

When universal coverage is not enough: a mixed methods exploration of tuberculosis medication adherence in Bangkok

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Research Article

Keywords: Tuberculosis, Medication adherence, Mixed methods, Universal health coverage, Healthcare access, Thailand

Posted Date: February 7th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8525948/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Tuberculosis remains a pressing public health concern in Thailand, where medication adherence largely determines treatment success and the prevention of drug resistance. This study sought to examine factors influencing anti-tuberculosis medication adherence among patients attending Lerdsin Hospital in Bangkok.

Methods

We employed a sequential explanatory mixed methods design. The quantitative phase surveyed 100 tuberculosis patients using a questionnaire grounded in the WHO five-dimensional adherence framework. The qualitative phase involved in-depth interviews with 12 patients selected through purposive sampling. Survey data were analysed using descriptive statistics and binary logistic regression; interview transcripts underwent thematic analysis.

Results

Eighty-seven percent of participants demonstrated good adherence. Logistic regression identified medication-related factors ($OR = 0.178$, 95% CI: 0.039–0.804, $p = 0.025$) and healthcare system factors ($OR = 0.327$, 95% CI: 0.108–0.985, $p = 0.047$) as significant negative predictors, with the model explaining 81.5% of variance. Five qualitative themes emerged: the protective role of universal health coverage, barriers to access and continuity, economic burden, social and family support, and cultural beliefs. Joint display analysis revealed both convergence and partial discordance—high satisfaction scores coexisted with process-level frustrations voiced during interviews.

Conclusion

Although Thailand's universal coverage schemes effectively absorb direct treatment costs, adverse drug reactions and indirect expenses persist as formidable obstacles. Strengthening proactive adverse event management, offsetting hidden costs, and screening for social support gaps at treatment initiation may enhance adherence and curb drug resistance.

Background

Tuberculosis (TB) remains one of the most significant global public health challenges, ranking among the leading causes of death from a single infectious agent. This chronic infectious disease is caused by *Mycobacterium tuberculosis*, an acid-fast bacillus that primarily spreads through aerosol droplets generated during coughing, sneezing, speaking, or laughing of infected individuals [2]. Despite decades

of international efforts to control the disease, epidemiological data reveal that TB incidence and mortality rates remain alarmingly high worldwide. The World Health Organization (WHO) estimates that approximately one-third of the global population, or roughly 2–3 billion people, are infected with *M. tuberculosis*, with 5–15% of these individuals at risk of developing active TB disease during their lifetime [2].

According to the Global Tuberculosis Report 2023 from the WHO, the global TB incidence in 2022 reached 10.6 million cases, with the Southeast Asia region accounting for 46%, followed by Africa (23%), Western Pacific (18%), Eastern Mediterranean (8.1%), the Americas (3.1%), and Europe (2.2%). This represents an increase compared to 2021 and 2020, which recorded 10.3 million and 10 million cases, respectively—a trend that contradicts the WHO's End TB Strategy target of reducing TB incidence by 50% by 2025. The increase in TB incidence during 2021 and 2022 has been attributed to disruptions in diagnosis and treatment services during the COVID-19 pandemic, which inadvertently facilitated increased transmission of the disease [3].

In the context of Thailand, TB continues to pose a substantial public health burden. The WHO classifies Thailand among the 14 countries with the highest combined TB burden globally [4]. Data from 2018 indicated that Thailand had approximately 10 million new and relapsed TB cases worldwide, with 1.5 million deaths, including approximately 860,000 HIV-positive individuals [5]. The International Union Against Tuberculosis and Lung Disease (IUATLD) has designated March 24 as World TB Day to raise global awareness. WHO estimates suggest that Thailand has approximately 101,000 new TB cases annually, corresponding to an incidence rate of 143 per 100,000 population, with approximately 15,000 TB-HIV co-infected patients and 7,400 annual deaths [6]. Recent data from 2022 indicate that new TB cases have increased to approximately 103,000, with over 12,000 deaths.

According to the Thailand TB Surveillance Report for fiscal year 2021 from the Division of Tuberculosis, data as of March 31, 2021, revealed that new and relapsed TB cases of all types (Thai nationals, non-Thai nationals, and prison populations) registered totaled 35,951 cases, representing a notification rate of 54.0 per 100,000 population. Results from the 2018 fiscal year showed that 85,029 patients were registered for TB treatment (new and relapsed cases), representing a case detection and treatment coverage rate of 80% (85,029/106,000) [7]. Multiple factors contribute to the low treatment coverage rate, including patients not entering the healthcare system, seeking services at private clinics or hospitals outside the Ministry of Public Health network, receiving care without proper diagnosis, or being diagnosed but not reported to the TB surveillance system [8].

In major urban centers where populations lead fast-paced and competitive lifestyles, many TB patients face significant obstacles in accessing appropriate healthcare. Amid towering buildings and congested streets, traveling to healthcare facilities is not straightforward for everyone, particularly those who depend on public transportation and have limited income. Furthermore, in communities that maintain traditional beliefs, some individuals remain hesitant to seek treatment due to fear of social stigma or misconceptions about the disease and its treatment. These phenomena reflect the impact of social

structures, cultural beliefs, and economic factors that impede healthcare access for TB patients in urban settings.

