e-ISSN: 2807-6257

Open Access Indonesian Journal of Medical Reviews

[OAIJMR]

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Smartphone Application for Self-Care in Type-2 Diabetes Mellitus Patients with Contextual Learning Model

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ARTICLE INFO

Keywords:
Contextual learning model
Self-care
Smartphone application
Type-2 diabetes mellitus

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All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/oaijmr.v4i2.528

A B S T R A C T

Type-2 diabetes mellitus (T2DM) is an emergency problem that can cause death and disability worldwide. By using contextual learning models, smartphone applications can be an innovative solution for improving self-care and health condition management. This research aims to know the effectiveness of smartphone applications for self-care in type-2 diabetes mellitus patients with contextual learning models. Pre-test and post-test control group design was used by researchers. The study was conducted in the period October 2nd, 2023 - January 2nd, 2024. The number of samples collected using the G Power formula was 110 intervention groups and 110 control groups. To select samples, researchers used a purposive sampling method. This research involved T2DM patients treated at nine Health Centers in Kediri, Indonesia. In the smartphone application educational intervention group with the contextual learning model, there was an increase in self-care from a mean of 43,03 to 81,53, and a p-value result of 0,008 was obtained. In the control group using the booklet, there was an increase in self-care from a mean of 37,19 to 52,62, and a p-value result of 0,000 was obtained. Smartphone applications with contextual learning models are more effective in improving self-care than education using booklets; however, both types of education can improve self-care in T2DM.

1. Introduction

Type-2 diabetes mellitus (T2DM) is a serious and emergency health problem throughout the world whose prevalence is increasing rapidly every year. Characterized by an increase in blood sugar levels due to insulin resistance and the body's inability to produce enough insulin to maintain blood sugar levels within normal limits.[1] T2DM is a disease that needs to be watched out for and can attack anyone, especially the elderly.[2] Many people use smartphone applications for health education, but their use is not optimal.[3] When using smartphone applications, each diabetes mellitus patient has different needs. Smartphone applications sometimes cannot be adapted to the specific needs of diabetes mellitus patients, which makes them less effective.[4] According to the International Diabetes Federation, the number of diabetes patients worldwide reached 436 million in 2019. This number may increase to 700 million in 2045. Indonesia is the country that is 7 out of 10 with the highest number of diabetes mellitus sufferers in the world, namely around 10 million population.[5] In Indonesia, the number of deaths due to diabetes reached 236,711 in 2021, an increase of 58% from 149,872 in 2011. From 2007 to 2019, the number of people with type 2 diabetes mellitus in East Java increased every six years. The number was 275,462 in 2007, 605,974 in 2013, and 841,971 in 2019.[6]

T2DM patients often lose interest or motivation to use smartphone applications consistently. This could be caused by a lack of understanding of the long-term benefits of using smartphone applications, and the

majority of people with diabetes mellitus are elderly.[7] T2DM patients with uncontrolled blood sugar levels can increase the risk of complications such as cardiovascular disease, nerve damage, kidney problems, and blindness if self-care is neglected by T2DM patients.[8] The contextual learning model aims to improve patient understanding, increase learning motivation, and develop thinking skills in everyday life[9]. Smartphone applications can be a useful tool to improve understanding, monitoring, and management of T2DM in patient self-care.[10] Smartphone apps can be a useful tool to help patients better manage their conditions. It is important to ensure that the application is created with patient security and privacy in mind.[11] The contextual learning model approach is often used in school environments and has never been applied in education for diabetes mellitus patients. Researchers want to create a contextual learning model education using a smartphone application to provide self-care changes in T2DM. The objectives of this study is knowing the effectiveness of smartphone applications for self-care in type-2 diabetes mellitus patients with contextual learning model.

2. Methods

Pre-test and post-test control group design was used by researchers. The study was conducted in the period October 2nd, 2023 - January 2nd ,2024. This study involved patients with type 2 diabetes who were treated at nine Health Centers in Kediri, Indonesia. Sample measurements can be carried out with G Power with a power analysis type effect size of 0,5, α err prob 0,05, and power (0,95).[12] So the minimum sample is 88 respondents in the intervention group and 88 respondents in the control group. In addition, the sample size must be increased by 25% to avoid type 2 errors, so that the total sample in this study for each intervention group and control group is 110 respondents. To select samples, researchers used a purposive sampling method. Inclusion criteria were that patients had to own and operate a smartphone, be willing to take part in the study for three months, be literate, suffer from type 2 diabetes mellitus, have fasting blood sugar of more than 126 mg/dl, be between 36 - 65 years old, be using insulin injections and take diabetes mellitus medication.

