

The Effectiveness of Android-Based Simantb (TB Monitoring Information System) on Medication Compliance of Pulmonary TB Patients in Ende Regency, East Nusa Tenggara

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Abstract

Tuberculosis (TB) is an infectious disease and one of the leading causes of death worldwide. One indicator of the TB control program's success is the treatment success rate. Various factors are believed to hinder the success of TB treatment, including therapy failure due to non-adherence, which is one of the main factors. Therefore, appropriate interventions are needed to monitor and evaluate TB patient medication adherence using suitable media that are easy to use and accessible anytime and anywhere through mobile health technology. This study aimed to analyze the effectiveness of the Android-based SIMANTB application on medication adherence in pulmonary TB patients. The research employed a Research and Development (R&D) design with a pre-experimental approach using a static group comparison, conducted over 28 days (1 month). The sampling technique used was simple random sampling, consisting of 30 respondents divided into intervention and control groups. Research data were analyzed using the Shapiro-Wilk and Mann-Whitney tests. The SIMANTB application was found to be highly suitable for tuberculosis patients, with material feasibility percentages of 93.06% and 93.75%. The use of the Android-based SIMANTB application significantly increased medication adherence in TB patients ($p = 0.004$). The development of the Android-based SIMANTB application is expected to provide a solution for health workers (doctors, nurses, TB officers) to support TB patients in monitoring and motivating their treatment, thereby increasing the success rate of treatment.

Keywords: medication adherence; pulmonary TB patients; SIMANTB application

INTRODUCTION

Infectious diseases are predicted to be the main public health problem; therefore, efforts need to be made to provide solutions to these conditions through effective and efficient prevention, control, and elimination measures (Bouri et al., 2020; Espinosa et al., 2020; Kováč et al., 2022; Zhang et al., 2019; Zieliński & Czarkowski, 2021). Tuberculosis (TB) is an infectious disease caused by the biological agent *Mycobacterium tuberculosis*. Transmission can occur when a TB patient coughs or sneezes. The bacterial species that cause TB mostly attack the lungs but can also affect other organs in the body (Wahdi & Puspitosari, 2021).

According to data released by the WHO Global TB Report in 2021, 10 million people worldwide suffer from tuberculosis (TB), leading to 1.2 million deaths annually. Indonesia is one of the countries with the highest TB burden, with an estimated 845,000 people falling ill due to TB, a death rate of 98,000 equivalent to 11 deaths per hour and a Loss To Follow-Up (LFU) rate of 10% (World Health Organization, 2021).

The number of TB patients in 2018 in East Nusa Tenggara Province (NTT) reached 6,583, with Ende district reporting 205 TB cases. Based on a preliminary study conducted on March 4, 2022, using an interview method, TB cases in Ende district increased to 317 new cases in

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2021, consisting of 166 BTA-positive pulmonary TB, 145 clinically diagnosed pulmonary TB, and 6 extrapulmonary TB cases (Ende Regency Health Office, 2022).

The success of TB therapy depends on patient compliance and family support. Adherence to treatment is challenging due to the complexity, side effects, and long duration of current treatment regimens for susceptible and drug-resistant TB. Regular and complete medication intake provides the best chance for TB patients to recover and also protects the community from further spread of TB (Amell et al., 2020; Duarte et al., 2018; Gesesew et al., 2016).

The development of application technology is very prevalent among the public, with diverse operating systems such as Android, iOS, and Windows. The Android operating system is one of the rapidly developing information platforms. According to InternetWorldStats data, Indonesia's internet users reached 212.35 million in March 2021, making the country third in Asia for the most internet users (Kusnandar, 2021).

The application of information communication technology in the health sector has become a necessity for health organizations, both government and private, to carry out service operations more efficiently. A study on pulmonary TB patients in Uganda who used a cellular health intervention (DOT Selfie) with social bundle incentive transfer showed improved TB treatment adherence (Sekandi et al., 2021).

Referring to the national infectious disease control strategy, the Ende district health office, through primary health facilities (health centers and clinics) and hospitals, implements TB disease control strategies. Health centers (Puskesmas), as first-level health facilities and the spearheads of TB treatment, are required to use SITB (TB Information System). However, SITB cannot be accessed by patients, PMOs, or families, making it difficult for TB coordinators to monitor and provide warnings regarding violations, including medication schedules and sputum examination appointments, in advance.

