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Association Between Anti-Tuberculosis Drug (OAT) Adherence and Tuberculosis Recurrence Among Pulmonary TB Patients at Dr. Pirngadi Regional Hospital, Medan

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Abstract: Pulmonary tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains a major public health problem. Treatment success depends heavily on adherence to anti-tuberculosis drug (ATD) therapy; however, the long treatment duration may reduce adherence and increase the risk of recurrence. **Objective:** This study aimed to describe the demographic characteristics of pulmonary TB patients and to analyze the association between adherence to ATD therapy and TB recurrence at Dr. Pirngadi General Hospital, Medan. **Methods:** A quantitative observational analytic study with a cross-sectional design was conducted among 33 pulmonary TB patients treated at Dr. Pirngadi General Hospital, Medan (November–December 2025). Data were collected using an ATD adherence questionnaire and complemented with medical record data. Descriptive statistics were used to summarize patient characteristics, adherence levels, and recurrence status, while the Chi-square test was applied to assess the association between adherence and recurrence ($p < 0.05$). **Results:** Most respondents exhibited low adherence to ATD therapy (66.7%), and a high proportion experienced TB recurrence (78.8%). The majority were male (51.5%), predominantly in the adult age group (41–60 years; 51.5%), had a senior high school education (87.9%), and were self-employed. A statistically significant association was found between adherence to ATD therapy and TB recurrence ($p = 0.046$). **Implications:** These findings reinforce the need to strengthen adherence-support strategies in hospital TB services, including structured counseling, active follow-up, and family or treatment supervisor involvement, to reduce recurrence risk and improve program outcomes. **Originality/Value:** This study provides facility-based evidence from Dr. Pirngadi General Hospital, Medan, demonstrating a significant relationship between adherence level and recurrence status, offering locally relevant data to guide targeted adherence interventions and recurrence prevention in hospital settings.

Keywords: Pulmonary tuberculosis; Anti-tuberculosis drugs; Medication adherence; Recurrence.

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INTRODUCTION

Pulmonary tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains a major public health problem because it is transmissible, affects working-age adults, and requires prolonged multidrug therapy to achieve durable cure. Globally, TB continues to impose substantial morbidity and mortality, and repeated episodes after prior treatment further increase healthcare use and the risk of ongoing transmission (WHO, 2024). In TB

programs, preventing recurrence is therefore not only a clinical objective but also a public health priority, because recurrent disease can reflect failures in treatment completion, persistent vulnerability, or re-exposure in high-risk environments (WHO, 2024).

In Indonesia, TB services similarly emphasize treatment completion and structured monitoring as essential components of routine care. National clinical guidance (PNPK) highlights standardized TB management, follow-up, and supervision within health facilities to ensure treatment success and reduce unfavorable outcomes (Kementerian Kesehatan Republik Indonesia, 2019). These priorities are highly relevant for hospital-based TB services in large urban areas such as Medan, where patient mobility, competing work demands, and variable social support may challenge sustained medication-taking behavior and continuity of care during long treatment courses (Nahid et al., 2016; WHO, 2024).

The literature consistently shows that adherence to anti-tuberculosis drug therapy is a core determinant of treatment success and a meaningful factor linked to recurrence. A large systematic review and meta-analysis reported that TB treatment outcomes improve when adherence-support interventions are implemented, underscoring that adherence is modifiable and clinically consequential (Alipanah et al., 2018). In recurrence-focused evidence synthesis, low adherence has also been identified as an important treatment-related risk factor associated with higher recurrence risk, although estimates vary by setting and by how recurrence and adherence are measured (Vega et al., 2024). These findings align with clinical treatment principles and guideline logic: drug-susceptible TB regimens require consistent dosing over time to eradicate persisting bacilli and prevent relapse after treatment completion (Nahid et al., 2016).

At the same time, recurrence is not explained by adherence alone, and prior studies indicate that host and behavioral factors can increase recurrence risk even among patients who appear to complete therapy. Comorbid diabetes mellitus, for example, has been associated with higher TB relapse risk in population-based analytic studies (Lee et al., 2014). Tobacco use has also been linked to worse TB treatment response and higher relapse risk, suggesting that recurrence prevention may require both adherence strengthening and risk-factor management as part of comprehensive care (Leung et al., 2015). This broader risk landscape is important in hospital settings where comorbidity burden and lifestyle risks may be more prevalent and may interact with adherence barriers.