Problems and inequities within the Thai public health system contribute to disparities in accessing equitable healthcare services, with socially vulnerable groups being disproportionately affected. These problems arise from multiple interconnected factors across various dimensions, including barriers to personal healthcare access related to social status (such as gender, language, ethnicity, place of origin, and culture), social capital (referring to interpersonal relationships and social networks—where having family, friends, or community members providing care and guidance increases opportunities for healthcare access), and human capital (such as education and occupation, where higher educational attainment is associated with better healthcare access) [9]. Additionally, research indicates that patients' tolerance of their own symptoms, reluctance to seek care unless symptoms are severe, and feelings of being a burden contribute to reduced healthcare-seeking behavior, particularly among vulnerable populations including the poor, those in remote areas, and laborers [10].

The consequences of delayed healthcare access are well-documented in the experiences of pulmonary TB patients. When patients allow suspicious TB symptoms to persist for extended periods without seeking proper examination and treatment, it leads to delays in TB control. This increases mortality risk among pulmonary TB patients and facilitates greater community transmission of the disease [11–13]. Understanding the impact of these delays is crucial for developing effective intervention strategies.

Despite the existence of effective TB control policies and treatment guidelines, a critical challenge remains: the lack of medication adherence among patients, particularly in the initial phases of treatment. This significantly affects treatment effectiveness, disease transmission reduction, and overall disease control [14–15]. Factors contributing to non-adherence include distance from healthcare facilities, financial burden, medication side effects, and lack of knowledge and understanding about the disease and treatment process. These barriers create a complex web of challenges that healthcare systems must address to improve treatment outcomes.

Premature discontinuation of medication or inconsistent drug intake is a major cause of drug-resistant TB, which renders standard first-line medications ineffective and necessitates the use of more expensive alternative drugs, longer treatment duration, and increased risk of severe side effects. Drug-resistant TB represents not only a clinical challenge but also a significant threat to public health systems globally. Understanding the factors influencing medication adherence in TB patients is therefore essential for developing guidelines or screening criteria that can identify at-risk patients early in their treatment, thereby enhancing long-term care efficiency and supporting national TB control objectives.

The conceptual framework for understanding TB medication adherence was developed through synthesis of theoretical and empirical evidence. According to the patient-centered access to healthcare framework proposed by Levesque et al. [16], healthcare access is conceptualized as the interface between health systems and populations, encompassing dimensions of approachability, acceptability, availability, affordability, and appropriateness from the supply side, and corresponding abilities to

perceive, seek, reach, pay, and engage from the demand side [1]. This framework provides a comprehensive lens for examining the multiple barriers TB patients face in accessing and maintaining treatment.

Factors influencing TB medication adherence can be categorized into five main groups. First, patient-related factors include individual characteristics such as age, gender, education level, TB knowledge, attitudes toward treatment, understanding of the treatment process, mental health status, and personal motivation, all of which affect patients' intention and ability to maintain consistent medication use. Second, medication-related factors encompass the physical characteristics and properties of TB medications, including the number of pills required daily, treatment regimen complexity, treatment duration, drug side effects, ease of administration, and medication storage requirements. Third, socioeconomic factors include economic status, income level, job security, education level, and social support from family, community, or friends, where strong social networks can enhance motivation and support treatment adherence. Fourth, healthcare system factors cover service readiness and quality, including accessibility of healthcare facilities, continuity of care, waiting times, counseling and follow-up by healthcare providers, reminder or support systems, and medication availability. Fifth, condition-related factors include the characteristics and severity of TB disease, such as stage of infection, presence of comorbidities (particularly HIV co-infection), symptom severity, impact on daily life, and patient understanding of disease prognosis.

Given the rising TB incidence and the persistent nature of TB as a significant public health problem in many countries, particularly in developing nations such as Thailand, this research aims to comprehensively analyze the various factors—including the impact of social structures, cultural beliefs, and economic factors—that affect healthcare access and medication adherence among TB patients in urban settings. Understanding these complex, interrelated factors will help design appropriate intervention strategies and support measures to enhance treatment efficiency and reduce the likelihood of drug-resistant TB development.

Research Objectives

The primary objective of this research is to examine the factors influencing TB medication adherence among patients receiving treatment at Lerdsin Hospital, Bangkok. The secondary objectives include: (1) analyzing individual factors such as knowledge, attitudes, and understanding of the disease that affect medication-taking behavior; (2) studying family and social factors, including family support and motivation from healthcare personnel; (3) exploring barriers that patients face in adhering to anti-TB medication regimens, such as drug side effects, service accessibility, and economic burden; and (4) understanding the influence of social structures, cultural beliefs, and economic factors on healthcare access for TB patients.

Study design

This study conducted a sequential explanatory mixed methods investigation comprising two consecutive phases. The initial quantitative phase employed a cross-sectional survey approach to determine medication adherence levels and examine associated factors among tuberculosis patients. Following the quantitative data collection, we undertook a qualitative phase using in-depth interviews to gain deeper insights into patient experiences and perspectives regarding anti-tuberculosis treatment. The entire investigation was carried out between November 2024 and March 2025.

