

Smear-positive pulmonary tuberculosis and risk factors in non-HIV patients at a tertiary care hospital in Larkana

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ABSTRACT

Objective: To determine the frequency of smear-positive pulmonary tuberculosis and identify its associated risk factors among non-HIV patients at a tertiary care hospital in Larkana.

Material and Methods: This cross-sectional study was conducted at the Department of Pulmonology, SMBBMU, Larkana, 15th December 2025 till 15th June 2026. A total of 176 HIV-negative patients aged 18 to 60 years with presumptive pulmonary tuberculosis were enrolled by consecutive sampling. Demographic, clinical, behavioural and radiological variables were noted, and two sputum samples were tested for AFB. Chi-square, Fisher's exact and logistic regression were used to assess associations through SPSS-26.0

Results: Among 176 HIV-negative presumptive PTB patients, 31 (17.6%) were smear-positive by direct sputum smear microscopy. The mean age was 36.8 ± 11.1 years, and males constituted 60.8% of participants. Smoking (aOR 7.97; $p < 0.001$), TB contact (aOR 4.99; $p < 0.001$), and previous TB history (aOR 4.84; $p = 0.003$) were independent predictors of smear positivity. Cavitation and consolidation were significantly more frequent among smear-positive patients.

Conclusion: Smear-positive pulmonary tuberculosis affected nearly one in six HIV-negative presumptive patients. In addition to diabetes, alcohol use and low BMI, exposure-related factors, especially smoking, and modifiable factors (contact with TB a case and previous TB) were independently associated with positivity. These findings convey the burden in that locality and the characteristics of the patients most likely to be smear-positive.

Keywords: Acid-fast, Microscopy, Risk factors, Smoking, Sputum, Tuberculosis, Pulmonary.

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INTRODUCTION

Tuberculosis (TB) is one of the oldest and longest-lasting diseases in history and is the result of infection with the bacterium *Mycobacterium tuberculosis*, which is transmitted via the airborne droplet nuclei containing infectious respiratory secretions, which can infect others upon inhalation [1]. It is usually found in the lung parenchyma, causing pulmonary tuberculosis (PTB), or outside the lungs, leading to extrapulmonary tuberculosis [2,3]. The course is chronic and is often insidious; hence, TB continues to impose a heavy toll of illness and death throughout the world today and is among the leading causes of death due to a single infectious agent [4,5].

Tuberculosis (TB) is a large global public health problem, with an estimated 10.8 million people

developing active TB every year globally. Most TB cases are in a few countries with a high TB burden and make a significant contribution to the TB disease burden worldwide [6]. Pakistan is also a country with high TB burden, and figures for the estimated number of TB cases are high in the country when compared to other countries worldwide. The burden of TB on morbidity, mortality and health care resources is still high in Pakistan and it remains a great challenge for the public health [7].

However, timely diagnosis of TB is often difficult due to the presence of clinical overlap with other diseases, inadequate diagnostic testing access and delays, especially in resource-poor areas [8]. Currently, mycobacterial culture is considered the gold standard for confirmation, but its cost, technical requirements and long turnaround time limit its use in routine practice in many parts of the developing world [9]. However, while less sensitive, direct sputum smear microscopy for AFB is a fast, cheap and technically simple method for identifying infectious cases, and it continues to be the mainstay of TB diagnosis in high-burden, low-resource settings [10].

There is increasing evidence that relates the tendency to smear-positive disease to a variety of host and behavioural factors. Community-based studies have linked close contact with a known case,

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cigarette smoking, and past treatment with smear positivity [11], while other studies have also found low BMI, alcohol intake, DM, and malignancy to be associated with smear positivity [12]. Similar findings have been reported in Pakistani patients, in which increasing age, poverty, smoking and other associated factors like diabetes have been associated with poor outcomes in smear-positive PTB [13]. This association has been well described in large cohort studies showing that individuals with diabetes have a significantly increased risk of developing TB and that poor lifestyle increases this risk [14,15].

