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Non-adherence to pulmonary tuberculosis treatment: prevalence and associated factors in an urban community health center in Makassar, Indonesia

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Abstract

Purpose: Non-adherence to tuberculosis (TB) treatment remains a major public health concern, contributing to drug resistance, ongoing transmission, and increased morbidity and mortality. This study aimed to determine the prevalence and determinants of treatment non-adherence among pulmonary TB patients at the Tamalate Public Health Center, Makassar City, Indonesia, focusing on sociodemographic, behavioral, and health-related factors. **Methods:** A cross-sectional study was conducted from April 2024 among 110 pulmonary TB patients selected through exhaustive sampling. Treatment adherence was measured using the Morisky Medication Adherence Scale (MMAS). Data were collected via structured interviews using KoboCollect and analyzed in Stata 14.0 using univariate and bivariate analyses (Chi-square and odds ratio). **Results:** Among 110 respondents, 30.0% were non-adherent. Most demonstrated poor TB-related knowledge (77.3%), low income (65.4%), and low education levels (42.7%). More than half experienced adverse drug effects (55.4%) and reported high family support (54.6%). In multivariate analysis, poor knowledge about tuberculosis remained independently associated with treatment non-adherence (aOR = 7.3; 95% CI: 2.13–25.30). Other factors, including adverse drug effects, household income, educational level, employment status, health insurance type, and family support, were not independently associated with non-adherence after adjustment. **Conclusion:** Treatment non-adherence in urban TB patients was primarily driven by poor tuberculosis-related knowledge, underscoring the need for strengthened, structured patient education within TB control programs.

Keywords: non-adherence; pulmonary tuberculosis (TB); tuberculosis treatment; urban settings

INTRODUCTION

Pulmonary tuberculosis (TB) is one of the infectious diseases that continues to be a global public health burden to this day [1]. This disease is caused by *Mycobacterium tuberculosis* and is transmitted through the air, especially when people with active TB cough, sneeze, or talk [2]. TB not only affects infected individuals but also has broad social, economic, and health consequences, especially in developing countries [3–6]. According to the Global Tuberculosis Report 2025 released by the World Health Organization (WHO), there were an estimated 10.7 million new TB cases and approximately 1.23 million TB-related deaths in 2024. Southeast Asia, Africa, and the Western Pacific account for the largest share of the global TB burden [7,8]. In

2024, Indonesia ranked second globally in TB burden, with an estimated 1,070,000 cases, underscoring TB as a major public health problem requiring sustained attention.

One of the main challenges in TB control is patient non-adherence with anti-TB treatment [9–11]. TB treatment requires a relatively long time, at least six months, with a combination of several drugs that have the potential to cause side effects. Non-adherence with medication can lead to treatment failure, recurrence, and even the emergence of drug-resistant TB (DR-TB), which is much more difficult and expensive to treat [12]. Previous studies have identified factors associated with non-adherence with TB treatment, including individual factors (knowledge, attitude, motivation), treatment factors (drug side effects, duration of therapy), psychosocial factors (stress, family support), and socioeconomic factors (income, employment, and access to health services) [9,10,13–16].

Some international studies have reported high rates of TB treatment non-adherence in various countries. Research by Gebreweld et al. (2018) in Asmara found that non-adherence to TB treatment remains a significant problem, influenced by low knowledge and social support [17]. Silva et al. (2017) also reported that socioeconomic factors and patients' perceptions of treatment play an important role in adherence to TB therapy [18]. Another study by Rivera Lozada et al. (2024) in Peru showed that the living environment and access to health services also influence medication adherence [19]. Although these studies provide important insights into the determinants of TB non-adherence, most focus on general contexts or rural areas and have not specifically examined the characteristics of densely populated urban areas.

Urban areas with high population density have different social and environmental dynamics, which have the potential to exacerbate TB problems and treatment adherence [20]. Housing density, poor housing conditions, high population mobility, and economic pressures can affect the success of TB treatment [21]. In Indonesia, Makassar is one of the major cities with a high TB burden, and the Tamalate District is known for its high population density. However, to date, research specifically examining factors of non-adherence with anti-TB medication among densely populated urban communities in this region remains limited.

Previous studies have been limited by a lack of contextual approaches that consider the interactions among individual, social, and urban environmental factors in shaping TB treatment adherence. Therefore, more in-depth research is needed to fill this research gap, particularly in densely populated urban areas with a high TB burden. Based on the above description, this study aims to analyze the factors influencing non-adherence with anti-TB medication among pulmonary TB patients in densely populated urban areas, with a focus on the Tamalate District of Makassar City. This study is expected to contribute to the scientific development of more contextual TB control strategies and to inform the formulation of effective interventions to improve TB treatment adherence. With increased patient adherence, treatment success can be improved, and the globally set TB elimination targets can be more easily achieved.

