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Adherence to anti-tuberculosis treatments by patients using an instrument based on the health belief model

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ABSTRACT

Introduction: Several studies report a persistently high rate of non-adherent patients globally, with tuberculosis patients failing to comply with prescribed regimens. Adherence rates often decline during advanced treatment phases due to patients feeling cured, treatment fatigue, or obstacles related to access and employment. The aim of the study was to compare TB patient's adherence to treatment using two instruments: the researchers AMI-TB and the MMAS-8 questionnaire.

Research Methodology: This study employed a cross-sectional observational design with descriptive assessments using two adherence-related instruments. No intervention or repeated measurement was performed. The study population consisted of all registered patients diagnosed with tuberculosis undergoing anti-tuberculosis treatment, totaling 489 patients. A total of 148 respondents participated in this study using simple random sampling. Data were collected using the MMAS-8 and AMI-TB questionnaire. Data analysis included univariate and bivariate analyses using an independent t-test with a significance level of $p < 0.05$.

Results: The average treatment status measured using MMAS-8 was 6.48 (standard deviation = 1.48), and using AMI-TB was 59.13 (standard deviation = 4.13). A previously reported p value of 0.005 resulted from a raw-score comparison; this does not constitute a valid test of comparative adherence because the instruments have different score ranges and conceptual targets.

Conclusion: The findings describe adherence-related scores obtained using two conceptually different instruments in the participating tuberculosis services. MMAS-8 assesses self-reported medication-taking behavior, whereas AMI-TB addresses selected Health Belief Model perceptions. These results do not demonstrate superior validity, accuracy, or interchangeability of either instrument. Further study-specific reliability, construct validity, criterion validity, and clinical outcome analyses are needed before recommending routine comparative use. Questionnaires based on the health belief model can be used to measure TB patients' adherence to anti-tuberculosis treatment.

Keywords: tuberculosis; medication adherence; health belief model; psychometric assessment.

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INTRODUCTION

Tuberculosis (TB) remains a major global health problem and is of particular concern in Indonesia. Successful therapy depends on strict medication adherence for a minimum of six months. Non-adherence can result in treatment failure, relapse, sustained transmission, and the emergence of drug resistance, posing severe challenges to TB control programs. TB, caused by Mycobacterium tuberculosis, spreads via droplets from coughs or sneezes of infected individuals. Several studies report a persistently high rate of non-adherent patients globally, with 25–45% of TB patients failing to comply with prescribed regimens (Bea et al., 2021; Gashu et al., 2020) Adherence rates often decline during advanced treatment phases due to patients feeling cured, treatment fatigue, or obstacles related to access and employment (Bahukudumbi et al., 2024; Gebreweld et al., 2018; Ozaltun & Akin, 2024). Indonesia, especially Central Sulawesi, has one of the world's highest TB burdens. According to the WHO, Indonesia ranks second in the number of TB cases after India. This situation underscores the need to prioritize TB in national and regional health development.

The 2023 Indonesian Health Survey (SKI) highlights tuberculosis as a persistent public health threat, especially in relation to population density, socioeconomic status, environmental sanitation, nutrition, and healthcare access. Identified key barriers limited case detection, poor treatment adherence, and low therapy success sustain community transmission (Kementerian Kesehatan Republik Indonesia, 2024). Central Sulawesi Province exemplifies this challenge, with the 2023 Central Sulawesi Health Profile reporting that several districts and cities remain below the national 90% target for TB detection. Delayed case reporting, poor internet access in remote areas, ineffective contact investigations, and insufficient health worker engagement in active case finding are the main obstacles (Dinas Kesehatan Propinsi Sulawesi Tengah, 2024).

This paragraph focuses on the challenges of TB control in Palu City and Donggala Regency, Central Sulawesi Province. Palu City, the provincial capital, has one of the highest TB case numbers in the region, recording approximately 718 cases as of September 2023, surpassing most other localities in Central Sulawesi. The city's high TB burden is affected by factors such as population mobility, residential density, and socioeconomic conditions. In contrast, Donggala Regency, which serves as a buffer zone for Palu City, grapples with similar TB control problems, compounded by its expansive geography, inconsistent access to health services, and limited health infrastructure. Previous studies in Donggala Regency specifically note issues with anti-tuberculosis drug resistance and low treatment success rates linked to patient discontinuation and inadequate health service access. Thus, there is a critical need for precise adherence measurement to detect treatment failure early (Yan et al., 2018) and to inform the design of interventions such as social support, education, and digital technology-based approaches (Alipanah et al., 2018; Pradipta et al., 2020).