Study setting

This investigation took place at the tuberculosis clinic (Green Clinic) of Lerdsin Hospital, a tertiary care facility located in Bangkok, Thailand. The clinic operates under the World Health Organization-recommended Directly Observed Treatment Short-course (DOTS) programme and serves patients with both drug-susceptible and drug-resistant tuberculosis from the greater Bangkok metropolitan area and surrounding provinces.

Phase 1: Quantitative component

Participants and sampling

The study population consisted of tuberculosis patients receiving anti-tuberculosis medications at the tuberculosis clinic of Lerdsin Hospital. We included adults aged 18 years or older who could communicate in Thai and provided informed consent. Patients were excluded if they had severe psychiatric conditions that would impair their ability to provide reliable information or were physically unable to complete the questionnaire. Sample size was calculated using a single mean estimation formula with a 95% confidence level ($z = 1.96$), standard deviation of 2.57, and acceptable margin of error of 0.5. Based on a total patient population of 520 individuals, we determined that 88 participants would be required. To account for potential data loss, we increased this number by approximately 10%, yielding a final target of 100 participants recruited through simple random sampling.

Data collection instrument

We developed a structured questionnaire grounded in the World Health Organization Adherence Framework and existing literature on tuberculosis medication adherence. The instrument comprised two sections. The first section gathered demographic and clinical information including age, sex, ethnicity, nationality, occupation, income, educational attainment, religion, healthcare coverage, presence of caregivers, comorbidities, medication-taking behaviours, missed doses, and transportation accessibility. The second section assessed factors influencing anti-tuberculosis medication adherence through 30 items spanning five dimensions consistent with the WHO framework: patient-related factors, medication-related factors, socioeconomic factors, healthcare system factors, and condition-related factors. Responses were recorded on a five-point Likert scale. Three subject matter experts evaluated the

instrument for content validity, yielding an item-objective congruence index of 0.88. The English version of the questionnaire is provided as Additional file 1.

Phase 2: Qualitative component

Participants

In-depth interviews were conducted with tuberculosis patients attending the tuberculosis clinic at Lerdsin Hospital. We employed purposive sampling to recruit participants with diverse demographic characteristics, clinical profiles, and treatment experiences. Participant recruitment continued until data saturation was achieved, that is, until no new themes emerged from subsequent interviews. In total, twelve patients participated in the qualitative phase.

Data collection

Interviews were guided by a semi-structured topic guide developed from the quantitative findings. The guide explored occupational and social circumstances, educational background, household income, medical expenses, healthcare service experiences, ability to afford treatment costs, beliefs and attitudes toward tuberculosis treatment, and decision-making processes regarding treatment adherence. Each interview lasted approximately 30 to 60 minutes and was audio-recorded with participant consent. Recordings were transcribed verbatim within 48 hours of each interview. Interviews were conducted in Thai; an English version of the interview topic guide is provided as Additional file 2.

Data analysis

Interview data were analysed using thematic analysis supported by ATLAS.ti version 25.0.1. The analytical process began with repeated readings of transcripts to achieve familiarisation with the data. Initial codes were generated from meaningful text segments, then grouped into categories based on conceptual similarities. These categories were subsequently refined into overarching themes and subthemes. Trustworthiness was established through several strategies: prolonged engagement with participants to build rapport, observation of participant behaviour throughout interviews, triangulation of data sources, reflexive discussions within the research team, member checking by returning preliminary findings to participants for verification, and peer debriefing with external experts.

Data integration

Findings from both phases were integrated using a joint display approach. Quantitative and qualitative results were systematically compared to identify areas of convergence and divergence, thereby generating a comprehensive understanding of factors influencing anti-tuberculosis medication adherence.

Statistical analysis

Quantitative data were analysed using statistical software. Descriptive statistics including frequencies, percentages, means, and standard deviations characterised the study sample. We examined associations between categorical variables and medication adherence using chi-square tests. Binary logistic regression analysis identified predictive factors for medication adherence. Statistical significance was set at $p < 0.05$.

Results

Quantitative findings

Participant characteristics

One hundred tuberculosis patients took part in the quantitative phase. Their mean age was 51.6 years (SD = 17.3), and the majority were male (73.0%). Nearly all participants identified as Thai (94.0%). Regarding employment, roughly one-third reported being unemployed (31.0%), with a comparable proportion having no income (32.0%). Primary school represented the most common educational attainment (32.0%). Buddhism was the predominant religion (95.0%). Healthcare coverage was divided between the Universal Coverage Scheme (49.0%) and Social Security (48.0%), while only 1.0% lacked any form of health insurance.

From a clinical standpoint, most participants were newly diagnosed cases (81.0%) with drug-susceptible tuberculosis (90.0%). Recurrence following previous successful treatment was uncommon (12.0%). Nonetheless, comorbidities were prevalent, affecting more than half of the sample (56.0%). Hypertension, diabetes mellitus, and HIV infection emerged as the most frequently observed concurrent conditions. Self-reported medication-taking behaviour was generally favourable: 87.0% denied ever forgetting doses, and 94.0% had never missed clinic appointments for medication refills. Transportation to the hospital posed no difficulty for most participants (82.0%). Complete demographic and clinical data appear in Table 1.