This study aims to analyze the effectiveness of the android-based *SIMANTB* application on medication compliance in pulmonary TB patients in Ende district, East Nusa Tenggara. The benefits of this research include: (1) providing evidence-based solutions for TB medication adherence challenges through mobile health technology; (2) contributing to the development of digital health interventions specifically designed for resource-limited settings; (3) offering healthcare providers a practical tool to enhance patient monitoring and support; (4) providing insights for policymakers regarding the integration of mobile health applications in TB control programs; and (5) establishing a foundation for future research on digital health interventions in infectious disease management.

METHOD

This study uses a research and development (R&D) approach with a pre-experimental design through a static group comparison approach which was carried out for 28 days (1 month). The research was conducted from October to November 2022 in the working area of the Onekore Health Center and the Ende City Health Center, Ende Regency, East Nusa Tenggara Province.

The target population in this study is all pulmonary TB patients in the working area of the Ende district health office health center, which totals 317 people. The affordable population is pulmonary TB patients who are treated at the Onekore Health Center and the Ende City Health Center which amount to 71 people.

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The sampling technique uses simple random sampling with a large sample calculation using a sample calculation formula for an average of two groups. Based on calculations, the number of samples in this study was 30 people, with a division of 15 subjects in the treatment group and 15 subjects in the control group.

Inclusion criteria include: pulmonary TB patients living in the working area of the Onekore Health Center and the Ende City Health Center; pulmonary TB patients who are undergoing treatment for pulmonary TB in the active phase with a diagnosis based on bacteriology and radiology, maximum of the 4th week of treatment; pulmonary TB patients aged ≥ 15 years; have at least graduated from elementary school; have an Android mobile phone with internet network facilities; and willing to be a research respondent.

Exclusion criteria include: non-pulmonary TB patients; pulmonary TB patients with complications or severe or terminal physical illnesses; pulmonary TB patients who experience drug resistance (OAT); and pulmonary TB patients are not willing to continue the application program.

The SIMANTB application is developed using the Software Development Life Cycle (SDLC) method with stages: needs analysis, system and design, implementation, integration and testing, as well as operation and maintenance. This application has five main menus, namely home, profile, alarm, treatment and supporting examinations.

The instruments used include: respondent assessment format, application traffic data via the web, SIMANTB application instrument, MMAS-8 (Morisky Medication Adherence Scale) drug compliance questionnaire, and Technology Acceptance Model (TAM) questionnaire to measure the effectiveness of information systems.

Data analysis using SPSS version 26.00. Univariate analysis to explain the characteristics of respondents on each variable. The normality test uses the Shapiro-Wilk test. Statistical tests to determine the effectiveness of SIMANTB application on medication adherence were conducted using the Mann Whitney test with a significance level of 95% (alpha 0.05).

RESULTS AND DISCUSSION

SIMANTB Application Development and Validation

The SIMANTB application has gone through a comprehensive development and validation stage. The results of the application feasibility test showed a very good feasibility level with a score of 93.06% which included functionality (84.99%), usability (92%), efficiency (95.23%), and maintainability (100%) tests. The material aspect test also showed very decent results with a percentage of 93.75%.

Table 1. Characteristics of Respondents Based on Age, Gender and Education

Respondent Characteristics	Intervention Groups	Control Group	Value p
Age (Mean $\pm$ Elementary School)	38.20 $\pm$ 15.74	43.00 $\pm$ 11.63	0,000*
Gender			0,465**
Man	7 (46,6%)	10 (66,6%)	
Woman	8 (54,4%)	5 (33,4%)	
Education			0,008**
SD	1 (6,6%)	1 (6,6%)	

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Respondent Characteristics	Intervention Groups	Control Group	Value p
JUNIOR	3 (20%)	4 (26,7%)	
SMA	8 (53,4%)	7 (46,7%)	
Academy/PT	3 (20%)	3 (20%)	

*Independent T-test, **Chi Square-Test

Based on Table 1, the average age in the intervention group was 38 years while in the control group it was 43 years. Characteristics of respondents based on gender in the intervention group were more women (54.4%), while in the control group there were more men (66.6%). The highest level of education in both groups is high school.

Table 2. Normality Test of Medication Compliance

Variable	Control Group	Intervention Groups
Medication adherence (Post Test)	0,000	0,004

*Shapiro-Wilk Test

The results of the normality test showed that the significant value of adherence to taking medication (post-test) in both groups was <0.05 , which means that the data in both groups were abnormally distributed, so the Mann-Whitney test was used.

Table 3. Differences in Medication Adherence Between Control Groups and Intervention Groups

Medication Compliance	Post Test	P value
Median (min-max) Red $\pm$ SD		
Control	2,00 (1-3)	1.80 $\pm$ 0.48 0,001
Intervention	3,00 (2-3)	2.67 $\pm$ 0.67

*Mann Whitney Test

Table 3 shows that in the intervention group there was an average drug adherence value of 2.67 and in the control group of 1.80 with a p value of 0.001 (<0.05). It was concluded that the SIMANTB application was effective in increasing the medication adherence of TB patients for 28 days.

