Diabetes & Metabolic Syndrome: Clinical Research & Reviews 16 (2022) 102537

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

A smartphone application of diabetes coaching intervention to prevent the onset of complications and to improve diabetes self-management: A randomized control trial

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ARTICLE INFO

Article history:
Received 28 October 2021
Received in revised form
23 March 2022
Accepted 3 June 2022

Keywords:
Smartphone application
Coaching program
Self-management
Diabetes complication
Randomized control trial

ABSTRACT

Background and aim: Diabetes mellitus (DM) has been a worldwide public health problem during the last two decades. To examine the effect of a smartphone application of diabetes coaching intervention on improving self-management behaviors and preventing onset diabetes complications.
Methods: A randomized control trial, two groups, pre-test, and post-test design with a non-equivalent control group was conducted. The intervention group received a 12-week smartphone application of diabetes coaching intervention to improve diabetes self-management behaviors and to prevent onset diabetes complications. While the control group received the usual care from the community health centers. The smartphone application consisted of narrative App-based coaching, a printed user guide, mindfulness-based coaching; skill-based coaching, and a small App-interaction.
Results: After implementation, the self-management behaviors among the experimental group were improved than the control group in terms of dietary control, physical exercise, blood glucose monitoring, medication adherence, and screening of complications. The clinical outcomes were also significantly improved among the experimental group and to the control group.
Conclusions: A smartphone application-based diabetes coaching intervention was feasible to apply as a nationwide program to promote diabetes self-management (DSM) during the covid-19 pandemic

1. Introduction

Diabetes mellitus (DM) has been a worldwide public health problem during the last two decades. More than 90% of DM was type II diabetes (T2DM) which was related to unhealthy behaviors including high fat and high sugar consumption, alcohol consumption, and insufficient physical activity [1,2] estimated that more than 346 million people had been diagnosed with diabetes [2]. DM and its complications have a significant impact on both patients and societies as a whole. DM affected an increasing healthcare cost to the health service system, reducing the life expectancy and quality of life among the population [3]. In Indonesia, 133 million people were also reported living with diabetes mellitus, and 87.5% of them were glycemic uncontrolled [4] (see Fig. 1).

Glycemic uncontrolled can be defined as the patients' conditions with recently had HbA1C levels equal or more than 7% (International expert). Most of them were difficult to achieve the target goal of well glycemic control. This condition could impact diabetic complications such as retinopathy, nephropathy, and neuropathy, leading to long-term disability and premature death [2].

Patients with diabetic neuropathy have lost sensation in their feet, leading to the risk of injury and chronic ulcers. Chronic ulceration may lead to foot amputation and permanent disability. World Health Organization (WHO) estimated that 60–70% of 347 million people worldwide have neuropathy symptoms [5]. A recent study is reported the main complications of DM comprised neuropathy (13%–78%), microvascular complications (16%–53%), and diabetic foot ulcers (7.3%–24%0, respectively [6]. Approximately 16.2% of diabetes mellitus developed diabetic foot ulcers in Indonesia and required amputation. The main reason is insufficient information on the prevention of diabetes complications and foot ulcers.

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https://doi.org/10.1016/j.dsx.2022.102537
1871-4021/

