

EduTB as an Effort to Improve Tuberculosis Treatment Adherence

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Abstract The success of tuberculosis (TB) treatment is significantly dependent on patient adherence. Moreover, ensuring treatment adherence is crucial for pulmonary TB patients, as it improves positive treatment outcomes and prevents drug resistance. To enhance health literacy, self-efficacy, and treatment adherence, the current use of digital media offers a distinct opportunity for disseminating information. Therefore, this research aimed to develop EduTB as an online health information application to enhance knowledge and adherence to TB treatment. The design of EduTB included the combination of the PRECEDE-PROCEED and MATCH models, serving as a health promotion model starting with the analysis stage. This was followed by designing a TB health education model, namely Partnership Online Learning (POL). In the design stage, the model and educational product have been developed. The supporting products for the education model and testing instruments for development include validity and practicality testing on small and larger groups. The results showed that the EduTB application has been successfully developed, with a validity testing of 0.84, categorized as valid, and the practicality of 83%, classified as practical. The practicality result was based on the perception of educators in the experimental group, which was 91%, categorized as highly practical.

Keywords EduTB Application, Health Education, Treatment Adherence

1. Introduction

The prevalence of tuberculosis (TB) deaths doubled in 2021, reaching 1.4 million people due to the impact of the COVID-19 pandemic. Global TB Report data shows an increased incident rate of 3.6% in 2020 and 2021, with Indonesia ranking as the second-highest globally for TB cases, increasing from 8.4% to 9.2% [1], [2]. In Riau Province, the Case Notification Rate (CNR) reached 134 per 100,000 population in 2021, with Treatment Coverage (TC) of only 33.5%. Pekanbaru City had the highest number of suspected cases, accounting for 3,602 patients, with a CNR of 315 per 100,000 population, a Cure Rate of 58%, and a Success Rate (SR) of 75.8% [3]. The reduction in TB patients since the pandemic suggests an increasing number of undiagnosed and untreated TB cases, leading to high community infection transmission [1], [4].

TB is an airborne disease that spreads rapidly through the air, facilitating easy transmission from positive patients to healthy individuals, such as during coughing [5]. Pulmonary TB patients with positive acid-fast bacilli (BTA+) have the potential to transmit to 10-15 people per year, increasing the possibility of infection transmission [6]. The success of TB patients in adhering to treatment is closely related to family support from fellow patients, motivating them to take medication as prescribed [7]. Consequently, establishing social support from family, friends, patient groups, peer counseling, and individual management can help patients adhere to treatment protocols [8], [9].

Several health efforts are directed toward TB patients,

ensuring high-quality care and active case-finding strategies, particularly for high-risk groups [10], such as people living with HIV, confirmed bacteriological TB cases in pulmonary contact households, and clinically high-risk groups [11]. Patient adherence to TB treatment is also crucial for treatment success. This is because adherence to medication among pulmonary TB patients can enhance positive treatment outcomes and prevent drug resistance. Moreover, treatment adherence can be influenced by various factors, including peer group and family support [12]. External factors affecting the process include family environment, peer influence, and pre-facility facilities [13]. Peer group support activities for multidrug-resistant tuberculosis (MDR-TB) patients also contribute to increasing self-efficacy [14].

Health promotion is defined as an effort to disseminate health messages [15], [16] and enhance the ability of a community to live healthily independently. This is achieved by influencing, enabling, and reinforcing decisions or actions in line with planned values and goals [17]. To combat TB, health promotion intensification is conducted to improve public knowledge, awareness, and behavioral changes through advocacy activities, communication, social mobilization with extensive outreach, and partnerships [18], [19].

The current use of digital media provides an opportunity to disseminate information, thereby improving health literacy, self-efficacy, and treatment adherence. However,

its use has social risks, such as the spread of incorrect or misleading information unsupported by scientific knowledge [20]. In 2022, the data from the Central Statistics Agency showed that 67.88% of Indonesians aged 5 and above own a mobile phone, and 62.1% had accessed the internet. The average time spent using mobile applications is 5.7 hours per day. This reflects an information-open climate and societal acceptance of technological developments, progressing towards an information society.

Health practitioners can use technology to obtain patient health information and conduct related promotion activities through smartphones and websites [21]. Due to the time constraints and limited budgets often faced by health practitioners, online education has become a preferred option [22]. This has led to the increasing demand for information, media, and technology skills, showing the importance of possessing knowledge and proficiency [23], [24].

Human resource quality is reflected in disease burden, measured using Disability Adjusted Life Years (DALYs), representing the number of deaths caused by disability, premature death, disabling diseases, and road injuries. One DALY loss implies losing one healthy/productive year, where higher losses indicate a greater disease burden on the population in a particular area [25]. Based on the reports, it is known that one of the top causes of death is TB, as shown in Figure 1 below:

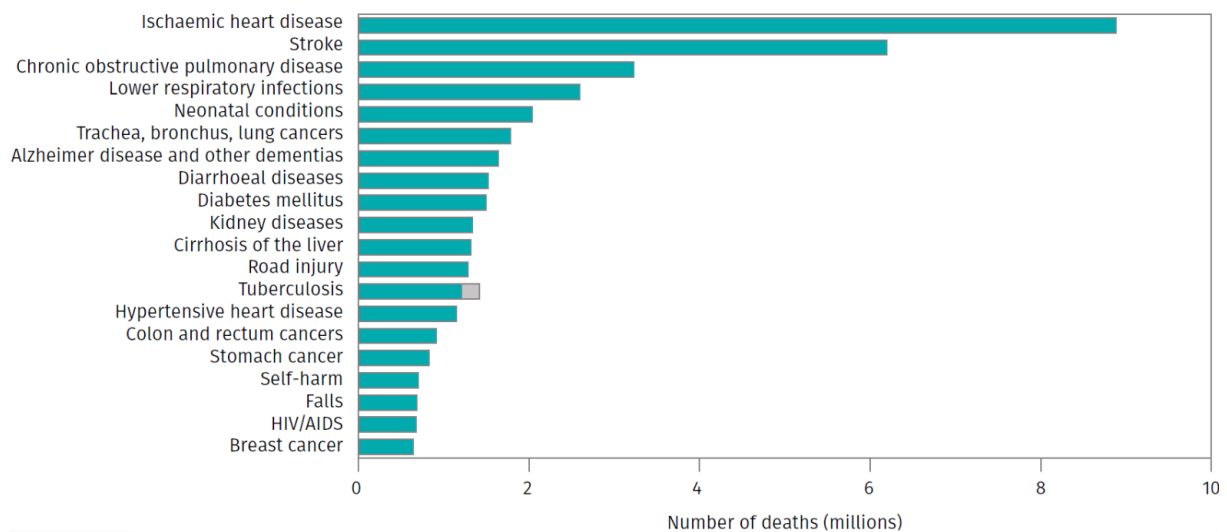


Figure 1. Top Causes of Death Globally in 2019, Source: [1]

