DEVELOPMENT OF A SELF-SCREENING EDUCATION MODEL FOR HOUSEHOLD CONTACTS OF PATIENTS WITH PULMONARY TUBERCULOSIS

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Abstract
The prevalence of tuberculosis (TB) in Indonesia continues to increase every year, placing Indonesia second in the world in terms of the number of TB cases. Efforts by the government to control TB are still hampered, one of which is the difficulty of detecting suspected TB cases due to negative stigma that makes patients reluctant to disclose their condition. This is due to a lack of knowledge. This study aims to develop a website-based educational model, "KECAPI," enabling household contacts of TB patients to conduct self-assessments of transmission risk anytime and anywhere. The study was a development research (Research and Development) using a mixed-method approach within the ADDIE framework. The study subjects include 3 individuals in a one-on-one test, 15 persons in a small group test, and 35 persons for the field test and a control group of 35 persons. User satisfaction with the educational model was assessed using the System Usability Scale, and knowledge improvement was analyzed using the Mann-Whitney test. The "KECAPI" educational model (Recognize-Record-Check) was developed based on the Health Belief Model, Trans Theoretical Model, and Technological Acceptance Model, and was proven to be effective, easy to use, and improved household contacts' knowledge about TB. This model presents animated videos, text, and images and can be accessed via the link https://s.id/kecapitb. It is hoped that this model can be utilized by health institutions to detect suspected of TB cases in the community, thereby increasing the case detection rate and ensuring prompt and appropriate treatment.
Keywords: educational media; tuberculosis; self-screening; self-detection; household contacts.

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INTRODUCTION

Tuberculosis (TB) remains a top priority worldwide and is one of the targets of the SDGs (Sustainable Development Goals). TB affects millions of people every year and is the second leading cause of death among infectious diseases worldwide after HIV/AIDS (1). The rapid transmission process has caused the prevalence of tuberculosis to increase every year. There were an estimated 969,000 cases of pulmonary tuberculosis in 2021 (one person infected with tuberculosis every 33 seconds). This figure is up 17% from 2020. In 2022, there were 718,000 TB cases with a detection rate of only 74% (while the target is 85%). According to the 2023 Global TB Report, Indonesia ranks second in the world for the highest TB case burden after India, followed by China. (2). The number of TB cases is estimated at 1,060,000, with 134,000 deaths from TB per year in Indonesia (3).

Eliminating tuberculosis is one of the government's main priorities in the health sector. An important element in the tuberculosis control program is early diagnosis and prompt and

appropriate treatment. Sources of transmission and increased transmission in the community occur when diagnosis and treatment are delayed. (4). Delays in diagnosing pulmonary TB increase the risk of widespread and prolonged transmission of infection, as one person with TB can infect 10-15 people around them, especially those living in the same household (5–7). The highest transmission rate occurs among household contacts, which increases the risk of transmission (8). Research in India found that 70% of household contacts of TB patients showed symptoms of TB (9).

The number of TB cases treated in Jambi Province was 2,500 out of a target of 15,000 cases (16.7%) in 2019. However, through screening at hospitals in several districts/cities, only approximately 600 cases were detected (10). This indicates that the case detection rate is still very low. Undetected TB patients can be a source of transmission in the community, so a solution is needed to enable self-detection at the community level. A common challenge encountered in the field is the difficulty for health workers to identify TB suspects. One of the efforts undertaken by the government is to activate TB cadres in every village. However, this has not been fully optimized due to the lack of an application or tool that can help accelerate the work of health workers or cadres through an educational medium that follows the principle of identifying, recording, and then raising awareness (encouraging) the community to get tested, especially household contacts of TB patients who are at high risk of infection.

Most Indonesians now own smartphones. The numerous features that make it easier for people to access various information and the affordable price make smartphones a primary necessity for the public. Current data shows that internet usage in Indonesia is very high, with the number of smartphone users reaching 167 million people or 89% of the total Indonesian population (11). This situation indicates that it is highly feasible to utilize smartphones as a medium for providing health education to the public in detecting the risk of TB transmission among household contacts independently.

The use of smartphone applications is very useful in helping to identify suspected TB cases in the community. Smartphone applications can make it easier for the community to learn about TB. In addition, smartphone applications can be used to teach the community how to independently detect the risk of TB transmission, and the data can be directly connected to health workers. The use of this app can facilitate communication between the community and healthcare workers, ensuring that community privacy is maintained while healthcare workers can promptly develop follow-up plans for individuals deemed at risk of TB infection.