A further stream of research highlights that adherence is strongly shaped by the support environment and the way treatment monitoring is delivered. While directly observed therapy (DOT) has long been used to support adherence, contemporary evidence emphasizes patient-centered delivery and the potential value of alternative models, including technology-assisted supervision, to reduce patient burden while maintaining observation and follow-up (Alipanah et al., 2018). Randomized trial evidence shows that video-observed therapy can be an effective approach to treatment observation and may be preferable for many patients compared with conventional DOT, indicating that the "how" of adherence support can materially influence adherence continuity (Story et al., 2019). In addition, a randomized noninferiority trial in a large public health program found electronic DOT to be noninferior to in-person DOT for observed dosing, supporting the feasibility of modern adherence-support options in real-world TB services (Burzynski et al., 2022).

Despite this extensive literature, practical gaps remain in facility-level evidence, particularly in how adherence categories relate to recurrence status within specific hospital contexts and with the constraints of routine measurement. Studies differ in operational definitions (e.g., relapse vs undifferentiated recurrence), documentation completeness, and adherence measurement approaches, which can lead to inconsistent estimates and limit direct translation into local quality-improvement priorities (Vega et al., 2024). Consequently, hospital-based analyses that describe patient characteristics, quantify adherence levels, and test their association with recurrence can provide actionable, context-specific input for strengthening TB services.

Accordingly, this study aimed to (1) describe the characteristics of pulmonary TB patients based on age, sex, occupation, and educational level; (2) determine the level of adherence to anti-tuberculosis drug therapy; and (3) analyze the association between adherence to anti-tuberculosis drug therapy and TB recurrence at Dr. Pirngadi General Hospital, Medan. By generating facility-based evidence, the study is expected to support targeted adherence-strengthening strategies in hospital TB services, aligned with patient-centered treatment principles (Nahid et al., 2016; Alipanah et al., 2018).

Based on existing evidence and the therapeutic rationale of TB chemotherapy, this study hypothesized that lower adherence to anti-tuberculosis drug therapy is associated with a higher likelihood of TB recurrence. This hypothesis is consistent with recurrence-focused synthesis findings that identify low adherence as a meaningful risk factor (Vega et

al., 2024) and with clinical guideline principles emphasizing sustained, complete dosing to prevent relapse after treatment completion (Nahid et al., 2016).

RESEARCH METHOD

This study examined individual pulmonary tuberculosis (TB) patients as the unit of analysis. Each patient constituted one observation, with two key variables assessed: (1) the level of adherence to Anti-Tuberculosis Drugs (OAT) as the independent variable, and (2) pulmonary TB recurrence status as the dependent variable, determined from the patient's clinical history during the study period.

An analytic observational design with a cross-sectional approach was selected because the objective was to evaluate the association between adherence level and recurrence status at a single assessment window, without manipulating exposure or providing an intervention. This design is appropriate for describing the distribution of variables and testing whether adherence categories are statistically related to recurrence status within the study setting.

The study was conducted at Dr. Pirngadi General Hospital, Medan, using patient data from January to October 2025. The data sources consisted of (a) primary data obtained through a structured questionnaire to measure OAT adherence and adherence-related factors, and (b) secondary data extracted from hospital records to support clinical classification of patients and to determine recurrence status based on documented diagnosis history and treatment information available during the period. Institutional permission and research ethics procedures were followed according to applicable hospital and university regulations.

Data were collected using a self-developed questionnaire administered to eligible patients who attended the hospital within the study period. The questionnaire was designed to categorize adherence into low, moderate, and high levels and to capture factors commonly linked to adherence, such as perceived drug side effects, medication supervision (PMO), family support, and the role of health workers. Prior to full data collection, the questionnaire underwent validity and reliability testing. Validity testing assessed whether each item measured the intended construct, while reliability testing assessed internal consistency using Cronbach's alpha, with values ≥ 0.60 considered acceptable for exploratory instruments in this study context.