METHODS

Study design and setting

This study employed an observational, analytical, cross-sectional design to determine the prevalence and associated factors of medication non-adherence among patients with pulmonary TB. The study was conducted in April 2024 in the Tamalate Community Health Center (CHC) catchment area, one of the areas with the highest TB case burden in Makassar City, Indonesia. The study population included all patients with drug-sensitive pulmonary TB (TB-SO) receiving treatment at the health center during the study period. An exhaustive sampling approach was used. Inclusion criteria were patients aged ≥18 years with TB-SO who consented to participate; those unable to complete the interview were excluded. Of 125 registered patients, 110 met the eligibility criteria and were included in the analysis.

Data collection

Data were collected through structured face-to-face interviews using a standardized questionnaire. Medication adherence was assessed using the Morisky Medication Adherence Scale (MMAS), a validated, widely used instrument. Additional variables included sociodemographic characteristics, TB-related knowledge, family support, and perceived drug side effects. To enhance data accuracy and consistency, data were collected electronically using the KoBoCollect application.

Data analysis

All collected data were edited, coded, and cleaned prior to analysis and analyzed using STATA version 14.0. Univariate analysis was conducted to describe the distribution of all categorical variables using frequencies and percentages. Bivariate analysis was performed using the chi-square test to assess associations between independent variables and medication non-adherence, with results presented as crude odds ratios (ORs) and 95% confidence intervals (CIs). Multivariate logistic

regression analysis was subsequently conducted to identify factors independently associated with non-adherence, and the results were expressed as adjusted odds ratios (aORs) with 95% CIs. A *p*-value <0.05 was considered statistically significant, and the findings are presented in tabular and narrative formats.

RESULTS

Table 1 presents more than half were male, and most were in the productive age group. The majority of patients were in the advanced stage of treatment, and more than half reported experiencing adverse drug effects. Poor knowledge about TB and low socioeconomic status were common among respondents. Family support was generally limited, and non-adherence to treatment was observed in a substantial proportion of patients. Table 2 describes the association between treatment adherence and selected clinical, sociodemographic, and psychosocial factors among TB patients. Non-adherence was observed more frequently among patients who experienced adverse drug effects compared with those who did not; however, this difference was not statistically significant. A significant association was found between patients' knowledge of TB and treatment non-adherence, with a markedly higher proportion of non-adherence among patients with poor knowledge than among those with good knowledge. This finding suggests that inadequate knowledge may play an important role in treatment non-adherence.

Table 1. Sociodemographic and clinical characteristics of patients (n = 110)

Characteristic	n (%)
Sex	
Male	59 (53.6)
Female	51 (46.4)
Age (years)	
<17	10 (9.1)
18-44	51 (46.4)
45-59	31 (28.2)
≥60	18 (16.4)
Treatment stage	
Initial stage	29 (26.4)
Advanced stage	81 (73.6)
Adverse drug effects	
No	49 (44.6)
Yes	61 (55.4)
Knowledge about TB	
Good	25 (22.7)
Poor	85 (77.3)
Educational level	
High	47 (42.7)
Low	63 (57.3)
Household income	
Low	72 (65.4)
Medium	22 (20.0)
High	16 (14.6)
Employment status	
Employed	60 (54.6)
Unemployed	50 (45.4)
Health insurance type	
BPJS–PBI (Subsidized)	54 (49.1)
BPJS–Non-PBI (Self-paid)	56 (50.9)
Family support	
Poor	60 (54.6)
Moderate	39 (35.4)
Good	11 (10.0)
Treatment adherence	
Adherent	77 (70.0)
Non-adherent	33 (30.0)

Note: *n* = frequency; % = percent

Table 2. Factors associated with non-adherence treatment among patients

Variable	Non-Adherent n (%)	Adherent n (%)	*p*-value
Adverse drug effects			
No	12 (36.4)	37 (48.1)	0.260
Yes	21 (63.6)	40 (51.9)	
Knowledge about TB			
Good	18 (54.5)	67 (87.0)	**<0.05**
Poor	15 (45.5)	10 (13.0)	
Educational level			
High	17 (51.5)	46 (59.7)	0.425
Low	16 (48.5)	31 (40.3)	
Household income			
Low	23 (69.7)	56 (72.7)	0.22
Medium	6 (18.2)	6 (7.8)	
High	4 (12.1)	15 (19.5)	
Employment status			
Employed	16 (48.5)	34 (44.2)	0.68
Unemployed	17 (51.5)	43 (55.8)	
Health insurance type			
BPJS–PBI (Subsidized)	16 (51.6)	40 (54.1)	0.82
BPJS–Non-PBI (Self-paid)	15 (48.4)	34 (45.9)	
Family support			
Poor	4 (12.1)	7 (9.1)	0.72
Moderate	10 (30.3)	29 (37.7)	
Good	19 (57.6)	41 (53.2)	

