

ORIGINAL ARTICLE

Development and Feasibility Testing of the Aku Rawat Application for Self-care Management in Diabetes Mellitus Patients

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ABSTRACT

Introduction: Self-care is a natural decision-making process to maintain health and control disease. Self-care management is carried out independently to overcome the inability to manage the disease independently, which can cause complications in people with Diabetes Mellitus. This study aims to develop the Aku Rawat application to improve self-care management in people with Diabetes Mellitus. **Method:** The study design used is a mixed-methods approach to assess the development and implementation of a structured educational application for Diabetes Mellitus patients at Gondang Tulungagung Community Health Center. Development of structured educational applications through material preparation, exploration, descriptive surveys, focus group discussions, expert consultations, due diligence, and training of application use. According to the inclusion and exclusion criteria determined and adjusted at each stage, the research sample amounted to eighty respondents. Data collection was carried out using questionnaires and evaluation sheets. Data analysis was carried out using descriptive statistics. **Result:** The reliability test showed a Cronbach's Alpha of 0.947, indicating that all question items are reliable. The SUS result was 72.25, which indicates Acceptance, Good in terms of adjective rating, and C in the grade scale. Feasibility testing and training session showed that the application was accepted and received a positive response from users. **Conclusion:** Structured educational applications can be used as a health education medium so that people with Diabetes can change their behavior towards good self-care management.

Malaysian Journal of Medicine and Health Sciences (2026) 22(2): 1-10.doi:10.47836/mjmhs.v22.i2.1527

Keywords: Diabetes mellitus, Digital Education, DSME, Health Education, Self-Care Management

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INTRODUCTION

Self-care management is an individual's effort to care for themselves independently in response to perceived signs and symptoms (e.g., taking additional medication to treat symptoms). (e.g., taking extra medication for symptoms). All these behaviors involve a naturalistic decision-making process that reflects automatic, impulsive, and contextual decisions that people make in typically ambiguous situations, where the options are often vague (1,2).). Self-care management involves individuals independently managing their care, which allows patients to develop problem-solving skills,

enhance self-confidence, and support the application of knowledge in daily life (3). Issues that arise during the care of Diabetes Mellitus patients are initially addressed by the patients and their families (4). The rate of Diabetes Mellitus complications tends to increase and worsen due to the patient's inability to manage their condition independently (5).

According to data from the International Diabetes Federation (IDF), the number of people with Diabetes Mellitus in 2019 was around 463 million people aged 20-79 years worldwide (6) and increased to 537 million people in 2021 (7). Meanwhile, the prevalence of Diabetes Mellitus in Indonesia increased by 8.8 million from 2019 to 2021 (6,7). In addition, data from the Gondang Health Center, Tulungagung Regency, stated that the number of people with Diabetes Mellitus in Gondang District over the past three years was recorded

as 432 sufferers in 2019 and 457 sufferers from 2020 to 2022. Thus, based on these data, there has been no significant decrease in cases over the past three years. Knowledge of self-care is essential for Diabetes Mellitus patients to manage their condition effectively, as they play a critical role in their care (8). Self-care involves behaviors that maintain lifestyle, health, and environment (9). Effective diabetes self-management relies on motivation and awareness to control symptoms and prevent complications (10). Key treatment pillars include education, dietary control, exercise, medication, and regular glucose monitoring. Education is vital for promoting healthy living and effective diabetes management (11). Structured health education, provided by healthcare professionals, helps patients and their families manage Diabetes safely and prevent complications (12,13).

Educational efforts aim to convey health information and ensure the public receives accurate details through various media such as printed materials, billboards, and electronic platforms (14). For patients with Diabetes Mellitus, the study on how technical innovations can enhance self-care, medical outcomes, and complication prevention is needed. Telenursing, which includes health education, a referral system, and a therapeutic relationship with clients through Communication methods like phone or the Internet, is crucial (15). Studies show this approach can improve the quality of life of Type 2 Diabetes Mellitus patients and that mobile health apps and smartphones support effective self-care and health behaviors (16). Home-based monitoring systems also increase nursing activity in primary care settings (17).