Health workers and community health workers face difficulties in identifying TB cases throughout Indonesia. Some people consider having TB to be shameful and worry about being ostracized by their community. In addition, many people are unaware of TB patients in their community. Efforts are needed to increase public awareness of the transmission of pulmonary TB through the development of education and self-screening models to quickly identify TB cases so they can be treated and managed as soon as possible, especially among high-risk groups such as household contacts of TB patients.

This educational model must be easily accessible through familiar devices such as smartphones/computers/laptops/notebooks. In this educational model, in addition to providing information to enhance public understanding—particularly among household contacts—about

pulmonary TB in a comprehensive manner, it can also function as a self-screening tool to accurately identify the signs and symptoms of the disease (recognition), as well as serve as a record for healthcare workers regarding suspected pulmonary TB cases among household contacts, and also as a medium to encourage the public to undergo self-screening.

The educational model developed is named KECAPI (recognize, record, and examine), aiming to increase public awareness about the dangers of tuberculosis, how it spreads, prevention methods, and assist healthcare workers in identifying tuberculosis cases, as well as help the government in breaking the chain of transmission, improving surveillance, and early warning systems, thereby increasing the tuberculosis case detection rate. The objective of this study is to develop the KECAPI self-screening educational model as an effort to increase the knowledge of household contacts of pulmonary TB patients and to assess the effectiveness of this educational model.

METHODS

This study uses a mixed method approach with a research and development design. The product developed is a self-screening instrument to detect the risk of TB transmission independently among household contacts, using the ADDIE development framework, which includes analysis, design, development, implementation, and evaluation. The analysis phase involves identifying community needs for this instrument, while the design phase involves developing a prototype with the involvement of TB experts (pulmonologists) and instructional design experts to ensure the instrument is easy to understand. The development phase was conducted through expert validation (involving three experts: an IT expert, a subject matter expert, and a media expert), whose results served as the basis for revising the self-screening instrument and developing a website-based educational model. The implementation stages included individual trials (3 people), small group trials (6 people), and field trials (18 people), while the summative evaluation was conducted on 70 respondents divided into intervention and control groups.

The study population was the community living with pulmonary TB patients in the city of Jambi. The sample was selected purposively based on the following inclusion criteria: direct contact with TB patients, living near patients, able to read and write, and willing to participate. Primary data were collected through observations of socioeconomic characteristics, environment, and clean and healthy living behaviors (PHBS), as well as the completion of a self-screening instrument covering TB signs and symptoms such as coughing for more than two weeks, fever, and chest pain. Data on pulmonary TB patients were obtained from reports on pulmonary TB patients from the Jambi City Health Office and the community health center with the highest prevalence of pulmonary TB in Jambi City, namely the Putri Ayu Community Health Center.

The independent variable was the intervention of the pulmonary TB self-screening education model for household contacts, while the dependent variable was the knowledge and skills of household contacts of pulmonary TB patients in independently detecting the signs and symptoms of pulmonary TB. The education model developed was based on three behavioral theories, namely the Health Belief Model, the Trans Theoretic Model, and the Technical Acceptance Model.

The data were analyzed qualitatively and quantitatively using paired sample t-tests and independent t-tests to assess the effectiveness of the educational model in improving the knowledge and skills of household contacts of pulmonary TB patients in independently detecting the signs and symptoms of pulmonary TB. The educational model intervention, which involves self-screening for pulmonary TB, is considered effective if the p-value is < 0.05. The results of this study are expected to produce a website-based KECAPI educational model that has been tested to support TB elimination and improve case detection rates.

RESULTS

The result of developing an educational model for self-detection of transmission risk among household contacts of TB patients is a web-based application product. The product is named KeCaPi, an acronym for Ke = **Ke**nali (Recognize), Ca = **Ca**tat (Record), and Pi = **P**eri**k**sa (Check). The web-based application contains educational content about TB knowledge and self-detection of signs and symptoms of transmission risk among household contacts of TB patients. The KeCaPi application is a web-based platform designed to provide users with easy access to education about TB and how to self-detect signs and symptoms of TB. The application includes materials on the basic concepts of TB (definition, causes, modes of transmission, disease impact, who can be affected by TB, prevention methods) as well as self-detection of transmission risks. The results of the detection of signs and symptoms, as well as the follow-up actions that users should take, can be viewed after completing the form. Users can access the application on their smartphones or computers by entering the application link via the web.

