



Impact of the TB SEHAT Application on Medication Adherence in Pulmonary Tuberculosis Patients at Putri Ayu Health Center, Jambi City



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ABSTRACT

Aims Tuberculosis is still a significant global health challenge, particularly in developing countries. This study aimed to evaluate the impact of the TB SEHAT application on medication adherence among pulmonary tuberculosis patients in Jambi City.

Materials & Methods This quasi-experimental study employed a one-group pre-test-post-test design with a control group, comprising two groups; an intervention group that received TB SEHAT app-based education and a medication reminder program, and a control group that received standard care from medication supervisors. Each group included 37 participants, selected through simple random sampling. Data collection was done from May 13 to August 30, 2024, within the service area of the Putri Ayu Health Center. Data analysis was performed by SPSS 23.

Findings Following the use of the TB SEHAT application, the mean adherence to anti-tuberculosis drugs was 127.30±5.22 on the TB Medication Adherence Scale. In contrast, the mean adherence in the group receiving standard treatment supervision was 121.41±6.43. An analysis of covariance indicated a significant difference in adherence between the TB SEHAT application and standard treatment groups ($p=0.001$).

Conclusion The TB SEHAT application effectively improves adherence to anti-tuberculosis drugs in patients with pulmonary tuberculosis.

Keywords Tuberculosis, Pulmonary; Nursing; Mobile Applications; Medication Adherence

CITATION LINKS

[1] Mobile health apps for improvement of tuberculosis treatment ... [2] The global prevalence of latent tuberculosis: A systematic review ... [3] Development and content validation of a mobile application for monitoring latent ... [4] Determinant factors for loss to follow-up in drug-resistant tuberculosis patients: The importance ... [5] Adherence to drug medications amongst tuberculosis patients in a tertiary health ... [6] Evaluation of m-health on medication adherence in tuberculosis ... [7] Changes in the rate of bacillus tuberculosis infection in health workers in the first year of the COVID-19 ... [8] Effectiveness of self-management on adherence to self-care and on health status among elderly people ... [9] Analysis of factors affecting druging compliance in lung tuberculosis patients: Theory of health ... [10] Mobile application: Patients' adherence to medicine in-take ... [11] Design and prototype of TOMO: An app for improving drug ... [12] Effectiveness of electronic reminders to improve medication adherence in tuberculosis patients ... [13] Mobile applications to improve ... [14] Improving compliance to tuberculosis treatment: Supporting patients through ... [15] Design a TB treatment compliance ... [16] Patient-centered mobile tuberculosis treatment support tools (TB-TSTs) to improve ... [17] Statistical power analysis for ... [18] A primer for conducting experiments in ... [19] Effectiveness of digital adherence technologies in improving tuberculosis ... [20] The prevalence of depression among patients with ... [21] Male genital tuberculosis ... [22] An assessment of factors contributing to treatment adherence and knowledge of TB transmission among patients ... [23] Adherence to anti-tuberculosis treatment and treatment outcomes among tuberculosis patients ... [24] The effectiveness of mobile health on medication adherence in ... [25] Web and Android-based application for monitoring tuberculosis ... [26] My latent tuberculosis treatment-mobile application to assist in adherence ... [27] Mobile application development for improving medication safety in tuberculosis patients ...

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Introduction

Tuberculosis (TB) remains a significant global health challenge, particularly in developing countries [1]. Indonesia ranks third worldwide for the highest TB burden, with a treatment success rate of only around 50% [2]. Successful TB treatment requires a prolonged duration, and factors, such as drug side effects, socioeconomic barriers, and social stigma can adversely impact patient adherence to treatment. Ensuring adherence is essential, as it prevents the development of multidrug-resistant tuberculosis (DR-TB), thereby improving cure rates and treatment success and reducing transmission to others [3].

DR-TB presents a significant obstacle to global TB elimination efforts, with a worldwide treatment success rate of just 57%. Loss to follow-up (LTFU) is a primary factor contributing to this low success rate. In Indonesia, the treatment success rate is even lower, at under 50%, partly due to a high LTFU rate of 26% [4].