Table 1
Demographic and clinical characteristics of study participants
(N = 100)

Characteristics	n	%
Gender		
Male	73	73.0
Female	27	27.0
Ethnicity and nationality		
Thai	94	94.0
Myanmar	5	5.0
Lao	1	1.0
Occupation		
Unemployed	31	31.0
Daily worker	28	28.0
Merchant	13	13.0
Private company employee	8	8.0
Student	2	2.0
Self-employed	1	1.0
Government/State enterprise employee	1	1.0
Other	16	16.0
Monthly income (THB)		
Less than 5,000	1	1.0
5,001–10,000	6	6.0
10,001–15,000	25	25.0
15,001–30,000	18	18.0
30,001–50,000	6	6.0
More than 50,000	1	1.0
Irregular income	11	11.0
No income	32	32.0
Education level		

Characteristics	n	%
Gender		
No formal education	1	1.0
Primary school	32	32.0
Lower secondary school	12	12.0
Upper secondary school/Vocational certificate	17	17.0
Diploma/High vocational certificate	7	7.0
Bachelor's degree	16	16.0
Not specified	15	15.0
Religion		
Buddhism	95	95.0
Islam	3	3.0
Christianity	2	2.0
Healthcare coverage		
Universal Coverage Scheme	49	49.0
Social Security Scheme	48	48.0
Civil Servant Medical Benefit Scheme	2	2.0
No coverage/Self-pay	1	1.0
Patient type		
Previously treated	19	19.0
New case	81	81.0
Drug resistance status		
Drug-susceptible	90	90.0
Drug-resistant	10	10.0
TB recurrence		
No recurrence	88	88.0
Recurrence (1 episode)	9	9.0
Recurrence (> 1 episode)	3	3.0
Comorbidities		

Characteristics	n	%
Gender		
Present	56	56.0
Absent	44	44.0
Concomitant medications		
None	48	48.0
1 additional medication	16	16.0
> 1 additional medication	36	36.0
Missed doses (past month)		
Never	87	87.0
Once	9	9.0
Twice	2	2.0
More than twice	2	2.0
Treatment interruption		
Never	94	94.0
Less than 1 month	3	3.0
1 to < 2 months	1	1.0
≥ 2 consecutive months	2	2.0
Travel to hospital		
Not difficult	82	82.0
Difficult	18	18.0

Factors associated with medication adherence

Patient-related factors. Disease knowledge was exceptionally high among participants (97%), and confidence in medication efficacy was similarly robust (96%). The vast majority reported receiving support from those around them (84%). That said, nearly one in four (24%) indicated a lack of family support, and 6% felt stigmatised because of their diagnosis.

Medication-related factors. Participants overwhelmingly felt they had received adequate information about their medications (99%) and expressed trust in both drug efficacy and safety (97%). However, adverse drug reactions troubled more than half of respondents (55%), and approximately one-fifth (21%) perceived their medication regimen as burdensome.

Healthcare system factors. Satisfaction with healthcare services reached very high levels (96–99%). Insurance benefits were deemed sufficient by most (95%). Neither travel logistics nor waiting times constituted major obstacles, with 87–93% of participants reporting no difficulties in these areas.

Socioeconomic factors. A quarter of participants (25%) had experienced lost income opportunities due to treatment demands, and 16% believed that financial strain compromised their ability to maintain consistent treatment.

Condition-related factors. Ten percent of participants faced health issues that interfered with regular medication intake. Detailed findings on adherence factors are presented in Table 2.

Table 2
Factors affecting anti-tuberculosis medication adherence

Factors affecting anti-TB medication adherence	Level of agreement, n (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Patient-related factors					
I understand the importance of taking anti-TB medications regularly	97 (97.0)	1 (1.0)	1 (1.0)	0	1 (1.0)
I believe that taking medications will help me recover from TB	96 (96.0)	0	3 (3.0)	1 (1.0)	0
I understand the instructions and information on drug labels and from healthcare providers	97 (97.0)	0	0	2 (2.0)	1 (1.0)
I understand the symptoms and health impacts of TB	89 (89.0)	10 (10.0)	0	0	1 (1.0)
I understand that continuous medication is essential for recovery	94 (94.0)	4 (4.0)	1 (1.0)	1 (1.0)	0
I feel encouraged by support from colleagues and family for taking medications	84 (84.0)	4 (4.0)	4 (4.0)	2 (2.0)	6 (6.0)
I feel stigmatised or ashamed about receiving TB treatment	3 (3.0)	3 (3.0)	0	41 (41.0)	53 (53.0)
I feel the need to conceal my treatment from others or family	10 (10.0)	0	0	42 (42.0)	48 (48.0)
I receive support from family or caregivers in reminding me to take medications	73 (73.0)	3 (3.0)	0	14 (14.0)	10 (10.0)
I believe that my anti-TB medications are effective and safe	97 (97.0)	0	1 (1.0)	1 (1.0)	1 (1.0)
I have no problems taking medications as advised by healthcare providers	92 (92.0)	0	1 (1.0)	2 (2.0)	5 (5.0)
I feel that taking anti-TB medications improves my quality of life	90 (90.0)	1 (1.0)	1 (1.0)	4 (4.0)	4 (4.0)
Medication-related factors					
I received sufficient information about how to take medications and potential side effects	99 (99.0)	1 (1.0)	0	0	0
I can adapt my daily routine to accommodate medication schedules	82 (82.0)	14 (14.0)	2 (2.0)	1 (1.0)	1 (1.0)