Development of a structured educational application for Diabetes Mellitus, designed to be freely accessible on smartphones with the Android operating system. The Structured Education Application is expected to assist patients in planning care and treatment, thereby improving self-care management for individuals with Diabetes Mellitus. So, this study aims to develop a self-care management strategy for Diabetes Mellitus patients through the "Aku Rawat" application.

MATERIALS AND METHODS

This study used a mixed-methods approach to assess developing and implementing a structured educational application for Diabetes Mellitus patients at Gondang Tulungagung Community Health Center. The application development process includes an exploratory descriptive survey, a structured education evaluation sheet questionnaire, the Aku Rawat application stage development consisting of focus group discussions and discussions with related experts, application feasibility testing using the System Usability Scale (SUS) questionnaire, and dissemination. This research is part

of Research and Development (R&D), a process or stage in developing or improving a new product, ensuring it is accountable (18). The study population consists of Diabetes Mellitus patients in the Gondang sub-district and healthcare professionals at Gondang Tulungagung Community Health Center. The sample for this study is obtained from the population using purposive sampling based on inclusion criteria specified by the researcher. The study excludes patients with Diabetes Mellitus with physical limitations, such as blindness, deafness, or muteness, patients with a background in health-related education, and those working in the health sector.

This study uses descriptive analysis, which is presented in percentage data. In this analysis, the distribution and presentation of each variable are produced, and the data is presented in the form of a frequency distribution table or percentage of categories from sub-variables, namely the material preparation process, feasibility test, practicality test, and effectiveness test. The study stages outline the steps taken in this study, consisting of four key steps:

1. Exploratory Descriptive Survey

The exploratory, descriptive survey is a step to evaluate self-management skills, blood glucose levels, and health education in Type 2 Diabetes Mellitus patients by providing questionnaires, blood glucose tests, and interviews with patients and assess the phenomena that exist at the Gondang Tulungagung Health Center so that the results provide initial data used by researchers to identify strategic issues.

The instrument used is a structured education evaluation sheet questionnaire, which is used to assess the implementation of interventions to improve self-management. The evaluation sheet consists of 27 questions using Indonesian nursing intervention standards and the Diabetes Self-Management Education (DSME) concept. The assessment gives 1 for a no answer and 2 for a yes answer. The evaluation shows the scores of all question items.

The Diabetes Self-Management Questionnaire, abbreviated as DSMQ, is used to observe and measure self-care behavior before and after being given an intervention. DSMQ consists of 16 questions and four domains: glucose management, diet control, physical activity, and healthcare (19). The rating scale consists of 4 choices, namely 3 points (very suitable for me), 2 points (quite ideal for me), 1 point (slightly suitable for me), and 0 points (not ideal for me). The level of self-care is divided into two groups, namely poor self-care level ≤ 6 and 6-10 good self-care level (20).

2. Development of the Aku Rawat Application

Focus group discussions (FGD) were conducted offline, involving 20 Diabetes Mellitus patients outside the sample of each research stage and exploratory and descriptive

participants.. The second session held during the day was also conducted offline and involved 20 participants, consisting of 1 head of the health center, eight nurses, two doctors, two nutritionists, four health cadres, and three midwives. The purpose of this FGD was to present the results of the evaluation of glucose management, diet, physical activity, health maintenance, and overall self-management at the Gondang Tulungagung Health Center and to provide additional information to researchers regarding strategic issues that can be used as input in application development. In addition to conducting FGDs, researchers consulted with experts on the development process, including one internal medicine specialist and one clinical nurse focusing on Diabetes.

3. Application Feasibility Testing

After its development, the researcher will conduct a feasibility test on the Android-based Aku Rawat application. This involves administering questionnaires to 20 Diabetes Mellitus patients and 20 healthcare professionals at Gondang Tulungagung Community Health Center, including nurses, nutritionists, general practitioners, public health professionals, and health promoters. The System Usability Scale (SUS) is a simple measurement tool consisting of 10 items that provide a subjective view of the usability of an object (21). Sharfina & Santoso (2016) developed the SUS questionnaire in Indonesia with a Cronbach's Alpha value of 0.841, indicating that this version is reliable (22).

