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A Determinant Model of Sustainable Tuberculosis Treatment Compliance Based on the Health Belief Model in Tuberculosis Patients in Surakarta, Central Java, Indonesia

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ABSTRACT

Background: Tuberculosis (TB) is an infectious disease that remains a major global and national public health problem, with Indonesia ranking second worldwide after India. Treatment adherence is a key determinant of therapeutic success, yet it continues to be challenged by high dropout rates and drug resistance. This study aims to examine the Health Belief Model in relation to treatment adherence among tuberculosis patients in Surakarta.

Subjects and Method: This was a cross-sectional study conducted in Surakarta. A total of 400 tuberculosis patients were selected as the study sample. The dependent variable was treatment adherence. Independent variables included perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, self-efficacy, and family support. Data were collected using a questionnaire and analyzed using path analysis.

Results: Treatment adherence increased with higher cues to action (b = 4.01; 95% CI = 0.80 to 7.22; p = 0.01), perceived susceptibility (b = 2.00; 95% CI = 0.46 to 3.53; p = 0.01), and perceived benefits (b= 3.05; 95% CI= 0.17 to 5.93; p = 0.01). In contrast, higher perceived barriers decreased treatment adherence (b= −2.70; 95% CI = −4.39 to −1.01; p = 0.001). Indirectly, cues to action increased family support (b= 2.10; 95% CI= 0.13 to 4.08; p = 0.010), and perceived barriers increased cues to action (b= 3.68; 95% CI= 1.13 to 6.23; p = 0.01). Perceived susceptibility decreased cues to action (b = −0.64; 95% CI= −1.25 to −0.03; p = 0.01) but increased perceived barriers (b = 4.85; 95% CI = 1.17 to 8.54; p= 0.01). Perceived severity increased perceived barriers (b = 1.75; 95% CI = 0.41 to 3.09; p = 0.01) and decreased family support (b = −0.83; 95% CI = −1.48 to −0.18; p = 0.01), while perceived benefits increased family support (b = 2.41; 95% CI = 0.32 to 4.50; p = 0.01).

Conclusion: Higher cues to action, perceived susceptibility, and perceived benefits, as well as lower perceived barriers, improve treatment adherence. Family support also plays an important mediating role in strengthening adherence among tuberculosis patients.

Keywords: medication adherence, health belief model, cues to action, family support

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BACKGROUND

Tuberculosis (TB) remains a significant public health problem globally and in Indonesia. According to the World Health Organization (WHO), TB still causes millions of new cases and deaths each year, making effective prevention and treatment a national and local priority. Indonesia is one of the countries with the highest TB burden in the world, ranking second after India, with an estimated 1,060,000 new cases and 134,000 deaths annually (WHO, 2025).

Adherence to antituberculosis treatment regimens is key to successful therapy. Non-adherence contributes to therapy failure, relapse, and the emergence of multidrug-resistant tuberculosis (MDR-TB), which increases the clinical and economic burden. Factors contributing to non-adherence are multicausal, encompassing socioeconomic factors, health systems, drug side effects, stigma, and patient psychosocial and cognitive factors. Therefore, identifying adherence determinants appropriate to the local context is crucial for designing effective interventions (Munro et al., 2007).

In Indonesia, Central Java Province is one of the regions with the highest number of TB cases. In 2023, there were 96,917 TB cases recorded in this province (Fauziyah & Putri, 2024) Surakarta City showed a significant upward trend, with the number of cases rising from 1,225 in 2021 to 2,112 in 2022, and 2,393 in 2023. TB cases in children also increased sharply, from 170 in 2021 to 711 in 2023 (Ministry of Health, 2023).Local data shows that the distribution of TB cases forms clusters in several community health center work areas, emphasizing the need for contextual analysis to identify barriers to treatment adherence (Khoirunissa, 2021).

Globally, TB remains one of the ten leading causes of death, and is the leading cause of death caused by a single infectious agent (Sazali et al., 2023). Widespread latent infection is estimated to affect one-third of the world's population, with a risk of progression to active disease (Khamis et al., 2022). TB treatment success rates are often low due to high dropout rates, which leads to drug resistance. In this regard, health counseling plays a crucial role in improving patient understanding and encouraging treatment adherence (Efendi et al., 2022).

TB treatment presents special challenges because it requires a long-term regimen, usually 6–8 months using a combination of drugs (Zhou et al., 2012). Non-adherence to this regimen is a global problem, especially in patients with chronic diseases, because it increases the risk of drug resistance, relapse, and death, as well as prolonging the infectious period (Yadav et al., 2021).

