



Effectiveness of Web-Based Applications and Lecture Methods in Enhancing Knowledge and Self-Detection of Tuberculosis Transmission Risk

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ABSTRACT

Aims This study aimed to assess the effectiveness of using web-based applications and lecture methods in increasing knowledge and the ability to self-detect the risk of tuberculosis transmission.

Materials & Methods This study employed a quasi-experimental, two-group pre-test-post-test design with purposive sampling involving 120 close contacts of TB patients. The research was conducted in Jambi City, a known TB-endemic area, across five community health centers (Puskesmas). Data collection occurred from March to August 2024 through observations and questionnaire administration, with data analyzed using the analysis of covariance.

Findings The web-based application and the lecture method effectively enhanced tuberculosis knowledge among close contacts ($p < 0.05$). Both interventions significantly increased self-detection scores in this group; however, the web-based application demonstrated a greater mean improvement than the lecture method. This suggests that the web-based application is a more effective for enhancing TB-related knowledge and self-detection skills.

Conclusion Both the "Sijari Manis" web-based application and the lecture method effectively enhance knowledge and self-assessment of tuberculosis transmission risk.

Keywords Tuberculosis; Knowledge; Digital Health; Health Promotion

CITATION LINKS

[1] Bovine tuberculosis prevalence and risk factors in selected districts ... [2] Prevalence and risk factors for adult pulmonary tuberculosis in a metropolitan ... [3] Incidence and prevalence of tuberculosis in incarcerated populations ... [4] Risk factors for ... [5] Tuberculosis ... [6] The role of medication observer and compliance in ... [7] Risk factors for catastrophic costs associated with tuberculosis ... [8] Mortality and risk of tuberculosis among people living with HIV in whom TB ... [9] Prevalence and risk factors for Mycobacterium tuberculosis infection ... [10] Systematic review and meta-analysis: Prevalence of diabetes among patients ... [11] Risk factors and true prevalence of ... [12] Prevalence of bovine tuberculosis and risk factor assessment in cattle ... [13] Utilizing web based learning as 21st century learning media for ... [14] Where are we with Web-based learning in ... [15] Effectively incorporating instructional media into ... [16] Self-screening in the family members of tuberculosis ... [17] Revolutionizing healthcare awareness: Empowering ... [18] The Role of TB Cadres in the Development ... [19] Technology and tuberculosis control ... [20] Digital health interventions to enhance tuberculosis treatment ... [21] The role of independent measures of load... [22] Cognitive load theory and educational ... [23] Accelerating research and development of new vaccines ... [24] Revolutionizing infectious disease management ... [25] Effectiveness of health education intervention in improving ... [26] Psychological and educational intervention ... [27] Use of digital technology to enhance ... [28] Effectiveness of m-learning on knowledge and attitude ... [29] Evaluation of web-based information on Spine ... [30] Research article a comparative study of knowledge, attitude ... [31] Knowledge, attitude and practice towards tuberculosis in Gambia ... [32] Knowledge of infection prevention and control among healthcare ... [33] Effect of income level and perception of susceptibility and severity ...

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Introduction

Pulmonary tuberculosis (TB) remains a critical global health issue, particularly in developing countries [1-4]. According to the World Health Organization (WHO), TB is one of the leading causes of death from infectious diseases worldwide, with persistently high prevalence in numerous regions. In 2022, an estimated 10.6 million people globally were affected by TB, comprising 5.8 million men, 3.5 million women, and 1.3 million children [5].

In Indonesia, TB poses a major public health challenge, with high incidence rates demanding urgent measures for effective control. The prevalence of pulmonary TB in Indonesia has been rising steadily, with thousands of new cases identified each year. In 2022 the country reported 724,000 new TB cases, which escalated to 809,000 cases in 2023 [5]. Populations residing in areas with high population density and poor sanitation are particularly vulnerable to TB transmission. Additionally, the social stigma associated with TB often discourages patients from seeking timely treatment, further aggravating the spread and impact of the disease [6, 7]. Efforts to combat pulmonary TB have included diverse public health initiatives, such as awareness campaigns, active screening, and treatment protocols with appropriate therapies. The Directly Observed Treatment, Short-course (DOTS) program has been a key strategy to ensure patients adhere to regular and timely treatment. However, the impact of this intervention is frequently limited by factors such as insufficient community awareness of TB and its symptoms. Improving knowledge and understanding of TB within communities remains essential to enhancing the overall effectiveness of these interventions [2, 8].