Table 3. Multivariate logistic regression of factors associated with non-adherence treatment

Variable	OR (95% CI)	aOR (95% CI)
Adverse drug effects		
No	1 (Ref)	1 (Ref)
Yes	1.6 (0.69–3.74)	1.3 (0.51–3.74)
Knowledge about TB		
Good	1 (Ref)	1 (Ref)
Poor	5.5 (2.14–14.50)*	7.3 (2.13–25.3)*
Educational level		
High	1 (Ref)	1 (Ref)
Low	1.3 (0.61–3.17)	1.1 (0.39–3.55)
Household income		
Low	1 (Ref)	1 (Ref)
Medium	2.4 (0.71–8.34)	4.1 (0.61–27.1)
High	0.6 (0.19–2.16)	0.9 (0.13–6.78)
Employment status		
Employed	1 (Ref)	1 (Ref)
Unemployed	0.8 (0.37–1.90)	1.1 (0.26–4.53)
Health insurance type		
BPJS–PBI (Subsidized)	1 (Ref)	1 (Ref)
BPJS–Non-PBI (Self-paid)	1.1 (0.47–2.55)	2.4 (0.75–7.74)
Family support		
Poor	1 (Ref)	1 (Ref)
Moderate	0.7 (0.30–1.83)	0.6 (0.22–1.90)
Good	1.2 (0.32–4.72)	0.9 (0.19–4.22)

Note: *p < 0.05; Ref = Reference; aOR = Adjusted Odds Ratio

Table 3 shows the crude and adjusted associations between selected factors and treatment non-adherence. After adjustment, poor knowledge about TB remained independently associated with non-adherence. Other factors, including adverse drug effects, educational level, household income, employment status, health insurance type, and family support, showed higher proportions of non-adherence in certain groups but were not independently associated with treatment non-adherence in the multivariate analysis.

DISCUSSION

This study highlights the important factors associated with non-adherence to anti-TB treatment among patients living in densely populated urban settings. Overall, the findings suggest that clinical factors do not solely influence treatment adherence, but are also shaped by knowledge [12,23]. These results underscore the complexity of TB treatment adherence and the need for multifaceted public health interventions, particularly in urban areas with high population density and social vulnerability [2]. One of the key findings of this study is the prominent role of patient knowledge in shaping adherence behavior. Patients with limited understanding of TB and its treatment tended to demonstrate poorer adherence, suggesting that inadequate knowledge may hinder patients' ability to recognize the importance of consistent medication intake [24,22]. This finding reinforces the importance of strengthening patient education as an integral component of TB control programs [25]. Health education delivered during routine clinic visits, treatment initiation, and follow-up encounters may improve patients' comprehension of treatment duration, potential side effects, and the consequences of treatment interruption. In densely populated settings, where healthcare workers often face high workloads, structured and standardized educational approaches may help ensure that essential information is consistently conveyed to patients [26].

Socioeconomic conditions also appear to influence adherence behavior. Patients from middle-income households had higher odds of non-adherence than those from high-income households, although these associations did not reach statistical significance. Lower educational attainment was likewise associated with a greater tendency toward non-adherence [12,27]. Economic constraints may limit patients' ability to prioritize health, particularly when competing demands such as employment, transportation costs, or family responsibilities are present [28,29]. These findings indicate that TB control efforts should be integrated with broader social protection strategies. Providing flexible treatment schedules, workplace-friendly medication delivery options, or community-based treatment support may help reduce the burden on economically disadvantaged patients and improve adherence outcomes [30].

After adjustment for potential confounders in the multivariate analysis, poor knowledge about TB remained independently associated with treatment non-adherence [24]. Patients with inadequate knowledge were more likely to discontinue or inconsistently take medication compared with those with good knowledge, indicating that knowledge plays a dominant role beyond other sociodemographic and clinical factors [33]. This finding suggests that improving patient knowledge may substantially impact adherence outcomes, even in the presence of socioeconomic

constraints and treatment-related challenges.

