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

ABSTRACT

Aims. This study aimed to evaluate the impact of the TB SEHAT Application on medication adherence among pulmonary TB patients in Jambi City.

Materials & Methods. This quasi-experimental study employed a one group pretest-posttest with control design, comprising two groups: an intervention group, which received TB SEHAT app-based education and a medication reminder program, and a control group, which received standard care from medication supervisors. Each group included 37 participants, selected through simple random sampling. Data collection took place from May 13 to August 30, 2024, within the Putri Ayu Health Center service area. Data analysis was performed using an ANCOVA test.

Findings. The mean age of respondents in the intervention group was 43.76 years, with a standard deviation of 16.31 years. Following the use of the TB SEHAT application, the mean adherence to anti-tuberculosis medication (OAT) was 127.30 on the TB Medication Adherence Scale (TBMAS), with a standard deviation of 5.22. In contrast, the mean adherence in the group receiving standard treatment supervision was 121.41, with a standard deviation of 6.43. An independent t-test yielded a p-value of 0.001, indicating a significant difference in adherence between the TB SEHAT application group and the standard treatment group.

Conclusion. The TB SEHAT application effectively improves adherence to OAT in patients with pulmonary tuberculosis.

Keywords: Tuberculosis, Pulmonary, Nursing, Mobile Applications, Medication adherence

INTRODUCTION

Tuberculosis 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, thereby improving cure rates, treatment success, and reducing transmission to others [3].

Drug-resistant tuberculosis (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%, due in part 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 using 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 of 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. Tuberculosis, 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 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 indicates a rising trend in pulmonary TB cases and a persistently high dropout rate among patients. Consequently, the researchers are motivated to investigate the study titled "The Effect of the TB SEHAT Application on Medication Adherence in Patients with Pulmonary TB at the Putri Ayu Health Center, Jambi City."

METHOD

Study Design

This research design uses a one group pretest-posttest with control design with 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 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 of the study included adult TB patients aged 17 years and older who had been undergoing treatment for at least one month, were receiving first-line OAT, and were accompanied by their families while using the Android application. Exclusion criteria comprised 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, an adequate sample size was estimated using the formula for the 'mean of the two groups' (Cohen, 1988, p. 53). The effect size was determined based on the findings from the study by Hoffman et al. (2020), 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 (1988) guidelines were employed to estimate the sample size based on the specified significance criteria ($\alpha = 0.05$, power = 0.80) with the following parameters: $\mu1 = 42.1$, $\mu2 = 49.9$, $SD1 = 11$, and $SD2 = 11.3$. 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.

Variable and data collection

OAT adherence refers to the respondents' compliance with health workers' recommendations regarding the intake of anti-tuberculosis medication (OAT). This variable was evaluated using a questionnaire 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 variable in this study. 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 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 linked to the "TB SEHAT" application. The sampling technique employed was simple random sampling.

Statistical analysis

Descriptive analysis was conducted to characterize the respondents' demographics. Descriptive statistics summarized 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 ANCOVA test was employed. Data analysis was performed using SPSS version 23.0. A 95% confidence interval that does not include the value of 1 indicates statistical significance.

Ethical Consideration

No economic incentives were offered or provided for participation in this study. The study was performed in accordance with the ethical considerations of the Helsinki Declaration. This study

obtained ethical feasibility under the Health Research Ethics Commission of the Ministry of Health, Jambi, and registration number: LB.02.06/5/162/2024.

RESULTS

Table 1. Overview of Respondent Characteristics

Variables	Intervention (n=37)	Control (n=37)
Age	43.76±16.31	45.62±16.15
Gender (M/F)	27/10	23/14
Level of Education		
Elementary	16	16
Junior Shool	6	6
High school	11	11
Marital status		
Married	21	19
Single/divorced	16	18
Working status		
Employment	12	12
Unemployment	25	25
Income		
> minimum regional wage	17	15
< minimum regional wage	20	22

Table 1 presents the demographic characteristics of the respondents. The mean age of participants in the intervention group was 43.76 years, with a standard deviation of 16.31 years, while the control group had a mean age of 45.62 years and a standard deviation of 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 2. Mean adherence to OAT before and after using the TB SEHAT app in the intervention and control groups

OAT Adherence	Mean±SD	Minimum-Maximum
Intervention Group		
Pretest	121,16±6,185	108-131
Post test	127,30±5,222	118-137
Control Group		
Pretest	121,41±6,379	108-131
Post test	121,41±6,431	108-132

SD: Standard Deviation
OAT: anti-tuberculosis drugs

Table 2 illustrates the compliance scores of respondents taking OAT. The mean compliance score before using the TB SEHAT application was 121.16 (TBMAS), while the mean compliance score after using the application increased to 127.30. This indicates an improvement in adherence among respondents following the implementation of the TB SEHAT application. In contrast, the mean compliance score for respondents undergoing standardized treatment monitoring remained unchanged, with a score of 121.41 both before and after monitoring, indicating no improvement in adherence.

The study results showed a significant difference in adherence to oral anticoagulant therapy (OAT adherence) between the intervention and control groups. In the intervention group, the mean

adherence was 127.30 ± 5.22, while in the control group, it was 121.41 ± 6.43. Statistical analysis revealed a p-value of 0.001, indicating that this difference was statistically significant. These findings demonstrate that the intervention effectively improved adherence to OAT in the intervention group compared to the control group.

DISCUSSION

The study results indicate that the majority of respondents were male, totaling 50 individuals (67.58%), with 27 participants in the intervention group and 23 in the control group. The average age of participants in both groups was similar: 43.76 years (range: 19-75) for the intervention group and 45.62 years (range: 18-73) for the control group, 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, increasing 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 [17]. These findings are consistent with previous research [18–20] 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 [21].

The results indicated a significant difference in the average compliance of respondents, as measured by the Tuberculosis Medication Adherence Scale (TBMAS), before and after using the SEHAT TB Application in the intervention group, with an increase of 6.14 points (127.30 - 121.16). In contrast, the control group showed no change in the average adherence score, which remained at 121.41. Further statistical analysis revealed a p-value of 0.001, indicating that the TB SEHAT application significantly enhances 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 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: 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.

In contrast, the control group, which received supervision from the PMO, demonstrated lower effectiveness in promoting adherence. The researcher hypothesizes 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.

The findings of this study align with research conducted by Fuadiati et al. [22], which indicates 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 that captures attention effectively. 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 [23].

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 [24,25].

This study aligns with research conducted by Iribarren et al. [16], which indicates that self-management of pulmonary tuberculosis (TB) through SMS communication can significantly enhance treatment adherence and patient awareness regarding their examinations. Furthermore, findings from Wijayanti et al. [26] 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, which ultimately enhances 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 implications of this study for the field of health are significant. The findings indicate that the TB SEHAT app has notably improved medication adherence, positioning it as an essential tool in tuberculosis 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.

LIMITATION

The sample size for this study 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.

CONCLUSION

The use of the TB SEHAT app significantly enhanced medication adherence among patients with pulmonary tuberculosis. Statistical analysis revealed substantial differences in both the frequency and volume of fluid intake between the group utilizing the app and the control group. These findings underscore the effectiveness of technology as a valuable tool in assisting TB patients in maintaining optimal hydration, which is crucial for the healing process and overall treatment success. Consequently, the implementation of the TB SEHAT app is recommended as an essential component of tuberculosis management strategies and serves as a model for the future development of similar health applications.