Indonesia has implemented the DOTS program in line with WHO recommendations; however, DOTS alone has proven insufficient, as challenges with patient adherence to TB medication persist [5]. Traditional direct supervision has had limited success in addressing these adherence issues, highlighting the need for innovative approaches that utilize electronic and communication media to support medication supervision by health workers. Research on the effectiveness of digital health solutions to improve medication adherence among TB patients remains limited in Indonesia [6].

Mobile health (M-Health) applications, particularly those that are Android-based, represent an innovative approach in the healthcare sector aimed at facilitating behavioral change and promoting health management outside traditional hospital settings. Technology-based services offer the potential for efficient, effective, and high-quality care. By utilizing technology, patients are empowered to actively engage in self-screening and treatment, fostering greater self-care awareness and optimizing health outcomes [7-9].

M-Health is advancing rapidly and has been applied across a wide range of disease areas. TB, one of the leading causes of death from infectious diseases globally, stands to benefit significantly from M-Health applications, which contribute meaningfully to enhancing TB treatment outcomes [10, 11]. Specifically, applications that support dose individualization, adherence monitoring, or provide targeted information and education about the disease serve as effective tools for preventing drug-resistant TB and disease relapse.

M-Health holds substantial promise for addressing key challenges in TB treatment. Although mobile technology has shown a positive impact on adherence and treatment outcomes, further clinical evidence is needed to confirm its benefits for

individualized dosing, patient education, and diagnostic support [6, 12].

M-Health, which leverages smartphones as a platform, is highly accessible and widely adopted within communities [13]. Community nurses, especially those in primary healthcare settings, can apply M-Health effectively. Given the challenges of managing large service areas with limited human resources, M-Health offers a valuable alternative for delivering remote nursing care and monitoring patients who require supervision [10, 14].

Research relevant to the Lung TB Treatment Monitoring Application includes the study titled "Design of TB Treatment Compliance Application" [15], which highlights the importance of adherence to treatment. Additionally, Iribarren *et al.* [16] demonstrate that self-management of pulmonary TB through SMS can significantly enhance treatment adherence and patient awareness regarding follow-up examinations.

Building on the insights gained from the TB Treatment Adherence Application Design, the researchers developed an Android-based Oral Anti-Tuberculosis (OAT) Adherence Application featuring a more comprehensive set of tools. Notable enhancements include educational components covering TB infection prevention, the importance of adhering to OAT, nutritional management, and stress management, along with features, such as a calendar, notifications, and consultation options. This application specifically targets the needs of TB patients and their families.

Data from the Putri Ayu Health Center indicate a rising trend in pulmonary TB cases and a persistently high dropout rate among patients. Accordingly, this study aimed to evaluate the impact of the TB SEHAT application on medication adherence among pulmonary TB patients in Jambi City.

Materials and Methods

Study design

This research employed a one-group pre-test-post-test design with a control group using prospective data collection.

Participants

This study was conducted in the service area of the Putri Ayu Health Center in Jambi City, Indonesia, from May to July 2024. Respondents, selected through simple random sampling, were categorized into two groups; the intervention group, which received education and medication reminders through the TB SEHAT app, and the control group, which received standard care from medication supervisors. The subjects included adult TB patients aged 17 years and older who had been undergoing treatment for at least one month, were receiving first-line OAT medication, and were accompanied by their families while using the Android application. Exclusion criteria included patients with mental disorders, those undergoing

directly observed treatment, short-course (DOTS), patients who did not consistently attend follow-up appointments, and those who had dropped out of treatment.

Sample size

To achieve a power of 0.80 at an alpha level of 0.05, adequate sample size was estimated using the formula for the “mean of the two groups” [17]. The effect size was determined based on the findings from the study by Hoffman *et al.* [18], which assessed the effectiveness of the TB SEHAT app in enhancing medication adherence. Utilizing Cohen’s formula, the effect size (d) was calculated to be 0.20 ($p < 0.05$). Furthermore, Cohen’s guidelines were employed to estimate the sample size based on the specified significance criteria ($\alpha = 0.05$, power = 0.80) considering $\mu_1 = 42.1$, $\mu_2 = 49.9$, $SD_1 = 11$, and $SD_2 = 11.3$. This yielded a minimum required sample size of 31 participants per group. To accommodate potential dropouts, an additional 20% was added to each group, resulting in a final sample size of 37 participants per group.