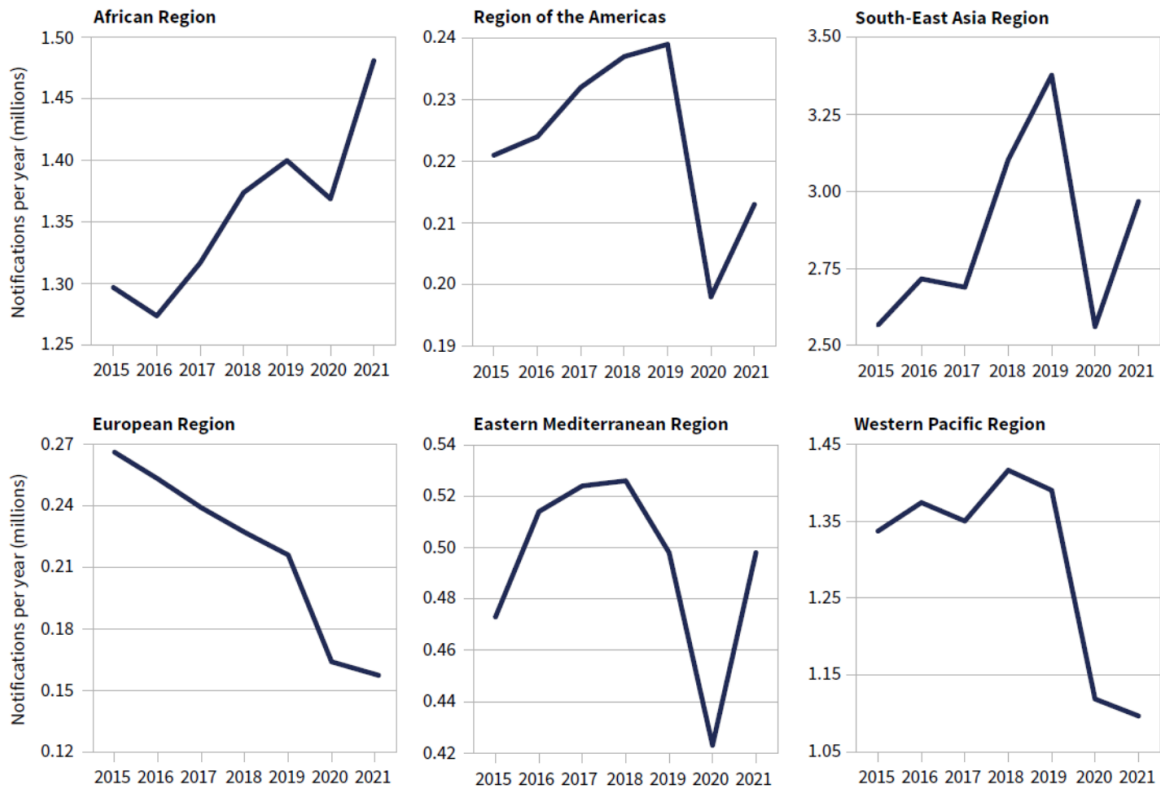


Figure 2. Trends in TB New Case Notifications by WHO Region 2015–2021

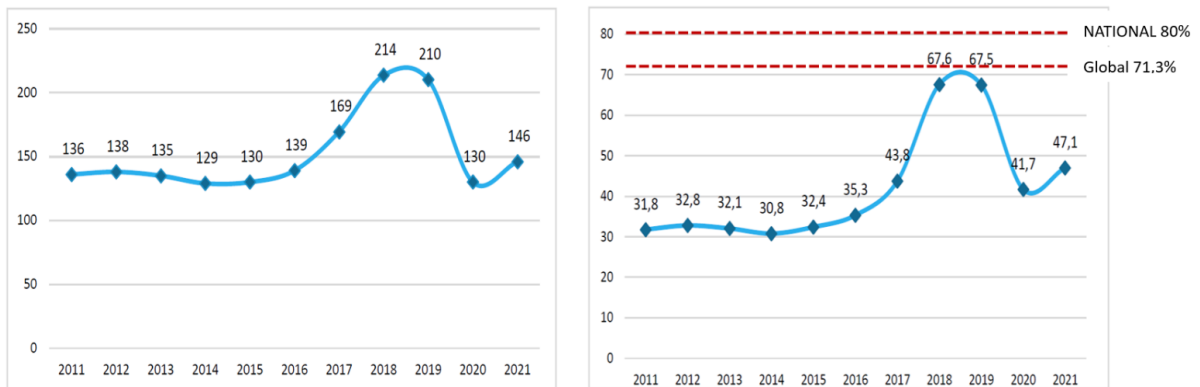


Figure 3. TB Cases Notification (Left) and Treatment Coverage (Right) in Indonesia 2011-2021

Based on Global TB Report data, a significant increase in incidence rate at 3.6% was observed between 2020 and 2021. Geographically, the highest number of TB cases was in Southeast Asia (45%), with Indonesia ranking second globally from 8.4% to 9.2% [1], [2], [26], as shown in Figure 2.

According to the Indonesian health profile in 2021, the data obtained on the number of treated and reported TB cases (CNR) increased from 130 to 146 per 100,000 population. However, the coverage of detection and treatment (TC) reached 47.1% of the national target of 80% and 71.3% globally. Based on observation as shown in Figure 3, the treatment SR of 86.0% was found to be below

the target of 90% [27].

The highest number of suspected TB cases receiving health services is observed in Pekanbaru City. In 2021, the number of TB patients reached 3,602, with a CNR of 315 per 100,000 population, Cure Rate of only 58%, and SR of only 75.8% [28]. The reduction in the number of reported positive cases since the pandemic suggested a growth in undiagnosed and untreated TB cases, leading to increased community infection transmission [1], [4].

Death among TB patients is attributed to delays in case management, due to low knowledge, the distance to health facilities, the presence of comorbidities, and inadequate healthcare services [29], [30]. Additionally, a lack of

understanding regarding the importance of preventive and promotive efforts against the disease, including adequate transmission and prevention methods, can lead to the spread of the disease. Some members of the community may neglect symptoms, such as allowing a persistent cough for more than three weeks. Insufficient knowledge about TB and misconceptions leading to negative stigma also pose challenges and hinder control programs [31], [32]. The lack of awareness among patients to complete treatment is also a risk factor for transmission to close contacts [33].

WHO has developed the End TB 2030 strategy, a part of the Sustainable Development Goals (SDGs) to eradicate the TB epidemic worldwide. The components of the strategy include management and health efforts focused on TB patients such as prevention interventions for high-risk groups [10], household contacts of bacteriologically confirmed TB cases, and clinical risk groups [11]. Health efforts are integrated, comprehensive, and continuous, health promotion, preventive, curative (treatment), and rehabilitative (recovery) aspects [34]. Other programs include infection prevention and control, as well as vaccinating children with the Bacille Calmette-Guérin (BCG) vaccine to provide protection, particularly against severe TB cases [34], [35]. The TB control strategy is known as DOTS (Directly Observed Treatment Shortcourse), which includes all health facilities playing an active role [3] (Cross et al., 2019). In Indonesia, the government has implemented a program aimed at achieving TB elimination by 2030, such as the Healthy Indonesia Program with a Family Approach (PIS PK). The five components of DOTS include political commitment from the government to implement the national TB program, diagnosis through microscopic examination of sputum, treatment with a combination of Anti-TB Drugs (OAT) directly observed by a Drug Supervisor (PMO), continuity of OAT supplies, as well as standardized recording and reporting to facilitate monitoring and evaluation of the pulmonary TB control program. This program is integrated across various initiatives, including community empowerment through cadres. Another program is the Public Private Mix, which forms partnerships with the private sector such as hospitals, doctor practices, and health clinics, including the Find, Treat, Reach, Cure (FTRC) TB program [3]. Moreover, facilitating treatment adherence requires long-term and cost-effective interventions [36].

An effort that has been established to improve treatment adherence is through continuous education. Online health education can be more engaging, practical, sustainable, flexible, easily accessible, and cost-effective, providing an opportunity to educate people with broad reach and acceptance [34], [37]. Furthermore, it makes face-to-face learning that cannot be conducted effectively in achieving learning goals. Encouraging public meetings, community-based treatment models, and appropriate and

accessible messaging are all part of comprehensive health promotion that should be used to highlight the significance of early diagnosis and treatment adherence [34], [38]. Acha-anyi [39] stated that social media platforms have the potential to significantly create health awareness. Holst [40] also stated that providing health messages in digital format would enhance health-related knowledge. The use of digital technology, such as text messages, wearable devices, and mobile applications, is highly recommended as an opportunity to bridge gaps in TB treatment and care. Consequently, health practitioners can use technology to obtain information about patients and conduct promotion activities through smartphones and websites [3]. This phenomenon has made the provision of online education a preferred option as health practitioners often lack time and limited budgets to implement extensively [22].

Community Health Centers have been gradually implementing the TB Eradication Program using the DOTS approach. There are currently programs in place to help TB sufferers promote their health, but one of the challenges faced by the TB program was the inability to provide all TB patients with the regular health promotion activities they needed because of time and energy shortages. No media technology can monitor the medication adherence of patients. Other than that, there have been no attempts to include TB survivors in the role of peer educators.