Data analysis was performed using SPSS. Univariate analysis was conducted to summarize categorical variables as frequencies and percentages, presented in tables and/or graphs. Bivariate analysis was used to test the relationship between adherence level and recurrence status using the Chi-square test with a significance threshold of $p < 0.05$. When the distribution of data produced small expected cell counts, an exact alternative (Fisher's exact test) was considered to ensure the validity of the association test.

RESULT AND DISCUSSION

Respondent characteristics were first summarized to provide an overview of the study sample and to support interpretation of the adherence–recurrence analysis. The distribution of respondents by sex is presented in Table 1.

Table 1. Frequency Distribution of Respondent Characteristics Based on Gender

Gender	Number (n)	Percentage (%)
Male	17	51.5%
Female	16	48.5%

As shown in Table 1, the sample was nearly balanced by sex, with males slightly more represented (17 respondents; 51.5%) than females (16 respondents; 48.5%). This relatively even distribution suggests that the findings are not dominated by a single sex group within the study population.

Table 2. Frequency Distribution of Respondent Characteristics Based on Age

Age	Number (n)	Percentage (%)
21–40 years	10	30.3%
41–60 years	17	51.5%
>60 years	6	18.2%

Table 2 indicates that most respondents were adults aged 41–60 years (17 respondents; 51.5%), followed by those aged 21–40 years (10 respondents; 30.3%) and those older than 60 years (6 respondents; 18.2%). This pattern shows that the study sample was

predominantly middle-aged, which is relevant because age may influence treatment continuity, comorbidity burden, and follow-up behavior.

Educational attainment was then summarized because it may influence health literacy, understanding of treatment instructions, and adherence behavior. The distribution of respondents by educational level is shown in Table 3.

Table 3. Frequency Distribution of Respondent Characteristics Based on Educational Level

Education Level	Number (n)	Percentage (%)
Senior High School	29	87.9%
Bachelor's Degree	3	9.1%
Master's Degree	1	3%

As presented in Table 3, most respondents had completed senior high school (29 respondents; 87.9%), while a smaller proportion had a bachelor's degree (3 respondents; 9.1%) and a master's degree (1 respondent; 3.0%). The dominance of the senior high school category suggests that adherence support strategies should emphasize clear communication and practical counseling suited for a broad range of health literacy levels.

Occupation was also described to capture the socioeconomic context that may shape clinic attendance, medication-taking routines, and the ability to complete treatment. Table 4 presents the distribution of respondents according to occupation.

Table 4. Frequency Distribution of Respondent Characteristics Based on Occupation

Occupation	Number (n)	Percentage (%)
Self-employed	17	51.5%
Housewife	8	24.2%
Unemployed	6	18.2%
Private Employee	1	3%
Civil Servant	1	3%

Table 4 shows that self-employed respondents constituted the largest group (17 respondents; 51.5%), followed by housewives (8 respondents; 24.2%) and unemployed respondents (6 respondents; 18.2%). Only a small number were private employees and civil servants (each 1 respondent; 3.0%). This profile suggests that many participants likely faced variable daily schedules and competing responsibilities, which can influence adherence and continuity of care.

After describing the demographic profile, the study summarized questionnaire-based factors that may contribute to recurrence through reduced treatment continuity and

inadequate support. The total scores of "Yes" responses for each factor domain are presented in Table 5.

Table 5. Distribution of Factors Contributing to Recurrence Based on Questionnaire Results

Contributing Factors	Total Score
Drug Side Effects	47
Medication Supervisor	18
Family Support	21
Role of Health Workers	32

As shown in Table 5, the lowest total "Yes" score was observed for the medication supervisor (PMO) domain (total score = 18), followed by family support (21) and the role of health workers (32), while drug side effects had the highest total "Yes" score (47). This distribution suggests that perceived side effects were the most frequently reported barrier, whereas gaps in supervision and support may also play an important role and warrant strengthening to improve treatment continuity and reduce recurrence risk.

Medication Adherence Level

Medication adherence levels were categorized into three groups, namely low adherence, moderate adherence, and high adherence, using a questionnaire that classified respondents into these three categories. The following presents the frequency distribution based on questionnaire responses regarding adherence to Anti-Tuberculosis Drug (OAT) consumption.