Even with this growing literature, there is limited local evidence on the prevalence of smear-positive PTB and the risk factors associated with it among HIV-negative people in the Larkana region, and the majority of the available evidence comes from populations that are significantly different from the social, nutritional and epidemiological characteristics of the interior Sindh. Knowledge of the current burden and understanding of factors associated with smear-positive TB in this context is crucial for early diagnosis, optimal use of limited resources, and local TB control.

The present study was therefore conducted to estimate the prevalence of smear-positive pulmonary TB in non-HIV patients and to find out the risk factors associated with it in tertiary care hospital, Larkana.

MATERIAL AND METHODS

A cross-sectional study was conducted for 6 months from 15th December 2025 till 15th June 2026 after approval had been obtained from the CPSP and the institutional ERC (Ref. No. SMBBMU/IRB/87 dated 09 December 2025), and written informed consent was taken from every participant before enrolment. Patients were recruited through consecutive sampling from among adults of both sexes aged 18 to 60 years who presented with presumptive PTB and were confirmed HIV-negative on serology. Presumptive PTB was defined as a productive cough for two weeks or longer, and the presence of at least one of the following: weight loss ≥ 5 percent of body weight, fever ≥ 100.4 degrees Fahrenheit, night sweats, haemoptysis or shortness of breath with respiratory rate > 20 per minute. Those who were critically ill or were unwilling to participate, and those who had extrapulmonary TB were excluded. Smear-positive pulmonary tuberculosis (PTB) was defined as presumptive PTB in a patient who had an AFB-positive smear of his sputum specimen on direct microscopy. Smear-positive was defined as the

presence of AFB in one or more of the sputum smear specimens examined under the microscope by the patient. The risk factors recorded comprised diabetes mellitus (documented diagnosis/on treatment or fasting plasma glucose ≥ 126 mg/dL), hypertension (documented diagnosis/on treatment or blood pressure $\geq 140/90$ mmHg), chronic kidney disease (eGFR < 60 mL/min/1.73 m² for ≥ 3 months or documented diagnosis), malignancy (histopathologically confirmed), previous anti-tuberculosis treatment, family history of tuberculosis, contact with a tuberculosis patient within the preceding six months, and current smoking or alcohol use within the past six months. The sample size was determined from OpenEpi version 3.01 (Sample Size for Frequency in a Population module) using an estimated 18.2% smear positive pulmonary tuberculosis with an absolute precision of 6% and a 95% confidence interval. The minimum sample size calculated was 159 participants. A total of 176 patients were included in the study based on feasibility and availability of the eligible patients. After enrolment, a single trained postgraduate researcher recorded each participant's demographic details, monthly income and anthropometric measurements, weight, height and BMI. A detailed account of comorbid conditions and behavioural risk factors, together with the presenting signs and symptoms, was documented for every patient. A chest radiograph was obtained to note consolidation, cavitation, nodular opacity or miliary shadows suggestive of PTB, two consecutive sputum specimens from each patient were examined for acid-fast bacilli by direct smear microscopy to confirm the diagnosis; and a blood sample was tested with a rapid HIV assay. Data were analysed using SPSS version 26.0. Continuous variables such as age, BMI, monthly income, duration of symptoms, fever temperature and respiratory rate were reported as mean $\pm$ standard deviation (SD) or median (inter quartile range [IQR]) depending on the data distribution. Categorical data, such as sex, residence, marital status, education status, smoking status, alcohol consumption, diabetes mellitus, hypertension, chronic kidney disease, malignancy, past TB history, family TB history, TB contact, symptoms of presentation, and radiological findings were presented as percentages and frequencies. Pearson's Chi-square test or Fisher's exact test was used to compare the categorical independent variables with smear-positive pulmonary tuberculosis status as appropriate. All the variables that were significant in the univariate analysis were used in a

multivariable binary logistic regression model. Smear positive pulmonary TB (yes/no) was dependent variable, smoking status, contact of patient, history of TB was independent variables in the logistic regression model. Results were expressed as adjusted odds ratios (aORs) and 95% confidence intervals (CIs) and associated p-values. Statistically significant was defined as a p-value <0.05.