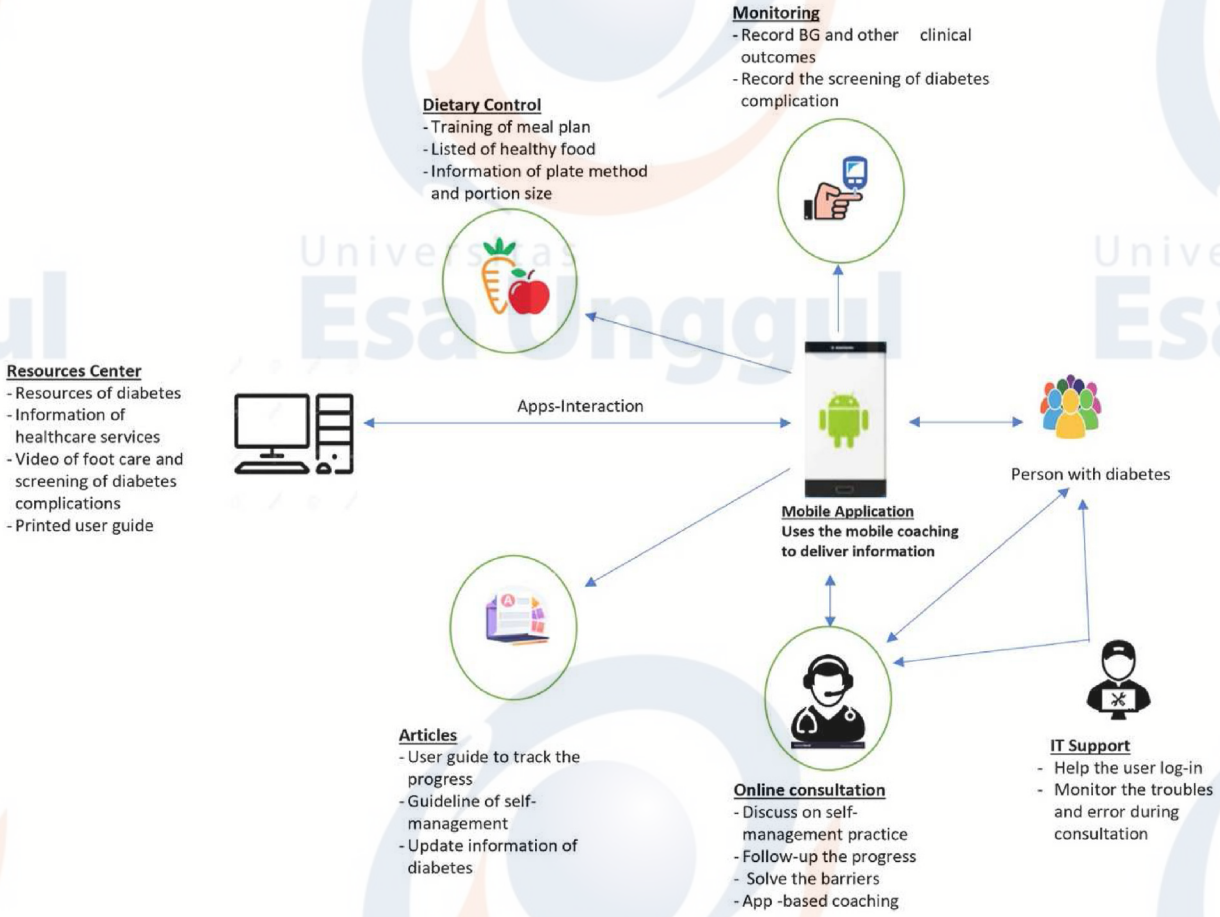

Fig. 1. Overview of mobile technological devices of diabetes coaching intervention process. Random allocation by lottery sampling.

American Diabetes Association (ADA) has recommended diabetes self-management (DSM) behavior as an essential foundation to promote a healthy lifestyle among T2DM to improve health outcomes and clinical biomarkers (American diabetes association, 2020). Self-management practice also requires diabetic patients to reconcile with dietary control, physical exercise, -monitoring of blood glucose, and regular check-up for diabetes complications [7]. A self-management program has been proved as an effective strategy to enhance healthy lifestyle behavior, improve the clinical biomarkers, and prevent the onset of diabetes complications among T2DM persons.