A major factor contributing to the success of TB interventions is the general lack of public awareness and knowledge about TB transmission risks and symptoms [9]. Many individuals remain unaware of their own risk or fail to recognize the early signs of the disease, resulting in delayed testing and treatment. Thus, community education is critical in reducing TB prevalence rates by encouraging early detection and timely intervention [10-12].

In the digital era, web-based educational media has emerged as an innovative solution to enhance public knowledge about health, including the prevention and management of TB. This medium offers a key advantage in its wide accessibility, allowing information to reach people in various regions, including remote areas with limited healthcare services.

Additionally, web-based platforms can be integrated with interactive features, such as quizzes or self-screening tools, encouraging active community participation in understanding and managing their health risks. With relatively low operational costs, this medium is an efficient and cost-effective tool for

disseminating impactful health information on a large scale [13-15].

Previous research has demonstrated that M-Health applications are well-suited for practical implementation. Results from field trials indicate a significant increase in participants' knowledge following exposure to the M-Health app. Utilizing health education resources related to TB has proven effective in raising public awareness and understanding of the disease [16, 17].

The novelty of this research lies in implementing an innovative combination of web-based applications and lecture methods to increase knowledge and the ability to self-detect the risk of TB transmission. The integration of these two approaches opens up the possibility of developing educational models that are more efficient and easily accessible, especially in areas with limited resources. By utilizing digital technology to disseminate information, this research offered a cost-effective solution to reach a wider audience. The implication for the health sector is the potential to strengthen efforts to prevent and detect TB early in the community. This approach can increase awareness, improve preventive behavior, and reduce transmission rates, ultimately supporting broader and more sustainable TB control efforts. This study aimed to assess the effectiveness of using web-based applications and lecture methods in increasing knowledge and the ability to self-detect the risk of tuberculosis TB transmission.

Materials and Methods

Design study

The quasi-experimental research employed a two-group pre-test-post-test approach. The study utilizes a media product developed through research, specifically the M-Health Si Jari Manis (tuberculosis independent screening system).

Setting

This research was conducted from March to August 2024 in the working areas of five public health centers in Jambi City, including Putri Ayu Health Center, Aur Duri Health Center, Tahtul Yaman Health Center, Talang Bakung Health Center, and Tanjung Pinang Health Center. The five locations were selected based on the high number of TB patients visiting each health center, making them a primary focus for the local government's TB control efforts.

Participants

The research population included individuals residing in close proximity to patients diagnosed with pulmonary TB in Jambi City. According to the Jambi City Health Office, there were a total of 1,942 confirmed cases of TB in the city in 2023.

Participants were selected using simple random sampling, resulting in 120 individuals divided into two groups: 60 in the intervention group and 60 in the control group. The inclusion criteria for participation included individuals who frequently

had direct contact with TB patients, those living in the vicinity of the TB patient's residence, participants not diagnosed with other infectious diseases that could affect study outcomes, individuals with access to a device with an internet connection to utilize web-based applications, and those willing to participate in the study. Conversely, potential participants were excluded if they were undergoing treatment for TB or related infections, had mental or cognitive impairments that could hinder their understanding of the study material, or were pregnant due to potential associated health risks.

Sample size

The sample was drawn from 120 individuals who met the inclusion criteria. The sampling was conducted using a margin of error of 5% and a total identified population of 172 TB patients in the study area.

Tools

The study focused on knowledge of TB and self-detection of transmission risk. Knowledge was assessed using a closed-ended questionnaire consisting of ten questions that addressed various aspects of TB, including its symptoms, modes of transmission, and prevention strategies. The self-detection of transmission risk was evaluated through a separate set of five questions, which required participants to rate their understanding of transmission risk based on recognized symptoms and environmental factors.

A Likert scale was employed for both questionnaires, where responses were scored from one to five, with one representing "strongly disagree" and five representing "strongly agree." For the knowledge assessment, total scores could range from ten (indicating very low knowledge) to 50 (indicating very high knowledge). In the risk self-detection assessment, scores ranged from five (indicating very low-risk detection) to 25 (indicating very high-risk detection). The scores for each question were aggregated to derive a final score, which was then subjected to descriptive analysis to calculate the mean and standard deviation.