KECAPI is an application used to support government programs. In addition to educating the public about TB, this application can also assist health workers in identifying suspected TB cases. The education provided guides users to understand TB, particularly its impacts, modes of transmission, prevention methods, and follow-up plans if users experience TB symptoms, with the aim of increasing knowledge and thereby reducing TB incidence rates. To achieve a TB-free Indonesia by 2030, the Ministry of Health is implementing health transformations, one of which is primary care transformation through public education and secondary prevention. The KECAPI app also includes a self-screening feature that users can complete independently. The results of the self-screening provide an overview of the user's risk level and can serve as a source of data on TB suspects for healthcare services.

The intervention stages in developing the self-detection education model for transmission risk among household contacts of TB patients are based on the Health Belief Model (HBM) and the Transtheoretical Model (TTM). The connection between the HBM and TTM theories and the intervention stages can help design more effective health behavior change programs centered on understanding, motivation, evaluation, and adoption of positive health behaviors. The intervention stages are: awareness, interest, evaluation, trial, and adoption. The features and educational model developed are in the form of the KECAPI model, which consists of three stages (recognize, record, check) and the expected impact (Figure 1).

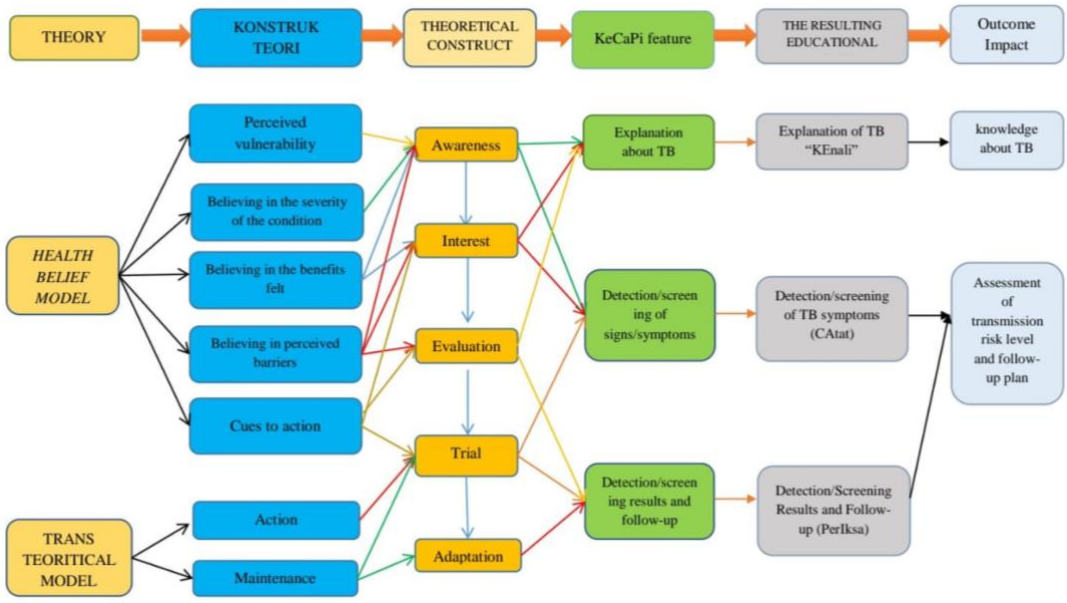

Figure 1. Framework for Developing an Educational Model for Self-Screening of Pulmonary Tuberculosis Transmission Risk

The development stage begins with designing a storyboard, with the development team consisting of researchers, supervisors, and an IT team. The storyboard is developed based on the results of problem analysis obtained from field analysis and supporting theories, and is considered feasible to answer the research objectives. The storyboard design consists of sketches that are a sequence of stories accompanied by text, images, and video descriptions. In the next stage, the designed storyboard is discussed with the IT team to be developed into a prototype of the web-based educational model, followed by expert concept validation, expert model validation, and practitioner validation.

The expert validation of the self-assessment instrument reduced the number of questions from 8 to 9, classified according to risk level: high, moderate, and low (table 1).