A previous study on self-management-based coaching programs using the self-management concept showed a positive effect on improving healthy behavior and biological markers to reduce the onset of complications [8]. Another study confirmed that the self-management concept also improved the behavioral change for chronic diseases and prevented diabetes complications [9]. However, most of the interventions are delivered by plenary sessions, and some may include participatory learning by sharing ideas and practices. From previous findings, every study recommended the self-management concept as an effective strategy for glycemic control at a primary care level. The healthcare providers should be concerned about conducting an ongoing iterative process and patient-centered; create a collaborative goal-setting and decision-making between the healthcare provider and patients. Healthcare providers also should develop a problem-solving strategy to combat barriers, fill in gaps of unmet needs in outreach services, and maintain continuing follow-up.

Previous systematic review studies and application of digital technology to enhance self-care or self-management practice among chronic-ill patients indicated positive results. Digital technology can improve knowledge, awareness, and self-regulation to perform self-care practice continuously, control blood pressure, and delay the onset of complications [10,11].

The researchers developed a diabetes coaching intervention using digital technology based on the self-management concept and a health coaching model in this study. The innovation was developed based on a preliminary study using a qualitative method to explore the patients' needs and possible obstacles to DSM practice to ensure the developed program fits patients and healthcare providers' needs. With rising numbers of smartphone users, it is possible to apply a mobile application as a fundamental digital technology to empower the patients to realize and adhere to DSM practice.

The smartphone application-based health coaching program is an interactive and friendly used application for every patient to follow. The program is not only to provide information on self-care but also to enhance two-way communication via an interactive chatbot for online counseling using the narrative App-based coaching, a printed user guide, mindfulness-based coaching, skill-based coaching, and a small of App-interaction. The researchers also personalized online coaching on healthy behaviors and delivered a series of modules covering listed health food, foot care, and peripheral neuropathy screening in the mobile application. The online consultation was conducted to review the progress of self-management practice, monitor possible complications, and solve

the barriers during program implementation. The mindfulness-based coaching with positive reinforcement and interaction between the researcher and the clients were conducted through a telephone call to provide emotional support. This step is essential to assist the patients in dealing with the problems. Therefore, this study is aimed to examine the effect of a mobile application of diabetes coaching intervention on the improvement of self-management behaviors and clinical outcomes to prevent the onset of diabetes complications among uncontrolled T2DM. Findings from this study would be beneficial to diabetes patients and healthcare providers to apply the innovation of mobile application to routine services to increase DSM practice among T2DM patients and prevent complications in a community setting.

2. Materials and methods

2.1. Study aim

The study aimed to examine the effect of a smartphone application of diabetes coaching intervention to improve DSM practice and prevent onset diabetes complications.

2.2. Design

A randomized control trial (RCT), two-groups, pre-test, and post-test design with a non-equivalent control group was conducted into two sub phrases. An initial phase was aimed to explore the unmet needs and problems on DSM practice among T2DM patients and the feasibility of applying a smartphone application to promote DSM practice. Information obtained from the preliminary study is used to develop a mobile application to fit the target's needs. The later phase aimed to examine the effect of a mobile application of diabetes coaching intervention to improve the DSM practice and prevent diabetes complications among T2DM clients.

2.3. Setting

This study was conducted in the community under the catchment areas of three community health centers that were a hub to provide essential health services for T2DM patients.

2.4. Sample size and intervention procedure

Sixty T2DM patients were selected from patient records of the three community health centers using a systematic random sampling technique. The lottery sampling technique randomly allocated thirty samples to the experimental group and another thirty samples to the control group. The sample size calculation was based on a comparative study of two means average [12]. The calculated samples per group were 30 patients.

Inclusion criteria of the samples comprised; 1) uncontrolled T2DM patients with HbA1c >7%, 2) aged 35-59-years-old, 3) had been living with DM for more than two consecutive years, 4) be able to communicate in the Indonesian language, both verbal and written, and willingness to participate in this study. Patients with serious complications such as foot ulcers, chronic renal diseases, and retinopathy were excluded from this study.

