Transforming Diabetes Management: A Study on the Effectiveness of Smartphone Applications in Enhancing Knowledge, Attitudes, and Behavior of People with Diabetes Mellitus

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Abstract

BACKGROUND: Smartphone-based applications are important for increasing knowledge, attitudes, and behavior in people with diabetes mellitus (DM).

AIM: This study was measuring the effectiveness of the smartphone-based Electronic-Muhammadiyah Chronic Disease Monitoring (E-MMCD) application to change knowledge, attitudes, and behavior in people with DM.

METHODS: This study used quantitative methods with an explanatory design. This study begins with a preliminary study using secondary data from international journals from 2020 to 2023. The sample size in the quantitative study was 84 people with DM. The sampling technique uses the randomized control trial with a computer machine. The instrument used to determine differences in knowledge, attitudes, and behavior after the intervention is a valid and reliable questionnaire. Paired t-test was used to determine the difference before and after the intervention.

RESULTS: The results of the normality test for the intervention group concluded that the distribution of knowledge data (p > 0.05) and the distribution of attitude data (p = 0.000) were not normal (p < 0.05) so the statistical test used was the Wilcoxon test. While the practice in the intervention group after the normality test was carried out, the data distribution was normal (p > 0.05), so the test used was the paired t-test. The results of the analysis test concluded that p = 0.019. This value indicates a difference in the average PSP before and after the E-MMCD intervention.

CONCLUSION: The E-MMCD application effectively changes the knowledge and attitudes of people with DM in hospitals. A longer E-MMCD intervention is needed to improve the behavior of people with DM.

Introduction

Diabetes mellitus (DM) is a non-communicable disease whose number continues to increase [1]. This disease causes high morbidity that causes a decrease in quality of life, especially in low- and middle-income countries [2]. Low knowledge about healthy living practice causes a higher risk of DM. The causes of DM are unhealthy eating patterns, lack of physical activity, tobacco use, and alcohol consumption [3].

In Indonesia, it was reported that in 2018, the prevalence of DM increased by 2% from 2013 [4]. The International Diabetic Federation (IDF) reported in 2021 Indonesia is ranked fifth with the highest number of DM, which is around 19.5 million [5], [6]. The high prevalence of DM in Indonesia is accompanied by various problems related to efforts to overcome it [7]. Diet patterns an important role in controlling blood glucose and preventing obesity. Regular consumption of drugs can also help patients control blood glucose [8].

Collaboration of health workers, patients, and families is very important to increase the success of DM treatment. Education for patients and families is needed to understand the importance of healthy living practice to prevent complications [9]. Awareness about the prevention and control of DM disease is needed [10]. Health education is an important part of the DM management program. Knowledge, attitudes, and behavior are important factors in evaluating the results of health education in people with DM [11].

Education to patients and families about the prevention and control of DM to prevent complications needs to be done [12]. Lack of motivation is the main cause of low public awareness in preventing DM. This condition is the reason for not doing physical activity and controlling your diet regularly. High motivation is needed to implement healthy living practices. Patients will feel motivated after receiving education and sharing experiences to adopt a healthy lifestyle[13].

In the era of digital technology, innovations in Information Technology-based monitoring of people with DM have been developed to increase knowledge, attitudes, and practices for healthy living. The use of smartphone-based applications (mHealth) plays a role in the prevention and control of blood glucose [13]. The
Previous research explained that providing education through video increases the knowledge of people with DM [14]. Education through short message service (SMS) can increase the knowledge of people with DM. The long-term benefit of this education is that it can improve hemoglobin A1C (HbA1c), low-density lipoprotein, cholesterol, blood urea nitrogen, and microalbumin levels in people with DM [15].

Each patient can carry out daily monitoring and treatment independently. The results of previous research explained that the Electronic-Muhammadiyah Chronic Disease Monitoring (E-MMCD) application can be used as a tool for monitoring healthy living behavior. This application is designed according to the needs and wishes of the patient. Patients can install and download the Google app for free. Patients who fill out survey data related to their health status will get an overview of their health condition. The patient will receive an initial assessment whether the condition in question is not at risk, is at moderate risk, or is at high risk. People with DM need to get recommendations to maintain or improve healthy living practices. The purpose of this study was to measure the effectiveness of the E-MMCD application in changing the knowledge, attitudes, and behavior of people with DM in hospitals.