RESULTS

A total of 176 HIV-negative patients with presumptive pulmonary tuberculosis (PTB) were included in the study. Everyone in the study had been tested for HIV and verified to be negative, and their sputum samples were tested for the presence of acid-fast bacilli (AFB) by direct smear microscopy. Smear-positive PTB was considered as AFB positive on at least one expectation of sputum smear. Participants' mean age was 36.8 ± 11.1 years. The majority belonged to the 31–45 years age group (80, 45.5%). 107 (60.8%) of the participants were males, and 107 (60.8%) of the patients were rural. Most participants were married (113, 64.2%), while 58 (33.0%) were illiterate. The mean BMI was 21.4 ± 3.9 kg/m², and 43 (24.4%) participants were underweight. There were 30 cases (17.0%) of diabetes mellitus and 32 (18.2%) of hypertension. 49 (27.8%) participants reported smoking, 18 (10.2%) reported alcohol use, 30 (17.0%) reported a history of TB and 43 (24.4%) reported contact with a TB patient. 31 patients were smear positive PTB and the smear positivity frequency was 17.6% among presumptive PTB patients (Table-I).

The association between demographic factors and smear status is presented in Table-II. Gender was significantly associated with smear-positive PTB ($p=0.013$). Smear positivity was higher among males than females (23.4% vs. 8.7%). No significant association was observed between smear status and age group, marital status, educational status, residential status, employment status, occupational status, or monthly income Table-II.

Smoking, TB contact, previous history of TB, diabetes mellitus, alcohol use, and underweight

status were significantly associated with smear-positive PTB (Table-III).

Smear positivity was highest among alcohol users (38.9%), followed by smokers (36.7%), participants with previous TB history (36.7%), TB contacts (34.9%), diabetic patients (33.3%), and underweight individuals (32.6%) Table-III.

Clinical and radiological findings according to smear status are presented in Table-IV.

Cavitation was significantly more frequent among smear-positive patients compared with smear-negative patients (58.1% vs. 8.3%, $p<0.001$). Consolidation was also significantly more common among smear-positive cases (61.3% vs. 33.8%, $p=0.004$).

Weight loss, night sweats, fever, and haemoptysis were significantly more frequent among smear-positive participants Table-IV.

Multivariable binary logistic regression was used to determine independent predictors of smear-positive pulmonary tuberculosis. Smear-positive PTB status (positive or negative) was entered as a dependent variable and smoking status, TB contact, and past TB were entered as independent variables. To avoid overfitting the model, the final model was limited to three predictors, based on the limited number of smear positive events (31 events).

Smoking was still an important independent predictor of smear positive PTB (aOR=7.97, 95% CI: 3.04–20.92, $p<0.001$). This means that, even after considering other factors, the odds of smear positivity were eight times higher among participants who smoked.

The other risk factor independently associated with smear-positive PTB was contact with a TB patient (aOR=4.99, 95% CI: 1.92–12.97, $p<0.001$). The odds of smear-positive were almost 5-fold higher for TB contact participants than for non-TB contact participants. Another important predictor of smear positive PTB was previous TB history (aOR=4.84, 95% CI: 1.69–13.83, $p=0.003$). The odds of smear positivity was about five times higher in patients with previous TB history than in patients without previous TB history Table-V.

Table-I: Baseline Characteristics of Study Participants (n=176)

Characteristics	n (%) / Mean $\pm$ SD
Age (years), Mean $\pm$ SD	36.8 $\pm$ 11.1
Age group	
18–30 years	54 (30.7%)
31–45 years	80 (45.5%)
46–60 years	42 (23.9%)
Gender	
Male	107 (60.8%)
Female	69 (39.2%)