The Evaluation menu displays a submenu for assessing the independence level of diabetes patients, building upon the Education Menu. The evaluation results are based on scores from the self-management questionnaire, with categories defined as follows: scores greater than 60% indicate independence or good management, while scores below 60% suggest poor management or a need for improvement. Consequently, users with a score of 95% are deemed to have a high level of independence. Additionally, the application features several other accessible menus, such as the Health Record Menu, which helps users input blood pressure and blood glucose data with graphical statistical displays. This functionality enables users to evaluate their health status independently at any time.

The testing began with preparing a trial version of the Aku Rawat application equipped with the main features. Next, a number of respondents who matched the application's target users, such as patients or care companions and health workers, were invited to try the application directly. They were asked to perform various tasks, such as creating an account, accessing health information, and filling out questionnaires available in the application.

After using the application, each respondent fills out the SUS questionnaire, and then the data from the

questionnaire is collected and analyzed. If the score is below it, it means there are still some aspects that need improvement. So, from the results of this test, the development team can find out which parts of the application need to be improved in terms of the interface, navigation, or clarity of instructions for users. User input is valuable because it is the basis for perfecting the application before being launched more widely. Through this stage, it is hoped that the Aku Rawat application will function technically and be truly friendly and comfortable for those who need it.

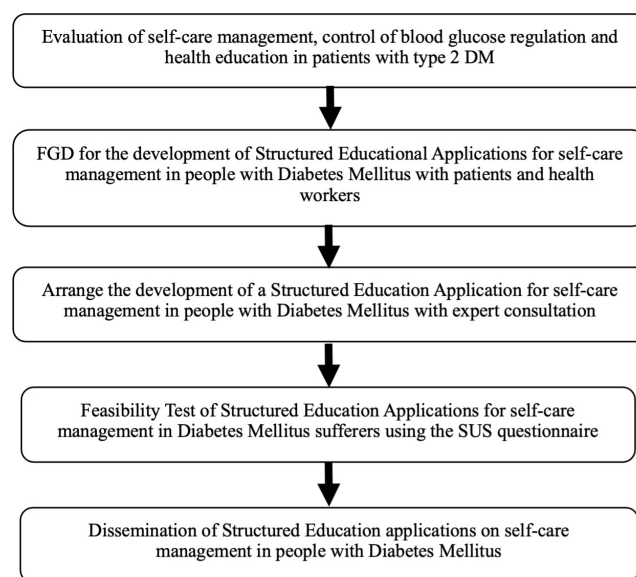


Figure 1: Operational Framework for Application Development Research.

4. Dissemination of Results

Conducting training sessions with healthcare providers and Diabetes Mellitus patients on how to use the Android-based Aku Rawat application, starting with the evaluation phase of self-care management for Diabetes and ending with the development and testing phase of the application at the next stage on a large scale or experiment.

5. Ethical Approval

This study obtained ethical approval from the Health Study Ethics Committee of the Faculty of Nursing, Universitas Airlangga (number 2584-KEPK). Therefore, it is deemed feasible, with specific considerations required during the pandemic, such as adhering to health protocols and ensuring the safety of researchers throughout the study.

RESULTS

Exploratory Descriptive Survey

The initial step taken by the researcher was to conduct a survey and identify strategic issues in the study area. Data collection techniques included open interviews, filling out questionnaires, and checking blood glucose.

Demographic data from 20 respondents in this study: the majority of respondents were aged 56-65 years (50%) and female (60%). In terms of education level, most had an elementary school education (75%), and almost all were married (80%) and lived with family (90%). Regarding employment, most respondents were civil servants (40%) and had suffered from Diabetes Mellitus ≤ 5 years (60%). At this stage, all respondents were assessed:

1. Evaluation of Health Education Intervention Implementation

Based on the survey results using the Structured Education Evaluation Sheet questionnaire, all respondents received health counseling through discussion methods (100%), without using health counseling media (100%), and implemented at the Rejosari Village Hall, Gondang Tulungagung (100%). The frequency of counseling was once a month (100%), according to the schedule, with the duration of counseling mostly less than 15 minutes (65%). Only 55% of the health counseling materials delivered were effective, and doctors conducted counseling (100%).