Factors affecting anti-TB medication adherence	Level of agreement, n (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Patient-related factors					
I take medications exactly as prescribed without missing doses	88 (88.0)	3 (3.0)	0	7 (7.0)	2 (2.0)
I always remember to take medications at the designated times	96 (96.0)	2 (2.0)	0	1 (1.0)	1 (1.0)
I feel that taking anti-TB medications is not burdensome or complicated	68 (68.0)	7 (7.0)	4 (4.0)	8 (8.0)	13 (13.0)
I have not experienced any side effects from anti-TB medications	44 (44.0)	0	1 (1.0)	24 (24.0)	31 (31.0)
Healthcare system factors					
I can easily access health information services from the hospital when I have questions about medications	97 (97.0)	1 (1.0)	0	0	2 (2.0)
I receive continuous support and advice from healthcare providers	99 (99.0)	0	0	0	1 (1.0)
I trust the expertise of the physicians, pharmacists, and nurses caring for me	99 (99.0)	0	1 (1.0)	0	0
I find it convenient to collect medications each time	96 (96.0)	1 (1.0)	1 (1.0)	0	2 (2.0)
I am satisfied with the follow-up and care I receive from the hospital	99 (99.0)	0	1 (1.0)	0	0
My healthcare coverage adequately covers TB treatment	95 (95.0)	0	1 (1.0)	3 (3.0)	1 (1.0)
Travel distance and mode of transport affect my TB treatment attendance	9 (9.0)	0	0	45 (45.0)	46 (46.0)
Waiting time to see the doctor or collect medications affects my treatment	9 (9.0)	2 (2.0)	2 (2.0)	42 (42.0)	45 (45.0)
Administrative procedures (eligibility verification, chest X-ray, referral letters) affect my treatment	4 (4.0)	0	3 (3.0)	43 (43.0)	50 (50.0)
Socioeconomic factors					
TB treatment causes me to lose income-earning opportunities	21 (21.0)	4 (4.0)	4 (4.0)	33 (33.0)	38 (38.0)
I believe that loss of income or lack of money affects my TB treatment	14 (14.0)	2 (2.0)	0	43 (43.0)	41 (41.0)

Factors affecting anti-TB medication adherence	Level of agreement, n (%)				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Patient-related factors					
Condition-related factors					
I have no health problems or conditions that hinder regular medication intake	89 (89.0)	1 (1.0)	0	2 (2.0)	8 (8.0)

Predictors of medication adherence

Binary logistic regression revealed that the fitted model differed significantly from the null model ($\chi^2 = 57.76$, $df = 19$, $p < 0.001$). The model accounted for a substantial proportion of variance in adherence behaviour (Nagelkerke $R^2 = 0.815$). Two factors emerged as significant negative predictors of good adherence. Medication-related problems were inversely associated with adherence (OR = 0.178, 95% CI: 0.039–0.804, $p = 0.025$); patients reporting greater medication-related difficulties had 82% lower odds of maintaining good adherence. Healthcare system barriers likewise showed an inverse relationship (OR = 0.327, 95% CI: 0.108–0.985, $p = 0.047$), with those experiencing more system-related problems demonstrating 67% reduced odds of good adherence.

Qualitative findings

Characteristics of interview participants

Twelve tuberculosis patients participated in the in-depth interviews. The group was demographically varied: women made up the larger share (58.33%), most fell within the 41–50 age bracket (41.67%), and Buddhism was the predominant faith (83.33%). Half relied on Social Security for healthcare coverage (50.00%), and the great majority were newly diagnosed with tuberculosis (83.33%). This diversity allowed for a broad range of perspectives on the treatment experience.

Emergent themes

Thematic analysis yielded five principal themes that captured how patients perceived and navigated anti-tuberculosis medication adherence.

Theme 1: Healthcare access under universal coverage

The Universal Coverage Scheme and Social Security played a decisive role in removing financial hurdles to treatment. Several participants spoke positively about their insurance benefits and found it possible to juggle work responsibilities alongside clinic visits. As one patient put it:

"I can still work while getting treatment. It's not like I have to stay in hospital. After seeing the doctor, I go home. Wake up the next morning and go back to work. Life goes on pretty much as usual." (TB-02)

Theme 2: Barriers to access and treatment continuity

Although insurance covered direct medical costs, patients still wrestled with a host of challenges: difficult commutes, out-of-pocket expenses that fell outside coverage, inconsistent follow-up arrangements, and lengthy waits at the clinic. These obstacles sometimes derailed treatment continuity. One participant recalled:

