Characteristics of Poor Tuberculosis Treatment Outcomes among Patients with Pulmonary Tuberculosis in Community Hospitals of Thailand

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Abstract. Pulmonary tuberculosis (TB) is a major global public health problem. Thailand is listed as one of the countries with a high burden of pulmonary TB. Various factors are known to contribute to unsuccessful pulmonary TB treatment. However, studies in Thailand remain limited, especially in rural settings. This study aimed to identify the prevalence and associated factors of unsuccessful pulmonary TB treatment in community hospitals. A cross-sectional study was conducted from June–July 2019. We enrolled all patients receiving treatments in four community hospitals in central Thailand. The collected data included baseline characteristics, comorbid illnesses, a history of directly observed treatment—short course (DOTS), sputum acid-fast bacilli smear results, and chest radiography and treatment outcomes. Univariate and multivariate analyses were used to identify factors associated with unsuccessful pulmonary TB treatment. A total of 786 patients were enrolled in the study. Prevalence of unsuccessful treatment was 18.7%. Associated factors of unsuccessful pulmonary TB treatment were previously treated TB (adjusted odds ratio [AOR]: 2.1, 95% CI: 1.2–3.7), existence of comorbid illnesses (AOR: 2.8, 95% CI: 1.5–5.0), DOTS not performed (AOR: 2.5, 95% CI: 1.4–4.5), chest radiography showing multiple lung lesions at first diagnosis (AOR: 3.0, 95% CI: 1.7–5.2), no chest radiography improvement in the first follow-up (AOR: 17.7, 95% CI: 8.2–38.0), and unknown status of chest radiography in the first follow-up (AOR: 48.1, 95% CI: 22.3–103.5). Health promotion and primary care should be implemented in the communities to achieve ultimate successful treatment.

INTRODUCTION

Pulmonary tuberculosis (TB) is an airborne infectious disease of the lower respiratory tract caused by *Mycobacterium tuberculosis*. Treatment outcomes are important indicators of successful TB control policy. Despite efforts to implement effective treatment for over five decades, it has been estimated that one-third of the global population has contracted TB¹ and 5–10% developed disease progression during their lifetime.² The WHO regions reporting a high burden of TB include sub-Saharan Africa, western Pacific islands, and Southeast Asia.¹ More than two million new cases were diagnosed annually in Southeast Asia.³ In the Southeast Asian region, where poverty rates are high, TB leads to a great burden on national budget expenditure.³ Tuberculosis is one of the major causes of death globally. In 2017, people with TB, who died from the disease, totaled 16%.² An estimated 10.0 million new cases of TB occurred in 2017.² The WHO aimed to reduce the TB incidence rate from % to 5% annually and the mortality rate to 10%.²

Although only a small proportion of people who contracted TB will develop the disease, the proportion of disease development is higher among patients with HIV.^{1,2,4} HIV stimulates the progression of TB and vice versa.⁵ In addition, controlling TB among patients with HIV is more difficult than usual⁴ because of atypical manifestations resulting from suppressed immunity.^{5,6} TB is a leading cause of death among patients with HIV,⁷ although antiretroviral medications are taken appropriately.⁷

Thailand is listed as one of 14 countries with burdens regarding TB, HIV-associated TB, and multidrug-resistant TB (MDR-TB).² Risk groups of TB in Thailand include prisoners and immigrant workers from neighboring countries.⁸ TB is also a major cause of death among both male and female populations in Thailand.⁹

According to Thai National Tuberculosis Control Programme guideline (NTCPG), screening for TB is usually performed in risk groups or among patients with suspected symptoms such as chronic cough, fever of unknown origin, and unexplained significant weight loss. After receiving a diagnosis of TB, patients will be screened for HIV infection and will be given a liver function test, renal function test, eye examination, and advice for alcohol drinking cessation. Treatment regimens for adults with new pulmonary TB consist of 2 months of an intensive phase (2HRZE) and 4 months of a continuation phase (4HR), whereas patients with other conditions receive different regimens. Treatment regimens can be altered during the course of treatment according to the monitoring of patients' conditions.⁸

Although various health policies, such as directly observed treatment—short course (DOTS) were implemented to control pulmonary TB; however, the successful treatment rate has remained stable at 72–82% from 2002 to 2016.²