Within the theoretical framework, the Health Belief Model (HBM) is one of the most widely used approaches to explain patient adherence to treatment. The HBM emphasizes six key cognitive constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action. Meanwhile, Social Cognitive Theory (SCT) adds important perspectives on self-efficacy and social support, particularly family support, which have been shown to influence patient adherence to TB treatment (Alyafei & Easton-Carr, 2024).

Based on this background, research is needed that can develop a sustainable HBM-based model of TB treatment adherence determinants, with the integration of SCT aspects, in order to increase the effectiveness of health interventions and the success of therapy in the Surakarta area.

SUBJECTS AND METHOD

1. Study Design

This study is an analytical observational study with a cross-sectional design using a path analysis model. The study was conducted from May to August 2025 in the Surakarta area.

2. Population and Sample

The population in this study was 2,356 TB sufferers in Surakarta with 17 existing health centers selected, 8 of which were then taken from each of 50 TB sufferers by random sampling so that the total sample size was 400 respondents.

3. Study Variables

The dependent and independent variables whose relationship will be analyzed in this study are as follows: Independent variables: Health Belief Model and Social Cognitive Theory (perceived vulnerability, perceived severity, perceived benefits, perceived barriers, self-efficacy, cues to action and family support); Dependent variables: TB treatment adherence

4. Operational Definition of Variables

Perceived vulnerability is the level of individual perception regarding the risk or possibility of contracting TB or experiencing a relapse if they do not comply with treatment.

Perceived severity is an individual's perception of the severity and negative impact of TB on their health and life.

Benefits felt is Individual perceptions regarding the advantages or benefits of compliance in undergoing TB treatment according to the recommendations of health workers.

Perceived obstacles is individual perceptions regarding factors that hinder compliance in undergoing TB treatment.

Self-efficacy is the level of individual confidence in their ability to complete TB treatment in full and according to recommendations.

Signal to action are external or internal factors that encourage individuals to start or continue TB treatment.

Family support is to provide encouragement or listen to patient complaints so that they continue undergoing TB treatment.

TB treatment compliance is the level of individual compliance in following the TB treatment regimen according to the recommendations of health workers until completion.

5. Study Instruments

The researchers used a structured questionnaire as the research instrument to capture respondents' reactions and perceptions regarding the studied variables. The questionnaire was developed based on relevant indicators aligned with the research objectives and measured using an appropriate rating scale. This instrument was employed to collect primary data directly from respondents at a single point in time, thereby enabling the analysis of relationships among variables in accordance with the cross-sectional study design.

6. Data analysis

Univariate analysis to obtain the frequency distribution and percentage of research subject characteristics. Bivariate analysis to analyze the differences in independent and dependent variables, and multivariate analysis using a path analysis model.

7. Research Ethics

Research ethics, including informed consent, anonymity, and confidentiality, were carefully addressed throughout the research process. A research permit approval letter was obtained from the Surakarta Regional Research and Innovation Agency No. 070/9078.LIT/VII/2025, on July 8, 2025.

RESULTS

1. Univariate Analysis

Univariate analysis showed that the average of all variables was in the high category. Perceived barriers (Mean = 27.51) had relatively low variation, meaning that most respondents felt the same barriers. Cues to action (Mean= 27.23) indicated that respondents received encouragement to take action quite frequently. Perceived benefits had the highest average (Mean = 28.14), indicating a strong belief in the importance of treatment. Perceived susceptibility (Mean= 27.28) indicated that respondents were aware of the risks of the disease. Meanwhile, family support (Mean = 27.01) was also high, but its variation was greater than other variables.

Table 1. Results of univariate analysis

Variables	Minimum	Maximum	Mean	SD
Perceived obstacles	18	30	27.51	1.92
Signal to action	20	30	27.23	2.48
Benefits felt	22	30	28.14	2.11
Perceived vulnerability	18	30	27.28	2.34
Family support	15	30	27.01	3.37

2. Bivariate analysis

Bivariate analysis showed that the variables in the Health Belief Model and family support had a significant relationship with respondent performance. Perceived barrier negatively affected performance (b= −3.00; 95% CI= −0.30 to −0.06; p= 0.001), meaning the higher the perceived barriers, the lower the performance. This finding is consistent with the HBM theory, which emphasizes that barriers can reduce an individual's likelihood of engaging in health behaviors.

In contrast, other variables showed a positive relationship. Cues to action (b= 2.16; 95% CI= −0.01 to 0.22; p= 0.003) showed that the more stimuli or triggers received, the greater the individual's chance of improving their performance. Perceived benefits also had a positive effect (b = 3.54; 95% CI = 0.09 to 0.33; p = 0.01), indicating that individuals with high perceived benefits tended to be more compliant and exhibited better performance. A similar effect was shown by perceived vulnerability (b= 2.34; 95% CI= 0.01 to 0.21; p= 0.002), where awareness of risk encouraged increased adaptive behavior. Furthermore, family support was shown to have a strong influence on performance (b= 3.65; 95% CI= 0.06 to 0.23; p= 0.001). This support not only acts as an external factor that strengthens motivation, but also as an important determinant in the sustainability of health compliance and performance.