Tabel 1 Categories of TB Signs and Symptoms Detection Results Based on Risk Level in Household Contacts (Expert Validation Results)

No	Signs and Symptoms	High Risk	Moderate Risk	Low Risk
1	Coughing for ± 2 weeks and still not recovered*	√	√	-
2	Coughing up blood **	√	-	-
3	Chest pain ***	√	√	-/√
4	Shortness of breath***	√	√	-/√
5	Fever***	√	√	-/√
6	Chills/hot flashes ***	√	√	-/√
7	Sweating at night even without physical activity ***	√	√	-/√
8	Decreased appetite ***	√	√	-/√
9	*** Weight loss in the last 6 months	√	√	-/√

Note :

Target users of the application:	This application is being tested on a limited basis among contacts living in the same household as TB patients.
High Risk (Red):	Experiencing typical symptoms of pulmonary TB, namely coughing for more than 2 weeks without recovery, accompanied by coughing up blood, indicates that the disease is chronic and will usually be followed by all accompanying symptoms (Results validated by practitioners)
Moderate Risk (Yellow):	Experiencing typical symptoms of pulmonary TB, no coughing up blood yet, but experiencing all accompanying symptoms (WHO)
Low Risk (Green):	No characteristic signs of TB and no accompanying symptoms or only some accompanying symptoms.
Sign*	Typical (major) symptoms of pulmonary TB
Sign **	Concomitant symptoms arising from typical symptoms of chronic pulmonary TB
Sign ***	Concomitant symptoms, not indicative of pulmonary TB if not accompanied by typical symptoms of pulmonary TB

Implementation and evaluation were carried out through one-on-one assessments, small group assessments, and field trials. One-on-one evaluations or assessments involved users and researchers interacting to evaluate the practicality of the product. The assessment was conducted on three household contacts of tuberculosis patients in the Putri Ayu Health Center area in the Solok Sipin neighborhood. The instrument used was the System Usability Scale (SUS). The results of the one-on-one product testing on three respondents yielded scores of 82.5, 80, and 75, with an average SUS score for the KECAPI application of 79.17, which falls under Grade B (excellent). The interaction between users and researchers successfully elicited information and user responses regarding the KECAPI application (table 2).

Small group assessments were conducted on 15 residents of Sungai Putri Village. The average assessment using the SUS instrument for the KECAPI application showed a score of 78.33, which is classified as Grade B (excellent). The application was filled out independently by individuals without significant difficulties, enabling them to enhance their knowledge and understanding of TB, conduct self-screening for tuberculosis infection risk, and receive recommendations and follow-up actions based on the results of the self-screening (table 2).

Table 1. Results of Impact and Acceptance Tests on the Use of the KECAPI Education Model

Hasil Pengujian	Min-Max	Mean	95% CI	SD	Grade
Individual testing	75,0 – 82,5	79,17	68 - 88,65	3,82	B (excellent)
Small group testing	72,5 – 82,5	78,33	76,83 – 79,67	2,94	B (excellent)
Field testing	72,5 – 90, 0	83,33	82,00 – 84,64	4,01	B (excellent)

The treatment using the KECAPI application was carried out on 35 respondents. Knowledge measurement was carried out on 70 respondents, consisting of 35 control subjects and 35 intervention subjects. The control group consisted of 65.7% women, with the majority aged between 21 and 25 years (25.7%), the highest level of education being high school and university (48.6%), and the majority employed in private/self-employed sectors (37.1%). The intervention group consisted of 68.6% women, with the majority aged between 15–20 years

and 26–30 years (22.9%), the majority having a high school education (57.1%), and the majority being housewives (40.0%) (table 3).

Table 3. Characteristics of Respondents in the Field Trial (n=70)

Number	Characteristics	Control Group (n=35)		Intervention Group (n=35)	
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
1	Gender				
	Female	23	65.7	24	68.6
	Male	12	34.3	11	31.4
2	Age				
	≤ 15 years old	1	2.9	2	5.7
	15 – 20 years old	8	22.9	8	22.9
	21 – 25 years old	9	25.7	6	17.1
	26 – 30 years old	3	8.6	8	22.9
	31 – 35 years old	4	11.4	3	8.6
	36 – 40 years old	3	8.6	3	8.6
	41 – 45 years old	3	8.6	1	2.9
	46 – 50 years old	4	11.4	4	11.4
3	Education				
	Elementary school	0	0	5	14.3
	Junior high school	1	2.9	8	22.9
	High school	17	48.6	20	57.1
	University	17	48.6	2	5.7
4	Work				
	Housewife	10	28.6	14	40.0
	Employee	8	22.9	5	14.3
	Laborer	4	11.4	2	5.7
	Entrepreneur/ private sector	13	37.1	5	14.3
	Student	0	0	9	25.7

In the field trial, the intervention group was introduced to the application through instructions based on the latest improvements. The purpose of the trial was to assess the impact and effectiveness of the application's use in the community. The average rating using the SUS instrument for the KECAPI showed a score of 80.21 (excellent). In addition to the implementation and testing of the KECAPI, at this stage, measurements of respondents' knowledge were conducted before and after using the KECAPI application (table 2).

