

## ORIGINAL ARTICLE

# DIMAS (Diabetes Management Support) Application: Mobile-Phone Based Intervention to Support Diabetes Self-Management Activities

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## ABSTRACT

**Introduction:** The self-management process in Diabetes Mellitus (DM) is essential to improve glycemic control. Currently, COVID-19 leading to a significant limitation in services and accessibility, especially regular support for diabetes patients. The utilization of DIMAS Mobile App is expected to be a support system to overcome these problems. This application has three menus such as health education containing information about diabetes, nutrition, medication, exercise, stress management, and foot care; self-care monitoring containing medication reminders, blood sugar and exercise records; and consultation with nurses. This study aimed to determine the effect of DIMAS (Diabetes Management Support) application on Diabetes Self-Management activities. **Methods:** Using an experimental study with One Group Pre-Posttest Design, the self-management activities were measured among 24 respondents after four weeks of intervention. The intervention was carried out with the DIMAS app and WhatsApp communication. Using the Summary of Diabetes Self-Care Activity (SDSCA) questionnaire, the data were analysed with one paired sample t-test using SPSS 22. **Results:** Statistically significant changes were observed between pre and post-intervention measures: DSM activities with SDSCA ( $p=0,000$ ) and the level of knowledge ( $p=0,000$ ). The results showed that the biggest change in self-care activity was foot care and exercise with the increase of scoring was 2.4 and 0.8 respectively. Respondents stated that the application was useful for reminding them to take medication and communicating with nurses. **Conclusion:** The application makes it easier for patients to keep connected with nurses despite being constrained by distance and provides practical benefits in nursing services at home.

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## INTRODUCTION

Diabetes Mellitus (DM) is one of the chronic diseases with a high incidence rate in Indonesia and ranks 7th country with the highest number globally. Basic Health Research data for 2018 stated that the prevalence of DM based on blood sugar examination was obtained at 8.5%, and increased from 6,5% in 2013 (1). It encourages the emergence of policies in handling as outlined in Government Regulation Number 2 of 2018 and Minister of Home Affairs Regulation Number 100 of 2018. This regulation pushed the optimization of health care systems in providing standard services to diabetic patients once a month. The minimum standard of service received includes blood sugar measurement, education, pharmacological therapy and referral if needed. Changes

in the principle of chronic patient care with a patient-centred approach are also carried out to improve the patient's independence in self-care activities.

Self-care management is a key component in diabetes care procedures that can improve quality of life and prevent complications (2). It includes blood glucose self-monitoring, a low-fat diet, daily exercise, and checking one's foot. Research has found that many of these self-care activities are independent of one another and significantly improve glycemic control (2,3). For patients, these self-care activities are complex, it requires knowledge and health workers guiding (4). Patients who have high knowledge, as well as high socioeconomic abilities, tend to have high self-efficacy and most adherence to regular exercise, dietary control and regular treatment (5,6). Patients who have access to the health care system have good glycemic control and HbA1C values compared to those who do not have social support and Health insurance (7,8).

Primary health care in Indonesia has an important role in the management of chronic diseases includes diabetes services. Longitudinal care services such as regular visits, regular follow-up, monitoring and handling the non-emergency case are more likely to be done at the primary health level (9). It can be more accessible and affordable than goes to the hospital.

The switching of both health services and healthcare workers for the management of COVID-19 makes preventive services such as screening and other services stopped. The lockdown regulation also makes the number of visits in primary health care decreased because of the limitation in mobilisation and transportation (10). The prior study about effect of pandemic COVID-19 for people with diabetes stated that the impact of the COVID-19 pandemic on DM patients includes limited access for support from health provider, adjustment in self-care, lack of knowledge and confidence, difficulties in switching treatment, mental health, and empowerment in self-management that caused from canceled appointments. Patients also reported the increased of stress and anxiety level, weight gain, and reduced exercise activities (11,12). Alternative strategies are needed to maintain the continuity of health services, one of which is by using telehealth. The utilization of information technology in health services can improve access, reduce costs and improve the quality of services in the management of chronic diseases (13).