2. Research Methods

The health promotion model implemented through the online-based EduTB application in this research integrates the combination of the Precede-Proceed theory and The Multilevel Approach to Community Health Model (MATCH). The method used the development approach according to Borg and Gall, which was reduced to five stages, namely a) product analysis, this stage entails analyzing the product, focusing on the need of patients for online education about TB, community readiness, and the need for online TB education materials, b) product development, the design process includes the development of online education concept model, the product validity test instrument, and the interface for EduTB using manual coding in HTML 5 and MySQL c) expert validation and revision, expert validation is carried out, including those in education evaluation, information technology, online health education, and public health. This process is followed by a practicality test of the product, such as TB health information, the accuracy of menu display layouts, color design accuracy, the compatibility of text and background colors, image clarity, information display, and application appearance, d) small-scale trials and revisions, the practicality test is conducted on a small scale, incorporating 3 educators and 10 TB patients and leading to product revisions, e) large-scale trials and final products engaging 7 health educators and 20 TB patients.

The conceptual model of EduTB is presented in Figure 4. Based on the diagram, the system actors included in the distribution of educational content are the admin, patients, and Drug Supervisors (PMO). Meanwhile, in the drug report diagram, the system actors are health centers, patients, and PMO as in Figures 5 and 6.

Users of EduTB can be patients, PMO, and healthcare workers in health centers or related departments. The next

stage is testing the effectiveness of the EduTB application on control groups (not using the TB application) and experimental groups (using the EduTB application) of 20 TB patients in each group. The aspects assessed are knowledge of TB and the proportion lost to follow-up patients. Data analysis used the dependent t test using a significance value (2-tailed) >0.05.