"We have to pay for things ourselves—transport, food. Nobody helps with that... There was one year I didn't come for treatment at all. No money, and getting here was just too hard." (TB-02)

Theme 3: Economic toll of tuberculosis treatment

The gap between earnings and expenses weighed heavily on patients' ability to sustain treatment. Informal workers, whose income hinges on daily attendance, felt this burden most acutely. Missing a day's work to attend clinic meant forfeiting wages outright:

"If I take the whole day off, I have to pay someone else three or four hundred baht to cover for me. That money's just gone." (TB-02)

Theme 4: Social and family support networks

Relatives and colleagues emerged as vital sources of encouragement for staying on treatment. Equally important was the quality of care delivered by healthcare staff; attentive and empathetic providers fostered trust and strengthened patients' commitment to the treatment process:

"The doctors here look after us well. That's why I wouldn't dare switch hospitals—I'm worried I'd end up with someone who doesn't care as much." (TB-08)

Theme 5: Cultural beliefs and personal resolve

Spiritual and religious convictions bolstered patients' mental wellbeing and hope. Personal determination, coupled with faith in the treatment regimen, served as a powerful motivator to persist with medication. Participants expressed this resilience in their own words:

"If it means getting better, I'll fight through it." (TB-02)

"I'm certain I'm going to recover." (TB-12)

Integration of findings

Bringing together quantitative and qualitative results through joint display analysis constitutes a pivotal step in mixed methods inquiry. The aim is to generate meta-inferences that carry greater weight than conclusions drawn from either data source alone. Placing numerical outcomes alongside narrative accounts makes it possible to discern three patterns: convergence, where both strands point in the same direction; complementarity, where one strand illuminates mechanisms or context that the other leaves

unexplained; and partial discordance, where apparent contradictions open up opportunities to probe the gap between aggregate satisfaction scores and lived experience on the ground. Five key issues emerged from this integrative analysis.

Health insurance coverage: near-universal reach, functioning as a financial safety net

Survey data indicated that 99% of participants held some form of healthcare entitlement—a figure reflecting broad systemic protection against direct treatment costs. Interview accounts corroborated this picture: informants described how insurance eligibility relieved their financial burden and enabled them to attend appointments and collect medications without interruption, particularly for those with limited household income.

This theme shows clear convergence. Near-universal coverage is not merely a system-level statistic; it translates into tangible protection that patients experience in daily life. Health entitlements function as a mechanism for reducing financial risk and serve as a foundational condition for initiating and sustaining treatment. A deeper reading, however, cautions that coverage does not equate to zero burden. Although direct medical costs may be absorbed, patients can still shoulder indirect expenses—transport, meals, lost wages—that fall outside insurance benefits. Coverage is thus a necessary but not sufficient condition for smooth treatment trajectories.

Adverse drug reactions: common occurrence with measurable impact on adherence

More than half of participants (55%) reported experiencing side effects from their medications. Regression analysis revealed a statistically significant inverse association between medication-related problems and good adherence (OR = 0.178, $p = 0.025$). Qualitative data added depth to this finding: some patients did not fully grasp the link between inconsistent pill-taking, self-initiated dose adjustments, and the risk of drug resistance or relapse. This gap in understanding often surfaced precisely when patients were grappling with unpleasant symptoms.

The two data strands converge in a manner that extends beyond directional agreement. Quantitative results establish that adverse reactions are significantly associated with treatment outcomes; qualitative accounts elucidate the mechanisms at play. Side effects provoke anxiety and hesitation; incomplete understanding prompts patients to manage symptoms on their own—skipping doses, halving tablets, alternating days—in ways that undermine treatment continuity and potentially heighten resistance risk. The systemic implication is that adverse event management ought to be viewed not as an individual patient's problem but as a core service competency, encompassing anticipatory counselling, accessible channels for reporting symptoms, proactive follow-up, and individualised care adjustments, particularly during the early weeks when patients have yet to find their footing.

Family support: prevalent and practical, yet a vulnerable minority remains

Quantitative findings showed that 84% of patients received support from family members, leaving 24% without such backing—a minority but one representing meaningful social risk for long-term treatment. Interview narratives gave concrete form to this support: relatives reminded patients to take pills, prepared suitable meals, accompanied them to hospital, and shouldered household tasks so that treatment could proceed uninterrupted.

Again, convergence is evident. Support from family extends beyond emotional encouragement; it involves tangible, day-to-day assistance directly tied to medication-taking behaviour and clinic attendance. The critical point for policy is the group lacking such support: migrants living alone, patients who conceal their diagnosis for fear of stigma, or those in households already stretched thin. Findings point toward routine social support screening at treatment initiation, enabling clinics to identify patients without adequate backing and to connect them with compensatory mechanisms—community health workers, peer supporters, digital reminder systems—that can fill the gap left by absent family networks.

Economic consequences: quantifying burden and uncovering hidden costs

One quarter of participants reported lost income opportunities attributable to their treatment—a striking figure that captures reduced working hours, missed workdays, and wages forfeited to attend clinic appointments. Qualitative data elaborated on dimensions of burden that typically escape insurance coverage: transport fares, meals during hospital visits, caregiver expenses, and the income volatility that forces patients to choose between earning a living and showing up for treatment.