T2DM patients are expected to follow various self-care practices in the summary of diabetes self-care activities (SDSCA). Diet planning, foot care, smoking, exercise, blood sugar monitoring, diabetes mellitus treatment, and insulin injections are part of the SDSCA. Uses a cut-off system to categorize and assign a score ranging from 0 to 7 to evaluate self-care behavior over the past seven days. Bad self-care behavior if you get a score lower than the average and good self-care behavior if you get a score higher than the average.[13] The research time was carried out according to schedule at nine public health centers. During data collection, the researcher was assisted by nursing students from the Bhakti Wiyata Kediri Institute of Health Sciences. The intervention group was given a smartphone application for diabetes mellitus education with a contextual learning model and the control group was given booklet education. On August 21st, 2023, the Health Research Ethics Committee Institut Ilmu Kesehatan of the Indonesian STRADA accepted this study under reference number 000354/EC/KEPK/I/08/2023.

3. Results and Discussion

Respondent characteristics intervention group with smartphone application

Table 1, the characteristics of T2DM patient respondents at the public health center in Kediri, Indonesia were 110 respondents. More than half of the population are women (56,4%), the majority of ages range between 56 - 65 years (37,3%), almost half have a senior high school education level (40,9%), almost half have an entrepreneurial occupation (22 ,7%), and almost half experienced diabetes mellitus for 1-5 years (42,8%).

Table 1. Respondent characteristics intervention group with smartphone application.

Respondent characteristics		f	%
Gender	Male	48	43,6
	Female	62	56,4
Total		**110**	**100**
Age	36-45 years	32	29,1
	46-55 years	37	33,6
	56-65 years	41	37,3
Total		**110**	**100**
Education levels	No formal education	4	3,6
	Elementary school	9	8,2
	Junior high school	12	10,9
	Senior high school	45	40,9
	Higher Education/Academy	40	36,4
	Total	**110**	**100**
Occupation	Doesn't work	15	13,6
	Farmer	23	20,9
	Private employees	20	18,2
	Entrepreneurs	25	22,7
	Civil servants	18	16,4
	Police/soldier	9	8,2
	Total	**110**	**100**
Long suffering DM	≤ 1 year	26	23,6
	1 - 5 years	47	42,8
	≥ 5 years	37	33,6
	Total	**110**	**100**

Respondent characteristics control group with booklet

Table 2, the characteristics of T2DM patient respondents at the public health center in Kediri, Indonesia were 110 respondents. More than half of the population are women (67,3%), the majority of ages range between 56 - 65 years (43,6%), almost half have a senior high school education level (42,7%), almost half have private employees (20,9%), and almost half had diabetes mellitus for ≥ 5 years (43,6%).

Table 2. Respondent characteristics control group with booklet.

Respondent characteristics		f	%
Gender	Male	36	32,7
	Female	74	67,3
Total		**110**	**100**
Age	36-45 years	27	24,6
	46-55 years	35	31,8
	56-65 years	48	43,6
Total		**110**	**100**
Education levels	No formal education	7	6,4
	Elementary school	8	7,3
	Junior high school	19	17,3
	Senior high school	47	42,7
	Higher Education/Academy	29	26,3
	Total	**110**	**100**
Occupation	Doesn't work	21	19,1
	Farmer	15	13,6
	Private employees	23	20,9
	Entrepreneurs	20	18,2
	Civil servants	17	15,5
	Police/soldier	14	12,7
	Total	**110**	**100**
Long suffering DM	≤ 1 year	22	20,0
	1 - 5 years	40	36,4
	≥ 5 years	48	43,6
	Total	**110**	**100**

The defference result in the smartphone application pre-test and post-test for self-care intervention group with contextual model

Normality test with Shapiro-Wilk, the data is not normally distributed. Thus, the Wilcoxon test was carried out and the result was a P value of 0.008 < 0.05, so H0 was rejected, meaning there was a difference between the average self-care before and after being given smartphone application education on the contextual learning model in the Intervention groups. There was an increase in self-care from a mean of 43.03 to 81.53 in Intervention groups at the nine public health centers in Kediri, Indonesia.

Table 3. The defference pre-test and post-test self-care for intervention group with contextual learning model.

	Self-Care						
No	**Month**	**n**	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**P value**
1	Pre self-care intervention	9	43,03	1,62	40,34	45,66	0,008
2	Post self- care intervention	9	81,53	5,32	72,52	87,23	

The defference result pre-test and post-test for self-care in the control group with booklet education

Normality test using the Shapiro-Wilk test, the data is normally distributed. Thus, the Paired T-test was carried out and the results were p value 0.000 < 0.05, so H0 was rejected, meaning there was a difference between mean self-care before and after being given booklet education to the control group. There was an increase in self-care from a mean of 37.19 to 52.62 in the control group at the nine public health centers in Kediri, Indonesia.