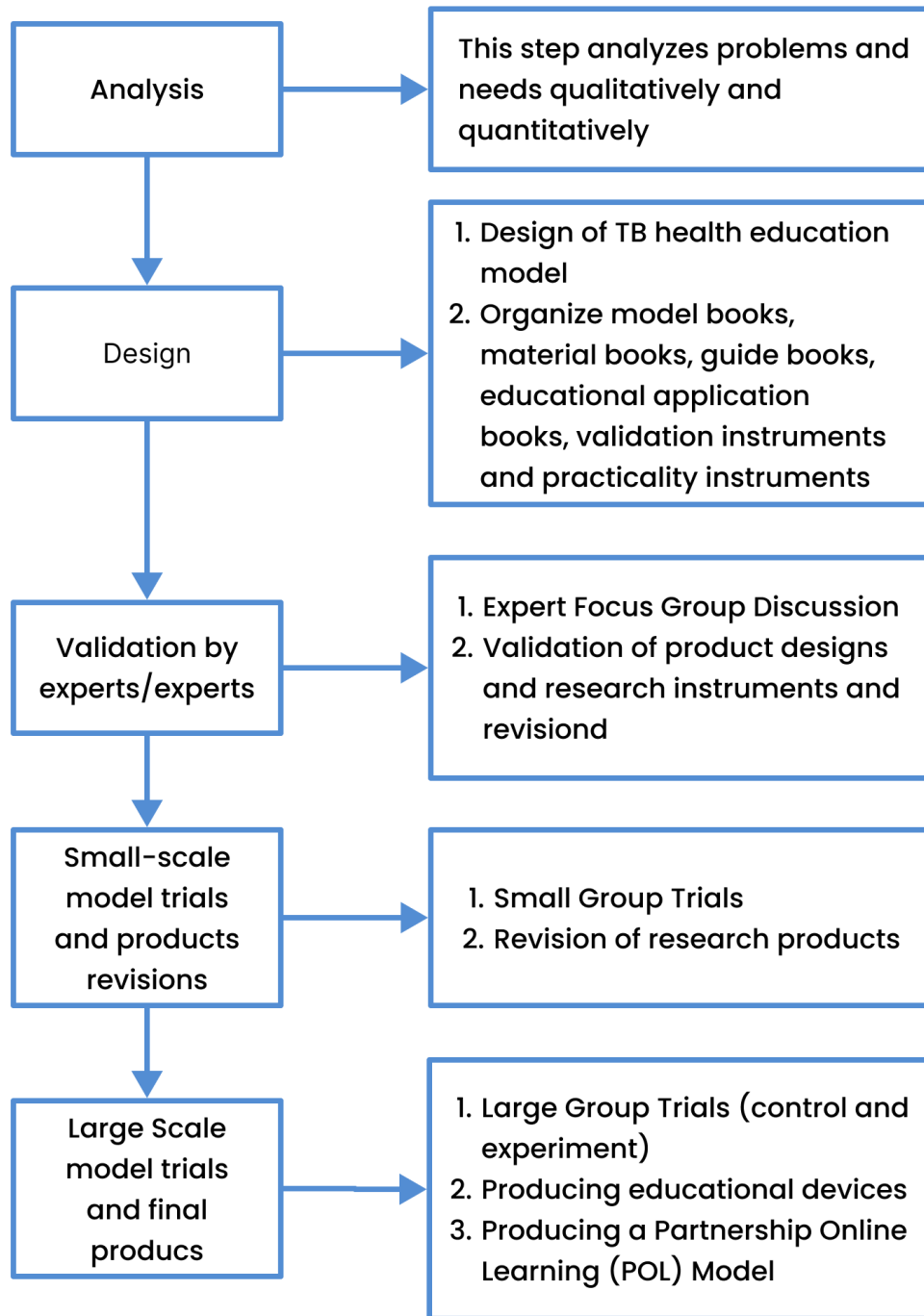


Figure 4. EduTb Health Promotion Model



Figure 5. ERD of Distribution of Education Content

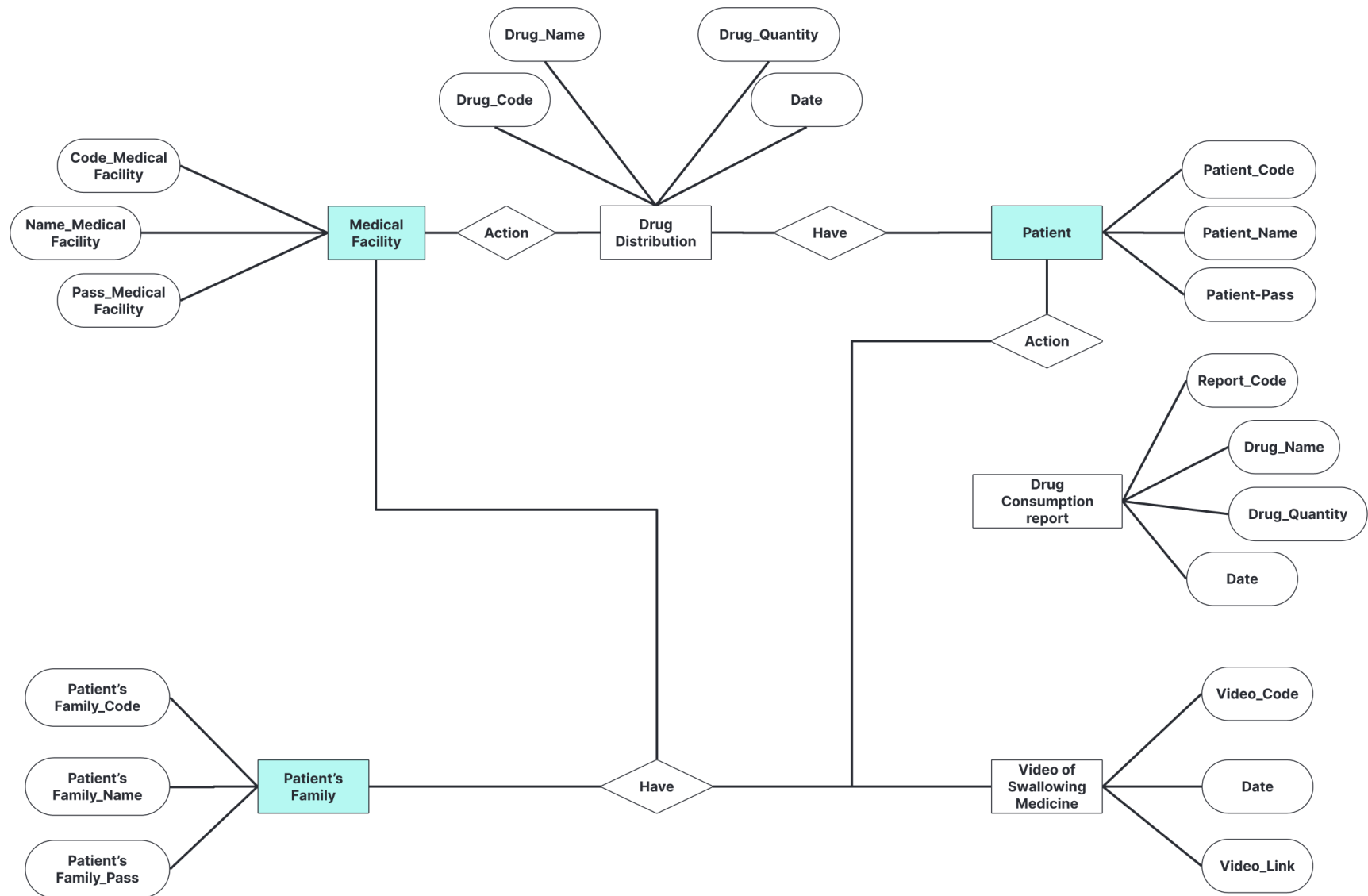


Figure 6. ERD of Drug Report

3. Result and Discussions

EduTB is a real-time online learning medium from any location for the community, enhancing knowledge and behavior regarding TB. This application can also be used to monitor TB treatment adherence in patients and as a medication reminder. In this application, educators consist of those in the health center and Health Department, providing information and facilitating the community in controlling health and consulting with experts or doctors. All programs in the application are arranged to facilitate health workers in providing and updating the latest TB-related information. Furthermore, a section to answer community questions ensures that issues or obstacles in TB treatment reported by the community are addressed, maintaining smooth online communication.

Users are required to register through EduTB on Android to access the application after being registered by health workers at the health center. After downloading and installing EduTB, the display page will appear as shown in the figure below:

Welcome Tuberculosis Education App's

Patient and Medication Monitor V.20



By. Dwi Sapta Aryantiningsih @2023



Figure 7. EduTB Application Display

Several steps that are followed to log in include 1) Enter the user name, 2) Enter the password provided by health workers, and 3) press the "MASUK (LOG IN)" button.

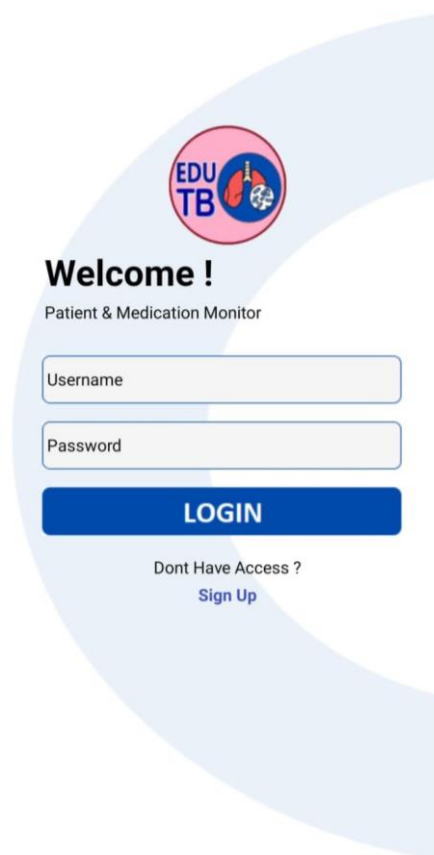


Figure 8. Login Application Display

The main menu shows the application and TB disease data, as shown in Figure 9.

In the drug recording section, patients can record a video while taking medicine. To access the drug recording menu, the steps are as follows click the "rekam minum obat (drug recording)" menu, and connect to the screen recording video. Furthermore, click the red record button and aim the camera at the patient to record the process of taking the medicine. Once finished, click the red button again as shown in Figures 10 and 11.

After entering this menu, click the "select file" button, and select the video to be uploaded. Furthermore, click the "upload file" button and wait for the upload process to reach 100%. This is followed by filling in the intermittent or daily column with the number 1, according to the type of drug consumed. Finally, press the save button.

In the drug section, essential information regarding the type of drug prescribed for patients, such as intermittent or daily, is available. To access the drug menu, click the drug menu and select the month and year to know the quantity of the drug. Furthermore, at the bottom, the types of drugs that patients must consume will appear as in Figure 12.