Table 4. Effect Size of SIMANTB Application on Medication Compliance

Group	Post-Test Medication Adherence	Cohen's Effect
	Mean	SD
Control	1,80	0,48 0,250
Intervention	2,67	0,67

The effect size on medication adherence was obtained with a value of 0.250 which is in the good category, showing that the SIMANTB application can have a good influence on the medication adherence of pulmonary TB patients.

Table 5. Comparison of Medication Adherence Between the Intervention Group and the Control Group

Group	Medication adherence			Sum	RR	RRI	ARR
	High (8)	Medium (6-7)	Low (<6)				
Intervention	7	5	3	15	1,52	52,9%	30%
Control	2	6	7	15			

The RR value of 1.52 means that the SIMANTB application increases medication adherence by 1.52 times higher than the control group. The Relative Risk Increase (RRI) value of 52.9% showed that the SIMANTB application increased medication adherence by 52.9% compared to the control group.

Discussion

SIMANTB Application Eligibility

The results of the study show that the SIMANTB application is very feasible to use with a feasibility rate of 93.06%. The SIMANTB application is an information technology development in the world of health designed specifically for TB patients to improve medication adherence. This application is equipped with a patient profile menu, information about TB, activities and alarms taking medication available in the form of a website and traffic data in the form of statistics.

The development of the SIMANTB application is in line with the development of information technology which is an opportunity to improve the quality of nursing care and increase the reach of nursing services for the community. The results of this study are supported by research that states that digital technology has an influence to help the treatment of tuberculosis patients as a reminder in treatment adherence and as a means of health education (Park et al., 2019).

The Effectiveness of SIMANTB Applications on Medication Compliance

The results showed that the SIMANTB application was effective in improving medication adherence for pulmonary TB patients with p value = 0.001. Medication adherence in the intervention group (2.67) was higher than in the control group (1.80). Of the 15 respondents in the intervention group, 9 respondents had high compliance and 6 respondents had moderate compliance, while in the control group only 2 respondents had high compliance.

The increase in medication adherence in the intervention group occurred because the SIMANTB application provided reminders in the form of alarms and notifications that reminded patients to take medication. This application is also equipped with a photo upload feature as proof that the patient has taken medication, thus allowing for better monitoring from health workers.

The results of this study are in line with the research of Lubis et al. (2016) which stated that SMS (Short Message Service) can be a reminder to improve treatment adherence in Diabetes Mellitus patients. Another study by Sari et al. (2018) also showed that the STAR NURSE (Smart Reminder for Tuberculosis Nursing Care) application can improve medication adherence in TB patients.

The SIMANTB application provides a good effect size with a value of 0.250 which can be interpreted as having good effectiveness on the medication adherence of TB patients. An

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RR value of 1.52 indicates that the SIMANTB application increases medication adherence by 1.52 times higher than the control group given the conventional DOTS strategy.

Self-Care and Increased Compliance

Self-care behavior will be formed if you get motivation, communication, and a good attitude. The SIMANTB application is an application that functions as a reminder media and aims to reduce treatment barriers and improve self-care for medication adherence to pulmonary TB patients.

The intervention provided in the SIMANTB application emphasizes the pharmacological management of TB, namely the adherence to taking TB patients by utilizing the android application. The SIMANTB application with the alarm feature can increase compliance with taking anti-tuberculosis drugs. The provision of SIMANTB application interventions for 28 days had a significant effect on medication adherence, although the time was relatively short to comprehensively assess adherence.

Clinical Implications

The results of the study show that the SIMANTB application can be an innovative solution in supporting TB control programs, especially in improving patient medication adherence. This application can be used as a complement to the DOTS strategy that is already running, providing more intensive and personalized monitoring to TB patients.

The use of mobile health technology in TB management provides advantages in the form of high accessibility, ease of use, and real-time monitoring capabilities. This is in line with the development of the digital era 4.0 where the use of information technology is the key to improving the quality of health services.

CONCLUSION

The android-based SIMANTB application effectively improves medication adherence in pulmonary TB patients, achieving a feasibility rate of over 93% and significantly increasing adherence with a p-value of 0.001, an effect size of 0.250, and a relative risk of 1.52 compared to controls. This demonstrates that patients using the application are 1.52 times more likely to adhere to their medication regimen, making SIMANTB a promising tool for health workers to support patient monitoring and motivation, potentially enhancing treatment success rates. Future research should focus on longitudinal studies to assess long-term effectiveness, examine impacts on clinical outcomes such as cure and sputum conversion rates, evaluate cost-effectiveness versus traditional DOTS strategies, test adaptability across diverse geographic and cultural settings, and explore integration of artificial intelligence for personalized reminders and predictive analytics to prevent treatment discontinuation.

