relatively small and drawn from one institution, thus findings may not be generalizable to other rural communities. Partly reliance on patient memory may have resulted in recall bias. The qualitative part offered helpful explanations and was limited to some patient experiences. In spite of these shortcomings, the study has given useful information that delayed diagnosis is prevalent among the pulmonary tuberculosis patients in rural areas and that delayed diagnosis is related to poor treatment outcomes.

CONCLUSION

This study concluded that delayed diagnosis was frequent among pulmonary tuberculosis patients living in rural communities. Patients with delayed diagnosis had poorer treatment outcomes, lower sputum conversion, reduced adherence, higher treatment interruption, and increased hospitalization compared with patients diagnosed earlier. The main reasons for diagnostic delay included poor awareness of tuberculosis symptoms, self-medication, financial hardship, long distance from healthcare facilities, stigma, and limited access to diagnostic services.

Early diagnosis and timely treatment initiation are essential to improve tuberculosis outcomes in rural populations. Strengthening primary healthcare services, improving referral pathways, increasing community awareness, reducing financial barriers, and expanding access to diagnostic facilities can help reduce diagnostic delay. Community-based education and follow-up support should be included in tuberculosis control programs to improve treatment adherence and reduce unfavorable outcomes.

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