Table 4. Results of trials on the impact and acceptance of the KECAPI educational model

Measurement	Min-Max	SD	Mean	95% CI	Median	Mean Difference	P-value
Pre test	5-10	1,06	7,66	7,31-8,01	8	2,03	0.001
Post test	7-10	0,77	9,63	9,37-9,88	10		

The average increase in knowledge before and after education was provided through the KECAPI application was 77% before education and increased to 96% after education was provided through the KECAPI application. Field trial results showed an increase in respondents' knowledge before the implementation of the KECAPI application, with the

average knowledge score increasing from 7.66 to 9.63, with an average difference of 2.03. There was a statistically significant difference in the average knowledge of respondents after the KECAPI implementation intervention, with a p-value of 0.001 (table 4).

Table 5. Results of Field Trials Knowledge Aspects in the control group

Measurement	Min-Max	SD	Mean	95% CI	Median	P-value
Knowledge	5-9	0,80	7,06	6,79 - 7,32	7	0.083

In the control group, knowledge testing was conducted without the KECAPI intervention but with a standard intervention in the form of education by health workers. There was an increase in the average knowledge score in the control group, from 6.89 to 7.06, with an average difference of 0.17, but this was not statistically significant with a p-value of 0.083 (Table 6).

Table 6. Results of the post-test knowledge analysis in the control and intervention groups

Group	N	Mean	p -value
Control	35	20.83	< 0.001
Intervention	35	50.17	

The Mann Whitney test results showed a p-value of 0.000, indicating a difference in knowledge scores between the control group (20.83) and the intervention (50.17), which was found to be significant (table 5). The difference in the average increase in knowledge scores was 29.34 (141%) between the post-test average scores of the intervention and the control group. This indicates that the KECAPI educational media had a significant impact on improving knowledge among household contacts in recognizing the signs and symptoms of tuberculosis and enabling them to use the application to detect it independently, quickly, and accurately anytime and anywhere without fear of negative stigma.

DISCUSSION

The results of this study indicate that there was a change in knowledge before and after using the KECAPI educational model. Observation results indicate users' interest in using the application and state that the educational model is beneficial in enhancing knowledge and skills for self-detection of tuberculosis signs and symptoms, as well as the results of self-detection assessments and follow-up actions users should take based on the severity of their condition using a self-screening instrument consisting of 9 validated questions. In the advanced stage, this research produces a database for identifying suspected TB cases if the website is connected to the health service server.

The improvement in knowledge among household contacts in this study was achieved through an educational model using a different approach, namely through the use of IT. The development of activities in providing education on prevention and self-detection of TB transmission considered the type of teaching activities and educational model technology that could provide comfort to household contacts of TB patients, who often feel afraid of negative stigma from society. Household contacts tend to be reluctant to acknowledge the presence of a

TB patient in their home. The development of an educational model for self-detection and prevention of transmission among household contacts of TB patients was implemented using a model without the presence of an educator, thereby facilitating self-screening by household contacts, which is quick, time-flexible, and cost-effective. (12).

This condition is in line with research conducted by Pangestika, Fadli & Alnur, 2019 on education for the prevention of TB transmission among household contacts, using brainstorming, education, mentoring, and evaluation methods. The study found that before the educational activities were carried out, the knowledge of TB was only 42.8%, after the educational activities, there was an increase in knowledge about TB to 71.4%, the transmission mechanism of tuberculosis to 71.4%, treatment of tuberculosis to 80%, and methods of tuberculosis prevention through PHBS (healthy life style) to 100%. This indicates that the educational activities were quite effective (13). The results of Datiko et al. study (2019) among 3,505 participants in Ethiopia showed that 96% reported that they would go to a community health facility if they experienced TB symptoms. Health education or counseling can increase the average knowledge score before and after the counseling session. This increase in knowledge is also accompanied by an increase in the average perception score, which can influence early disease detection behavior if follow-up on behavioral changes is conducted at least three months after the intervention through counseling (14).

The study findings are also supported by the results of research by Budi Yanti et al. (2022), which found that interventions in the form of audio-visual media and lecture methods were effective in increasing respondents' knowledge and attitudes regarding TB prevention efforts (p-value = 0.048). The use of audio-visual media is considered capable of stimulating more of the recipient's senses, so that the more frequently individuals are exposed to information through such media, the greater that the information will be well understood (15).