Technology-based interventions may overcome the problem of lack of time or money to visit medical health services. It helps patients to keep interacting with health care providers without face-to-face interactions, thereby offering the potential to reduce the costs and dependence on the clinical staff of providing additional services beyond regular clinical visits (14). Prior studies demonstrate that technology-based interventions promoting diabetes self-management may be acceptable to all patients include children and even for the elderly. These strategies have the potential to improve health outcomes and behaviours (e.g. HbA1c, blood glucose monitoring, stress diabetes, quality of life, self-efficacy and adherence to medication) (15,16,17). The potential benefits of mobile applications are the possibility of tracking a patient's health and strengthening communication between the patient and the health care provider. These features can be used as a consultation with the health provider, so the issue of adherence caused by inadequate treatment supervision, poor communication with providers, and other patient-related barriers such as poor knowledge and lack of self-efficacy and motivation can be solved. This bidirectional communication proves to increase patients adherence rather than using just a website without communication features. Communication by text messages, emails or telephone calls gives feedback thus increasing the motivation of patients (13,18). MHealth's innovation in various features is one way out in providing health

services suitable for chronic disease management. In addition, the utilization of technology in improving access to information has been shown to improve treatment compliance and quality of life of diabetic patients (19).

DIMAS is a health application developed in the form of a smartphone application that contains several functions to help clients in self-care practices. DIMAS was developed based on the Theory of Self-Care of Chronic Illness by Riegel, Jaarsma, and Stromberg (2018) with three components used to understand self-care behaviour such as self-care maintenance, self-care monitoring and self-care management. Self-maintenance includes lifestyle changes such as dietary management and increased physical activities, as well as medication adherence behaviour. Self-monitoring is indicated by regular blood sugar control, and regular foot checks. While self-management includes decision-making skills if there are emergency situation includes referral to health services (20). Based on these theories, DIMAS has three menus such as health education containing information about diabetes, nutrition, medication, exercise, stress management, and foot care; self-care monitoring containing medication reminders, blood sugar and exercise records; and consultation with the nurses. In the education menu, patients will be given information related to diabetes definition and symptoms, treatment, nutrition, physical activities program, stress management, foot care and additional information about COVID-19. The education menu also features a video of diabetic exercises that can be done in a sitting position and foot care guidelines. Additional information about COVID-19 is provided to reduce patient anxiety. The second function regarding monitoring system documentation in the form of a drug reminder system, blood glucose and blood pressure recording, and also physical activities.

Recording the value of physical activities, blood glucose and blood pressure recording, the data from the application will be stored in the application and will automatically be inserted into the website managed by the nurse. Nurses can monitor the health status and exercise activity, and responding to if there is a problem. The third function is a consultation menu that can be accessed by clients if they encounter problems. Nurses will intervene to improve self-management compliance by providing education each week on different topics through the application. Based on this, the purpose of this study is aimed to determine the effect of DIMAS (Diabetes Management Support) application on Diabetes Self-Management activities.

## **MATERIALS AND METHODS**

This research is using an experimental design with One Group Pre-Posttest Design. It was conducted in Kelurahan Mekarjaya Depok City Indonesia. The

research process consists of three stages, which is the first step is the application development stage, continued with intervention and the data collection as the last step. The selection of participants was conducted by purposive sampling in Posbindu (Pos Pembinaan Terpadu) activities at 5 sub-district and obtained by 24 participants. The inclusion criteria for participants: (1) had a type 2 DM and history of at least six months; (2) undergo treatment for at least three months; (3) > 18 years old; (4) participants or families who live at home have a smartphone; (6) can read and write; (7) able to perform activity daily living independently.