This theme exemplifies complementarity. Quantitative results establish the scale of the problem—one in four affected—while qualitative accounts reveal its texture: the burden is not confined to out-of-pocket payments but encompasses time lost and opportunities foregone. Reading these findings alongside the insurance coverage theme sharpens the picture: even when direct medical costs are covered, indirect expenses create friction that can derail attendance and adherence. From a policy standpoint, interventions addressing economic barriers—travel subsidies, flexible scheduling, extended dispensing intervals, remote follow-up channels—hold considerable potential for reducing treatment attrition among economically vulnerable patients.

Service quality: high satisfaction alongside process-level frustrations

Survey responses indicated exceptionally high satisfaction (96–99%), and regression analysis identified a significant association between healthcare system factors and adherence (OR = 0.327, $p = 0.047$). Qualitative narratives, however, painted a more nuanced picture. Patients acknowledged the dedication

and attentiveness of staff, yet they also recounted lengthy waiting times, gaps in follow-up, and scheduling inconveniences—experiences with palpable effects on their daily routines.

Here we encounter partial discordance—an apparent tension that is, upon reflection, explainable and commonly observed in health service evaluations. Elevated satisfaction scores may capture interpersonal care—courtesy, warmth, trust in providers—while complaints about waiting and follow-up reflect process quality: clinic flow, appointment systems, proactive tracking, inter-unit coordination. Consequently, high satisfaction does not signal an absence of problems; patients may be distinguishing between the goodwill of individual staff and the friction inherent in organisational processes. Cultural factors may also play a role: in some settings, respondents score highly out of politeness, deference, or modest expectations. From a methodological standpoint, joint display analysis serves as a reminder that quantitative indicators alone may lack the sensitivity to detect pain points in service delivery—particularly issues of time and follow-up that carry ongoing economic and adherence consequences.

Taken together, this integrative analysis underscores the value of mixed methods designs for unpacking complex phenomena. Numerical patterns gain texture through patient narratives; themes that appear unequivocal in survey form reveal hidden layers when probed in conversation. The five issues examined here—insurance coverage, adverse reactions, family support, economic burden, and service quality—each contribute a distinct piece to the puzzle of tuberculosis medication adherence. Their interplay suggests that effective interventions will need to address not single factors in isolation but the web of circumstances in which patients navigate their treatment journeys.

Discussion

This investigation set out to explore factors shaping anti-tuberculosis medication adherence among patients attending a TB clinic in Bangkok, Thailand. Drawing on a sequential explanatory mixed methods approach, we combined survey data with in-depth interviews to develop a nuanced picture of adherence behaviour. Our findings indicate that the majority of participants demonstrated good adherence (87%), a figure that compares favourably with global treatment success rates of approximately 88% reported for 2022 [20]. Binary logistic regression identified medication-related factors and healthcare system factors as significant predictors of adherence, consistent with the WHO's multidimensional adherence framework [17]. The model explained a substantial proportion of variance (Nagelkerke $R^2 = 0.815$), suggesting that these factors together account for much of the variability in patient adherence behaviour.

Medication-related problems emerged as a powerful negative predictor of good adherence (OR = 0.178, 95% CI: 0.039–0.804). Patients reporting greater difficulties with their medications had 82% lower odds of maintaining satisfactory adherence levels. This quantitative finding was corroborated by qualitative data: more than half of participants (55%) reported experiencing adverse drug reactions, and roughly one in five (21%) perceived their regimen as burdensome. These results align with work by Sant'Anna et al. [18], published in this journal, which identified gastrointestinal disturbances, cutaneous reactions, and

hepatotoxicity as common adverse effects that compromise treatment continuity. A recent comprehensive review by Mereškevičienė, R., & Danila, E. (2025) further underscores that both first- and second-line anti-tuberculosis agents carry substantial risk of side effects capable of disrupting adherence. The clinical implication is clear: systematic monitoring and proactive management of adverse reactions should be integral to TB care [19].

Healthcare system barriers likewise showed an inverse association with adherence (OR = 0.327, 95% CI: 0.108–0.985). At first glance, this finding might seem paradoxical: quantitative data revealed high levels of satisfaction with services (96–99%) and adequate insurance coverage (95%). Yet the qualitative interviews painted a more complex picture. Participants spoke of hidden costs that fall outside insurance benefits—transport fares, meals during clinic visits, and lost wages. One informant recounted abandoning treatment for an entire year because travel expenses proved insurmountable. Such out-of-pocket expenditures, though often overlooked in assessments of healthcare access, can decisively shape patients' capacity to sustain treatment. The WHO Global TB Report 2024 acknowledges that Thailand, despite having one of the strongest universal coverage systems among high-burden countries, still faces gaps in addressing indirect costs [20].