As of 2018, half of the Thai population is still living in rural settlements.¹⁰ Despite effective distribution of health-care services into rural regions of the country, TB control is still remaining a challenge.¹¹ This is a result from low-socioeconomic status, poor TB perceptions in communities, deficiencies in poor public health knowledge on TB, difficulty to access healthcare services, and complex consultation systems in public hospitals.^{12,13} From the Healthcare Accreditation Institute's survey, there were a total of 727 hospitals located in rural community areas of Thailand.¹⁴ These hospitals were termed “community

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hospital”—public hospitals with missions dedicated for primary and secondary health care, which included outpatient and inpatient services to patients with common health problems.¹⁵

It has been shown that several factors including high mycobacterial load,¹⁶ atypical clinical manifestation,¹⁶ lung cavitation and milary shadow,¹⁶ smear positive at the second month after initiation of treatment,¹⁷ immunocompromised status (HIV infection and diabetes mellitus),^{4,17,18} being male,^{16–18} older patients,^{18,19} and alcohol consumption^{17,20,21} were associated with unsuccessful treatment. However, studies remain limited of these associated factors of unsuccessful treatment outcomes in Thailand, especially in rural areas where primary and secondary prevention are important to control the disease. This study aimed to determine prevalence and associated factors of unsuccessful TB treatment in primary and secondary care settings in Thailand.

MATERIALS AND METHODS

Study population. The study population consisted of patients with TB receiving treatment in three community hospitals in Lopburi Province and a community hospital in Chachoengsao Province in central Thailand. The exclusion criteria comprised patients aged younger than 15 years, presenting extrapulmonary TB, latent TB; patients who were transferred to other healthcare units because of healthcare insurance; and patients who died from causes other than TB and TB-related illnesses. The causes of death of the patients are recorded by physicians in the TB treatment records.

Study setting. This study was conducted in three medium-sized (F2) community hospitals in Lopburi Province and one large-sized (F1) community hospital in Chachoengsao Province. F2 hospitals are community hospitals with 30 to 90 beds and have general practitioners (GPs) or family physicians providing secondary care services. F1 hospitals are community hospitals with 60 to 120 beds and have both GPs or family physicians and specialists from at least one major specialty (internal medicine, surgery, obstetrics—gynecology, pediatrics, orthopedics, and anesthesiology).

Study design. A cross-sectional study was conducted to determine prevalence and associated factors for unsuccessful TB treatment in four community hospitals in Lopburi and Chachoengsao provinces, central Thailand, from 2013 to 2018.

Data collection. Data were collected from TB treatment cards and medical records of patients from four community hospitals from 2013 to 2018. The case record form included seven parts which included 1) baseline characteristics including gender, age, occupation, provinces, and tobacco and alcohol consumption; 2) comorbid illness and history of illness; 3) clinical manifestation at first diagnosis whether typical (chronic cough and at least one of these symptoms: hemoptysis, significant weight loss, and prolonged fever) or atypical manifestation; 4) DOTS; 5) sputum smear at first diagnosis and followed throughout the treatment course; 6) chest radiography at first diagnosis and subsequent chest radiographs; and 7) treatment outcomes, that is, cured, completed, failed, dead, default, and transferred because of drug resistant-TB (DR-TB). Although DR-TB could not be identified by the community hospitals, the patients could be suspected as DR-TB if the patients did not response well with the drug regimen

prescribed by the hospitals. Whenever the patients were suspected of DR-TB, their sputum will be collected and sent to tertiary hospitals for laboratory confirmation. If the patients were confirmed to have DR-TB, they would be transferred to the tertiary hospitals for further treatment by pulmonologists and the referral would be noted in the treatment record, marking the end of treatment at the community hospitals. Cured and completed outcomes were grouped in successful treatment outcomes, whereas failed, dead, default, and transferred because of DR-TB were grouped in unsuccessful treatment outcomes.

Definitions. According to the WHO treatment²² and Thai NTCPG guidelines,⁸ pulmonary TB is a case of TB involving the lung parenchyma. Patients are considered to have smear-positive pulmonary TB when one or more sputum smear specimens at the start of treatment are positive for . Smear-negative pulmonary TB is considered when sputum acid-fast bacilli (AFB) smear is negative. However, culture positive for *M. tuberculosis* can also be considered or in a case where clinicians decide to treat with full course anti-TB therapy with radiographic abnormalities consistent with pulmonary TB. This involves either evidence of HIV infection, or if HIV-negative, the patient shows no improvement in response to a course of broad-spectrum antibiotics excluding anti-TB drugs, fluoroquinolones, and aminoglycosides.