As for the results of in-depth interviews, most respondents stated that the health education they received was done verbally without media and was given individually at the Rejosari Village Hall, Gondang Tulungagung. The education was related to the complaints felt by the patient. If the patient had no complaints, they only took the prescribed medication and did not receive further health education because they were considered to have understood the information. Patients stated that they sometimes forgot to take their medication and could not check their glucose levels on time. They also admitted that they were still confused about regulating their diet, physical activity, and how to monitor fasting blood glucose.

Table 1: Indicators of Self-Care Management in Diabetes Mellitus Patients at Gondang Tulungagung Community Health Center.

Self-Care Management Indicators	Responden (n)	Percent (%)
Blood glucose management :		
Good	6	30
Bad	14	70
Total	20	100
Diet or eating pattern settings:		
Good	2	10
Bad	18	90
Total	20	100
Physical activity:		
Good	8	40
Bad	12	60
Total	20	100
Health care used:		
Good	8	40
Bad	12	60
Total	20	100

2. Evaluation of Self-Care Management

Self-care management in diabetes mellitus patients can be evaluated through four aspects: blood glucose management, diet, physical activity, and overall self-management using DSMQ. According to Table 1, most respondents showed poor self-care management in blood glucose management (70%) and diet habits (90%). Physical activity indicators also showed poor results (60%). Health service indicators also showed less-than-optimal results (60%).

Development of a Structured Educational Application for Diabetes Patients

1. Focus Group Discussion (FGD)

After conducting the Focus Group Discussion (FGD), several recommendations were produced for the Development of the Structured Education Application for Self-Care Management of Diabetes Mellitus Patients at the Gondang Tulungagung Health Center, namely: 1) Educational materials should use simple and easy-to-understand language, 2) Health education information needs to be provided to improve patient soft skills related to self-management and blood glucose control, 3) A tool needs to be created to monitor blood glucose levels, 4) Health education needs to be provided in the form of a monitoring sheet to assess patient abilities/knowledge, 5) The method for developing the Structured Education Application for Self-Care Management of Diabetes Mellitus Patients is considered appropriate for the current needs of the hospital, namely to improve the ability of self-management and blood glucose control of patients.

2. Expert Consultation

In the next stage, researchers developed an Android-based application through expert consultation. This consultation aimed to obtain input based on literature reviews, field studies, and FGDs, which were then applied in developing a structured educational application on self-care management for Diabetes Mellitus patients. Through face-to-face meetings, the expert consultation involved two specialists: an internal medicine specialist and a nursing education expert with a doctorate in medical-surgical nursing. The results of the specialist consultation include: 1) Application development must comply with ethical principles and ensure the security of patient data, 2) The name of the application must be more general and easily understood by the wider community, 4) The program must be flexible, allowing data updates as needed and in line with advances in science, 5) The user guide module must be written in easy-to-understand language, systematic, follow established writing standards, and include relevant references, 6) The Structured Education Application (Aku Rawat) for Android not only provides health education and improves self-management skills and blood glucose control but also offers evaluation features. Healthcare professionals can use the evaluation to assess patient understanding and facilitate program design according to the patient's level of knowledge.

3. Application Development

Application development is carried out and adjusted to several core elements from the previous stage, namely adjusting needs based on the Exploratory Descriptive Survey, Focus Group Discussion (FGD) results, and recommendations from Expert Consultation. The application is designed to be compatible with smartphones running Android version 5 Lollipop and

later.

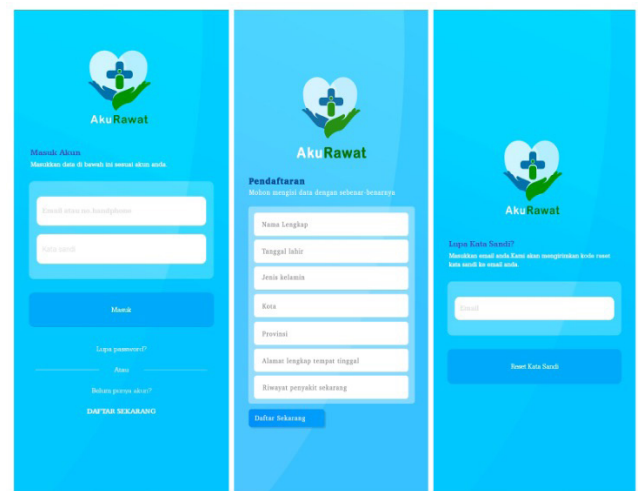


Figure 2: Structured Education Application Main Menu (Registration and Education)