Table 6. Distribution of Respondents Based on Adherence Level to Anti-Tuberculosis Drug (OAT) Consumption

Adherence Level	Number (n)	Percentage (%)
Low	22	66.7%
Moderate	8	24.2%
High	3	9.1%
Total	33	100%

Based on Table 6, the highest proportion of adherence to anti-tuberculosis medication was found in the low adherence category, with 22 respondents (66.7%). This was followed by moderate adherence with 8 respondents (24.2%) and high adherence with 3 respondents (9.1%).

Table 7. Frequency Distribution of Respondents Based on Recurrence

Recurrence Status	Number (n)	Percentage (%)
No Recurrence	7	21.2%
Recurrence	26	78.8%
Total	33	100%

Based on Table 7, the majority of pulmonary tuberculosis patients experienced recurrence, with 26 respondents (78.8%), while 7 respondents (21.2%) did not experience recurrence.

Table 8. Relationship Between Adherence to Anti-Tuberculosis Drug (OAT) Consumption and Recurrence of Pulmonary Tuberculosis

Adherence Level	Recurrence				Total		*p Value*
	No Recurrence		Recurrence				
	n	%	n	%	n	%	
Low	2	9,1%	20	90,9%	22	100%	
Moderate	4	50%	4	50%	8	100%	**0,046**
High	1	33,3%	2	66,7%	3	100%	
Total	**7**	**21%**	**26**	**78,8%**	**33**	**100%**	

Based Table 8 on the analysis of the relationship between adherence to anti-tuberculosis medication and recurrence of pulmonary tuberculosis, it was found that among 22 respondents with low adherence levels, the majority experienced recurrence, totaling 20 individuals. In the moderately adherent group, among 8 respondents, 4 individuals experienced recurrence. Meanwhile, in the highly adherent group, 1 respondent did not experience recurrence and 2 respondents experienced recurrence.

Statistical analysis using the Chi-Square test showed a p-value of 0.046 ($p < 0.05$), indicating that there was a statistically significant relationship between adherence to anti-tuberculosis medication and recurrence of pulmonary tuberculosis.

DISCUSSION

The findings of this study indicate that most respondents had low adherence to anti-tuberculosis drugs (OAT) and that pulmonary TB recurrence was common in the study sample. In the bivariate analysis, adherence level was statistically associated with recurrence status ($p = 0.046$), suggesting that patients with lower adherence tended to experience recurrence more frequently. In addition, questionnaire-based domains highlighted potential contextual barriers, where medication supervision (PMO), family

support, the role of health workers, and drug side effects emerged as key elements surrounding patients' treatment behavior and continuity.

The association between low adherence and recurrence can be explained by the nature of TB therapy, which requires regular, consistent, and long-term medication to eradicate Mycobacterium tuberculosis effectively. When adherence is poor, patients may miss doses, interrupt treatment, or discontinue therapy prematurely conditions that can reduce bacteriological clearance, increase the likelihood of persistence of infection, and heighten the probability of recurrent disease after a prior episode. This mechanism is also consistent with the descriptive pattern in this study, where recurrence was more frequently observed in the low-adherence group. In practical terms, the finding that medication supervision and support-related domains were prominent reinforces the behavioral pathway: insufficient supervision or support may weaken routines and accountability, making irregular intake more likely, especially when symptoms have improved or when adverse effects occur.

When compared with previous studies, the present findings align with evidence that adherence is a central determinant of TB treatment success and recurrence prevention. The important role of PMO reported in this study is consistent with earlier literature emphasizing that treatment supervisors can promote regular medication intake and encourage patients to complete therapy (Setyaningrum et al., 2023). The implication is that supervision functions not merely as "monitoring," but as a structured support system reminding patients, maintaining motivation, and facilitating follow-up schedules thereby reducing the risk of interruption that can contribute to recurrence. Similarly, the relevance of treatment barriers such as side effects is consistent with clinical observations that discomfort and fear of adverse reactions may reduce willingness to continue therapy, which can indirectly elevate recurrence risk (Afrianti, 2023). In this context, the contribution of this study is its facility-based evidence from Dr. Pirngadi Regional Hospital, Medan, showing that adherence differences within a hospital population are meaningfully associated with recurrence status and highlighting specific support domains that can be prioritized for local program strengthening.