The intervention was carried out over four weeks by nurses using an application installed on the smartphone of each client or their family. The DIMAS application was installed on the patient's smartphone by the nurse after the initial assessment including name, age, mobile phone number and medical history. The data that has been obtained will then be entered into a server and used to set up a username and password. The participants are required to log in to the application using the username and password given by the nurse. Interventions were carried out by nurses using Diabetes Self-Management Education (DSME) and were conducted using the information that available in the application. The education process includes discussions using WhatsApp twice a week. The topic of the health education program includes understanding DM, nutrition management in DM, treatment management, physical activities, stress and coping management, foot care, and COVID-19 information. For the self-monitoring program, participants will be reminded to take medication through the reminder notification by the nurse according to the prescription. In addition, participants were also encouraged to record their blood sugar values, blood pressure and physical activities regularly. Blood sugar measurements are carried out independently once a week by patients who have blood sugar measurement devices, and community health cadres will help measure them once a week for those who do not have the devices. The data collection on the server were monitored by the nurse and used for decision making or provides advice according to the participant's condition. This process was carried out until four weeks. The nurse will contact the patient once a week by phone to make sure they use the application effectively.

The Summary of Diabetes Self-Care Activity (SDSCA) and knowledge questionnaire was measured before and after the intervention. The SDSCA is questionnaire was modification from Toobert et al (2000), which were contain 14 question. The SDSCA items covered four DSM behavioural domains: Blood glucose level (BGL) monitoring (two items), diet (six items), exercise (two items), and foot care (four items). Participants were asked to recall their activities for the last seven days and state the number of days they performed the behaviours,

after which the mean scores across each activity domain was calculated. This instrument uses an 8-point likert type scale (0-7), which represent frequency in number of days of self management practice was performed. The maximum mean score for each respondent in each domain was 7, while the minimum score was 0. The second questioner regarding client knowledge develop from literature research contains ten questions that include: definition of diabetes (two questions), dietary management (two questions), exercise (two questions), blood glucose control (one question), stress management (one question), and foot check (two questions). Improvement in each of the outcomes was defined by a statistically significant increase between the pre-and post-intervention scores. The maximum score is 100 and minimum score is 0 for each respondent. The internal reliability was tested using cronbach's alpha, which resulted in a coefficient of 0,855 and 0,643 for SDSCA and knowledge, respectively.

All quantitative data were analyzed using SPSS version 22. Outcome measures (pre-and post-intervention data) and the acceptability of the intervention were reported using means and standard deviations (SD). The paired sample t-test was used to evaluate changes in the outcomes. The significant level was set at  $p < 0,05$  for all analyses.

Ethical approval was granted by the Health Research Ethics Committee of Faculty of Nursing, Universitas Jember Number 142/UN25.1.14/KEPK/2021. Each respondent was given an informed consent before conducting the study. Respondent data will be kept confidential and will only be used for research purposes

## RESULTS

### Demographics Characteristic

The findings presented in Table I indicate that out of the total 24 participants, majority (95%) were female, the average age was 53 years old (SD 6,38; range 40-62 years). Most of the participants were diagnosed with DM type 2 between one and five years ago ( $n=16$ ; 66,7%), had an undergraduate or higher ( $n=10$ ; 41,7%). Participants reported their medication mostly metformin ( $n=16$ ; 66,7%).

### Diabetes Self-Management Activities

Self-management activity data in table II before the intervention showed that dietary management was done 5 days a week, blood sugar monitoring 3 days in a short period while exercise activity and foot examinations had low scores with scores of 1 day and 0.6 days per week respectively. In the data after the intervention, there was an increase in each activity with the highest average score on foot examination activity with a score increase of 2.35, while the lowest was diet management and blood sugar monitoring with scores of 0.62 and 0.69 respectively.