Overall, these findings confirm that perceived benefits, vulnerabilities, cues to action, and family support are significant positive predictors of performance, while perceived barriers actually decrease it. Therefore, performance-enhancing interventions should focus on strengthening perceived benefits and family support while minimizing perceived barriers.

Table 2 Results of bivariate analysis of factors influencing performance

Variables	Regression coefficient (b)	95% CI		p
		Lower limit	Upper limit	
Perceived barrier	- 3.00	- 0.30	- 0.06	0.001
Cues to action	2.16	- 0.01	0.22	0.003
Perceived benefit	3.54	0.09	0.33	0.001
Perceived susceptibility	2.34	0.01	0.21	0.002
Family support	3.65	0.06	0.23	0.001

3. Multivariate analysis

This path analysis model (Figure 1) has good model fit, as indicated by the following fit indicators: p= 0.294; RMSEA= 0.068; CFI= 0.950; TLI = 0.912; SRMR= 0.038.

Indirect effect with the analysis results indicate that there is an indirect influence between several variables. Cues to action have a positive effect on family support (b= 2.10; 95% CI= 0.13 to 4.08; p= 0.001). Perceived barriers have a positive effect on cues to action (b= 3.68; 95% CI= 1.13 to 6.23; p= 0.001), while perceived vulnerability actually decreases cues to action (b= –0.64; 95% CI= –1.25 to –0.03; p= 0.001).

In addition, perceived vulnerability increased perceived barriers (b = 4.85; 95% CI= 1.17 to 8.54; p= 0.001), and perceived seriousness also positively affected barriers (b= 1.75; 95% CI= 0.41 to 3.09; p= 0.001). Conversely, perceived seriousness negatively affected family support (b= –0.83; 95% CI= –1.48 to –0.18; p= 0.001). Perceived benefits were shown to increase family support (b= 2.41; 95% CI= 0.32–4.50; p= 0.001).

Direct Effects The results of the path analysis also showed a direct influence of variables on treatment adherence. Cues to action had a positive and significant effect on treatment adherence (b = 4.01; 95% CI = 0.80 to 7.22; p= 0.001). Perceived barriers had a negative effect on treatment adherence (b= –2.70; 95% CI= –4.39 to –1.01; p= 0.001). Meanwhile, perceived susceptibility had a positive effect on treatment adherence (b= 2.00; 95% CI= 0.46 to 3.53; p= 0.01). Perceived benefits were the dominant factor in increasing treatment adherence, with a path coefficient of 3.05 (95% CI= 0.17–5.93; p = 0.01).

Table 3. Path analysis of factors influencing adherence to tuberculosis treatment

Dependent variable	Independent variable	Path coef. (b)	95% CI		p
			Lower limit	Upper limit	
Direct effect					
Treatment compliance	←Cues to action	4.01	0.10	0.43	0.001
Treatment compliance	←Perceived barrier	- 2.70	- 0.29	-0.04	0.001
Treatment compliance	←Perceived vulnerability	2.00	- 0.01	0.20	0.004
Treatment compliance	←Perceived benefit	3.05	0.17	0.40	0.001
Indirect effect					
Cues to action	←Family support	2.10	0.13	0.32	0.001
Perceived barrier	←Cues to action	3.68	0.13	0.39	0.001
Perceived vulnerability	←Cues to action	- 0.64	- 0.13	0.07	0.520

Dependent variable	Independent variable	Path coef. (b)	95% CI		p
			Lower limit	Upper limit	
Perceived vulnerability	←Perceived barrier	4.85	0.17	0.49	0.001
Perceived vulnerability	← Perceived benefit	4.03	0.17	0.43	0.001
Perceived vulnerability	←Family support	- 1.83	- 0.15	0.01	0.006
Perceived benefit	←Family support	2.71	0.11	0.32	0.001
RMSEA= 0.07; CFI= 0.95; TLI= 0.91; SRMR= 0.04; p= 0.294					