At the end of treatment, patients can be classified into six groups by treatment outcomes. Patients are considered cured when their sputum AFB smear or culture is negative at the end of treatment. Treatment is considered complete when patients have completed the treatment, but do not show a negative sputum AFB smear or culture results in the last month of treatment, but the latest sputum smear is negative. Treatment is considered failed when the sputum AFB smear or culture is positive at the fifth month or later during treatment. Dead includes all patients who died from any causes during treatment. Default is defined when treatment is interrupted for 2 consecutive months or more. Transferred out is considered when patients are transferred to another healthcare unit without known outcome treatment.

Statistical analysis. This study used SPSS version 23.0 (IBM Corporation, Armonk, NY) to calculate prevalence and associated factors of unsuccessful treatment outcomes. Data are displayed in frequencies and percentages for baseline characteristics and treatment outcomes. The chi-squared test is used for comparing categorical variables by hospital levels. To evaluate associated factors of unsuccessful treatment outcomes, comparison of variables between successful and unsuccessful treatment outcomes by univariate analysis was conducted. For multivariate analysis, multiple logistic regression with “enter” procedure was used. The potential factors for inclusion into multivariate analysis included factors that were significant in univariate analysis, factors with a *P*-value < 0.200, and factors that were significant in previous studies. Factors that were likely to be potential confounders to others were checked before by cross-tabulation function. The confounding factors would not be included in multivariate analysis. Unrecorded, unperformed, and uncollected data were marked with “unknown statuses.” A *P*-value < or equal to 0.05 was an indicator of statistically significant factors.

Ethical consideration. Our study was approved by the Institutional Review Board of the Royal Thai Army Medical Department. The study number was R054h/62_Exp.

RESULTS

Of 836 patients with TB receiving treatment in four hospitals, 50 patients were excluded from the study which included 21 patients with extrapulmonary TB, 14 patients who died from causes other than TB or TB-related illnesses, seven patients who were younger than 15 years, four patients with latent TB, and three patients who were transferred out because of health insurance issues. Thus, 786 patients were enrolled in the study. The screening process is depicted in Figure 1.

Baseline characteristics. Among 786 patients included in this study, 70.5% were male, 52.8% were laborers, 57.3% lived in Lopburi, 42.8% received treatment at Hospital A, 57.3% received treatment in F2 hospitals, 65.9% had at least one comorbid illness, 84.5% had typical clinical manifestations at the first diagnosis, and only 62.1% received DOTS. Most patients were 60 years old and older (35.2%). The median age was 52 (range: 15–91) years. A history of alcohol consumption and cigarette smoking was found among 42.1% and 46.8% of the patients, respectively. The most frequent comorbid illnesses were hypertension (28.8%) and diabetes mellitus (14.4%). Prevalence of HIV coinfection was 5.5%. A history of close contact with patients with TB was found among 24.7% of the patients. Most patients had smear-positive TB (61.2%). The rate of sputum specimens of the patients to be smear negative by the second month was 73.7% after initiating treatment. Most patients had one or no lung lesions at diagnosis (81.9%). The most frequent lung lesion was reticulonodular infiltration (81.0%). Most patients showed improvement in chest radiography during the first follow-up (54.3%) The baseline characteristics are displayed in Table 1.

Prevalence of unsuccessful TB treatment. The outcomes of treatment revealed that 81.3% of patients had successful pulmonary TB treatment and 18.7% of patients had unsuccessful pulmonary TB treatment. The unsuccessful outcomes could be classified into four groups: dead (7.3%),

default (4.7%), failed (3.9%), and transferred out to tertiary center because of DR-TB (2.8%). The prevalence of unsuccessful TB treatment is shown in Table 2.

Comparing baseline characteristics and treatment outcomes by the hospital level. Baseline characteristics significantly differed between existence of comorbid illnesses ($P < 0.001$), DOTS ($P < 0.001$), sputum AFB smear type ($P < 0.001$), sputum AFB at the second month ($P = 0.021$), and first follow-up of chest radiography ($P < 0.001$). Treatment outcomes significantly differed between F1 and F2 hospitals ($P < 0.001$). The comparison result is displayed in Table 3.