Residential status	
Rural	107 (60.8%)
Urban	69 (39.2%)
Marital status	
Single	54 (30.7%)
Married	113 (64.2%)
Widowed/ Divorced	9 (5.1%)
Educational status	
Illiterate	58 (33.0%)
Primary	42 (23.9%)
Secondary	50 (28.4%)
Higher	26 (14.8%)
BMI (kg/m²), Mean $\pm$ SD	21.4 $\pm$ 3.9
Underweight	43 (24.4%)
Normal	100 (56.8%)
Overweight	31 (17.6%)
Obese	2 (1.1%)
Comorbidities	
Diabetes mellitus	30 (17.0%)
Hypertension	32 (18.2%)
Chronic kidney disease	11 (6.2%)
Malignancy	4 (2.3%)
TB-related factors	
Previous TB history	30 (17.0%)
Family history of TB	34 (19.3%)
Contact with TB patient	43 (24.4%)
Behavioural factors	
Smoking	49 (27.8%)
Alcohol use	18 (10.2%)
Smear-positive PTB	31 (17.6%)

Study participants (n=176)

Table-II. Association of demographic characteristics with smear status (n=176).

Variables	Smear-positive n (%)	Smear-negative n (%)	p-value
Gender			
Male	25 (23.4)	82 (76.6)	0.013
Female	6 (8.7)	63 (91.3)	
Age group			
18–30	5 (9.3)	49 (90.7)	0.134
31–45	16 (20.0)	64 (80.0)	
46–60	10 (23.8)	32 (76.2)	
Marital status			
Single	9 (16.7)	45 (83.3)	0.921
Married	20 (17.7)	93 (82.3)	
Widowed/Divorced	2 (22.2)	7 (77.8)	
Educational status			
Illiterate	14 (24.1)	44 (75.9)	0.464
Primary	6 (14.3)	36 (85.7)	
Secondary	7 (14.0)	43 (86.0)	
Higher	4 (15.4)	22 (84.6)	
Residence			
Rural	18 (16.8)	89 (83.2)	0.731
Urban	13 (18.8)	56 (81.2)	
Job status			
Unemployed	9 (12.9)	61 (87.1)	0.178
Employed	22 (20.8)	84 (79.2)	
Monthly income			
<25,000 PKR	9 (15.8)	48 (84.2)	0.305
25,000–50,000 PKR	17 (22.4)	59 (77.6)	
>50,000 PKR	5 (11.6)	38 (88.4)	

Table-III. Association of Clinical and Behavioural Risk Factors with Smear Status

Risk factor	Smear-positive n (%)	Smear-negative n (%)	Crude OR (95% CI)	p-value
Smoking	18 (36.7)	31 (63.3)	5.09 (2.25–11.52)	<0.001
Contact with TB patient	15 (34.9)	28 (65.1)	3.92 (1.73–8.86)	<0.001
Previous TB history	11 (36.7)	19 (63.3)	3.65 (1.51–8.79)	0.003
Diabetes mellitus	10 (33.3)	20 (66.7)	2.98 (1.22–7.24)	0.013

Alcohol use	7 (38.9)	11 (61.1)	3.55 (1.25–10.08)	0.021
Underweight (BMI <18.5)	14 (32.6)	29 (67.4)	3.29 (1.46–7.45)	0.003
Family history of TB	6 (17.6)	28 (82.4)	1.00 (0.38–2.68)	0.995
Hypertension	6 (18.8)	26 (81.2)	1.10 (0.41–2.95)	0.852
CKD	1 (9.1)	10 (90.9)	0.45 (0.06–3.65)	0.692
Malignancy	0 (0.0)	4 (100.0)	0.50 (0.03–9.51)	1.000

Table-IV. Clinical and radiological findings according to smear status.

Findings	Smear-positive n (%)	Smear-negative n (%)	p-value
Fever	28 (90.3)	104 (71.7)	0.030
Night sweats	24 (77.4)	81 (55.9)	0.026
Weight loss	26 (83.9)	85 (58.6)	0.008
Haemoptysis	12 (38.7)	29 (20.0)	0.025
Shortness of breath	13 (41.9)	50 (34.5)	0.432
Consolidation	19 (61.3)	49 (33.8)	0.004
Cavitation	18 (58.1)	12 (8.3)	<0.001
Nodular opacity	13 (41.9)	37 (25.5)	0.066
Miliary shadows	2 (6.5)	4 (2.8)	0.285

Table-V. Multivariable binary logistic regression analysis of independent predictors of smear-positive pulmonary tuberculosis.