**Table I: Demography characteristics of the participants (n=24)**

Demographics	Value
a. Age (years) Mean (SD, range)	53 (6.38; 40-62 years)
b. Sex	
Male	1 (5%)
Female	23 (95%)
c. Time since diagnosis	
< 12 months	2 (8.3%)
1-5 years	16 (66.7%)
1-10 years	4 (16.7%)
> 10 years	2 (8.3%)
d. Education	
Elementary school	3 (12.5%)
Junior high school	5 (20.8%)
Senior high school	6 (25%)
Undergraduate or higher	10 (41.7%)
e. Medication	
- Metformin	16 (66.7%)
- Glibenclamide	2 (8.3%)
- Combination (Metformin + Glibenclamide/Acarbose)	6 (25%)

**Table II: Diabetes Self-Management Activities characteristics of the participants pre and post intervention (n=24)**

Component	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)
Diet	5.11 (1.10)	5.73 (0.72)
Physical Activity	1.93 (1.39)	2.79 (1.35)
Monitoring BGL	3.12 (0.94)	3.81 (0.34)
Foot check	0.66 (1.44)	3.01 (2.84)

Health education interventions provided by nurses through discussions via WhatsApp every two weeks help patients to understand about their disease and the treatment. Nurses also carry out follow-up monitoring once a week for each respondent to ask about their experiences and difficulties while using the application or entering data to application. However, in the implementation of recording BGL, only about 48% of patients enter data regularly as recommended. The most frequently reported that they often forget to report, lack of time and confusion about how to enter data into the application. Based on demographic data which is majority of the patients is the elderly, family assistance is needed for the data recording in the application.

**Diabetes Self-Care Activity (SDSCA) and Knowledge**

Table III shows the total mean scores of the SDSCA and participants knowledge about Diabetes before and after the intervention. At baseline, the total mean score in DSM activities was  $3,10 \pm 0,66$ . Data after the intervention showed an increase in the mean score of  $4.25 \pm 0.97$ . Participants’ knowledge before the intervention showed a score of  $64.17 \pm 11.38$  and after the intervention  $86.25 \pm 11.72$ . Comparison between pre-and post-intervention scores shows that diabetes self-management activities and knowledge significantly improved over time ( $p = 0.000$  respectively).

**Table III: Observed mean and standard deviations for the SDSCA and knowledge (n=24)**

Variable	Mean	SD	Std. Error Mean	p-value
<b>SDSCA</b>				
Pre-intervention	3.10	0.66	0.13	0.000
Post-intervention	4.25	0.97	0.19	
<b>Knowledge</b>				
Pre-intervention	64.17	11.38	2.32	0.000
Post-intervention	86.25	11.72	2.39	

**DISCUSSION**

Nutrition management and drug compliance are some of the activities that are quite good done by participants. Participants realized from experience that if not careful in food and taking medication it will raise blood sugar. Setting a diet by avoiding sweet foods is the most widely practised while eating according to schedule and the number of calories is not yet fully understood. The informational menu provided in the DIMAS application gives information about proper nutrition management including how to manage diets according to the amount, type, and schedule. Nurses also provide consultations about the number of calories intake according to the individual’s calorie needs. Other information provided is about the treatment, especially the type of drug and the side effect to make participants become more understanding of the consequences of the treatment. Health education with DSME and the use of DIMAS applications give clients the advantage of optimizing the 3 behavioural components in self-care of chronic illness. The prior study by Abdulrahman et al. (2020) provides the results that increasing knowledge with health education will increase understanding of the importance of self-care followed by improved behaviour (21).

Self-care management activities are one of the keys to the success of DM patients in improving glycemic control and preventing complications. In this study, participants reported that diet management and blood glucose monitoring by avoid high-carbohydrate foods and taking drugs were good enough, but activities that were still relatively low were exercise activities and foot care. Most participants stated that their reason for low scores in physical activities is they not getting used to doing exercise regularly. The data is also following the results of several studies on non-compliance with self-care management shown by diabetes patients which is non-compliance behaviour is most widely shown in exercise and foot care but in terms of adherence to taking drugs and diet relatively good (22).