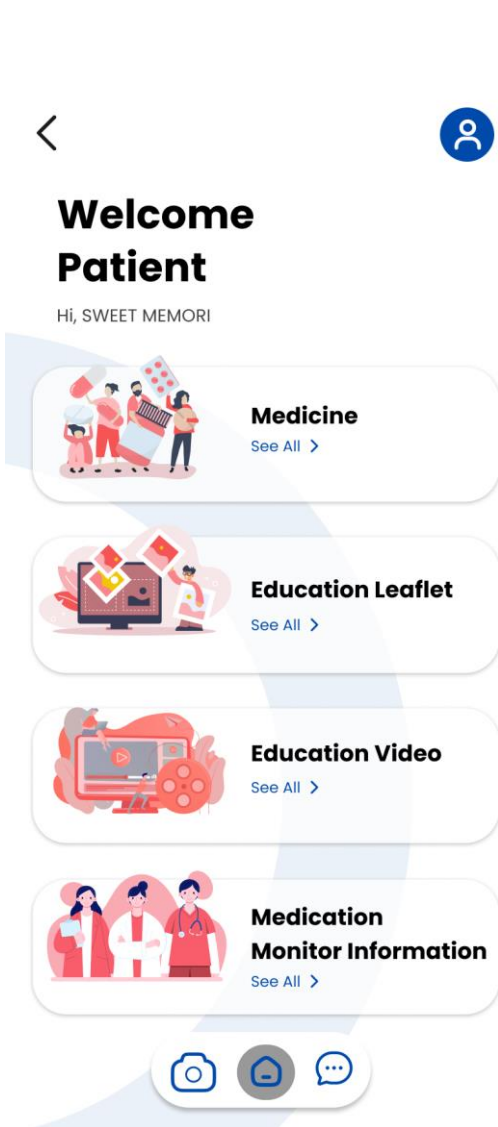


Figure 9. Main Page Display

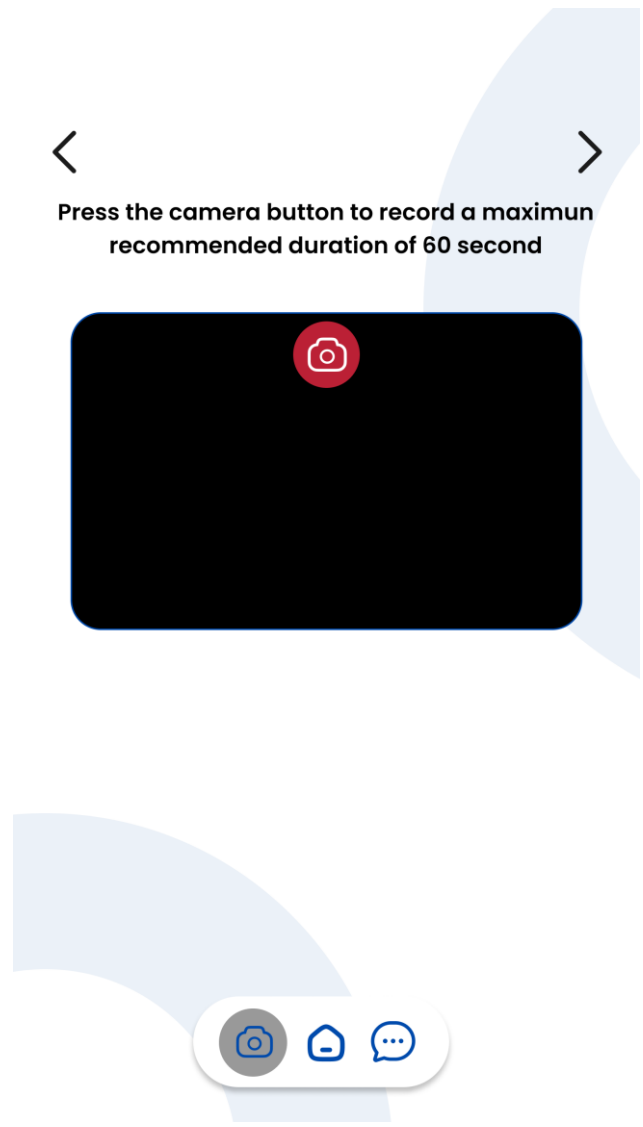


Figure 10. Screen Recording Page Display

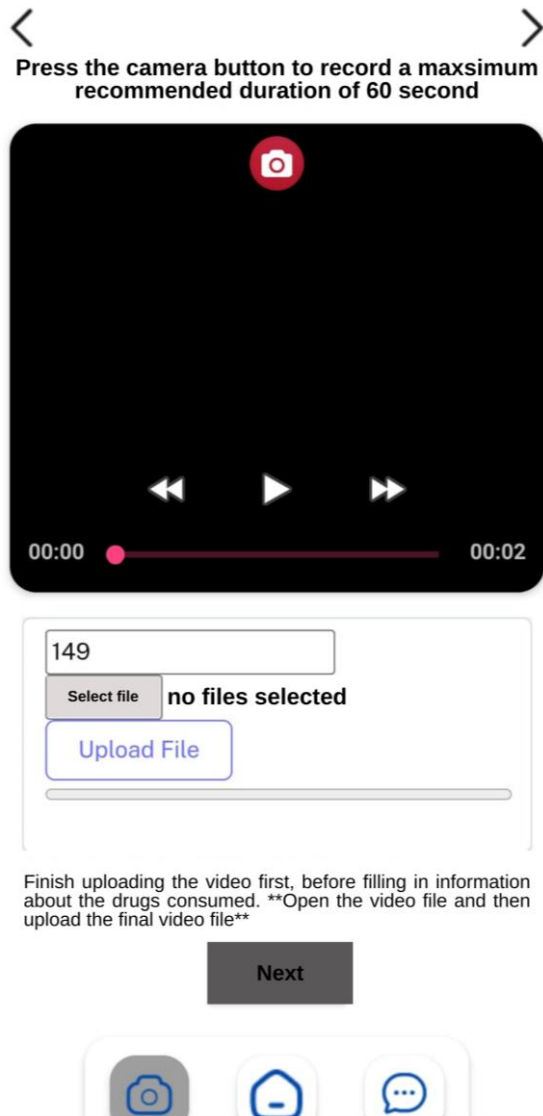


Figure 11. Video Upload Page Display of Swallowing Drug

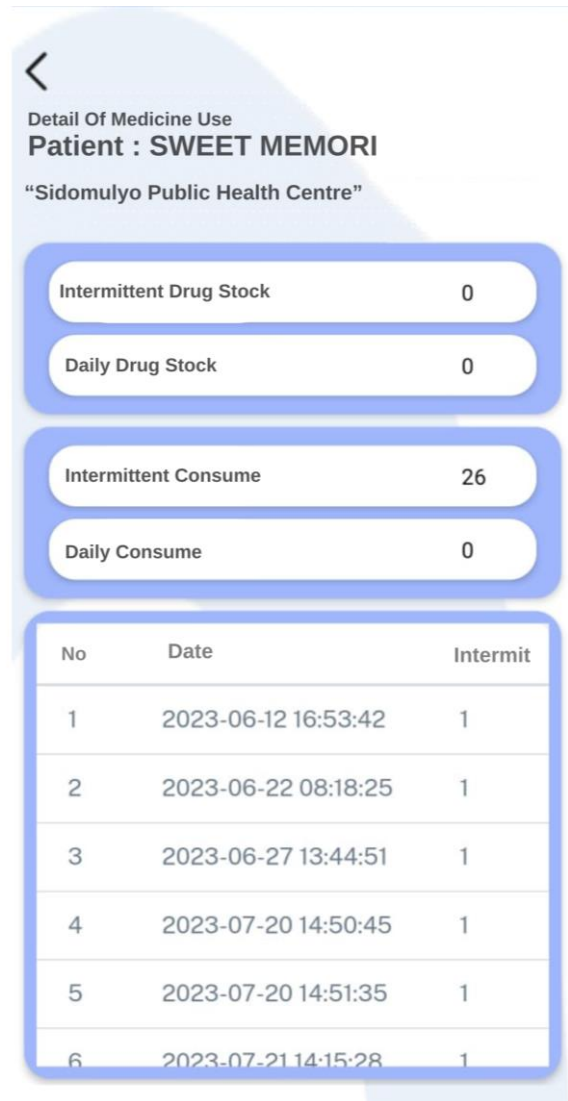


Figure 12. Drug Menu Page Display

In the educational leaflet menu, several articles related to TB are available. Each article is obtained from reliable sources, providing related knowledge with accompanying images. These materials serve as a source of knowledge, aiding users in understanding and adopting a clean as well as healthy lifestyle to prevent TB transmission and accelerate recovery. The presented articles cover various aspects of TB, including required nutrition. Additionally, the materials are presented attractively with images,

preventing readers from feeling bored and facilitating remembrance. To access the leaflet: Click the leaflet menu, click to select the leaflet to be read, and swipe to the right. This will show the text "Click to View" and it will show like Figures 13 and 14.

The educational video menu can be accessed by clicking the Video menu. This is followed by clicking to select the Video to be watched, and swiping to the right. This will show the text "Click to View", see Figures 15 and 16.