Treatment adherence is the process by which patients take their medications as prescribed. This includes three phases: 1) initiation: when the patient first begins taking the medication; 2) implementation: the extent to which the patient's daily medication regimen aligns with the recommended dosage, timing, and frequency; and 3) discontinuity: when the patient stops treatment prematurely (Vrijens et al., 2012; Asrianto et al., 2026). Generally, adherence is defined as the extent to which a patient's medication-taking behavior, diet, and lifestyle changes align with recommendations agreed upon with healthcare professionals (Chakrabarti, 2014; Julius et al., 2009). A focus on active and collaborative participation with patients, rather than simply following healthcare provider orders (Myers & Midence, 2020), in other words, a shared desire

(Singh et al., 2021), will optimize patient adherence and prevent therapy failure and treatment resistance.

Theories often used to assess patient adherence in the HBM are a model for long-term medication adherence, with five core components: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (Azizi et al., 2018; Tola et al., 2016). Researchers have developed their own tool to measure medication adherence based on the HBM theory, known as the AMI-TB questionnaire. The AMI-TB questionnaire was developed around selected Health Belief Model domains: perceived benefits, perceived barriers, and perceived seriousness and threat (Aminuddin et al., 2025). It is a focused application of the model rather than a comprehensive assessment of all HBM constructs. The MMAS-8 is an eight-item self-report measure of medication-taking behavior, with scores ranging from 0 to 8 and higher scores indicating greater adherence (Moon et al., 2017). The two questionnaires differ in content and numerical scale.

TB-specific questionnaires already address non-adherence risk factors and broader treatment behavior (Rianto et al., 2024; Prasetyo et al., 2025). The contribution of the present study is therefore the descriptive application of AMI-TB in local TB services, rather than the introduction of an entirely new adherence construct.Another frequently used instrument to assess adherence is the Morisky Medication Adherence Scale 8-item (MMAS-8), a self-report questionnaire with eight questions used to measure medication adherence in various chronic diseases (hypertension, diabetes, cardiovascular disease, asthma, etc.) (De Oliveira-Filho et al., 2014; Kwan et al., 2020). The total score ranges from 0–8, with higher scores indicating greater adherence (Okello et al., 2016; Plakas et al., 2016). This study aimed to compare TB patients' adherence to treatment using two instruments: the researchers' AMI-TB and the MMAS-8 questionnaire.

RESEARCH METHODOLOGY

Study Design

This study employed a cross-sectional observational design with descriptive assessments using two adherence-related instruments. No intervention or repeated measurement was performed. The design aimed to examine adherence using MMAS-8 and AMI-TB. It also reviewed the incidence of drug withdrawal in TB patients. Data were collected once to capture the conditions.

Study setting and period

The research was conducted in the public health center in Palu City and the Donggala district. Data collection was conducted from August 2024 to July 2025.

Population and Sample

The study population consisted of all registered patients diagnosed with tuberculosis undergoing anti-tuberculosis treatment, totaling 489 patients. The sample size was determined using simple random sampling. A total of 148 participants were reported. Table 2 indicates 69 MMAS-8 assessments and 79 AMI-TB assessments, summing to 148. The original source dataset must be checked to confirm instrument allocation, missing data, recruitment flow, and whether any participants completed both instruments.

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) patients diagnosed with tuberculosis; (2) undergoing anti-tuberculosis treatment; (3) registered at the selected public health centers; and (4) willing to

participate in the study. Exclusion criteria were: (1) severe cognitive impairment; (2) critical illness; and (3) inability to complete the questionnaire.

Research Variables

The independent variables in this study were TB treatment adherence, measured using the MMAS-8 TB treatment adherence instrument, compared with the AMI-TB instrument, which measures three things: perceived benefits, perceived barriers, and perceived seriousness and threat. The dependent variable was whether the patient had ever discontinued treatment.