We conducted a series of data collection into two sub-phases as mentioned above. The researchers informed the study and data collection process to the head and staff nurses at each community health center. The T2DM patients and public health nurses who were the responsible persons in diabetes care were identified. The eligible patients based on the inclusion criteria were recruited to participate in this study during an initial phase of exploring information. After randomly allocating the samples into the experimental and control groups, informed consent was delivered when they declared to participate in this study.

2.5. Smartphone application of diabetes coaching intervention

A smartphone application of diabetes coaching intervention was carried out during 12-weeks of the intervention period. The intervention group received the smartphone application of diabetes coaching intervention. The program consisted of 5 main menus: narrative App-based coaching, a printed user guide, mindfulness-based coaching, skill-based coaching, and a small App-interaction. The mobile diabetes coaching intervention was constructed based on the preliminary study and was co-designed with support from the information technology (IT) team.

The smartphone application of diabetes coaching intervention is a personalized coaching program delivered via a mobile phone. Several sub-menus contained knowledge and information to assist T2DM on healthy lifestyle in daily living. Contents of the sub-menus emphasized DSM practice, such as lists of healthy foods and a daily portion of food intake, types of physical activity to fit with T2DM patients, medication adherence, and blood glucose monitoring. Moreover, foot care and peripheral neuropathy screening are also included in the mobile application.

Participants were encouraged to record their self-management activities by filling the reporting menu of the application. Online consultation via Zoom meeting and a telephone call or line call was conducted to track the progress of DSM practice, monitor the possible complications, and solve the barriers during the program's implementation. The mindfulness-based coaching and small group interaction by sending empowering messages to adhere to DSM practice and answering questions were conducted to provide emotional support.

While among the control group, routine services were continuously provided by community health centers during the same period. They received the smartphone application of diabetes coaching intervention after the post-test at the end of the program implementation.

2.6. Instruments for data collection

A self-administered questionnaire comprised of three parts was used to collect information from the experimental and control groups. Details of each part were explained as follows:

2.6.1. Part I: Socio-demographic data

The researchers developed the socio-demographic questionnaire. This part consisted of 6 items to describe socio-demographic data, comprised age, sex, marital status, educational level, occupation, and family history of DM.

2.6.2. Part II: Indonesian version of diabetes self-management (DSM) questionnaire

The DSM questionnaire was modified from a previous study and translated into the Indonesian language by the researchers to assess the DSM practice, including dietary control, physical activity, blood glucose monitoring, medication adherence, and screening for diabetes complication. The modified English version of the DSM questionnaire was translated the Indonesian and back-translated by a native speaker familiar with the Indonesian language. The internal consistency showed that Cronbach's alpha coefficient was 0.84, considered a reliable questionnaire.

The Indonesian version of the DSM questionnaire included 4 items of dietary control, 3 items of physical activity, 4 items of blood glucose monitoring, 2 items of medication adherence, and 3 items of screening for diabetes complications. The score of DMS practice

is ranged from 0 to 3 as not at all (0), sometimes [1], often [2], and always [3]. High scores indicated good DSM practice.

2.6.3. Part III: Clinical outcomes measured

The clinical outcomes included HbA1c, systolic and diastolic blood pressure, high-density lipoprotein (HDL) level, and low-density lipoprotein (LDL) level were obtained from the laboratory results at the beginning before implementing the program. In the end, after twelve-week of the program implementation. The blood pressure level was measured using a mercury sphygmomanometer after 10 min of resting.

2.7. Ethical consideration

This study was approved by the ethical consideration from Esa Unggul University. Informed consent was obtained from each participant willing to participate in this study.

2.8. Data analysis

Chi-square and *t*-test were done to compare sociodemographic and clinical data between the experimental and control groups. Independent *t*-test and paired *t*-test were applied to examine the difference in DSM scores and the mean score of clinical outcomes between the experimental and the control groups. At the same time, paired *t*-test was used to compare mean scores of different within-group before and after implementing the diabetes-based coaching program. The level of statistical test was set up at p-value <0.05 (see Table 1).