REFERENCE

Amell, G. L., Villa, M. S., Lopez, J. R., Sierra, D. M., & Agamez, M. N. (2020). Social determinants of health and the loss of follow-up to the treatment of pulmonary tuberculosis. *Salus*, 24(1).

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- Bouri, E., Demirer, R., Gupta, R., & Pierdzioch, C. (2020). Infectious diseases, market uncertainty and oil market volatility. *Energies*, 13(15). <https://doi.org/10.3390/en13164090>
- Duarte, R., Lönnroth, K., Carvalho, C., Lima, F., Carvalho, A. C. C., Muñoz-Torrico, M., & Centis, R. (2018). Tuberculosis, social determinants and co-morbidities (including HIV). *Pulmonology*, 24(2). <https://doi.org/10.1016/j.rppnen.2017.11.003>
- Ende Regency Health Office. (2022). *Data from the Ende Regency Health Office in 2021*. Ende Regency Health Office.
- Espinosa, R., Tago, D., & Treich, N. (2020). Infectious diseases and meat production. *Environmental and Resource Economics*, 76(4). <https://doi.org/10.1007/s10640-020-00484-3>
- Gesezew, H., Tsehaineh, B., Massa, D., Tesfay, A., Kahsay, H., & Mwanri, L. (2016). The role of social determinants on tuberculosis/HIV co-infection mortality in southwest Ethiopia: A retrospective cohort study. *BMC Research Notes*, 9(1). <https://doi.org/10.1186/s13104-016-1905-x>
- Kováč, J., Slobodníková, L., Trajčiková, E., Rendeková, K., Mučaji, P., Sychrová, A., & Bittner Fialová, S. (2022). Therapeutic potential of flavonoids and tannins in management of oral infectious diseases—A review. *Molecules*, 28(1), 158. <https://doi.org/10.3390/molecules28010158>
- Kusnandar, V. B. (2021). Indonesian internet users rank 3rd most in Asia. *Databooks.id*. Retrieved January 15, 2023, from <https://databoks.katadata.co.id>
- Lubis, I. K., Harjoko, A., & Dewi, F. S. T. (2016). SMS-based reminder system design to improve treatment compliance of diabetes mellitus patients. *Journal of Public Health Information Systems*, 1(1), 3–9.
- Ministry of Health. (2019). *Indonesia's health profile in 2019*. Ministry of Health of the Republic of Indonesia.
- Park, J. Y. E., Li, J., Howren, A., Tsao, N. W., & de Vera, M. (2019). Mobile phone apps targeting medication adherence: Quality assessment and content analysis of user reviews. *JMIR mHealth and uHealth*, 7(1), e11919. <https://doi.org/10.2196/11919>
- Regulation of the Minister of Health of the Republic of Indonesia No. 67 of 2021. (2021). *Tuberculosis control*. Ministry of Health of the Republic of Indonesia.
- Sari, E. I., Sianipar, Y. M. L., Solehati, D. E., & Utami, R. S. (2018). An enhanced strategy to improve medication adherence in tuberculosis patients. *UI Proceedings on Health and Medicine*, 1(7), 1–4.
- Sekandi, J. N., Onuoha, N. A., Buregyeya, E., Zalwango, S., Kaggwa, P. E., Nakkonde, D., Atugonza, S., ... Katamba, A. (2021). Using a mobile health intervention (DOT selfie) with transfer of social bundle incentives to increase treatment adherence in tuberculosis patients in Uganda: Protocol for a randomized controlled trial. *JMIR Research Protocols*, 10(1), e25915. <https://doi.org/10.2196/25915>
- Wahdi, A., & Puspitosari, D. R. (2021). *Getting to know tuberculosis*. Pena Persada.
- World Health Organization. (2021). *Global tuberculosis report 2021*. WHO Press.
- Zhang, C., Maruggi, G., Shan, H., & Li, J. (2019). Advances in mRNA vaccines for infectious diseases. *Frontiers in Immunology*, 10(MAR), 594. <https://doi.org/10.3389/fimmu.2019.00594>

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Zieliński, A., & Czarkowski, M. P. (2021). Infectious diseases in Poland in 2019. *Przegląd Epidemiologiczny*, 75(4), 485–500. <https://doi.org/10.32394/pe.75.54>