To ensure the validity and reliability of the assessment tools, we conducted content validity testing by subject matter experts, along with reliability testing using Cronbach's alpha (0.85). A value above 0.70 for both parameters was considered indicative of good reliability. This method provides a robust evaluation of the effectiveness of both the web-based application and the lecture method in enhancing knowledge and the ability to detect the risk of TB transmission.

Data collection

The research was implemented in two groups; one utilizing the Si Jari Manis application (a TB education and self-screening tool) and the other serving as a control group receiving educational lectures. Data collection involved administering questionnaires and self-screening tools to assess the signs and symptoms of TB experienced by the respondents. The symptoms

evaluated included a persistent cough lasting more than two weeks, hemoptysis (coughing up blood), recurrent fever, night sweats, loss of appetite, shortness of breath, and chest pain.

Before the intervention, the knowledge levels and self-detection abilities regarding TB transmission risk among the participants were measured.

These initial observations and measurements were documented in the provided data sheets. Following this baseline assessment, researchers implemented the intervention using the Si Jari Manis application alongside the educational lectures. After the intervention, participants' knowledge and self-detection abilities for identifying the risk of TB transmission were reassessed.

Statistical analysis

Descriptive analysis was conducted to describe the characteristics of the data obtained, including the mean, standard deviation (SD), distribution, and frequency of the measured parameters. Additionally, the data distribution was analyzed to identify the pattern or trend of values that emerged, determining whether the data were normally distributed. The Chi-square test was used to determine the association between the characteristics of TB patients and their knowledge about TB transmission. Before performing inferential tests, a normality test was conducted to assess whether the obtained data was normally distributed.

The normality test results showed a $p > 0.05$, indicating that the data were normally distributed. Therefore, since the data met the normality assumption, inferential tests were conducted using parametric tests, specifically the analysis of covariance (ANCOVA). If the results showed a $p < 0.05$, it was considered significant. All data were analyzed using SPSS 23 software.

Findings

Most participants were aged between 25 and 45 years, with a nearly equal gender distribution between men and women in both groups. In terms of education level, most participants had a high level of education, although there was still a significant proportion with lower education. Regarding occupation, most participants were entrepreneurs and laborers, with others being housewives, civil servants/police, and students. As for income level, most participants in both groups earned more than 2 million IDR. All characteristics indicated an association with knowledge about TB transmission ($p < 0.05$).

Both the web-based application and the lecture method effectively enhanced knowledge about TB among close contacts ($p < 0.05$). Notably, the web-based application demonstrated a more substantial increase in knowledge, with an improvement of 30.5 points, statistically more significant than the lecture method's increase of 18.7 points (Table 2).

Table 1. The chi-square test results for the association between the frequency of respondents' characteristics and their knowledge

Parameter	Web application	p-Value	Lecture	p-Value
Age (year)				
<25	15(25)	0.001	12(20)	0.001
≥25-45	32(53)		32(53)	
>45	13(22)		16(27)	
Gender				
Female	30(50)	0.001	28(47)	0.001
Male	30(50)		32(53)	
Education level				
High (diploma, bachelor's degree, master's degree)	36(60)	0.001	32(53)	0.001
Low (elementary school, junior high school, senior high school)	24(40)		28(47)	
Occupation				
Housewife	8(13)	0.001	10(17)	0.001
Civil servant/police	10(17)		12(20)	
Student	10(17)		8(13)	
Entrepreneur	18(30)		16(27)	
Laborer	14(23)		14(23)	
Income level				
≥2 million	35(58)	0.001	33(55)	0.005
<2 million	25(42)		27(45)	

Table 2. Mean knowledge score before and after receiving the intervention

Parameter	Pre-test	Post-test	Mean difference	t	p-Value
Intervention (Si Jari Manis)	50.2±10.5	80.4±10.7	30.2±5.6	15.23	<0.001
Control (lecture)	52.1±11.2	70.8±9.6	18.7±6.8	9.87	<0.001

Table 3. The mean difference of self-detection of tuberculosis (TB) transmission risk in close TB contacts using web application and lecture

Parameter	Pre-test	Post-test	Mean difference	t	p-Value
Intervention (Si Jari Manis)	48.7±11.9	78.2±9.8	29.5±7.4	15.42	<0.001
Control (lecture)	49.4±12.3	65.9±10.7	16.5±8.2	8.72	<0.001

Both intervention methods—the web-based application and the lecture method—significantly improved the self-detection scores among close contacts of TB ($p < 0.001$). However, the web-based application exhibited a more considerable improvement of 29.5 points, which was statistically more significant than the 16.5-point increase observed with the lecture method. Thus, the web-based application was more effective in enhancing the self-detection abilities of close TB contacts (Table 3).