This is also in line with the research by Dewi Fitriani et al (2024), which shows that participants who were given education using m-health applications experienced a higher increase in knowledge compared to those who were only given psycho-education. This is due to the use of technology and the fact that patients and their families can study the material repeatedly from their own devices. The m-health app contains information about TB, prevention methods, and treatment for TB, as well as encouraging patients to adhere to their medication regimen. A similar study on the use of m-health technology in Uganda noted that m-health improves information and access to services in efforts to reduce cases of pulmonary TB failure, effectively enhancing knowledge (16,17).

The KECAPI education model was developed to address the challenge of low TB case detection rates in Indonesia, particularly among household contacts. Limitations in early detection, stigma, and low public awareness are the main obstacles to TB control in Indonesia. In this context, conventional passive educational approaches need to be replaced by more active, independently accessible digital educational media.

The KECAPI (Recognize-Record-Check) model was designed using a research and development approach and grounded in the Health Belief Model (HBM) and the Transtheoretical Model. Effectiveness testing results indicate that KECAPI can enhance the knowledge and skills of household contacts in independently detecting TB symptoms. This

indicates that education-based technology not only facilitates access to information but also enhances community readiness to take preventive actions. The constructs used share a similar approach in understanding health behavior change, such as in the HBM theory, which involves believing in perceived vulnerability, perceived severity, perceived benefits, and perceived barriers, which align with the TTM theory constructs of precontemplation and contemplation in the approach to health behavior change. therefore, the precontemplation and contemplation stages are not reintroduced in the construct of the educational model development for self-detection of transmission among household contacts of TB patients. (18,19).

All findings indicate that visual and digital media are effective strategies in TB education and early detection. In line with the KECAPI model, various other digital innovations have also been developed and have proven effective in improving TB literacy and early detection. One such innovation is the SMART TB app, an android-based application that not only provides early detection features but also includes therapy, follow-up schedules, BPJS referral systems, counseling services, and patient support communities. SMART TB was designed to address the limitations of healthcare facilities and bring healthcare services closer to the general public. A similar approach is demonstrated by the TuboCare app, which has proven to enhance patients' self-care management capabilities, improve treatment adherence, and provide a positive user experience (20,21).

The KECAPI app shares similarities with the E-TIBI app in terms of applying a digital technology-based self-assessment paradigm to support early detection of tuberculosis independently. Both apps are designed to make it easier for the public, especially high-risk groups such as household contacts of TB patients, to conduct initial symptom-based screening using a smartphone. Like E-TIBI, the KECAPI app offers educational features combined with interactive questionnaires to help users identify TB symptoms and receive follow-up recommendations. With this approach, KECAPI serves not only as an information platform but also as a tool for early detection, empowering the community to play an active role in identifying new TB cases. This aligns with the national tuberculosis elimination program by 2030 and WHO guidelines that encourage strengthening community involvement in identifying TB cases through digital health tools (22).

These findings reinforce that visual and digital media, including self-screening applications such as KECAPI, play an important role in public health education. By combining theoretical approaches, interactive technology, and healthcare system support, the KECAPI education model and similar innovations support the elimination of tuberculosis through stronger, broader, and more sustainable promotional and preventive strategies. The KECAPI model adds value by integrating education and self-screening based on behavioral theory and web technology. With this approach, KECAPI not only serves as an educational tool but also as part of a community-based active detection system supporting TB elimination.

CONCLUSION AND RECOMMENDATION

The TB transmission risk education and self-detection model developed, namely the KECAPI (KEnali, CAtat, PerIksa) application, has been successfully designed using the ADDIE approach and incorporating the Health Belief Model, Transtheoretical Model, and

Technical Application Model. This web-based application provides easy access for household contacts to learn more about TB and conduct self-detection and reporting of TB symptoms. The development of this model through a series of trials, including one-on-one, small group, and field tests, has proven its feasibility. The use of this educational model has shown an increase in tuberculosis knowledge and supports self-detection of transmission risks. The KECAPI application can enhance public awareness, particularly among household contacts, in recognizing TB symptoms and independently reporting transmission risks.

It is recommended that this model be utilized by health institutions to detect suspected of TB cases in the community, thereby increasing the case detection rate and ensuring timely and appropriate treatment. Further research could include sensitivity testing, adding treatment monitoring features, and self-consultation options.

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