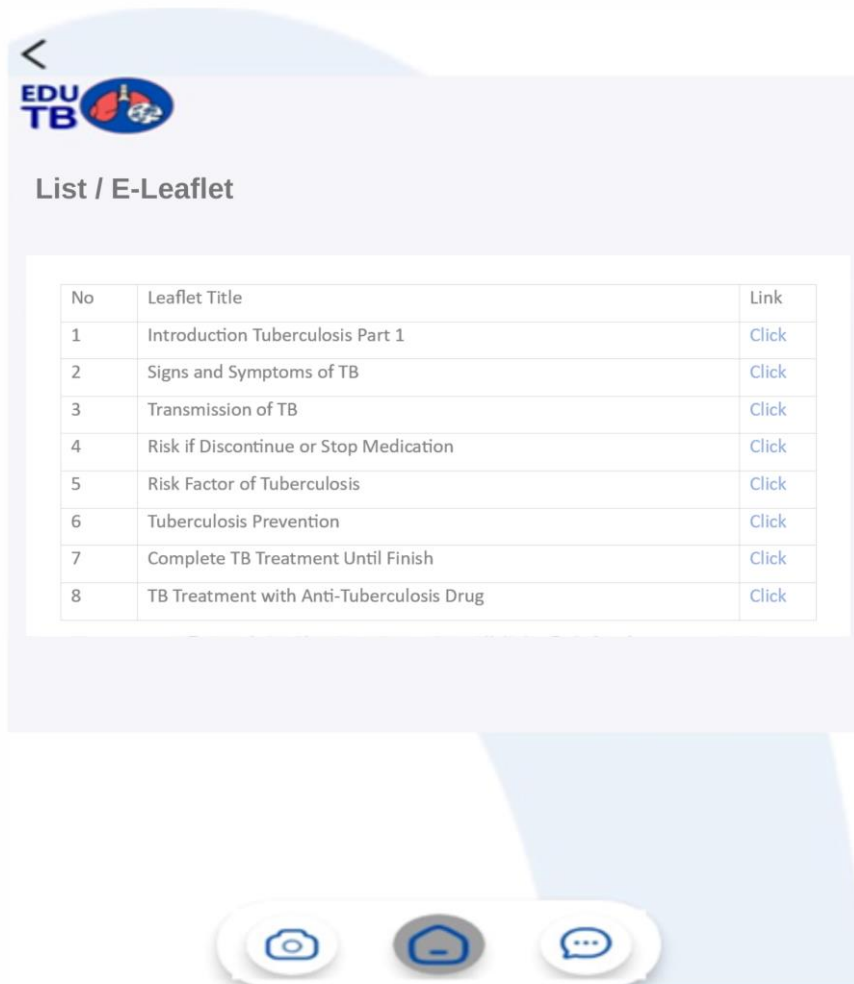


Figure 13. Education Leaflet Page Display

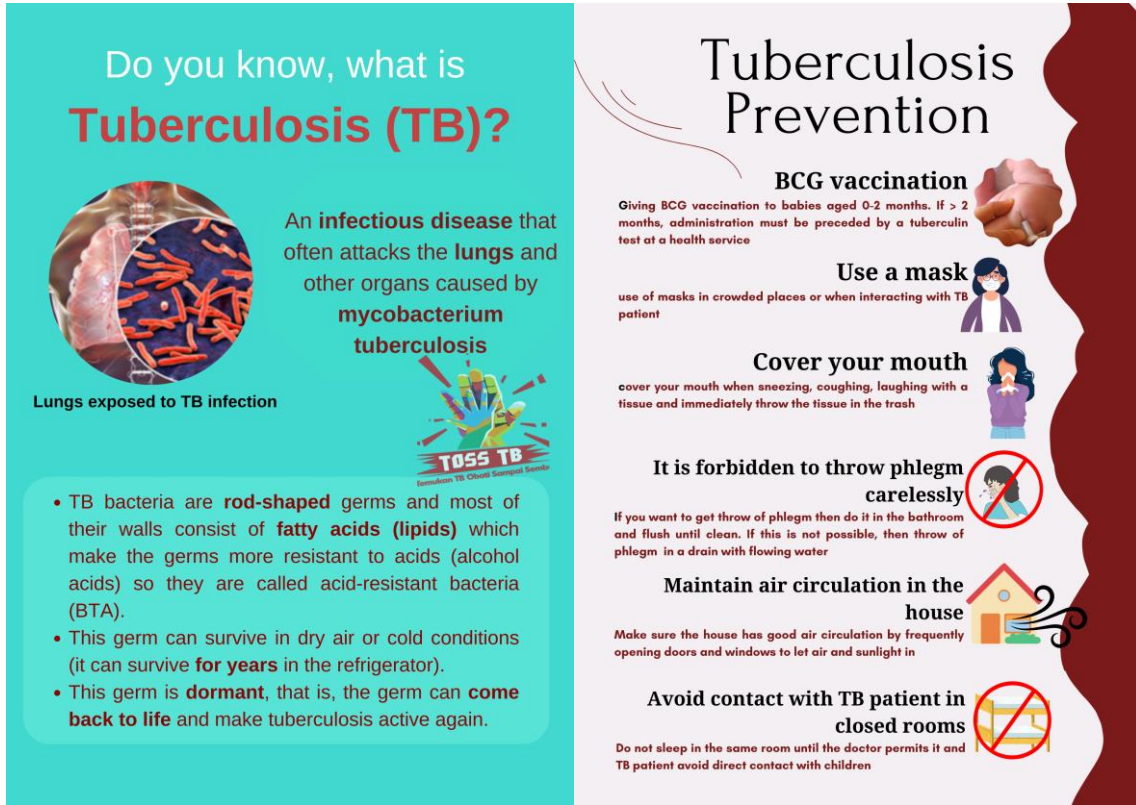


Figure 14. Education Leaflet Display

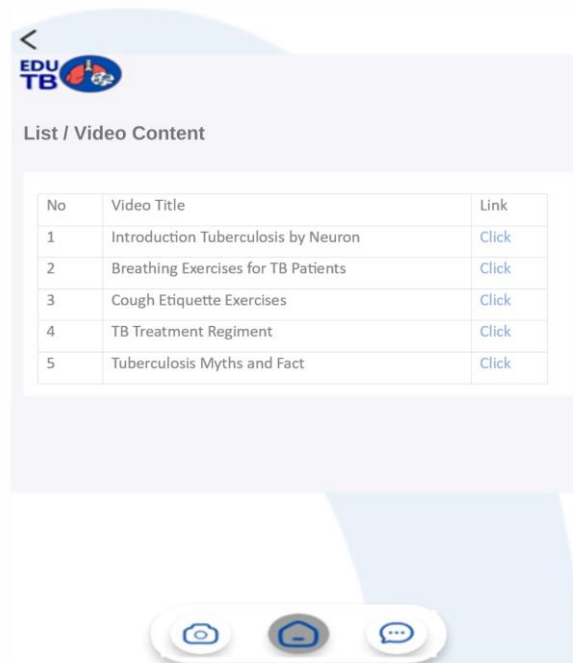


Figure 15. Education Video Page Display

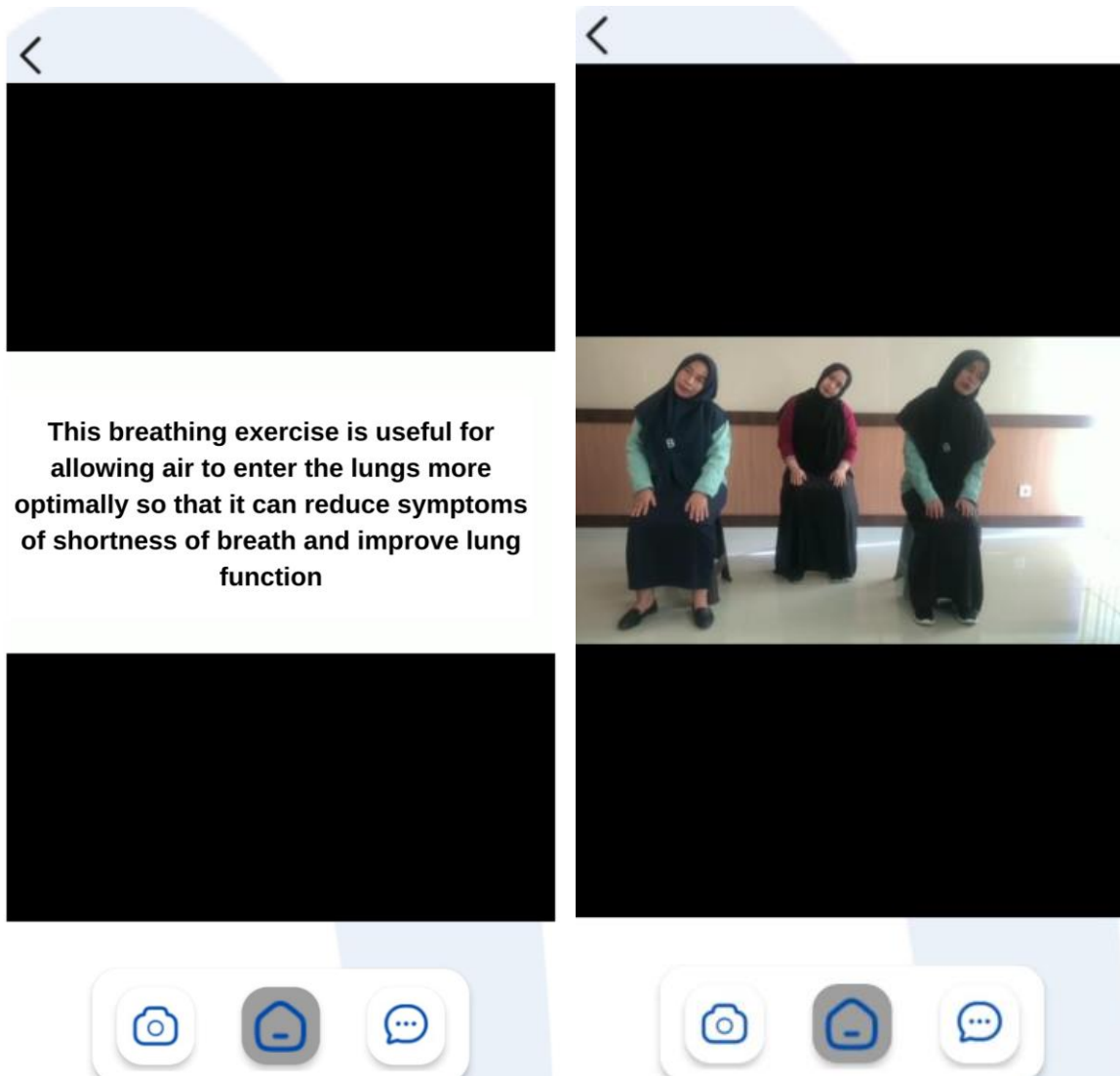


Figure 16. Education Video Display

The form is titled "Medication Monitoring Information" and features a "Change Photo" button. It contains the following input fields: Name, ID Number, Date of Birth, Gender, Address, Mobile Phone Number, and Work. At the bottom, there are three navigation icons: a camera, a home icon, and a chat bubble.

Figure 17. PMO Info Menu Display

The medication monitoring information menu contains various details regarding the patient's family members who are responsible for overseeing the patient's medication intake. To access this page, click the medication monitoring information menu, and data will appear in Figure 17.

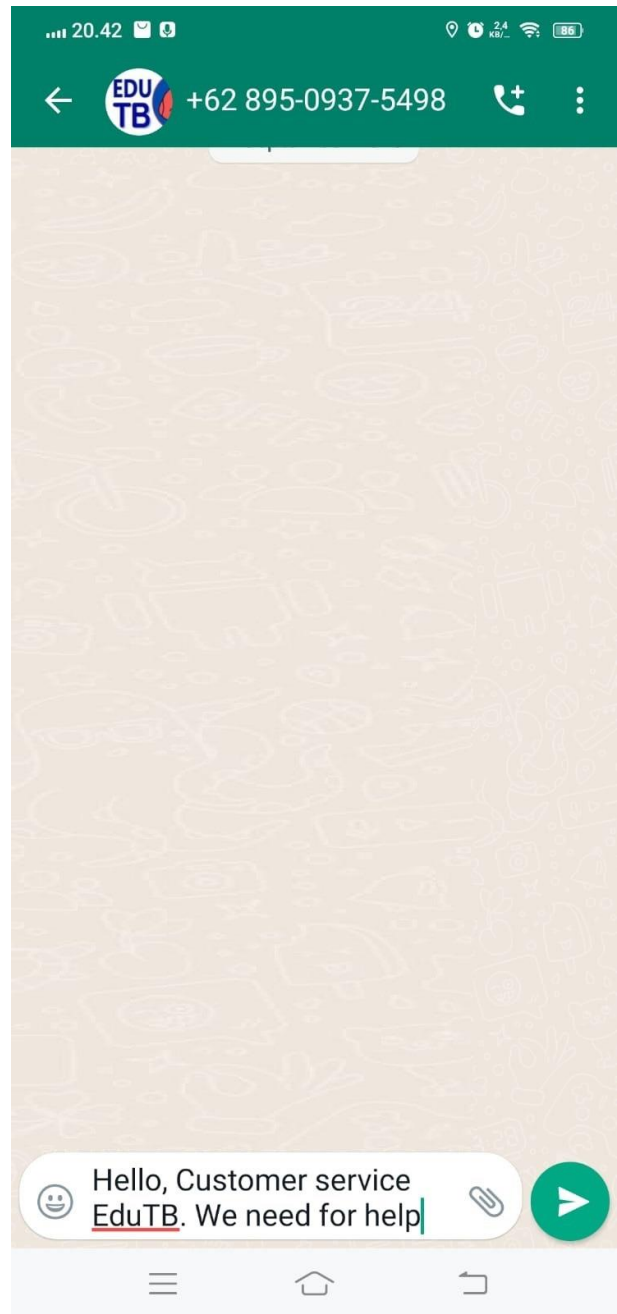


Figure 18. Article Menu Display

In the Whatsapp Chat menu, patients' Whatsapp will be connected to the health workers' Whatsapp. Consequently, the complaints of patients are communicated through chat, and the relevant health worker will provide answers, see Figure 18.