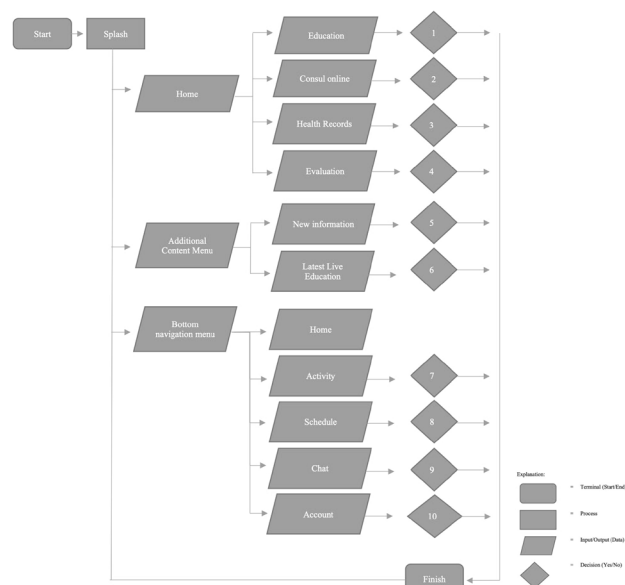


Figure 3: Application Design Flowchart

The advancement of electronic media in health through Android devices can facilitate more effective information delivery for managing Diabetes Mellitus. The structured educational application on self-care management is designed as a health education tool, blood glucose control media, and a resource for improving self-management skills for Diabetes Mellitus patients and their families. The structured educational application provides patients with health information, blood glucose monitoring, a virtual assistant, and evaluation sheets. The blood glucose monitoring feature automatically interprets the glucose values that patients or their families enter. Additionally, the application features a virtual assistant that patients can use to answer basic Diabetes Mellitus-related questions automatically. The main menus in the application include Education, Online Consultation, Health Records, Evaluation, Bottom Menu, Latest

Information, and Latest Live Education.

Patients or family members must first register to use the application. This process involves entering a 12-digit active mobile phone number and a registered email address to set a password. Users can log in once the account information is verified by clicking the login button at the bottom of the menu. If a password is forgotten, the "Forgot Password" menu allows users to reset it by verifying the email address used during initial registration. New users should use the "Register" menu to enter necessary patient data, including full name, email, mobile phone number, date of birth, gender, city, province, full residential address, and password. Users must re-enter their password for confirmation, and the "Register Now" button completes the registration and directs them to the home/start application menu.

The home menu features several functions: the Education Menu provides structured educational content as the core component of the application; the Online Consultation Menu facilitates interactive Communication via chat or third-party platforms like Zoom or Google Meet; the Health Records Menu allows users to record their health data digitally; the Evaluation Menu assesses self-care management and follows the Education Menu; the Bottom Menu includes sections for Activity Menu, Schedule, Chat/Message, and Account; and the Latest Information Menu offers current health-related news. In the Education Menu, the application focuses on Diabetes Mellitus with submenus for various topics. Icons like the + and closed padlock icons indicate accessible and restricted content. The I Understand button enables progression to evaluations. The Online Consultation Menu supports two-way Communication with healthcare providers, while the Evaluation Menu assesses self-care management based on questionnaire scores. The Health Records Menu also helps users track blood pressure and glucose levels, offering graphical statistics for independent and timely health status evaluation.

Application Feasibility Testing

The Indonesian version of the System Usability Scale (SUS) has been developed with a Cronbach's Alpha value of 0.841, indicating that this version is reliable (22). The validity of the questionnaire was tested by comparing the calculated *r* values (0.528-0.916) with the study table *r* value of 0.3961 (significance level 0.05). All question items were deemed valid as the calculated *r* values exceeded the table *r* value. Reliability was measured using Cronbach's Alpha, with the scale's internal consistency being acceptable if the alpha value was 0.6 or more (23). The reliability test results showed a Cronbach's Alpha of 0.947, indicating that all question items were reliable.