Data collection

OAT medication adherence refers to the respondents’ compliance with health workers’ recommendations regarding the intake of OAT drugs. This was evaluated using the Tuberculosis Medication Adherence Scale (TBMAS) consisting of ten items, with scores ranging from 10 to 100. Adherence was categorized into two objective criteria; compliant if the respondent’s score was ≥ 60 , and non-compliant if the score was < 60 .

The “TB SEHAT” application served as the intervention and independent parameter. The pre-test and initial intervention using the mobile application were conducted on day one, followed by a second intervention and post-test on day 30. The pre-test and post-test assessments focused on OAT medication adherence, which was measured by comparing the time of medication intake with the scheduled alarm time. TB patients were considered compliant if the time difference between taking the medication and the alarm schedule was no more than two hours; they were deemed non-compliant if this difference exceeded two hours. Medication adherence was monitored using a QR code found on the medication box, which was linked to the “TB SEHAT” application.

Statistical analysis

A descriptive analysis was conducted to characterize the respondents’ demographics. Descriptive statistics summarize the data using measures, such as mean, maximum, minimum, median, and standard deviation. To compare medication adherence between the group using the TB SEHAT application and the control group, an analysis of covariance (ANCOVA) was employed. Data analysis was performed using SPSS version 23.0. A 95% confidence interval not including the value of one indicated statistical significance.

Findings

The mean age of participants in the intervention group was 43.76 ± 16.31 years, while the control group had a mean age of 45.62 ± 16.15 years. The ages of respondents ranged from 18 to 73 years. A higher proportion of male respondents was observed, with 27 males (72.97%) in the intervention group and 23 males (62.16%) in the control group. The educational levels of respondents were comparable between groups, and the majority were married. Additionally, there were more respondents who were unemployed compared to those who were employed, with most reporting an income below the minimum wage (Table 1).

Table 1. Demographic characteristics of the respondents

Parameter	Intervention (n=37)	Control (n=37)
Level of education		
Elementary	16(43.2)	16(43.2)
Junior school	10(27)	10(27)
High school	11(29.7)	11(29.7)
Marital status		
Married	21(56.8)	19(51.4)
Single/Divorced	16(43.2)	18(48.6)
Working status		
Employed	12(32.4)	12(32.4)
Unemployed	25(67.6)	25(67.6)
Income		
Higher than minimum regional wage	17(45.9)	15(40.5)
Smaller than minimum regional wage	20(54.1)	22(59.5)

A significant difference was observed in adherence to OAT medication adherence between the intervention and control groups ($p = 0.001$). The mean compliance score before using the TB SEHAT application was 121.16 ± 6.19 , while the mean compliance score after using the application increased to 127.30 ± 5.22 . In contrast, the mean compliance score for respondents undergoing standardized treatment monitoring remained unchanged, with a score of 121.41 ± 6.38 before and 121.41 ± 6.43 after monitoring, indicating no improvement in adherence.

Discussion

This study aimed to evaluate the impact of the TB SEHAT application on medication adherence among pulmonary TB patients in Jambi City. The majority of respondents were male, totaling 50 individuals. The average age of participants in both groups was similar, both of which fall within the productive age category. This demographic trend may be attributed to the higher mobility of men in their productive years, which increases their likelihood of exposure to TB pathogens. Moreover, after puberty, the body’s capacity to prevent disease transmission through the bloodstream improves, yet its ability to guard against respiratory infections diminishes significantly. This decline is linked to the reduced functionality of the thymus gland, which plays a crucial role in the immune defense system during childhood [19]. These

findings are consistent with previous research^[20-22], indicating that men are more susceptible to TB, with a prevalence of 55.18% compared to 44.82% in women. Contributing factors include unhealthy lifestyle choices among men, such as smoking and alcohol consumption, which compromise the immune system and increase vulnerability to pulmonary TB infection^[23].

There was a significant difference in the average compliance of respondents, as measured by the TB MAS, before and after using the SEHAT TB application in the intervention group, with an increase of 6.14 points. In contrast, the control group showed no change in the average adherence score. Further statistical analysis revealed that the TB SEHAT application significantly enhanced adherence to OAT. These findings suggest a notable difference in the effectiveness of medication supervision through digital technology compared to that provided by directly observed therapy (DOT) by the drug-taking supervisors (PMO).