After developing the EduTB application, an expert validity test was conducted. This included experts from various sectors such as education evaluation, information technology, online health education, and public health. The elements assessed were content, presentation, language, and components of the application. The results obtained showed that EduTB on POL has an average score of $0.842 > 0.677$ (Table 1). This showed that the application is categorized as valid and suitable for use.

The next step is the practicality test for health educators and TB patients. Based on EduTB testing results with a small group, it was discovered that the average practicality

score for patients and educators was 80 and 88, respectively. Figure 19 shows that EduTB was practical and suitable for use.

Table 1. Results of Expert Validity Test on EduTB

No.	Assessed Element	Score	Category
1.	Application Content	0,80	Valid
2.	Presentation	0,83	Valid
3.	Language	0,88	Valid
4.	Components	0,86	Valid
	Average	0,842	Valid

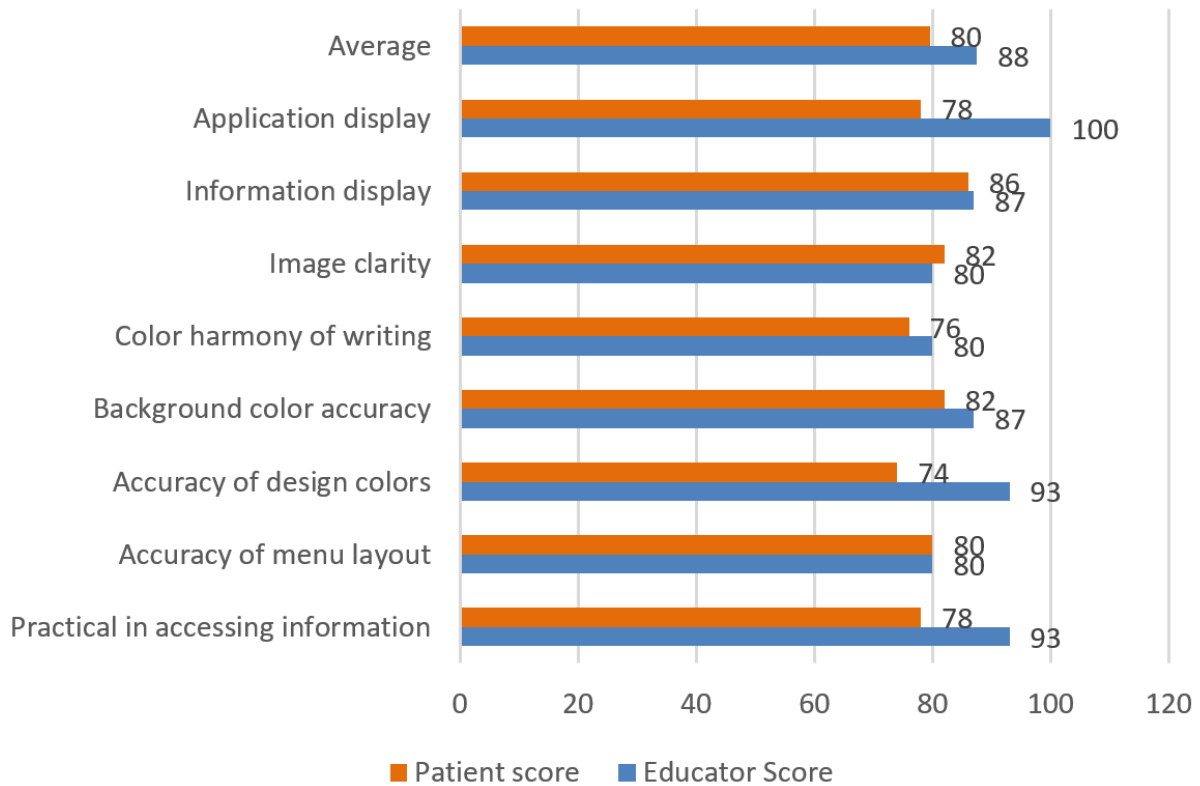


Figure 19. Practicality Analysis Results for Patient and Educator Small Group Assessment