Methods

The research method used is quantitative methods with an explanatory sequential design. This design was carried out through six stages and the target population of this study was people with DM (Figure 1).

Figure 1: Study Stages

This study begins with a preliminary study using secondary data from international journals from 2020 to 2023. The next stage, researchers conducted observations to identify the problem of people with DM in the hospital. The researcher tested the validity and reliability of the instruments to be used. The questionnaire was prepared based on recommendations from endocrinologist and previous studies. Based on the result of the validity and reliability test, all questions in the questionnaire were declared valid (p < 0.05) and reliable (p > 0.6). The next stage is data collection. Data collection was carried out using a questionnaire about healthy living behavior. Questionnaires were distributed to all samples in the control and intervention groups using the Google Form. This study involved people with DM without complications who routinely went to Aisyiyah Hospital. All samples stated that they agreed and were aware of participating in the research until it was completed.

The technique of determining the sample size was carried out by random control sampling (RCT). The RCT procedure is performed by randomizing numbers from 1 to 38. Every DM patient who is outpatient at the hospital before being examined by a doctor takes a lottery that has been randomized using a computer machine. The inclusion criteria for this study were as follows: (1) People with DM aged 18–60 years, (2) did not experience complications both microvascular and macrovascular, (3) had an Android-based smartphone that could be connected to the internet network, (4) accustomed to using smartphones independently, and (5) willing to be the subject of research until completion.

Pre-test was done in both groups before the intervention. The intervention group was given the E-MMCD application and face-to-face education, while the control group was given face-to-face education by doctors. The E-MMCD application intervention was carried out for 1 month. The sample sizes in the intervention group and the control group were 42 people with DM. During the intervention, there were two samples in the intervention group and two samples in the control group who dropped out. The next step is data processing. The data processed using Statistical Product and Service Solution application with normality test performed. If the data are normally distributed, data analysis is performed using paired t-test statistical test. The paired t-test statistical test was used to determine their difference in the mean of each group after receiving treatment. However, if the data are not normally distributed, an analysis is performed using a non-parametric test.

Results

This study was conducted at Aisyiyah Hospital, Kudus Regency, Central Java, Indonesia. More than 30% of the total outpatients per day are dominated by people with DM.

Based on respondents’ characteristics shown in Table 1, most of the intervention group was women (60.5%) with a junior high school education level (60%). In control group, the majority of people with DM were male (57.9%) with a high school education level (44.7%). The researcher determined the age limit
of the respondents, between 18 and 60 years old. The consideration for choosing this age is that, globally, the prevalence of DM in 2021 will occur in the age group 20–79 years as many as 536.6 million cases [6]. This estimate will increase to 783.2 million in 2045. Based on the gender of the study subjects, 51.3% (39 people) were female, and 48.6% (37 people) were male.

Based on the level of education, there are differences in the level of knowledge in the two groups. In control group, most of the respondents (50%) had a low level of education, 39.5% had a secondary education level, and 10.5% had higher education. While in the intervention group, most of the respondents had a high level of education (44.7%), 31.6% had low education, and 23.7% had secondary education.

Formal education is a structured and tiered education path consisting of basic education (elementary to junior high school), secondary education, and higher education (diploma and bachelor’s degree) [16]. Differences in one’s educational level can affect one’s level of knowledge. The higher the level of education, the easier it is to receive and develop knowledge and technology. A good education will produce positive practice. This affects the attitude of openness and objectivity in receiving information, especially information about the management of DM.

The results of the normality test for knowledge, attitudes, and behavior of the control group showed that the data distribution was not normal based on the Shapiro–Wilk test (p < 0.05). The intervention group for the knowledge and attitude normality test showed abnormal data distribution based on the Shapiro–Wilk test (p < 0.05), while the behavior normality test showed normal data distribution (p > 0.05) (Table 2). Statistical tests for abnormal data distribution use the Wilcoxon test, while normal data distribution uses the paired t-test.