The TB SEHAT application has proven effective in enhancing the knowledge and compliance of TB patients regarding their treatment. It features four key components that represent a novel advancement over previous applications, including education, consultation, calendar, and notifications. The education section includes animated videos on infection prevention, the importance of adhering to TB medication, nutritional management, and stress management techniques, including progressive muscle relaxation (PMR). This educational content is designed to enhance patient understanding of lung TB management, thereby promoting adherence to OAT medication.

In contrast, the control group, which received supervision from the PMO, demonstrated lower effectiveness in promoting adherence. It is hypothesized that this may be attributed to the PMO's busy schedules in meeting family obligations, potentially leading to lapses in reminders for patients to take their OAT medication.

Our findings align with research conducted by Fuadiati *et al.*^[24], indicating that animated videos are favored by patients over the age of 18 as a compelling form of media. This preference is attributed to the dynamic presentation of motion, images, and sound, which effectively captures attention. In contrast, counseling that utilizes printed media often involves direct verbal instruction and written content, which may convey a more formal tone. While printed materials can be informative, they tend to be perceived as less engaging compared to animated videos, making the latter a more appealing choice for counseling purposes^[19].

Furthermore, medication monitoring through mHealth applications based on Android technology represents a significant innovation in the healthcare sector, aimed at facilitating behavioral changes and enhancing health management beyond traditional

hospital settings. By leveraging technology, healthcare services can be delivered efficiently and effectively, ultimately improving the quality of care. Additionally, such technology empowers patients to take an active role in their health management, fostering self-screening and increasing awareness of self-care practices to optimize health outcomes^[25, 26]. This study is consistent with research conducted by Iribarren *et al.*^[16], indicating that self-management of pulmonary TB through SMS communication can significantly enhance treatment adherence and patient awareness regarding their examinations. Furthermore, findings from Wijayanti *et al.*^[27] support this notion, demonstrating that the use of social media platforms, such as BBM, Line, and Twitter can positively influence individual behaviors. The observed increase in medication adherence among pulmonary TB patients in the intervention group can be attributed to the ongoing interactions between the researchers and the respondents. This continuous engagement fosters social interaction and cultivates a reciprocal influence, ultimately enhancing the management strategies employed by each individual. Such relationships are critical in promoting adherence and improving health outcomes for patients undergoing treatment for pulmonary TB.

The sample size was limited to just 74 respondents, encompassing both the intervention and control groups. As a result, the generalizability of the findings to a broader population may be compromised. A small sample size can diminish statistical power, increasing the risk of Type I or Type II errors.

Additionally, the relatively short duration of the study may not adequately capture long-term changes in patient adherence following the implementation of the TB SEHAT app. Consequently, further research with a larger sample size and an extended timeframe is warranted to better assess the app's sustained impact on medication adherence among patients.

The implications of this study for the field of health are significant. The TB SEHAT app notably improved medication adherence, positioning it as an essential tool in TB management programs. This application offers valuable support for patients in maintaining optimal adherence to treatment protocols.

Furthermore, these results could stimulate the development of technology-based health applications for various other diseases, thereby enhancing the scope and effectiveness of digital interventions. Additionally, the findings may heighten awareness among healthcare professionals regarding the critical role of technological approaches in improving patient adherence, which could lead to better health outcomes and a reduction in TB-related complications. Lastly, this study provides a foundation for future research aimed at exploring additional factors that influence medication adherence and the utilization of health apps within the context of chronic diseases.

Consequently, the implementation of the TB SEHAT app is recommended as an essential component of TB management strategies and serves as a model for the future development of similar health applications.

Conclusion

The TB SEHAT application effectively improves adherence to anti-tuberculosis drugs in patients with pulmonary tuberculosis.

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Ethical Permissions: This study received ethical approval from the Health Research Ethics Commission of the Ministry of Health, Jambi, under protocol number LB.02.06/5/162/2024. All procedures adhered to established research ethics standards, ensuring the protection of participants' rights and privacy.

Conflicts of Interests: The authors reported no conflicts of interests.

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