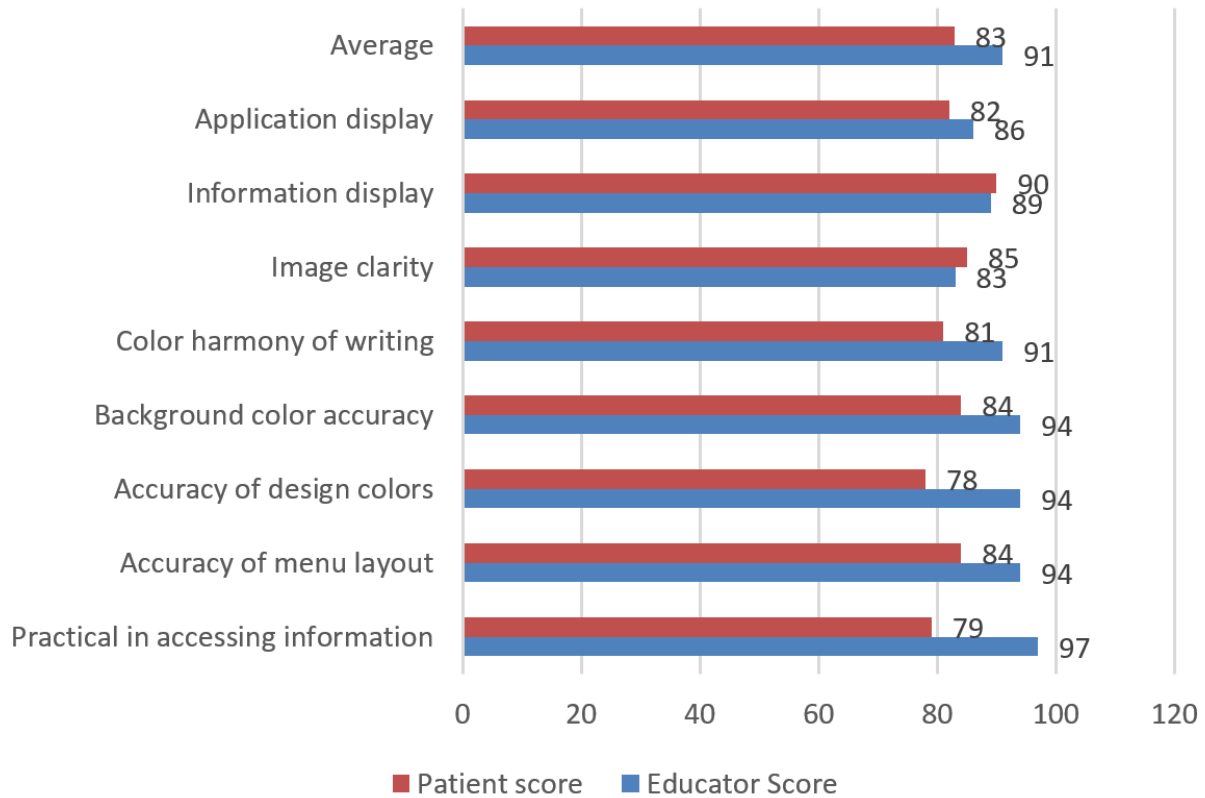


Figure 20. Practicality Analysis Results for Educator Large Group Assessment

A practicality test was conducted for health educators and TB patients in a large group. The average practicality score for patients and educators was 83 (practical) and 91 (very practical), respectively. This showed that the application was suitable for use and the results obtained are presented in Figure 20.

The results of the effectiveness EduTB application in the aspect of knowledge about TB in the experiment group and the control group can be seen and there is a difference in the average. The experimental group (n=20) achieved a knowledge score of 80.55, while the control group (n=20) scored 68.30. The maximum score in the experiment group was 93 and the minimum was 70, while the control group obtained a maximum score of 83 and a minimum of 50.

Next, the significant difference analysis, an independent sample t test was carried out. The prerequisite test was data normality test showing a Shapiro-Wilk (SW) test significance score of 0.119 for the experiment group data and 0.107 for the control group data. This data means that the data is assumed to be normally distributed. The results of the homogeneity test obtained Levene's Test results of 0.032 <0.05, which means the data is not homogeneous/variants are not the same. The results of the t test analysis show that the calculated t score (4.356) > t table (2.048) with (df=38) or P value (0.000) < α (0.05) which means that EduTB is effective in optimizing educational outcomes in the knowledge domain because there are differences educational results between the experimental group and the control group. Through the

surveillance of patients who discontinued the drug, it was shown that 4 out of 20 individuals (20%) in the control group and 1 out of 20 individuals (5%) in the experimental group were affected.

Table 2. Knowledge Data of Control and Experiment Group Respondents

		Control	Experiment
N	Valid	20	20
	Missing	0	0
Mean		68.30	80.55
Median		70.00	80.00
Mode		70a	80
Std. Deviation		10.687	6.629
Skewness		-.459	-.145
Std. Error of Skewness		.512	.512
Kurtosis		-.905	-.918
Std. Error of Kurtosis		.992	.992
Minimum		50	70
Maximum		83	90
Sum		1366	1611

a. Multiple modes exist. The smallest value is shown

The results showed that the application of EduTB in POL has been evaluated to address health professionals'

issues with handling online-based information and their inability to use online education resources to their full potential. As a result, health professionals still promote health on an individual basis, which requires more time and effort. In developing EduTB, TB, and information experts were included. Although collaborative approaches including local TB experts and patients during the design phase may take longer, the processes lead to interventions that are responsive to patient needs, culturally appropriate, and comprehensive [41]. Furthermore, health information is presented in the form of flyers and videos about TB, accessible to the public from any location. The availability of online health education videos from physicians managing tuberculosis can improve patients' understanding of the disease and alter their behavior in preventing tuberculosis. The video submission feature, allowing patients to show drug ingestion to healthcare workers can improve TB patient treatment adherence and serve as an evaluation tool for the success of education programs. Patients can learn more freely and without being restricted by time, place, or geography when searching for health information thanks to the EduTB application. In addition, the chat feature allows patients, TB survivors, and health professionals to connect and share information about treatment experiences, which encourages patients to adhere to their prescribed course of action. The need for application use in the digital era became the basis for developing POL, which has the principles of effective, efficient, user-friendly, and cost-minimizing education. Similarly, Arnold Sejie & Mahomed [42] stated that comprehensive health promotion programs using appropriate and accessible messages as well as meetings with patients should be used to emphasize the importance of early diagnosis and treatment adherence.

Health education originating from development based on real-world community aims to produce products serving as solutions to community health problems, particularly for TB patients. The information contained in EduTB includes bacteria, transmission methods, risk factors, ingestion methods, side effects, germ incubation processes, cough etiquette, the role of drug swallowing companions, diet for pulmonary TB, myths and facts about TB, and the treatment experiences of TB survivors. Furthermore, EduTB can assist healthcare workers in addressing issues related to the low understanding of the community regarding TB prevention and transmission, simultaneously preventing the spread of incorrect health information to the public. The research by Berg explained that online health education is more engaging, practical, sustainable, flexible, easily accessible, and cost-effective [37].

4. Conclusions

In conclusion, this research showed that EduTB was developed to facilitate healthcare workers in monitoring TB patients in taking medication under supervision from

the patient's family. Patients used EduTB as an activity to obtain health information and monitor treatment adherence. The validity testing in POL with an average of 0.84 showed valid results. The practicality testing in the development of the POL model showed 83% (practical) based on TB patient assessments and 91% (very practical) according to health educators.

Acknowledgments

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