Discussion

This study aimed to assess the effectiveness of using web-based applications and lecture methods in increasing knowledge and the ability to self-detect the risk of TB transmission. The web application effectively enhanced user knowledge. This can be attributed to the strengths of web-based media as a powerful tool for knowledge acquisition and access to diverse information sources. Specifically, web-based media enables users to obtain information anytime and anywhere, provided they have internet connectivity. This ease of access empowers individuals to explore knowledge that may have previously been inaccessible.

Furthermore, web-based platforms facilitate rapid updates of information, which is particularly crucial in fields requiring current data, such as science, technology, and healthcare. They also promote two-way interaction between users and information providers. Features, like discussion forums, comments, and sharing options encourage greater

user engagement in the learning process. Additionally, web-based media offers various types of resources, including articles, videos, podcasts, and e-books, supporting a flexible and multi-sensory learning experience [16, 18-20].

The application further promotes active user participation through interactive features, such as quizzes and knowledge tests, which have proven effective in reinforcing learning and ensuring comprehension. According to Sweller's Cognitive Load Theory, this interactivity serves to reduce cognitive load by facilitating the digestion and retention of information. Users are more likely to remain engaged with educational materials presented in an interactive and captivating format, thereby enhancing their overall learning experience [21, 22].

Our findings carry significant implications for public health policy. The integration of web-based applications as support tools in TB early detection programs could play a pivotal role in national health strategies, particularly in the context of a global pandemic where physical access to health services is often restricted. Policies that promote the development and implementation of similar applications could expedite the control of TB and other infectious diseases in the future, ultimately enhancing public health outcomes [23, 24].

The lecture method provides a valuable opportunity for direct interaction between the presenter and participants, enabling immediate clarification of any questions or confusion. Moreover, a well-structured lecture can systematically deliver information,

facilitating participants' understanding of essential TB concepts, such as symptoms, modes of transmission, and prevention strategies. By incorporating visual aids and case examples, the lectures helped participants connect theoretical knowledge to real-life scenarios, thereby enhancing information retention. This improved knowledge is anticipated to encourage individuals to proactively identify symptoms and risk factors associated with TB and to educate others within their communities [17, 25, 26]. Thus, both web-based applications and lecture-based methods hold substantial potential for raising public awareness and understanding of TB, ultimately contributing to the disease's prevention and control in the broader community [27-29].

The education, both through web-based applications and lecture methods, had a significant impact on improving participants' knowledge. This is supported by the characteristics of the predominantly young respondents with most participants being under the age of 45—a group that tends to have better access to technology and greater interaction with digital media. This age group also has a higher learning capacity, which allows them to quickly absorb new information [30].

In addition, the dominance of higher educational levels played a key role in enhancing the effectiveness of education. Most participants possessed a higher level of education, which makes it easier for them to understand the material presented, whether through web applications offering various information sources or lectures that provide direct explanations. Higher education is typically associated with better analytical abilities, allowing participants to better link the provided information with the knowledge they already possess [31].

The type of occupation also influenced the success of knowledge improvement. Most participants were employed as civil servants or were self-employed, which generally provides economic stability and better access to the technology and resources needed to engage with web-based education. These jobs often require continuous updating of skills and knowledge, including in health-related topics, which motivates participants to take advantage of available educational opportunities [32].

Furthermore, the relatively high income (more than 2 million IDR) also supported access to the technology and resources necessary for engaging with web-based educational methods. With better income, participants have the means to access the internet, purchase necessary devices, and attend training or seminars that can enhance their knowledge. Higher income is also often linked to better health awareness, as these individuals tend to have better access to healthcare services and health information [33].

The study identified certain technical limitations associated with using the app, including the

requirement for a stable Internet connection and sufficient digital literacy skills.

While the app was designed for ease of use, some users with lower digital literacy experienced challenges in navigation. These findings suggest a need for supplemental training or a more intuitive interface to enhance accessibility across diverse user groups.

Conclusion

Both the "Sijari Manis" web-based application and the lecture method effectively improve knowledge and self-assessment of TB transmission risk.

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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.02.06/5/166/2024. 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 interest.

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