Associated factors of unsuccessful pulmonary TB treatment. Adjusted associated factors of unsuccessful pulmonary TB treatment included previously treated TB (AOR: 2.1, 95% CI: 1.2–3.7, $P = 0.009$) existence of comorbid illnesses (AOR: 2.8, 95% CI: 1.5–5.0, $P = 0.001$), DOTS not performed (AOR: 2.5, 95% CI: 1.4–4.5, $P = 0.002$), having multiple lung lesions at first diagnosis (AOR: 3.0, 95% CI: 1.7–5.2, $P < 0.001$), and the first follow-up of chest radiography showing no improvement (AOR: 17.7, 95% CI: 8.2–38.0, $P < 0.001$), and unknown status of chest radiography in the first follow-up (AOR: 48.1, 95% CI: 22.3–103.5, $P < 0.001$). Adjusted confounding factors included genders, age-groups, hospital levels, previously treated TB, underlying respiratory diseases, existence of comorbid illnesses, DOTS status, lung lesions at diagnosis, and the first follow-up of chest radiography. The results are summarized in Table 4.

DISCUSSION

This study identified prevalence and associated factors of unsuccessful pulmonary TB treatment in community hospitals located in central Thailand. This study demonstrated a similar prevalence of unsuccessful pulmonary TB treatment in community hospitals as compared with the 2018 WHO report of TB in Thailand² and also studies conducted in Russia,²¹ southern Ethiopia,²³ and India.²⁴ The prevalence was higher

FIGURE 1. Screening process of samples for the study.

TABLE 1

Baseline characteristics of pulmonary tuberculosis patients (*n* = 786)

Characteristic	<i>n</i> (%)
Gender	
Male	554 (70.48)
Female	232 (29.52)
Age (years)	
15–29	74 (9.41)
30–44	177 (22.52)
45–59	258 (32.82)
60 and older	277 (35.24)
Occupation	
Labor	415 (52.80)
Unemployed	272 (34.61)
Others	99 (22.59)
Province	
Lopburi	450 (57.25)
Chachoengsao	336 (42.75)
Hospital	
Hospital A	336 (42.75)
Hospital B	227 (28.88)
Hospital C	162 (20.61)
Hospital D	61 (7.76)
Hospital level	
F1 hospital	336 (42.75)
F2 hospital	450 (57.25)
Alcohol use	
Yes	362 (42.06)
No	424 (53.94)
Tobacco use	
Yes	368 (46.82)
No	418 (53.18)
Comorbid illnesses and history of illnesses (<i>n</i> = 838)*	
Underlying hypertension	226 (28.75)
History of TB contact	194 (24.68)
Underlying diabetes mellitus	113 (14.38)
Previously treated TB	111 (14.12)
HIV coinfection	43 (5.47)
Underlying respiratory diseases	41 (5.22)
Underlying chronic kidney disease	9 (1.15)
Others	101 (12.85)
Existence of comorbid illnesses	
Yes	518 (65.90)
No	268 (34.10)
Clinical manifestation at first diagnosis	
Typical	664 (84.48)
Atypical	122 (15.52)
DOTS status	
Performed	488 (62.09)
Not performed	136 (17.30)
Unknown†	162 (20.61)
Sputum AFB at diagnosis	
Positive	481 (61.20)
Negative	286 (36.39)
Unknown‡	19 (2.42)
Sputum AFB at second month	
Positive	46 (5.85)
Negative	579 (73.66)
Unknown‡	161 (20.48)
Chest radiography lesion at diagnosis	
One or no lung lesion	644 (81.93)
Multiple lung lesions	142 (18.07)
Lung lesion (<i>n</i> = 926)	
Reticulonodular infiltration	637 (81.04)
Lung cavitation	115 (14.63)
Pleural effusion	50 (6.36)
Miliary shadow	8 (1.02)
Others	116 (14.76)
First follow-up of chest radiography	
Improved	427 (54.33)
Not improved	174 (22.14)
Unknown	185 (23.54)

* Some patients had more than one comorbid illness.

† One sixty two cases had unknown DOTS status.