Based on Table 3, the results of the post-test analysis in the control group showed that 16 patients had less knowledge, 18 patients had increased knowledge, and four patients had no change in knowledge. In the attitude variable, 18 people had a less attitude, 19 people had an increased attitude, and one patient did not experience a change in attitude. In the practice variable, 12 patients had less good behavior than before. Nineteen people experienced an increase in good practice and seven patients did not experience a behavior change. The results of the Wilcoxon test for each variable obtained p = 0.296 for knowledge, 0.756 for attitudes, and 0.099 for practice (p > 0.05), meaning that there were no significant differences in the knowledge, attitudes, and behavior of the control group before and after the intervention in the form of monitoring carried out by hospital.

Based on Table 4, the results of the post-test analysis in the intervention group showed that six patients had less knowledge, 27 patients had increased knowledge, and five patients had no change in knowledge. The results of the Wilcoxon test obtained p = 0.000 (p < 0.05), meaning that there was a significant difference in knowledge before and after being given the intervention through the E-MMCD application. These results also show a comparison of the attitudes of the intervention group before and after being given the intervention through the E-MMCD application. As many as one person had a less good attitude than before the intervention, 35 people had a better attitude before the intervention, and two people had a fixed attitude after the intervention. The Wilcoxon test results obtained a p = 0.000 (p < 0.05). This means that there is a significant difference in attitude before and after being given an intervention through the E-MMCD application.

In the behavioral variable, after being given the intervention, an average of 36.03 was found to experience an increase in behavior, meaning that there was a change in the practice of people with DM who received education through the E-MMCD application. The results of the paired sample t-test showed a significant difference in mean practice before and after education through the E-MMCD application, namely, p = 0.019 (p <0.05) (Table 5).

Based on Table 6, there were significant differences in knowledge and attitudes between the control group and the intervention group using the E-MMCD (p <0.05). In the behavior aspect, there was no significant difference between the control and intervention groups (p > 0.05). In this study, it can be seen that the level of education in the control group on the variables of knowledge, attitudes, and behavior has a p > 0.05. This
Table 3: Analysis of control group data with Wilcoxon

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>n</th>
<th>Mean rank</th>
<th>Sum of ranks</th>
<th>Asymptotic significant (two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative rank</td>
<td>16</td>
<td>14.74</td>
<td>236.50</td>
<td>0.295</td>
</tr>
<tr>
<td>Positive rank</td>
<td>18</td>
<td>19.92</td>
<td>358.50</td>
<td>0.129</td>
</tr>
<tr>
<td>Ties</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attitude</th>
<th>n</th>
<th>Mean rank</th>
<th>Sum of ranks</th>
<th>Asymptotic significant (two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative rank</td>
<td>18</td>
<td>18.39</td>
<td>331.00</td>
<td>0.756</td>
</tr>
<tr>
<td>Positive rank</td>
<td>19</td>
<td>19.58</td>
<td>372.00</td>
<td>0.592</td>
</tr>
<tr>
<td>Ties</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavior</th>
<th>n</th>
<th>Mean rank</th>
<th>Sum of ranks</th>
<th>Asymptotic significant (two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative rank</td>
<td>12</td>
<td>13.67</td>
<td>164.00</td>
<td>0.099</td>
</tr>
<tr>
<td>Positive rank</td>
<td>19</td>
<td>17.47</td>
<td>332.00</td>
<td>0.019</td>
</tr>
<tr>
<td>Ties</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td></td>
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</table>

Statistical tests in both groups were carried out directly to see differences in post-test scores in the intervention group and the control group using the Mann–Whitney test. The results obtained indicated that there were significant differences in knowledge and attitudes between the intervention group and the control group. This is indicated by the value of knowledge and attitude variables p < 0.05. In the behavioral variable, there was no significant difference between the intervention group that used the E-MMCD application and the control group that did not use the E-MMCD application (p > 0.05).

Discussion

The theory of the health belief model explains that to change behavior, patients must feel threatened by complications due to DM and believe in the benefits of taking action. Monitoring physical activity, controlling eating patterns, taking the medication regularly, seeing a doctor, and managing stress are interventions that are urgently needed to control glucose and HbA1c levels in people with DM. Methods that can be used to carry out these interventions can be done face-to-face, remote discussion, or a combination and can be done in groups or individually [17]. The results of study conducted on student explained that low knowledge, attitudes, and behavior about DM. This condition occurs because the education system that has been implemented does not focus on health literacy [18]. Health literacy is a person’s access to obtain and understanding information about various basic health services to make decisions [19]. The role of health literacy is very important to improve health. This literacy can be trained through the skills in reading, listening, analyzing, making decisions, and the ability to apply them to specific health situations [20].