3. Results

3.1. Comparison of socio-demographic data between the experimental and the control group

The majority of patients in the experimental group (80%) and the control group (63.3%) were females. The mean average age in the experimental group was 56.2 ± 7.63 years old, and the control group was 54.5 ± 9.20 years old. Around one-third of the experimental group had completed high school (33.3%), while around one-fourth (26.7%) were found among the control group. About one-fifth (20%) of the experimental group were illiterate, whereas only a few (3.3%) were in the control group. Regarding the family history of diabetes, slightly more than half were found in the experimental group (53.3%), while nearly half were found among the control group (46.7%). There was no significant difference in the socio-demographic and clinical data between the experimental and the control group (Table 2).

3.2. Comparison of DSM practice scores between the experimental and the control group before and after receiving the mobile application of diabetes coaching intervention

Table 3 compares mean scores on DSM practice between the experimental and the control group before and after implementing the mobile application of diabetes coaching intervention. The findings showed no significant difference in DSM practice between the experimental and control groups before implementing the intervention ($p > 0.05$). While after implementing the mobile application of diabetes caching intervention, all components of the DSM practice comprised dietary control ($p < 0.001$), physical exercise ($p < 0.001$), SMBG ($p < 0.001$), medication adherence ($p < 0.001$), and screening for diabetes complications ($p < 0.001$) were significantly improved in the experimental group compared with the control group.

3.3. Comparison of clinical outcomes between the experimental and the control group before and after implementing the mobile application of the diabetes coaching intervention

Table 4 shows the comparison of mean score on clinical outcomes of the diabetic patients between the experimental and the control groups. Before implementing the mobile application of diabetes caching intervention, all clinical outcomes such as HbA1c level, systolic BP, diastolic BP, body mass index, HDL, and LDL in both groups were not significantly different.

After implementing the intervention, some clinical outcomes included HbA1c level ($p < 0.001$), systolic BP ($p = 0.003$), diastolic BP ($p = 0.035$), HDL ($p = 0.001$), LDL ($p = 0.005$) were significantly different between the experimental group and the control group. In contrast, the body mass index confirmed no significant difference between the two groups ($p = 0.329$).

4. Discussion

4.1. Effect of a mobile application of diabetes coaching intervention on DSM behaviors to prevent onset diabetes complications

This study showed the effectiveness of the mobile application of diabetes coaching intervention on DSM practice to prevent the onset of diabetes complications among uncontrolled T2DM. The improvement of DSM behaviors based on self-management concept with health coaching integrated can prevent the onset diabetes complications among the experimental group compared to the control group. . This finding can be explained by the health action process approach (HAPA). HAPA suggests a distinction between (a) pre-intentional motivation processes that lead to a

Table 1
The main menu of contents, strategies, and media used in the mobile application of diabetes coaching intervention.

Main menu of contents	Smartphone-based coaching Activities	Strategy & medias
Problem-solving based coaching	- Sharing experience on problems & obstacles of DSM practice - Goal setting and personal feedback	
Narrative-based coaching	- Online teaching on diabetes and diabetes prevention - Update information on DSM practice	- Online discussion via Zoom and google meet - Resources center Need an explanation of what it is? - a printed user guide
Mindfulness-based coaching	- Emotional support - Positive communication and empowering the patients' achievement	- Online consultation via Zoom - Positive responsiveness - Line call/phone call to FU. of DSM practice
Skill-based coaching	- Online training on dietary control, meal plan, and plate method via Zoom - Coaching on self-management blood glucose (SMBG) monitoring - Training on tracking the progress using the mobile App - Online training on preventing diabetes complications via Zoom	- Online consultation via Zoom - Video App/VDO clips - Progress tracking App - Series of module - a printed user guide
Follow-up	- Weekly follow-up - Progress report using a social media	- Telephone call/Line call for follow-up - Post of information via social media

Table 2
Comparison of socio-demographic data and clinical data between the experimental and the control group.