‡ Some cases did not perform sputum AFB at diagnosis or at 2 months.

§ Some patients had multiple lung lesions.

|| One eighty five cases did not perform follow-up chest radiography.

TABLE 2

Classification of pulmonary tuberculosis (TB) patients by treatment outcomes (*n* = 786)

Treatment outcome	<i>n</i> (%)
Successful	
Cured	375 (47.71)
Completed	264 (33.59)
Unsuccessful	
Dead	57 (7.25)
Default	37 (4.71)
Failed	31 (3.94)
Transferred because of multidrug-resistant TB	22 (2.80)

than studies conducted in Europe,²⁵ United Kingdom,²⁶ and PR China.¹⁶

The chi-squared test and independent *t*-test revealed significant differences in baseline characteristics and treatment outcomes between F1 and F2 hospitals. In F2 hospitals, patients were more likely to have comorbid illnesses, never managed or unknown status of DOTS, smear-negative pulmonary TB, have positive sputum AFB smear by the second month, had no improved chest radiography follow-up, and a higher unsuccessful treatment rate. The differences in quality of facilities, infrastructures, staff, and systems were contributors to these characteristics. In a study in Nigeria, hospitals' quality in TB case management was affected by the DOTS strategy, patients' health knowledge, and efficacy of laboratory investigations used to diagnose and monitor patients.²⁷ Although DOTS provides many advantages in all pulmonary TB treatments consisting of smear-negative or -positive, new or retreated cases compared with self-administration therapy,^{28–30} the result of DOTS coverage in this study was still low compared with the WHO³¹ recommendation and other studies conducted in other regions of Thailand^{32–34} and was not effectively operated by F2 hospitals. Related studies indicated that DOTS coverage was inconsistent across Thailand and compliance to the strategy was poor.^{32,35} There was also unknown status of DOTS in F2 hospitals, which was contributed by poor records of DOTS and unrecorded DOTS data. This poor quality of DOTS data could result in difficult follow-ups of patients' treatment. Studies in India and South Africa have shown that poor diagnostic and treatment outcomes are contributed by health-care providers' weak knowledge, weak health systems, and weak general management of TB cases by nonphysician healthcare providers.³⁶ Moreover, in F2 hospital settings, TB cases are managed by GPs. A study in Indonesia indicated that management of TB cases by GPs may not be in line with the standard guidelines.³⁷

Similar to recent studies, previously treated TB was associated with unsuccessful treatment.^{19,20,38,39} A study in Morocco indicated that patients who failed previous treatment were also more likely to fail retreatment.⁴⁰ Also, default in retreatment was more frequent among patients who defaulted from previous treatment.⁴⁰ Moreover, previous treatment outcomes could be used to predict the development of DR-TB.^{41–43}

This study had shown that patients who did not receive DOTS were more likely to have unsuccessful treatment outcomes. In a setting of this study, patients usually received DOTS at the clinic, thus resulting in low rates of DOTS applied. It appeared that lack of staff was a major reason that DOTS was inadequately applied in this study. In a study

TABLE 3
Comparison of baseline characteristics of pulmonary tuberculosis patients and treatment outcomes by hospital levels ($n = 786$)

Characteristic	Hospital level		P-value
	F1 hospital, n (%)	F2 hospital, n (%)	
Gender			0.163
Male	228 (67.86)	326 (72.44)	
Female	108 (32.14)	124 (27.56)	
Age (years) (mean $\pm$ SD)	53.18 $\pm$ 16.50	51.84 $\pm$ 16.08	
Existence of comorbid illnesses			< 0.001**
Yes	183 (54.46)	335 (74.44)	
No	153 (45.54)	115 (25.56)	
Directly observed treatment—short course status			< 0.001**
Performed	318 (94.64)	170 (37.78)	
Not performed	18 (5.36)	118 (26.22)	
Unknown*	0 (0.00)	162 (36.00)	
Sputum AFB at diagnosis			< 0.001**
Positive	235 (69.94)	246 (54.67)	
Negative	96 (28.57)	190 (42.22)	
Unknown†	5 (1.49)	14 (3.11)	
Sputum AFB at the second month			0.021**
Positive	14 (4.17)	32 (7.11)	
Negative	264 (78.57)	315 (70.00)	
Unknown†	58 (17.26)	103 (22.89)	
Chest radiography lesion at diagnosis			0.537
One or no lung lesion	272 (80.95)	372 (82.67)	
Multiple lung lesions	64 (19.05)	78 (17.33)	
First follow-up of chest radiography			< 0.001**
Improved	204 (60.71)	223 (49.56)	
Not improved	33 (9.82)	141 (31.33)	
Unknown‡	99 (29.46)	86 (19.11)	
Treatment outcomes			< 0.001**
Successful	295 (87.80)	344 (76.44)	
Unsuccessful	41 (12.20)	106 (23.56)	

* One sixty two cases had unknown DOTS status.