At the same time, this study also found that recurrence occurred even among patients categorized as having good adherence, indicating that adherence alone may not fully explain recurrence risk. This pattern supports prior discussion that recurrence may also reflect host factors and environmental re-exposure. Reduced immune function, poor nutritional status, and comorbidities such as diabetes mellitus or other infections may

increase vulnerability to recurrent TB despite adequate medication-taking behavior (Dhanny & Sefriantina, 2022). Moreover, living or working in crowded environments with inadequate ventilation can facilitate re-exposure and reinfection, which may be clinically recorded as recurrence in routine settings (Penentu et al., 2024). Therefore, the meaning of the findings is that recurrence prevention requires not only adherence reinforcement, but also broader risk management that includes comorbidity screening, nutritional support, and environmental risk reduction.

From a broader perspective, the results have important implications for patient safety, service quality, and TB control. Functionally, improving adherence and strengthening supervision can increase treatment success, reduce repeated healthcare utilization, and mitigate the risk of drug resistance, which is a critical public health concern. Conversely, if low adherence persists particularly in the presence of weak support systems patients may experience repeated episodes, higher economic burden, prolonged infectious periods, and potential escalation to more complex, costly treatment pathways. These "dysfunctions" can affect not only individuals and families, but also hospital workloads and public health targets for TB control.

Based on these findings, the study supports several actionable steps. First, TB services at the hospital level should strengthen PMO implementation, ensuring that each patient has an identifiable treatment supervisor and that supervisor roles are operationalized through clear routines (daily reminders, adherence logs, and follow-up schedules). Second, structured patient and family counseling should be intensified to address misconceptions, reinforce the necessity of completing therapy even after symptom improvement, and build consistent support at home. Third, proactive adverse-effect management should be embedded into follow-up visits, including early identification of side effects and practical guidance to prevent discontinuation. Fourth, recurrence prevention should integrate risk-factor screening particularly for nutritional problems and comorbidities so that adherence interventions are coupled with clinical risk mitigation. Finally, future work should consider larger, multi-center designs and more objective adherence measures to strengthen evidence and reduce information bias, given that this study's cross-sectional design and self-report adherence approach limit causal inference and may be subject to recall and social desirability biases (Nopita et al., 2023).

CONCLUSION

This study highlights a central lesson for hospital-based TB care: adherence to anti-tuberculosis drugs (OAT) is meaningfully associated with pulmonary TB recurrence among patients treated at RSUD Dr. Pirngadi Medan. The chi-square analysis showed a statistically significant relationship between adherence level and recurrence status ($p = 0.046$), while descriptively the sample was characterized by a high proportion of recurrence (78.8%; 26/33) and a predominance of low adherence (66.7%; 22/33). In addition, the diagnostic profile indicates that TB case confirmation in this sample was supported by bacteriological findings in part of the cohort (AFB-positive: 18/33) and by radiological examination across all respondents (chest X-ray positive: 33/33), reinforcing the clinical relevance of recurrence assessment within hospital services.

The scientific contribution of this study lies in providing facility-based empirical evidence from Medan that links adherence categories to recurrence status within a defined hospital population. By documenting adherence distribution and recurrence patterns in the same sample, the study strengthens the local evidence base for prioritizing adherence-support strategies particularly supervision and counseling interventions within TB service delivery at RSUD Dr. Pirngadi. These results can support quality-improvement efforts aimed at reducing recurrence risk through more consistent treatment monitoring and patient support during the therapy period.

Several limitations should be acknowledged. First, the cross-sectional design supports an associational interpretation and does not establish causality between adherence and recurrence. Second, the relatively small sample size reduces statistical precision and may limit generalizability beyond RSUD Dr. Pirngadi Medan. Third, adherence was measured using a self-report questionnaire, which may be affected by recall and social desirability bias. Finally, potential confounders such as nutritional status, smoking, environmental exposure, contact history, and comorbidities were not fully measured or controlled, which may influence recurrence risk. Future studies are therefore recommended to use larger multi-center samples, longitudinal or cohort designs, and more objective adherence measures, while incorporating broader clinical and social risk factors to provide a more comprehensive understanding of pulmonary TB recurrence prevention.

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