Table II: Evaluation Results of Application Usage by Users

Quality Components	Category	Measurement Value
<i>Acceptability range</i>	<i>Not Acceptable</i> (0-50)	
	<i>Marginal</i> (50-70)	<i>Acceptable</i> (72,19)
	<i>Acceptable</i> (70-100)	
<i>Grade Scale</i>	A (skor 90-100)	
	B (skor 80-90)	
	C (skor 70-80)	C (72,19)
	D (skor 60-70)	
	F (skor < 60)	
<i>Adjectives Rating</i>	<i>Wort imaginable</i> (0-25)	
	<i>Poor</i> (25-40)	
	OK (40-50)	
	<i>Good</i> (50-75)	Good (72,19)
	<i>Excellent</i> (75-85)	
<i>Percentiles</i>	<i>Best Imaginable</i> (85-100)	
	Good (> 68)	Good (72,19)
	Bad (<68)	

Based on the System Usability Scale (SUS) assessment results, each value from the odd questions is reduced by one, and the value of the even questions reduces the score by five. Then, the total score is multiplied by 2.5 and averaged across all respondents to produce a value of 72.25. This score is converted into Acceptability, Adjective, and Grade scales using the above SUS score interpretation scale. So, the usability test results on the Aku Rawat application using the SUS method are marginal in terms of acceptability, GOOD in terms of adjective rating, and C in the Grade scale. So, the application is considered adequate, efficient, and usable for users with Diabetes.

Dissemination of Application

The Dissemination of the Educational Application, or "Aku Rawat," was conducted on a small scale with 20 diabetes mellitus patients and 14 healthcare providers at Puskesmas Gendang. These patient respondents were separate from those participating in the application feasibility testing. The demographic data from this stage revealed that most diabetes mellitus patients were female (80%), aged 36-45 years (40%), and 46-55 years (40%). In terms of education, most had attended elementary school (65%). Regarding marital status, 85% were married, 30% were self-employed, 90% lived with their families, and 75% had been suffering from diabetes mellitus for less than 5 years. The healthcare provider respondents were the same as in previous data.

Training activities were conducted periodically and face-to-face with each respondent, lasting about 15-20 minutes per session. Participants included patients, family members, and healthcare providers willing to continue with the study phase and who met the

established inclusion criteria. The training covered the application's menus and usage instructions, focusing on its role in health education, blood glucose monitoring, and enhancing self-management skills for diabetes mellitus patients and their families. The Structured Educational Application provides health information, automatic blood glucose monitoring interpretations, and a virtual assistant for answering basic diabetes-related questions. The main menus of the application include Education, Online Consultation, Health Records, Evaluation, Bottom Menu, Latest Information, and Live Education. The explanation included installation, registration, application features, and data storage to ensure that respondents understand and can effectively operate the application.

DISCUSSION

This study aimed to develop an Android-based educational application to support the self-management of Diabetes Mellitus (DM) patients. Based on the initial survey results, most respondents were female, aged 56-65 years, and had a low level of education. Most of them have also had Diabetes for less than five years. Although they received health education, the results showed ineffective methods in improving patient understanding of diabetes management. Therefore, reliable and valid steps are needed to manage self-care in diabetes mellitus patients (24). The success of Diabetes self-management depends on the motivation for care and self-awareness, specifically designed to control symptoms and prevent complications (9), so patient education is critical to increase public awareness of diabetes mellitus (25). This is carried out through a systematic, structured health education program supported by unique methods needed by diabetes mellitus patients (26).

Several previous studies have shown that mHealth technology can improve self-management for DM patients by providing better monitoring, medication reminders, and education about the disease and healthy lifestyles. Similar to the use of social media as a tool for impactful education (27), some researchers have also used short message service (SMS) to provide education on Diabetes self-management and lifestyle behaviors. Text messages offer suggestions, motivation, support, and reminders, resulting in significant improvements in foot care practices (28), changes in body mass index (BMI) and hemoglobin A1c (HbA1c) (29), as well as the willingness to accept mobile-based diabetes healthcare services (30,31). Some studies have also used applications to provide interventions; however, some challenges, such as the delivery method and the interface's ease, still need refinement. Therefore, the "Aku Rawat" application adopts and refines by simplifying the user interface and providing more structured or systematic education designed and tailored to meet the needs of diabetes patients as users.