† Some cases did not perform sputum AFB at diagnosis or at 2 months.

‡ One eighty five cases did not perform follow-up chest radiography.

** Significant at $P < 0.05$ at 95% CI.

conducted in India, patients treated without DOTS had higher risks of adverse outcomes than patients treated with DOTS.⁴⁴ The rural area was indicated to be one of the factors contributing to low adherence to DOTS in studies conducted in Egypt,⁴⁵ China,⁴⁶ and Nepal.⁴⁷ There were various reasons that made the rural area being the contributing factor to low DOTS adherence such as travel costs, illiteracy, poor knowledge of TB, and frequent visits to the clinic.^{48–51} In one study, patients receiving community-based DOTS achieved successful treatment and curative treatment more than self-administered therapy.²⁹ In another study, completion was 100% in patients receiving community-based DOTS.⁵² This strategy could enlighten a new model for treatment of TB in rural communities.

In this study, the existence of comorbid illnesses was associated with unsuccessful treatment of pulmonary TB. In resource-limited countries, comorbidity of TB with both communicable and noncommunicable diseases is common; thus, a high efficacy of responses to both TB and other comorbid illnesses is required.⁵³ However, this attempt is difficult to achieve in resource-limited countries. Moreover, noncommunicable diseases increase individuals' vulnerability to TB.⁵³ Comorbid illnesses and poor health status also increase mortality rates among patients with TB.⁵⁴ In addition, from this study, 35.2% were patients aged 60 years and older. Treatment of TB in older patients is more complicated than in other age-groups because of impaired immunity from underlying conditions, increased incidence of drug side effects, and limitations due to polypharmacy.⁵⁵

Multiple lung lesions are associated with unsuccessful pulmonary TB treatment. In this study, 21.7% of patients with cavity and 62.50% of patients with miliary shadow experienced unsuccessful treatment. Studies conducted in the United Kingdom and Brazil indicated that lung cavitation was prone to high mycobacterial load.^{56,57} *Mycobacterium tuberculosis* is more likely to lodge in these cavities that are less affected by anti-TB drug actions, resulting in poor treatment success.⁵⁸ In a study in PR China, patients with miliary shadow were more likely to have unsuccessful treatment outcomes,¹⁶ whereas a study conducted in the Netherlands stated that miliary TB was one of the predictors for mortality in both drug susceptible- and drug resistant-tuberculosis.^{59,60} This study indicated that patients with more lung lesions such as coexistence between reticulonodular infiltration and cavitation or miliary shadow were more likely to have unsuccessful treatment outcomes because of higher mycobacterial load and low efficacy of anti-TB drugs to penetrate these lung lesions. Interpretation of chest radiography by specialists such as radiologists in tertiary care centers could be more accurate than by GPs; thus, diagnosis and follow-ups would be successful in tertiary care centers.

Patients showing no improvement in chest radiography during the first follow-up also revealed a higher likelihood to have unsuccessful outcomes. According to the clinical practice guidelines in Thailand, following up chest radiography first at the second month after initiation of treatment and second at the end of treatment is recommended.⁶¹ Chest radiography is useful to diagnose and follow up in smear-negative TB cases^{62,63} as a large proportion of smear-negative TB cases

TABLE 4

Univariate and multivariate analysis of associated factors of unsuccessful pulmonary tuberculosis (TB) treatment outcomes in rural Thailand, 2013–2018 ($n = 786$)