Research Instruments

Data were collected using questionnaires. Medication adherence was measured using the eight-item MMAS-8. Another questionnaire used was the AMI-TB questionnaire, developed by the researchers based on the Health Belief Model, consisting of 20 questions. All instruments have been widely used and have demonstrated acceptable validity and reliability in previous studies. A goodness-of-fit analysis was conducted using LISREL; although some items yielded values below 0.5, the researcher retained them based on specific considerations (Aminuddin et al., 2025)

Data Collection Procedure

Researchers trained data collectors who were TB program managers at the Gonenggati Donggala Community Health Center, Wani Community Health Center, and Singgani Community Health Center. Respondents were informed of the study's purpose and provided informed consent before participation. Questionnaires were administered directly to respondents.

Data Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize respondent characteristics using frequencies and percentages. Because MMAS-8 and AMI-TB use different constructs and numerical score ranges, a direct independent-samples t-test of their raw scores does not establish comparative adherence, agreement, or instrument superiority. The previously reported p value is retained only as an unverified historical analysis and is not interpreted as evidence of comparative validity. Appropriate analyses require individual-level data, instrument scoring protocols, and a prespecified external criterion or linked clinical outcome.

Ethical Considerations

Ethical approval for this study was obtained from the KEPK Poltekkes Kemenkes Palu with number 001925/KEPK POLTEKKES KEMENKES PALU/2025. Permission was also secured from all respondents using informed consent. All respondents participated voluntarily and were assured of anonymity throughout the research process.

RESULT

This section presents the study's findings. The results are organized into two main parts. First, univariate analysis describes the sociodemographic characteristics, and second, bivariate analysis examines the mean difference in adherence to tuberculosis between MMAS-8 and AMI-TB using an independent t-test. Table 1 presents the sociodemographic characteristics of tuberculosis patients, including age and sex distributions, treatment adherence levels assessed using the MMAS-8 and AMI-TB instruments, and the proportion of patients who reported treatment discontinuation. These findings provide an overview of participant characteristics and adherence patterns across the study population.

Table 1. Sociodemographic characteristics, adherence and dropped out of treatment.

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	<30	32	21.6
	31-40	23	15.5
	41-50	38	25.7
	≥ 50	55	37.2
Sex	Male	88	59.5
	Female	60	40.5
Adherence	MMAS-8		
	High	16	23.19
	Medium	35	50.72
	Low	18	26.09
	AMI-TB		
	High	52	65.8
	Medium	27	34.2
Treatment status			
	Withdrawl	17	11.49
	Never	131	88.51

The table above illustrates the sociodemographic data of TB patients at three community health centers (Puskesmas) in Palu City and Donggala Regency. The majority of respondents were over 41 years old. The youngest respondent was 19, and the oldest was 77. More men had TB than women. Measuring adherence using the MMAS questionnaire revealed a higher proportion of respondents with moderate and low adherence, while only 16 (23.19%) had high adherence. Measuring adherence using the AMI-TB questionnaire revealed that the majority of respondents (52) had high adherence, while the remaining 27 (34.2%) had moderate adherence. Table 2 presents the mean scores, standard deviations, and standard errors of tuberculosis treatment adherence assessments using the MMAS-8 and AMI-TB instruments. The findings provide a descriptive overview of the scores obtained from each instrument, highlighting differences in their measurement scales and score distributions.

Table 2. Shows the average distribution of TB patient treatment adherence using two adherence instruments.

Treatment status	Mean	SD	SE	P value	N
MMAS-8	6.48	1.48	0.18	0.005	69
AMI-TB	59.13	4.13	0.46		79

The descriptive means were 6.48 (SD 1.48; n = 69) for MMAS-8 and 59.13 (SD 4.13; n = 79) for AMI-TB. The instruments have different scoring scales and assess partly different constructs; their unstandardized means cannot be compared as if they were the same outcome. The previously reported p = 0.005 should not be used to infer that either instrument measures greater adherence or performs better. Reanalysis of individual-level data is required.