Several mHealth interventions conducted in countries such as Malaysia, Singapore, and Thailand, for example, also use an app-based education approach or mHealth to improve patient knowledge and adherence to treatment (32–35). In general, findings from these studies indicate that mobile-based technology can increase patient awareness of the importance of self-management, as also found in this study. Another similarity is the importance of simple design and culturally relevant content to be well received by users. However, the "Aku Rawat" application has several unique features compared to previous interventions. One is its structured and integrated educational approach, with interactive features that provide information and encourage active user engagement through reminders, two-way interactions, and daily feedback. Several other mHealth interventions tend to be one-way or limited to providing information only, while "Aku Rawat" is designed to form a daily routine and accompany the process of sustainable behavior change. In the future, conducting further direct comparison studies with similar interventions in Southeast Asia would be very useful in strengthening generalizability and evidence-based policy development.

Structured educational applications in enhancing self-management are vital to health management and personal development. First, such applications can help individuals, particularly patients with chronic conditions like diabetes mellitus, monitor and manage their health more effectively. With the available features, this application makes it easier for patients to follow medical recommendations and monitor changes in their condition, ultimately improving adherence to treatment and reducing the risk of long-term complications. Additionally, structured educational applications also serve as tools to enhance patient health literacy by providing easily accessible information tailored to individual needs, which aids in better decision-making related to self-care.

Another important implication is the potential of educational applications to support more sustainable behavior change. Through consistent interaction and feedback provided by the application, users may feel more engaged and motivated to maintain new habits, improving self-regulation and enhancing overall quality of life. Therefore, structured educational applications have benefits in improving health management and can also contribute to enhancing individual well-being. However, several challenges arise, especially from elderly users who find it difficult to operate the technology. There are also technical constraints, such as the need for a stable internet connection and limitations on low-spec phones. In addition, some users need an initial explanation or a short guide to understand how to use the application optimally.

CONCLUSION

We developed a structured educational application that uses a technology-based approach to improve self-care management in patients with diabetes mellitus. Data were collected through exploratory descriptive surveys, focus group discussions (FGD), and expert consultations. The survey results showed that most respondents did not have optimal self-management, especially regarding blood sugar level control, eating habits, and physical activity. The developed application includes essential features, such as structured health education, blood sugar level monitoring, and self-care management evaluation, which aim to improve patient self-care skills. The feasibility test of the application using the System Usability Scale (SUS) showed that this application is feasible to use, efficient, and effective in supporting diabetes patients. In addition, this application facilitates Communication between patients and health workers and provides an assessment to measure patient understanding. Dissemination of the application on a small scale shows great potential in helping diabetes patients manage their condition independently with the support of family and health workers. Thus, this application has the potential to be an effective tool in improving the quality of life of Diabetes mellitus patients through better self-care management.

This study contributes to developing contextualized, needs-based mHealth interventions to support self-management in people with Diabetes Mellitus. The findings of this study strengthen the evidence that participatory digital support can improve health literacy, medication adherence, and decision-making in chronic care. From a practical perspective, this application offers a cost-effective and sustainable intervention alternative for health systems, especially in developing countries facing limited workforce and access to health services. Clinically, the implementation of similar applications can play a role in reducing long-term complications and improving health outcomes through a more proactive approach to self-management.

Thus, this study not only adds new knowledge to digital health practice but also opens up opportunities for replication and further development in other populations and chronic diseases. Long-term evaluation and integration into primary health care systems are critical next steps.

ACKNOWLEDGEMENT

We sincerely thank the expert consultants in this study: Dr. Yohana Sahara, a specialist in internal medicine, and Dr. Ika Yuni Widyawati, an expert in nursing. We also appreciate the support of the heads of community health centers and the village midwives who contributed to this study.

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