Characteristic	Outcomes		Crude OR	95% CI	P-value	Adjusted OR	95% CI	P-value
	Successful, n (%)	Unsuccessful, n (%)						
Gender								
Female	197 (84.91)	35 (15.09)	1.00			1.00		
Male	442 (79.78)	112 (20.22)	1.43	0.94–2.16	0.094	1.04	0.62–1.75	0.890
Age (years)								
15–29	66 (89.19)	8 (10.81)	1.00			1.00		
30–44	145 (81.92)	32 (18.60)	1.82	0.80–4.20	0.156	1.92	0.73–5.03	0.185
45–59	210 (81.40)	48 (18.60)	1.89	0.85–4.19	0.119	1.96	0.77–5.00	0.161
60 and older	218 (78.70)	59 (21.30)	2.23	1.02–4.91	0.046	1.63	0.64–4.16	0.309
Occupation								
Labor	338 (81.45)	77 (18.55)	1.00					
Unemployed	210 (77.21)	62 (22.79)	1.30	0.89–1.89	0.177			
Others	91 (91.92)	8 (8.08)	0.39	0.18–0.83	0.015			
Province								
Chachoengsao	295 (87.80)	41 (12.20)	1.00					
Lopburi	344 (76.44)	106 (23.56)	2.22	1.50–3.28	< 0.001			
Hospital								
Hospital A	295 (87.80)	41 (12.20)	1.00					
Hospital B	133 (82.10)	29 (17.90)	0.64	0.38–1.07	0.088			
Hospital C	164 (72.25)	63 (27.75)	1.76	1.07–2.89	0.025			
Hospital D	47 (77.05)	14 (22.95)	1.37	0.67–2.81	0.395			
Hospital level								
F1 hospital	295 (87.80)	41 (12.20)	1.00			1.00		
F2 hospital	344 (76.44)	106 (23.56)	2.22	1.50–3.29	< 0.001	1.73	0.95–3.17	0.075
Alcohol use								
No	341 (80.42)	83 (19.58)	1.00					
Yes	298 (82.32)	64 (17.68)	0.88	0.62–1.27	0.497			
Tobacco use								
No	341 (81.58)	77 (18.42)	1.00					
Yes	298 (80.98)	70 (19.02)	1.04	0.73–1.49	0.829			
History of TB contact								
No	481 (81.25)	111 (18.75)	1.00					
Yes	158 (81.44)	36 (18.56)	0.99	0.65–1.50	0.952			
Previously treated TB								
No	566 (83.85)	109 (16.15)	1.00					
Yes	73 (65.77)	38 (34.23)	2.70	1.74–4.21	< 0.001	2.11	1.20–3.71	0.009*
Underlying diabetes mellitus								
No	546 (81.13)	127 (18.87)	1.00					
Yes	93 (82.30)	20 (17.70)	0.93	0.55–1.56	0.768			
HIV coinfection								
No	606 (81.56)	137 (18.44)	1.00					
Yes	33 (76.74)	10 (23.26)	1.34	0.65–2.79	0.432			
Underlying respiratory diseases								
No	612 (82.15)	133 (17.85)	1.00					
Yes	27 (65.85)	14 (34.15)	2.39	1.22–4.68	0.011	1.15	0.49–2.70	0.741
Underlying chronic kidney disease								
No	632 (81.34)	145 (18.66)	1.00					
Yes	7 (77.78)	2 (22.22)	1.25	0.26–6.06	0.786			
Existence of comorbid illnesses								
No	243 (90.67)	25 (9.33)	1.00			1.00		
Yes	396 (76.45)	122 (23.55)	3.00	1.89–4.74	< 0.001	2.76	1.53–4.99	0.001*
Clinical manifestation at first diagnosis								
Typical	541 (81.48)	123 (18.52)	1.00					
Atypical	98 (80.33)	24 (19.67)	1.08	0.66–1.75	0.765			
Directly observed treatment—short course status								
Performed	418 (85.66)	70 (14.34)	1.00					
Not performed	88 (64.71)	48 (35.29)	3.26	2.11–5.02	< 0.001	2.52	1.40–4.54	0.002
Unknown†	133 (82.10)	29 (17.90)	1.30	0.81–2.09	0.276	1.28	0.65–2.53	0.475
Sputum AFB at diagnosis								
Negative	230 (72.33)	88 (27.67)	1.00					
Positive	393 (87.53)	56 (12.47)	0.92	0.63–1.34	0.659			
Unknown‡	16 (84.21)	3 (15.79)	0.77	0.22–2.74	0.686			
Sputum AFB at the second month								
Negative	528 (91.19)	51 (8.81)	1.00					
Positive	32 (69.57)	14 (30.43)	4.53	2.27–9.04	< 0.001			
Unknown‡	79 (49.07)	82 (50.93)	10.75	7.05–16.39	< 0.001			