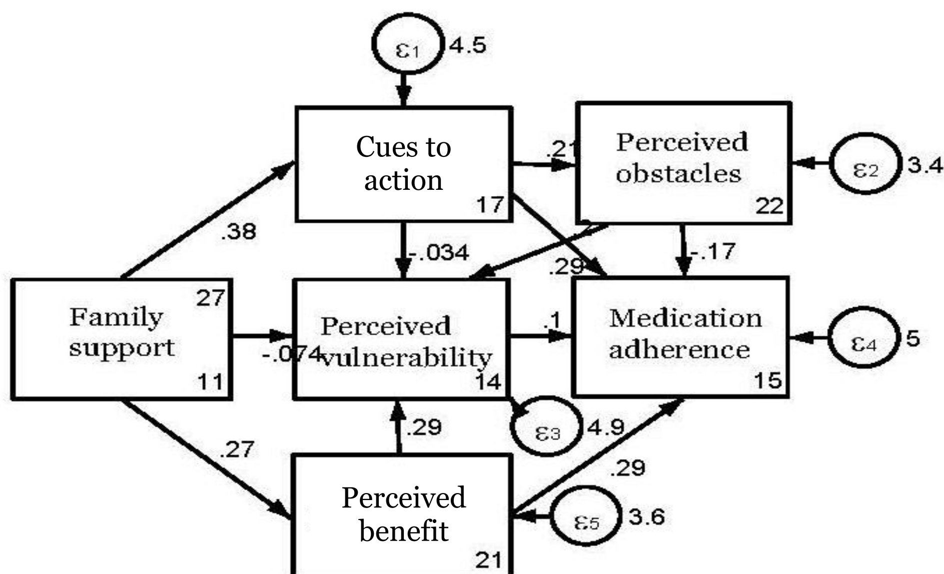

Figure 1. Path analysis of the determinants of medication adherence

DISCUSSION

The results of this study indicate that medication adherence is influenced by a combination of individual perceptions, cues to action, and family support, as described in the Health Belief Model (HBM) framework. Perceived benefits were shown to be the most dominant factor in increasing medication adherence. This finding aligns with previous research showing that perceived benefits are a key motivator for patients to adhere to medication, particularly for chronic diseases such as hypertension and diabetes mellitus (Pagès-Puigdemont et al., 2016).

The dominant role of perceived benefits highlights the importance of patients' beliefs regarding the effectiveness of treatment in preventing disease complications and improving quality of life. When patients clearly understand and believe in the benefits of medication, they are more likely to maintain adherence over time. This finding reinforces earlier studies demonstrating that perceived benefits are among the strongest predictors of adherence in chronic conditions such as hypertension, diabetes mellitus, and tuberculosis (Wulandari et al., 2020).

In addition to perceived benefits, cues to action were found to have a significant effect on medication adherence. This finding is consistent with the Health Belief Model, which conceptualizes cues to action as critical triggers that stimulate individuals to initiate and maintain health-related behaviors. External stimuli, including repeated health education, medication reminders,

counseling, and support from healthcare professionals and family members, play an essential role in translating health beliefs into actual adherence behavior. These cues act as catalysts that activate individuals' readiness to change and reinforce sustained medication adherence, as has been demonstrated in previous studies involving patients with tuberculosis and other chronic conditions (Suprijandani et al., 2025).

Perceived vulnerability also positively impacted treatment adherence. The more vulnerable patients felt to their disease, the greater their motivation to adhere to therapy. These results are consistent with a study in East Lombok that found that perceived vulnerability significantly influenced adherence in tuberculosis patients (Suprijandani et al., 2025). The positive influence of perceived vulnerability suggests that patients who recognize their susceptibility to disease complications are more motivated to comply with treatment recommendations. This awareness increases the perceived urgency of adherence, particularly in chronic or infectious diseases. Similar findings have been reported in previous studies, where perceived susceptibility was associated with higher levels of adherence due to increased concern about disease progression (Nurmala et al., 2018a)

Conversely, perceived barriers negatively affected medication adherence. Barriers such as access to services, cost, medication side effects, and social stigma can prevent patients from remaining adherent. This is consistent with previous research that found barriers to be the strongest negative predictor in the HBM (Nurmala et al., 2018b). Therefore, identifying and reducing barriers needs to be part of a compliance improvement strategy.

In addition to the direct effect, this study also found an indirect effect through family support. Cues to action and perceived benefits increased family support, while perceived seriousness decreased it. Family support plays an important role as a mediator that strengthens the relationship between individual perceptions and treatment adherence. The Bali study also showed that family support can strengthen the effectiveness of HBM-based educational interventions and SCT in improving adherence in diabetes mellitus patients (Sartika et al., 2020).

An interesting finding from this study is the negative influence of perceived seriousness on family support. This can be interpreted as meaning that the perception of a disease as too serious can cause anxiety or stress, which in turn reduces family involvement. Several previous studies have also reported that severity variables are not consistently positively related to health behaviors, particularly when influenced by psychological factors such as fear and stigma (Glanz et al., 2015).

AUTHOR'S CONTRIBUTION

All authors have made significant contributions to the data analysis and preparation of the final manuscript.

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CONFLICT OF INTEREST

There is no conflict of interest in this research.

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