Socio-demographic data	Experimental group		Control group		p-value
	N(30)	%	N(30)	%	
Socio-demographic data					
Age (Min-Max = 34–69)	M = 56.2	SD = 7.63	M = 54.5	SD = 9.20	.877*
Sex					
Male	6	20	11	36.7	
Female	24	80	19	63.3	
Marital status					
Married	30	100	30	100	
Had not married	0	0	0	0	
Occupation					
Unemployed	2	6.7	2	6.7	
Housewife	18	60.0	12	40	
Farmer	5	16.7	6	20	
Seller	1	3.3	1	3.3	
Entrepreneur	2	6.7	4	13.3	
Civil servant	2	6.7	5	16.7	
Education					
Un-literate	6	20	1	3.3	
Primary school	6	20	7	23.3	
Secondary school	5	16.7	7	23.3	
High School	10	33.3	8	26.7	
Diploma	0	0	0	0	
Bachelor/master	3	10	7	23.3	
Family history of diabetes					
Have diabetes	14	46.7	17	56.7	
No have diabetes	16	53.3	13	43.3	
Clinical data					
Weight	M = 55.33	SD = 8.25	M = 59.83	SD = 10.26	.106*
Height	M = 152.97	SD = 6.98	M = 155.97	SD = 6.26	.843*
Body mass index	M = 23.70	SD = 3.52	M = 24.62	SD = 3.50	.067*
Fasting blood glucose	M = 229.50	SD = 62.19	M = 254.40	SD = 100	.053*
HbA1c	M = 8.04	SD = 1.96	M = 8.55	SD = 2.95	.123*
Systolic BP	M = 128	SD = 13.83	M = 128	SD = 18.21	.047*
Diastolic BP	M = 83.33	SD = 7.11	M = 82	SD = 8.86	.183*
Cholesterol total	M = 204	SD = 32.66	M = 199	SD = 41.35	.446*
LDL	M = 117.63	SD = 49.61	M = 107.50	SD = 37.24	.408*
HDL	M = 65.17	SD = 14.40	M = 65.47	SD = 23.81	.001*

*p-value from *t*-test.

Table 3
Comparison of mean score on DSM practice and clinical outcomes between the experimental and the control group before and after implementing the intervention.

Variable	*Experiment group (n = 30)*		*Control group (n = 30)*		t(df)	p
	Mean	SD	Mean	SD		
DSM practice before implementing the intervention						
a. Dietary control	3.97	1.497	4.37	1.273	1.115 (58)	.845
b. Physical exercise	3.43	2.063	3.23	1.455	.434 (58)	.080
c. SMBG	4.53	1.776	4.07	1.574	1.077 (58)	.614
d. Medication adherence	2.57	1.382	3.03	1.790	1.130 (58)	.149
e. Screening of diabetes complication	1.90	2.074	1.97	1.810	-.133 (58)	.316
DSM practice after implementing the intervention						
a. Dietary control	8.83	1.802	5.17	1.840	7.798 (58)	.000*
b. Physical exercise	6.87	1.358	3.77	1.251	9.197 (58)	.000*
c. SMBG	10.23	1.478	7.40	1.354	7.741 (58)	.000*
d. Medication adherence	4.97	.999	3.10	.607	8.742 (58)	.000*
e. Screening of diabetes complication	6.27	1.258	2.13	1.196	13.046(58)	.000*

p-value<0.001*.

behavioral intention and (b) post-intentional volition processes that lead to the actual health behavior [13].

When an individual is notified by doctors on the problem of health-compromising behaviors which difficult to change, such as physical inactivity and poor eating behavior, they would be aware of adopting the recommendations to change unhealthy behaviors by performing regular self-management. The goal-setting to reach a milestone on preventing and controlling lifestyle-related illness by adequate self-management will enhance an intention to perform healthy behaviors. The intention might not standstill without a post-intentional process to maintain healthy behaviors. The post-intentional process is dependent on several factors, such as counseling and empowering to motivate regular practice and self-monitoring. A previous study confirmed that self-management, using behavioral change strategies, improved health behaviors and achieved glycemic control [14].