The World Health Organization reported that health literacy is one of the determining factors for one’s health [21]. Implementation of people with DM monitoring through E-MMCD-based healthy lifestyle education is urgently needed. The results of this study help people with DM in monitoring their health conditions. People with DM need to increase knowledge, attitudes, and healthy behavior to reduce the risk of complications due to DM [22]. This study concluded that there were no significant differences in behavior of people with DM without E-MMCD intervention. This condition was caused by the limited intervention time for the E-MMCD application, which was only 1 month. It takes at least 3 months to change healthy behavior in people with DM. The doctor’s limited time and the patient’s fear of asking a doctor are the main problems. No social support also causes low healthy living behavior in people with DM.

Knowledge is obtained after sensing certain objects. Most people knowledge is obtained through the senses of sight and hearing [23]. The educational obstacle when consulting at a doctor’s practice is the limited time for the consultation. There is no educational media that meets the needs of patients to gain knowledge about health which is also a problem for most people with DM. This situation will certainly worsen the health condition of people with DM in the future. The results of this study are in line with previous study that the level of knowledge and attitudes was low in DM sufferers before intervention using audio-visual media [24].
The results of this study also concluded that there were differences in the average knowledge, attitude, and practice of respondents before and after being given an intervention using the E-MMCD application. Education for DM patients through the E-MMCD application indirectly trains patients to regulate their physical activity, eating patterns, examinations, medication adherence, and spirituality in their daily life. Patients who routinely fill out their daily activities in this application will add to their knowledge, making it easier for patients to change their habits. When the patient's knowledge and awareness increases, the patient can gradually improve their lifestyle as expected. Based on the findings in this study, it can be seen that the E-MMCD application is effective in changing patient knowledge and attitudes.

This is in line with previous study on the effect of health education on the knowledge and attitudes of people with DM in the wound-healing process [25]. The use of SMS messages through mobile phones in people with DM is very effective. Mobile phones can be used as an educational medium for DM patients. Mobile phones play a role in improving the quality of services that require routine treatment, such as DM, hypertension, stroke, cancer, and heart disease. Health service providers must have the ability to take advantage of technological developments. The results of this study strengthen the results of the previous studies regarding the effectiveness of health services and costs in people with DM. Various health services can use this application by adapting to the environment. Smartphone equipped with voice and text messages can be used anywhere and anytime. This convenience is an opportunity to design and provide health service interventions according to the needs of the community [15].

There is a relationship between the level of knowledge and the behavior of preventing diabetic wounds. The higher the level of knowledge, the better the practice of preventing diabetic injuries. Behavior to prevent wound recurrence can be improved by attending lectures, direct caring experiences, and sharing between patients and patient families. This can be done by optimizing access to electronic media and social media [26]. The results of a similar study also found significant differences in the knowledge of people with DM before and after being given an intervention through the use of SMS [27].

This study shows that people with DM who are given the E-MMCD intervention experience increased knowledge and attitudes about healthy living behaviors. The E-MMCD intervention effectively changes the knowledge and attitudes of people with DM. Educational programs with group discussions can change the behavior of people with DM [28]. The use of the E-MMCD application requires a big commitment to report physical activity, healthy eating patterns, schedule to see a doctor, take regular medication, and patient spirituality every day.

**Limitation of the study**

This study has limitations in terms of the duration of the intervention. Intervention should be carried out for a longer time, at least 3 months to find out changes in behavior in people with DM.

**Conclusion**

The results of this study indicate that the use of the E-MMCD application is effective in changing the knowledge and attitudes of people with DM at Aisyiyah Hospital. Consistency in the use of the E-MMCD application is the key to success in increasing knowledge and attitudes about management of DM. Socialization is needed regarding the profile of the application and the benefits of the application for people with DM.

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**References**

PMid:30200534


PMid:31248094


PMid:22538140

PMid:23497632


PMid:36466517

PMid:20046666

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