DISCUSSION

TB remains a major health problem today. One of the biggest challenges is the social and economic impact of the lengthy treatment period. This is due to the lengthy treatment period and the increasing risk of drug resistance. Recent developments in TB treatment indicate a shift from conventional treatment protocols to shorter, more effective therapies. A 4-month course of rifapentine and moxifloxacin has been shown to be as effective as a 6-month regimen, thereby shortening the previous 6-month treatment period (Dorman et al., 2021). However, the main challenge remains drug resistance, which requires a multidrug therapy approach (World Health Organization (WHO), 2022). The treatment strategy that has become the mainstay of TB

treatment globally is Directly Observed Treatment Short-course (DOTS), where implementation has increased cure rates from 50% to 85%. More recently, with technological advancements, this method can be combined with digital technology to achieve optimal results. Research shows that adherence to TB treatment is influenced by various factors.

Factors influencing adherence include individual factors, such as patient knowledge of the disease and treatment, perceived benefits of treatment, and perceived side effects. Additionally, family support, knowledge, employment, the role of medication supervisors, and distance are factors. Several modifications are made, in which health workers sometimes make efforts to ensure patients continue taking their medication regularly, such as by visiting patients at home to distribute medication. Furthermore, patients' knowledge, attitudes, and beliefs about treatment, treatment duration, and adherence are important. Patients sometimes refuse to take medication and become non-adherent due to feeling better, trying traditional remedies, or experiencing side effects from treatment. Patients without comorbidities have a high level of adherence to TB medication; the more severe the comorbidity, the lower the adherence rate. TB treatment adherence is crucial for several reasons: 1) the effectiveness of long-term TB treatment to ensure complete bacterial eradication; 2) preventing drug resistance due to non-adherence by TB patients that leads to resistance to treatment; 3) preventing transmission to others; and 4) program efficiency, which aims to increase efficiency, reduce treatment costs, and optimize the use of healthcare resources. One way to encourage patient adherence is to use HBM.

The HBM assumes that a person's health behavior is determined by their beliefs and perceptions about health and disease. This model is cognitive, meaning it emphasizes the individual's thought processes and beliefs in making health decisions. The HBM also recognizes that health behavior is influenced not only by individual factors but also by social and environmental factors. Some indicators of TB treatment adherence include attendance (e.g., the percentage of visits to health facilities), ensuring medication is taken, urine tests for isoniazid, daily reports, electronic attendance monitoring, and DOTS (directly observed therapy, short-course).

From this study it can be seen that the youngest respondents were 19 years old and the highest at 77 years old, the average respondent was 45 years old, respondents who were in the age range <40 years old were 55 people (37.1%) in the productive age range in line with WHO, so that this disease can disrupt the productivity and socio-economic of TB patients. Men were more numerous than women, 88 people (59.5%). A total of 68 people (46%) were assessed for adherence using the MMAS-8 questionnaire, which is very appropriate for quantitatively measuring patients' regular medication adherence, or, in other words, measuring the level of patient adherence (Xu et al., 2017). Another study that measured patient adherence using the MMAS-8 questionnaire found that the prevailing stigma in society for TB treatment greatly affects patient adherence (Yan et al., 2018); however, this was not described in the MMAS-8 questionnaire because the MMAS-8 is more prioritized for measuring patient adherence with chronic diseases (Burleson et al., 2025). Meanwhile, the HBM-based questionnaire has the advantage of being more focused on why patients are adherent or non-adherent, based on their perceptions of the disease and treatment. In other words, adherence questionnaires using the HBM focus more on the 'why' or reasons behind the observed adherence behavior. Questionnaires using the HBM tend to adopt an inductive approach because they allow relevant themes and factors to emerge from data collected by exploring the diversity of patient experiences and perceptions. This is in line with the opinions of (Haldane et al., 2021; Sulistyono et al., 2020), who revealed reasons for patient non-adherence to TB treatment, such as perceived barriers due to long distances to

health facilities, costs and travel factors, low perceived benefits, where many patients do not understand the importance of completing treatment, stopping treatment when symptoms improve, and experiencing disturbing side effects of medication such as nausea, dizziness, and rashes. Furthermore, there is still a high stigma in society related to TB, resulting in ostracism in the community and workplace.