Independent variable	Adjusted OR (95% CI)	p-value
Smoking (Yes vs No)	7.97 (3.04–20.92)	<0.001
Contact with TB patient (Yes vs No)	4.99 (1.92–12.97)	<0.001
Previous TB history (Yes vs No)	4.84 (1.69–13.83)	0.003

DISCUSSION

Tuberculosis is still a big burden of an infectious disease, especially in the high burden countries where delayed diagnosis and ongoing transmission is sustaining the disease. In this study, 31 out of 176 patients with presumptive pulmonary TB were found to be smear-positive pulmonary TB (17.6%) and were HIV-negative. This frequency shows that a significant number of infectious TB patients were found among those who were symptomatic and attended a tertiary care hospital. In resource-poor settings, sputum smear microscopy continues to play a useful role in the diagnosis of TB because of ease of access, low cost, and the fact that it identifies those patients with a greater bacillary load who are more likely to transmit the infection.

We found the frequency of smear-positive PTB comparable with other studies in high burden settings. Mantefardo *et al.* described smear-positive pulmonary tuberculosis and associated risk factors among healthcare facility clients in Southern Ethiopia, which showed the smear-positive pulmonary TB patients are still contributing to the disease transmission and the need of identifying associated risk factors among presumptive TB clients [11]. The same has been found in studies on predictors of a positive sputum smear – the behavioural and clinical characteristics were linked to the likelihood of bacteriological confirmation [12].

Male gender was significantly associated with smear positivity as compared to female gender (23.4% vs. 8.7%) in the present study with male gender

comprising the majority (60.8%). This male predominance is similar to that of previous studies which have indicated that smear-positive TB cases are more common among males. This may be explained by a higher occupational exposure, smoking behaviour, health care seeking and delay in males resulting in higher severity of disease and bacillary load. Hameed *et al.* tested risk factors of smear-positive pulmonary tuberculosis patients and highlighted clinical and demographic factors contributing to poor TB outcome in Pakistani population [13].

In our study, smear positive PTB was significantly associated with diabetes mellitus as diabetic individuals had higher smear positivity than non-diabetic (33.3%). Diabetes can affect immune function including the activity of macrophages and cell mediated immunity, which leads to greater susceptibility to active TB and may also exacerbate the bacterial disease burden. Park *et al.* showed that lifestyle factors and metabolic changes in type 2 diabetes were determinant factors and that diabetes management is a key issue in TB prevention [14]. In a similar fashion, Antonio-Arques *et al.* observed that individuals with diabetes mellitus also suffered from an elevated risk of TB, thus corroborating the importance of diabetes as a major co-morbidity for TB development [15].

The smoking status was the strongest independent predictor of smear-positive PTB in the present study. Smokers were found to have a significantly higher smear positivity than non-smokers (36.7% vs. 10.2%)

and smoking was independently associated with smear positivity after adjustment (aOR 7.97). Smoking might predispose to TB due to impaired mucociliary clearance, altered immune response, and damage to pulmonary tissue. Smoking has also been shown to be associated with TB outcomes in previous studies. Sinshaw *et al.* pointed out the importance of patient characteristics and risk factors in the determination of TB occurrence in presumptive pulmonary TB population, noting the role of behavioural factors in TB assessment [16].

Several other studies have also found other determinants to be associated with TB transmission and the pattern of drug resistance. Amin *et al.* examined presumptive TB cases and emphasized the need for systematic evaluation of the high-risk groups in an environment where there is a high risk for TB transmission [17]. Likewise, Sorsa and Kaso found that accurate diagnostic methods are crucial for TB patients, especially in vulnerable groups, and their study stressed the need for better diagnostic techniques, in addition to the usual microscopy [18].