That said, our qualitative data also highlighted the protective role of Thailand's Universal Coverage Scheme and Social Security system. Several participants expressed appreciation for the financial protection these schemes afford, noting that treatment does not require hospitalisation and that they can continue working while receiving care. Thailand has been recognised internationally for achieving a Service Coverage Index above 80 and limiting catastrophic health expenditure to just 2% of households [20]. This achievement rests on strong primary healthcare infrastructure and sustained domestic investment [21]. Our findings suggest that while universal coverage effectively removes direct treatment costs, complementary mechanisms are needed to address indirect expenses that disproportionately burden economically vulnerable patients.

The qualitative component underscored the significance of social and family support in maintaining treatment continuity. Participants identified relatives and colleagues as vital sources of encouragement. Equally important was the quality of provider-patient relationships: informants spoke of reluctance to transfer to other facilities for fear of encountering less attentive staff. These observations resonate with a mixed methods systematic review by Maynard et al. [22], which concluded that effective TB interventions provide multidimensional support encompassing both material and psychological dimensions. Recent Thai research by Konsaku and colleagues (2025) further demonstrates associations between mental health difficulties and TB treatment adherence, pointing to the value of integrating psychosocial care into routine TB management [23].

A final theme emerging from interviews concerned the role of cultural beliefs and personal determination. Several informants described how religious faith sustained their hope and mental wellbeing during treatment. Personal resolve—captured in statements such as “If it means getting better, I'll fight through it” and “I'm certain I'm going to recover”—served as a powerful motivator for persisting

with medication despite obstacles. These findings echo earlier qualitative syntheses by Munro et al. [24], which identified patients' beliefs about treatment efficacy and hope for cure as key influences on adherence behaviour. Understanding and respecting these belief systems may help healthcare providers tailor communication and support to individual patients.

Integrating quantitative and qualitative findings through joint display analysis revealed both convergence and divergence. While survey data suggested widespread satisfaction and minimal access problems, interview accounts exposed hidden challenges—particularly among patients facing economic constraints. This discrepancy illustrates the value of mixed methods designs in capturing phenomena that neither approach alone would fully illuminate. As Creswell and Plano Clark (2018) have argued, combining numerical and narrative data yields a more complete and contextually grounded understanding than either method in isolation [25].

Several policy and practice implications flow from these findings. First, systematic adverse drug reaction monitoring and management should be strengthened within TB programmes. A systematic review by Pradipta et al. [26] demonstrated that counselling combined with close ADR surveillance improves adherence outcomes. Second, mechanisms to offset indirect costs—transport subsidies, meal allowances, or compensation for lost income—warrant consideration, particularly for informal workers and low-income patients. Third, fostering family and community involvement, alongside enhancing providers' capacity for patient-centred communication, may bolster adherence. Finally, routine integration of mental health screening and support within TB clinics could address the psychological burden that accompanies long-term treatment.

Several limitations merit acknowledgement. Data were collected from a single TB clinic in Bangkok, which may restrict generalisability to rural or provincial settings where access barriers differ. Adherence was assessed through self-report, a method susceptible to social desirability bias, though qualitative interviews helped triangulate these data. The qualitative sample of twelve participants, while adequate for thematic saturation, may not capture the full diversity of patient experiences. Future research employing objective adherence measures and spanning multiple sites would strengthen confidence in these findings.

Conclusion

This mixed methods investigation reveals that the majority of tuberculosis patients attending the TB clinic at Lerdsin Hospital maintained satisfactory medication adherence, with medication-related factors and healthcare system factors emerging as significant negative predictors. Although Thailand's universal coverage schemes effectively eliminate direct treatment costs, indirect expenses, adverse drug reactions, and gaps in social support continue to undermine treatment continuity for a vulnerable subset of patients. Integrating numerical survey data with patient narratives exposed a telling discrepancy: high satisfaction scores coexist with tangible process-level frustrations, suggesting that patients distinguish between the goodwill of individual providers and the friction inherent in clinic operations. These findings

point toward a multifaceted approach to TB care—one that weaves together proactive adverse event management, financial assistance for indirect costs, systematic screening for social support deficits at treatment initiation, and more flexible appointment arrangements—as the path most likely to bolster treatment success and curb the emergence of drug resistance.

Declarations

Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. This study received ethical approval from the Human Research Ethics Committee of the Faculty of Pharmacy, Siam University (approval number: COA.013-2567). All participants were provided with detailed explanations of the study objectives and procedures and gave written informed consent prior to enrolment. Participation was voluntary, and individuals could withdraw at any time without affecting their clinical care. All data were kept confidential and reported in aggregate form without personal identifiers.

Author contributions

Shinnawat Saengungsumalee: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Visualization. Patreeya Kitcharoen: Methodology, Investigation, Writing – review & editing. Kamolwan Tantipiwattanaskul: Methodology, Validation, Writing – review & editing. Suyanee Pongthananikorn: Investigation, Resources, Writing – review & editing. Nattakarn Thongtae: Investigation, Data curation, Writing – review & editing. Pattarachit Choompol Gozzoli: Conceptualization, Supervision, Writing – review & editing, Project administration.

Disclosure statement

The authors declare no conflicts of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability statement

The quantitative data supporting the findings of this study are available within the article. Qualitative interview transcripts are not publicly available due to participant confidentiality but are available from the corresponding author upon reasonable request and with appropriate ethical approval.

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