A theory-based questionnaire may organize questions about perceived benefits, barriers, and seriousness of illness. However, a theoretically relevant item is not necessarily a reliable or discriminating measure. For AMI-TB, the weak model fit reported in the development study remains relevant to interpretation of the present scores. Repeated use of the questionnaire does not itself resolve these measurement concerns. The recorded category distributions differed between the assessment sets. This pattern may reflect participant composition, questionnaire content, response tendencies, or classification rules. Without established thresholds and a common external criterion, it cannot show which questionnaire better identifies missed medication (Suprapto et al., 2026). The observed proportions should therefore not be presented as comparative prevalence estimates of non-adherence.

The absence of a low-adherence category among the reported AMI-TB assessments deserves particular attention. It could reflect the beliefs of the patients assessed, the scoring thresholds, or limited discrimination at the lower end of the construct. It does not demonstrate that these patients took every prescribed dose. Conversely, the MMAS-8 distribution cannot be used to establish that its respondents had poorer adherence than the AMI-TB respondents. Item-level response distributions and the derivation of category thresholds would help determine whether the observed pattern reflects patient differences or properties of the questionnaire. A ceiling effect remains a possibility to investigate, rather than a finding established by the current summary data.

The 17 participants with a reported history of treatment discontinuation represent another potentially informative aspect of the findings. However, an aggregate history of discontinuation cannot validate either questionnaire without linking that history to individual scores and specifying when discontinuation occurred. Beliefs assessed after a treatment interruption may differ from those present before it. A future analysis should distinguish past interruption from current medication taking and subsequent treatment completion. This temporal distinction would help determine whether AMI-TB identifies an existing difficulty, reflects a previous experience, or predicts a future adherence outcome.

All of the above further demonstrates that no single instrument can independently measure patient adherence; rather, a combination of the two questionnaires is necessary. The MMAS-8 questionnaire is used as a standard screening tool for TB patients at the start of treatment. Subsequently, patients at risk or with low adherence (score <6) and those with moderate adherence (6-7) are identified and interviewed using an HBM-based guide or questionnaire. This implies that all healthcare workers are encouraged to measure adherence using the MMAS-8 questionnaire and are even facilitated in doing so by the MMAS-8 Android application for data collection. Furthermore, for patients with moderate or low adherence, more specific reinforcement is provided by exploring potential barriers to using the HBM questionnaire and by tailoring it to local culture, as adherence can vary from person to person (Shringarpure et al., 2023). Furthermore, education is provided on the use of telemedicine systems for HBM-based consultations in rural areas where access to community health centers is remote or inaccessible. Education is provided in simple language that patients can easily understand.

CONCLUSION

The findings describe adherence-related scores obtained using two conceptually different instruments in the participating tuberculosis services. MMAS-8 assesses self-reported medication-taking behavior, whereas AMI-TB addresses selected Health Belief Model perceptions. These results do not demonstrate superior validity, accuracy, or interchangeability of either instrument. Further study-specific reliability, construct validity, criterion validity, and clinical outcome analyses are needed before recommending routine comparative use. Questionnaires based on the health belief model can be used to measure TB patients' adherence to anti-tuberculosis treatment. Broader measurements using the AMI-TB instrument can be conducted in community health centers, targeting patients undergoing anti-tuberculosis treatment and who tend to be less adherent.

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Conflict of Interest

There are no potential conflicts of interest relevant to this article.

Declaration of generative AI

There are no generative AI dan AI assisted technologies in the writing process.

Ethical Approval

This study received ethical approval from the appropriate institutional research ethics committee prior to data collection. All research procedures were conducted in accordance with established ethical standards, ensuring the protection of participants' rights, safety, and confidentiality. The ethical clearance has been issued by the Ethics Commission of the Poltekkes Kemenkes Palu.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical and privacy considerations.

Authors' Contributions

Aminuddin contributed to the study design, data collection, and manuscript drafting. Irsanty Collein contributed to data analysis, interpretation of results, discussion, and conclusion, and to the revision of the manuscript. Ismunandar contributed to the data collection and final approval. All authors read and approved the manuscript.

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