Table 4
Comparison of mean score on clinical outcomes before and after implementing the mobile application of diabetes coaching intervention between the experimental and the control group.

Variable	Experiment group		Control group		t(df)	p-value
	Mean	SD	Mean	SD		
Clinical outcomes before implementation						
a. HbA1c	8.043	1.960	8.553	2.952	-.788 (58)	.435
b. Systolic BP	128.67	13.83	128.33	18.21	.080 (58)	.939
c. Diastolic BP	83.33	7.112	82.00	8.867	.643 (58)	.524
d. Body mass index	23.70	3.529	24.32	3.510	-.680 (58)	.497
e. HDL	65.17	14.406	65.47	23.815	.895 (58)	.954
f. LDL	117.63	49.611	107.50	37.246	-.059 (58)	.376
Clinical outcomes after implementation						
a. HbA1c	6.440	1.144	8.240	2.605	−3.464 (58)	.001*
b. Systolic BP	120.00	11.142	129.67	12.72	−3.130 (58)	.003*
c. Diastolic BP	72.50	8.685	78.00	10.95	−2.155 (58)	.027*
d. Body mass index	23.58	2.800	24.28	2.690	-.984 (58)	.328
e. HDL	91.80	20.73	61.57	19.349	5.839 (58)	.000*
f. LDL	89.10	14.910	109.57	35.663	−2.900 (58)	.004*

p-value<0.001*.

This study conducted mobile diabetes coaching intervention process sequentially every week during the 12 weeks. The main contents of the coaching program consisted of 5-sessions, including 1) problem-solving-based coaching, 2) narrative-based coaching, which was performed by using a small group discussion and a case study via online meeting by Zoom, 3) mindfulness-based coaching; 4) skill-based coaching and 5) follow-up to track on progression and to monitor DSM practice via phone call. Critical information on DSM practice and obstacles was obtained at initial phase through a qualitative study. The findings of this process could assist the researchers in a deep understanding of the problems and barriers of DSM practice among T2DM patients in the community, perception of the benefits of DSM practice, and how they performed their behaviors to prevent the onset of diabetes complications. The second phase was a mobile application focusing on problem-solving of the improper DSM practice. In this phase, the researcher and diabetes patients shared experiences on obstacles of DSM behaviors and established the goal-setting to reach a milestone of well glycemic control. Enhancing problem-solving skills to overcome the barriers of self-management practice was emphasized. Individual feedback was conducted during the discussion process. All activities were performed using a mobile application. A previous study revealed that mobile technological devices specifically enhanced self-management skills and self-efficacy. They used mobile technological devices to record blood glucose data to alerts them for recurring medication tasks [15]. A systematic review reported mobile technological devices could improve health outcomes and enhance symptom control among chronic diseases [16].

Besides reflection and sharing sessions, the researchers also conducted online teaching and empowering on DSM and preventing diabetes complications. The specific information was given

individually toward diabetes prevention to ensure T2DM patients well understood the information. This was similar to a previous study to confirm that particular education could improve diabetes self-management [17].

The following process of mobile diabetes coaching intervention was mindfulness-based coaching. While implementing the intervention, emotional support and empowering communication were conducted to motivate the patients' achievement in glycemic control. The mindfulness-based intervention could support the emotional problems. It was consistent with a previous study that reported that mindfulness meditation-based intervention positively affected holistic care, reduced stress, and improved patient well-being during self-management implementation [18]. This previous study also indicated that emotional support and positive communication improved patients' and their family members' confidence to manage adverse symptoms. Sufficient decision-making skills, communication skills, and analytical skills were crucial to address the DSM problems. Previous studies reported that empowering communication and supporting skills were essential aspects of coping with stress and comprehending self-management practice [19,20].