Some studies suggest that obstacles in doing regular physical activities in DM patients include a lack of understanding and difficulty in doing exercise due to complications or diabetic foot, old age, lack of motivation and family support and inability to perform



physical activity (23,24). Whereas in practice, the benefits of exercise are useful to increase glycemic control because of the increase in insulin sensitivity (25). Physical activities that are recommended for DM patients are activities that are carried out regularly as much as three or five times per week for about 30-45 minutes, with a total of 150 minutes per week can improve the quality of life of people with Diabetes (26). Recommended exercise activities are swimming, brisk walking, cycling and jogging. Participants reported that they did not have free time to do regular exercise because of the household chores and were hindered to the exercise facility because of the distance and lockdown regulation. Lack of appropriate facilities/equipment/space during pandemic COVID-19 were most associated with decrease of physical activities level in patients with diabetes (27). After health education and the provision of exercise demonstration video material in the DIMAS application, participants stated that the video gives easy examples of how to exercise at home and gives the motivation to practice the movement. Communication with nurses who regularly ask about their physical activities also motivates participants.

Foot care are one of the activities that have the lowest score. The elderly factor becomes an obstacle in the implementation of foot care activities due to cognitive decline and difficulties to practice the procedures (28). Sari et al (2020) stated that the factors that affect low foot care activity in Indonesia are due to low knowledge and climate factors that make patients more comfortable wearing open sandals than shoes. Recommendations to improve knowledge and skills of foot care for people with DM are done by providing information through demonstrations that show how to do the procedure (29). In this study, the majority of participants said they had no prior information about foot care and never get an examination about the risk factor before. Therefore, in the education menu, the DIMAS Application provides a video of foot care that can be seen by participants so that they can practice what is exemplified. The increased of foot care activities carried out by participants were more to the practice of washing and cutting nails as recommended. One of the factors that encourages them to do foot care is the fear of the risk of complications of foot injuries. Fear of the consequences obtained if not doing the treatment will make DM patients motivated to carry out routine foot care (29). Participants who have experience of foot injuries or have a high risk of foot injuries will be motivated to do regular foot care. Participants who felt symptoms of numbness and dry skin tended to do regular foot care than those who did not feel the symptoms.

The factor of non-compliance in taking drugs is caused by "forgetfulness" especially in the elderly and becomes one of the determinants of low blood sugar control. Research by Adu et al. (2019) states that one of the causes of non-compliance of DM patients is their forgetfulness

and reminder system in application were found useful to give alert especially during busy schedule (30). The utilization of notification during applications, namely the DIMAS application is expected to be one of the efforts to overcome this problem. However, the results of the intervention provide data that the application is not optimal due to some obstacles, namely not being used to record and use applications felt more complicated. The process of filling in the treatment history data does not run optimally because diabetes says bother or do not have time to do a checklist. The limitation of the notification system is that it only provides notifications when taking medication, but does not give re-notifications when the checklist is not filled. This makes participants do not fill in the data even though they have done the medication or other self-care activities following the schedule. From the results of the interview obtained data from 8 clients, all said the application is useful and notification messages are very helpful to remind them to take the medication. This is in line with the results of a study by Goh et al. (2015) which illustrates that application use decreased in the first two weeks of use from 8 weeks of intervention (31). Consistent users were only 9% (8 out of 84) in 8 weeks of study. This is influenced by boredom from the respondents, difficulty in monitoring, busy work or have felt better without the help of applications. Supervision and monitoring of nurses are needed so that patients can better optimize the benefits of the application.

## CONCLUSION

The results showed that the use of mobile-phone applications to provide nursing interventions, especially in diabetes, has a significant impact on improving self-management practices. The application makes it easier for patients to keep connected with nurses despite being constrained by distance and provides practical benefits in nursing services at home. A joint program with the information system in medical health services and the possibility to install this platform in primary care's server can improve the quality of care in medical health services.

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