Another important independent predictor in our study was close contact with a known TB patient. Participants with TB contact had higher smear positivity (34.9%) and almost 5 times higher odds of smear-positive disease (aOR 4.99). The results confirm the need for contact investigation in TB control programmes. Martinez *et al.* showed that having a TB case in the household or close contact to for a long time is an important risk factor for active TB disease [19]. Moreover, evidence from systematic review by Siddalingaiah *et al.* [20] confirmed that contact exposure is one of the significant factors for TB development, especially in vulnerable population.

Also, in our study, smear-positive PTB was independently associated with the previous TB history. The smear positivity was higher (36.7%) and the odds of smear-positive disease were higher (aOR 4.84) among patients with previous TB history. Previous TB may be due to relapse, reinfection, incomplete treatment response or persistent host susceptibility. The previously treated patients may be even more vulnerable to the additional risk of smoking and other behavioural factors. Systematic review and meta-analysis by Pourali *et al.* showed that smoking was an important determinant of TB recurrence which indicated the need to modify risk factors among TB patients with prior TB episodes [21].

Another important factor that was identified in this study was nutritional status. The underweight participants had significantly higher smear positivity

(32.6%) than the individuals with normal BMI. Malnutrition can lead to a decrease in immune competence and decrease the host response to *Mycobacterium tuberculosis*; leading to more disease progression. Nutritional scores were found to be associated with outcomes among pulmonary TB patients which underlines the need for nutritional assessment and support in the overall management of TB [22].

The present study also showed a relationship between smear positivity and severity of the disease, which was supported by radiological findings. There was a high prevalence of smear positivity among patients who had cavitation (58.1%) compared with those who did not have cavitation (8.3%). In a similar way, the smear-positive cases were more likely to show signs of consolidation. Cavitory lesions promote drainage of infected lung tissue, which enhances the release of bacillary material and the chances of finding bacilli by smear examination. This study is important in contributing to the TB control strategies. Patients should be targeted for early diagnostic assessment if they have a history of TB, TB contacts, diabetes and undernutrition. Specific screening strategies, behavioral interventions, nutrition support and better contact tracing can help to decrease the spread of TB.

LIMITATION

There are a number of limitations in this study. The cross-sectional design does not allow for the determination of causal relationships between risk factors and smear positivity. The study was carried out in a single tertiary care centre which restricts generalizability. Also, sputum smear microscopy may not be as sensitive as molecular diagnostic techniques in detecting paucibacillary disease. Future multicentre studies with improved diagnostic tools are recommended.

CONCLUSION

Smear positive pulmonary tuberculosis is still a significant burden in HIV negative presumptive TB patients. Smoking, contact with TB patients, previous TB history, diabetes mellitus, alcohol use, and low BMI were significantly associated with smear positivity. These findings underline the need to identify high-risk persons and take behavioural, nutritional and metabolic factors into account when assessing TB, in order to facilitate timely diagnosis and effective control of the disease.

CONFLICT OF INTEREST

None

GRANT SUPPORT & FINANCIAL DISCLOSURE

Declared none

AUTHORS CONTRIBUTION

Talib Hussain Jakhrani: Substantial contribution to study design, data acquisition and interpretation, manuscript drafting / review, final approval, responsible for every aspect of the research

Rizwan Ali Tunio: Substantial contribution to concept, study design and methodology; literature review, clinical guidance, data interpretation, supervision and critical manuscript review, final approval, responsible for every aspect of the research

Ali Waliullah: Substantial contribution to methodology, critical manuscript review, final approval, responsible for every aspect of the research

Tanzeel Ur Rehman: Substantial contribution to data acquisition, data organization, manuscript preparation/review, final approval, responsible for every aspect of the research

Nazeer Ali Unar: Substantial contribution to data interpretation, and critical manuscript review, final approval, responsible for every aspect of the research

Fahim Hadi: Substantial contribution to data acquisition and data entry, final approval, responsible for every aspect of the research

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