The participants in this present study received the skill-based coaching intervention systematically within a 12-weeks intervention. Using the online coaching via Zoom with video application devices, the researchers trained participants to manage a healthy diet, create a meal plan, and manage the portion size using the plate method. Eventually, some patients faced challenges to carry out the dietary control. However, it could be solved by individual online consultation and telephone calls with full support from the family members. Family members play an essential role in reminding the participants to avoid a particular food. It was consistent with the previous study that reported that family members positively support patients in controlling the behaviors [21]. Online coaching for preventing diabetes complications also was delivered for patients. The researchers trained patients and their family members regarding strategies for screening the neuropathy symptoms and how to monitor the hypoglycemia symptoms. Diabetes management requires the self-directed to make day-to-day decisions about controlling their blood glucose. Understanding of appropriate technologies for glucose monitoring and medication compliance was crucial. A previous study mentioned that traditional education supplemented several web portals and structured online information for diabetes management [22].

Regular follow-up was also reported as a crucial strategy to track progression and barriers of self-management implementation and monitor diabetes complications symptoms. All participants were required to report the progress of self-management practice and discuss the possible barriers using the tracking App. This strategy could influence the patients' confidence and expectation to maintain positive behaviors. This finding was similar to the previous study, which indicated diabetes apps for self-management have significantly improved self-care behaviors and regular glucose monitoring [23]. Another study confirmed that telephone follow-up was positively associated with diabetes self-management behaviors [24].

4.2. Effect of a mobile technological device of a diabetes coaching intervention on clinical outcomes among diabetic patients

The clinical outcomes such as HbA1c level, blood pressure, and cholesterol profile were measured before and after implementing the mobile application coaching program. The findings reported that after implementing the program, all clinical outcomes except BMI status in the experimental group are significantly improved than the control group. Improvement of the clinical outcomes due to several reasons such as:

Firstly, the researchers conducted the skill-based coaching method by discussing self-management behaviors such as dietary management and active physical exercise. The researchers also coached patients to monitor blood glucose based on the recommendations. The findings were similar to the previous study to confirm that dietary control positively affected on clinical outcomes among diabetes patients [8,25].

Actively physical exercise also contributed to improving the clinical outcomes among diabetic patients. In this study, the researchers coached how to perform appropriate physical activity based on the recommendations that fit each client's age and symptoms. All respondents actively performed aerobic exercise at public health centers once a week. It was most beneficial to prevent diabetes progression, increase the stimulation of glucose disposal, maintain the blood glucose level, and prevent the foot ulcer. It was consistent with the previous study on anaerobic exercise to reduce blood glucose and HbA1c levels that increased quality of life among the patients [26]. Another study reported that aerobic exercise positively lowers blood glucose altering the body composition and reactivating of insulin resistance [27]. A systematic review revealed that aerobic exercise was significantly reduced cholesterol profiles such as HDL, LDL, and total cholesterol levels [28,29]. In contrast with BMI status, physical exercise has not positively affected maintaining BMI status and body fat percent. However, it could only reduce the risk of overweight and high body fat percent [30].

5. Conclusion

This study concludes and supports the feasibility and applicability of mobile application of diabetes coaching intervention for DSM. The findings revealed that the intervention has significantly improved self-management behaviors to prevent diabetes complications. Further study needs to examine the mobile diabetes coaching intervention in a large-scale study and the different settings.

Author contribution

Study design: RAP, AMU. Data Collection: RAP, AMU. Manuscript writing: RAP, KC, AMU, Edit the manuscript: RAP, KC.

Declaration of competing interest

The authors declared no conflict of interest in writing the manuscript.

Acknowledgment

We thank all the respondents who are willing to participate in this study. A special thank would like to deliver to the *Ristekbrin* for granting this study. We also express our gratitude to the research assistant team and healthcare providers in the study setting, who provided continuous support during the data collection process.

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