Table 4. The defference result pre-test and post-test for self-care in the control group with booklet education.

	Self-Care						
No	**Month**	**n**	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**P value**
1	Pre self-care intervention	9	37,19	3,61	30,34	41,51	0,000
2	Post self- care intervention	9	52,62	3,65	48,15	57,59	

Smartphone application pre-test and post-test for self-care intervention group with contextual learning model

The research results showed that the prevalence of the intervention group who were given education via a smartphone application with a contextual learning model, the level of self-care increased from a mean of 43,03 to 81,53 and a P value of 0,008. Diabetes mellitus self-care includes diet planning, foot care, smoking, exercise, blood sugar monitoring, diabetes mellitus treatment, and insulin injections. After reviewing the database, the majority of T2DM patient respondents who received education using smartphone applications were over 60 years old. Women have higher levels of self-care than men and support changes in glucose control behavior, increased healthy habits, and significant weight loss.[14] Most T2DM patients over the age of 60 years are no longer working so they are more likely to carry out self-care at home such as activities, foot care, and blood glucose control than patients who are still actively working. Patients are satisfied with the mobile phone application provided.[15] According to research results, the majority of respondents were women aged 56-65 years who experienced increased self-care in T2DM

after being given smartphone application education with a contextual learning model.

Mobile learning applications can improve self-care behavior pre-test and post-test after education on T2DM with a mean self-care value of 44,75 to 76,95, Foot care with a mean value of 1,87 to 1,91, Diet with a mean value of 16,25 becomes 26,7, and sport with a mean value of 3,04 becomes 8,45.[16] Assessment before and after intervention using a smartphone application showed changes in self-care motivation in T2DM patients after 6 – 18 months. Make changes to healthy eating patterns, always do physical activity, and often monitor blood sugar regularly.[17] There was an increase in self-management when using the smartphone application and helped reduce HbA1c levels at every 3-month and 6-month measurement.[18] Using the iBGStar smartphone application, there was an increase in diabetes mellitus care behavior in the intervention group in adult diabetes mellitus patients resulting in a decrease in HbA1c.[19] By using diabetes self-management education diabetes mellitus-based Android application can influence self-management which includes increasing self-efficacy with a significant value of 0,001, decreasing Hba1c with a significant value of 0,005, and increasing insulin use with a P-Value of 0,000.[20] Smartphone applications that use contextual learning model methods can help improve health and independent care for patients.[9] The material in contextual learning must be adapted to the patient's experience in managing their health. In diabetes mellitus patients such as providing information about diet, exercise, and blood glucose monitoring.[21] The conclusion above is that in the intervention group before and after being given education via a smartphone application on the contextual learning model, there was an increase in self-care in the average T2DM patient score. This happens because smartphone application education is effective in changing the level of self-care in T2DM patients.

Pre-test and post-test for self-care in the control group with booklet education

The results of the study showed that the prevalence of the control group was given booklet education with a p value of 0,000. There was an increase in self-care from a mean of 37,19 to 52,62. Most diabetes mellitus patients are female and aged > 60 years. Self-care for patients before and after education using booklet media is very different. The change in self-care before was 12,82 and the change in self-care after was 16,32.[22] These results are by research results that the control group that was given booklet education was mostly more than half of the population were women, the majority of ages ranging from 56 - 65 years.

Information through booklets can improve self-care for type 2 diabetes mellitus and treatment adherence. There was a significant difference before and after being given the booklet education between HbA1c and measurements using the Morisky Medication Adherence Scale (MMAS-8) with a p-value of 0,001.[23] After being given diabetes mellitus education using booklets, there was an increase in the mean value of public knowledge about the prevention and treatment of diabetes mellitus, namely the pre-test score was 10,17 and the post-test score was 14,20. There is a relationship between before and after being given booklet education with p-value of 0,000.[24] Booklet education using self-care theory can increase compliance with diabetes mellitus management, reduce blood glucose levels, and independence in foot care in T2DM patients.[25] The majority of diabetes mellitus patients are women. The level of knowledge of diabetes mellitus patients increases after being given education through booklets so that physical activity, lifestyle, responsibility in self-care, and nutrition are carried out well by diabetes mellitus patients.[26] The conclusion above is that in the control group before and after being given education through booklets, there was an increase in self-care in the average T2DM patient score. This happens because booklet education is effective in changing the level of self-care in T2DM patients.

4. Conclusion

There was an increase in self-care in type-2 diabetes mellitus patients before and after being given education using the smartphone application with contextual model. Smartphone applications with contextual learning models are more effective in improving self-care than education using booklets, however, both education can improve self-care in type-2 diabetes mellitus patients.

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