However, these findings differ from several previously cited studies and warrant further consideration. While previous research has reported independent associations between adverse drug effects, socioeconomic factors, and family support with treatment non-adherence [34], the present study found that these factors did not remain independently associated after multivariable adjustment. In contrast, poor TB-related knowledge remained a strong predictor of non-adherence. Several explanations may account for this divergence. First, contextual characteristics of densely populated urban settings may accentuate the role of patient knowledge, as individuals often navigate complex treatment regimens alongside competing social and occupational demands [35]. Second, heterogeneity in the measurement, categorization, and operationalization of socioeconomic status, family support, and adverse drug effects across studies may contribute to inconsistent findings [36]. Third, the relatively modest sample size may have limited the statistical power to detect independent associations for variables with smaller effect sizes [37], suggesting that some non-significant results may reflect limited precision rather than the absence of an underlying effect. Consequently, although the prominent role of patient knowledge observed in this study appears meaningful within this context, the potential contribution of other factors should be interpreted with caution and further explored in larger or longitudinal studies [38].

Other factors, including adverse drug effects, income level, educational attainment, employment status, health insurance type, and family support, did not retain an independent association with non-adherence after adjustment. This suggests that the effects of these variables may be mediated through patient knowledge or operate in combination rather than independently [27,39]. From a public health perspective, these findings have important implications for TB control programs, particularly in urban settings. TB is not only a biomedical condition but also a social disease that reflects broader issues such as poverty, education, and social support [40,41]. Addressing treatment non-adherence, therefore, requires interventions that extend beyond clinical management. Integrating TB services with health promotion, social assistance programs, and community empowerment initiatives may enhance the effectiveness and sustainability of TB control efforts [42,43].

This study also provides insights for future research. Further longitudinal studies are needed to examine how adherence behavior changes over time and to identify critical periods during treatment when patients are most vulnerable to non-adherence. Qualitative research may also be valuable for capturing patients' lived experiences, perceptions of treatment, and contextual barriers that are not fully addressed by quantitative methods. Additionally, intervention studies assessing the effectiveness of educational, social, or digital adherence-support strategies would provide valuable evidence for program development.

From a practical and policy perspective, the findings suggest that strengthening patient knowledge should remain a central focus of TB control programs in Indonesia. The independent association between poor TB knowledge and treatment non-adherence underscores the need for structured and consistent patient education within routine TB services at CHC, particularly at treatment initiation and during follow-up visits. In line with the National Tuberculosis Control Program, adherence education can be reinforced through directly observed treatment and by strengthening the role of treatment supporters, including family members and community health workers. In urban settings with high patient loads, feasible approaches such as brief counseling sessions, standardized educational materials, and mobile phone-based reminders may help address time and resource constraints. At the policy level, integrating TB services with health promotion and community-based support initiatives may further enhance adherence and improve treatment outcomes in densely populated urban areas.

Several limitations should be considered when interpreting the findings of this study. The cross-sectional design limits the ability to infer causal relationships between the identified factors and treatment non-adherence. Self-reported adherence measures may be subject to recall or social desirability bias, potentially leading to underestimation or overestimation of non-adherence. Furthermore, the study was conducted in a single primary health care setting, which may limit the generalizability of the findings to other urban or rural contexts. Despite these limitations, the study provides meaningful insights into adherence challenges in densely populated urban areas and offers practical implications for strengthening TB control programs.

CONCLUSION

In summary, this study demonstrates that treatment non-adherence among patients with pulmonary TB in densely populated urban settings is influenced by a complex interplay of individual, social, and contextual factors, with patient knowledge emerging as the most consistent and independent determinant. Although

socioeconomic conditions, family support, and treatment-related factors were associated with non-adherence at the descriptive level, these factors did not remain independently significant after adjustment, suggesting that their effects may be mediated by patient knowledge or shaped by contextual characteristics of urban environments. These findings highlight the critical importance of strengthening TB-related knowledge through structured and consistent patient education as a core component of TB control strategies. Addressing non-adherence in urban settings, therefore, requires integrated approaches that combine clinical care with health education, social support, and community-based interventions to achieve sustainable improvements in treatment outcomes.

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Authors' contribution
Z.P.A.S.: Study conception, design, data collection, analysis, and interpretation of the results; R.A.: Study conception and design; E.W.: Draft manuscript preparation and interpretation of the results; O.S.: Draft manuscript preparation; B.S.W.: Draft manuscript preparation and interpretation of the results. All authors approved the final manuscript.

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Data availability
Data are available from the corresponding author upon reasonable request and appropriate approval.

Ethics statement
Ethical approval for this study was obtained from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University (No. 931/UN4.14.1/TP.01.02/2024; April 19, 2024).

Conflicts of interest
None.

Use of artificial intelligence (AI)
Nothing to declare.

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