(continued)

TABLE 4
Continued

Characteristic	Outcomes		Crude OR	95% CI	P-value	Adjusted OR	95% CI	P-value
	Successful, n (%)	Unsuccessful, n (%)						
Chest radiography lesion at diagnosis								
One or no lung lesion	539 (83.70)	105 (16.30)	1.00			1.00		
Multiple lung lesions	100 (70.42)	42 (29.58)	2.16	1.42–3.27	< 0.001	2.98	1.72–5.17	< 0.001*
Reticulonodular infiltration								
No	126 (84.56)	23 (15.44)	1.00					
Yes	513 (80.53)	124 (19.47)	1.32	0.81–2.16	0.257			
Cavitation								
No	549 (81.82)	122 (18.18)	1.00					
Yes	90 (78.26)	25 (21.74)	1.25	0.77–2.03	0.367			
Pleural effusion								
No	602 (81.79)	134 (18.21)	1.00					
Yes	37 (74.00)	13 (26.00)	1.58	0.82–3.05	0.175			
Miliary shadow								
No	636 (81.75)	142 (18.25)	1.00					
Yes	3 (37.50)	5 (62.50)	7.47	1.76–31.60	0.006			
First follow-up of chest radiography								
Improved	418 (97.89)	9 (2.11)	1.00			1.00		
Not improved	116 (66.67)	58 (33.33)	23.22	11.17–48.27	< 0.001	17.68	8.23–37.99	< 0.001*
Unknown§	105 (56.76)	80 (43.24)	35.39	17.20–72.81	< 0.001	48.08	22.33–103.51	< 0.001*

* Significant at $P < 0.05$ at 95% CI.

† One sixty two cases had unknown DOTS status.

‡ Some cases did not perform sputum AFB at diagnosis or at 2 months.

§ One eighty five cases did not perform follow-up chest radiography.

develop in consistent with chest radiography for TB.⁶³ A study in Indonesia indicated that chest radiography grading scores correlated with TB severity and response to treatment.⁶⁴ One related study suggested that chest radiography without improvement may indicate DR-TB or other lung lesions.⁶⁵

This study had some limitations. First, data on anti-TB regimens were not collected because of varying and modified regimens and unequal extended periods of treatment among patients; however, anti-TB regimens could constitute an important factor for treatment outcomes. As one study had discovered that patients with resistance to the second-line drug regimen could result in poor treatment outcomes.⁶⁶ Second, MDR-TB accounts for 2.2% of new cases and 24% of related cases treated in Thailand.² Success rates of MDR-TB treatment totaled only 60% in 2015 in Thailand.² Thus, MDR-TB could serve as a factor for unsuccessful treatments.¹ In a study conducted in Pakistan and the Netherlands, MDR-TB and extensively DR-TB were predictive factors of unsuccessful treatment outcomes.^{60,66} However, because of limited resources in community hospitals, MDR-TB cases cannot be diagnosed in this setting. Thus, no records of MDR-TB were available in community hospitals. Third, there were some variables with missing data in this study, which included the DOTS status (20.61%), sputum AFB at diagnosis (2.42%), sputum AFB at the second month (20.48%), and first follow-up of chest radiography (23.54%). Two variables (DOTS status and first follow-up of chest radiography) were included into multivariate analysis. We prevent the selection bias by labeling these missing data as the “unknown status” category in each variable. Thus, all cases were included into multivariate analysis.

One recommendation is for F2 hospitals to apply approach strategies in communities for earlier diagnosis and better follow-up for patients. Consultation and communication between GPs and specialists should be conducted to optimize ultimate treatment outcomes by GPs. Special training in radiography interpretation for healthcare providers should be emphasized to expand TB care in communities.

This study provided data on prevalence and associated factors of unsuccessful pulmonary TB treatment in community hospitals of Thailand. These data could assist with distributing and planning of healthcare resources to improve public well-being. For healthcare practitioners, it serves to highlight the importance of diagnosis, treatment, and monitoring of patients with TB.

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