

Effect of mobile structured educational applications on self-care management in diabetes mellitus patients

Efecto de las aplicaciones educativas estructuradas móviles en el manejo del autocuidado en pacientes con diabetes mellitus

Devangga Darma Karingga^{1a}, Ferry Efendi^{2,a*}, Retno Indarwati^{3,a}, Angeline Bushy^{4b}

SUMMARY

Introduction: Self-care management is carried out independently by Diabetes Mellitus (DM) patients to meet their needs and control blood glucose. The inability to manage the disease independently can cause complications in people with DM. This study aims to determine the effect of structured educational applications to improve self-care management in people with DM. **Methods:** The research design was a quasy experimental. The research sample was Type 2 DM which, according to the inclusion and exclusion criteria, consisted of 134 people divided into the control and intervention groups. Data collection was carried out using a self-care management questionnaire. Data analysis used a statistical test to assess the effect of the intervention on the patient. **Results:** Based on

the Wilcoxon test, both groups showed a significant difference ($p < 0.05$), indicating that both are mutually influential. Based on the Mann-Whitney test, a significance value of 0.0001 was obtained for both groups. There was a difference in the gain value of 45.62 for the intervention group, indicating that the intervention group was higher than the control group.

Conclusion: Structured educational applications can be used as health education media for people with DM and have an impact on improving self-care management. Also, using the application makes it more accessible and efficient and saves enough operational costs compared to conventional/standard interventions.

Keywords: Non-communicable diseases, education, mHealth, self-care management, telemedicine, application.

RESUMEN

Introducción: El manejo del autocuidado para cubrir sus necesidades y controlar la glicemia lo realizan de forma independiente los pacientes con Diabetes Mellitus (DM). La incapacidad para manejar la enfermedad de forma independiente puede causar complicaciones en personas con DM. Este estudio tiene como objetivo determinar el efecto de aplicaciones educativas estructuradas para mejorar la gestión del autocuidado en personas con DM. **Métodos:** El diseño de investigación utilizado fue cuasiexperimental. La muestra de investigación fue DM Tipo 2, la cual, de acuerdo con los criterios de inclusión y exclusión, estuvo conformada por 134 personas que se dividieron en el grupo control y el grupo intervención. La recolección de datos se realizó mediante un

DOI: <https://doi.org/10.47307/GMC.2023.131.2.3>

ORCID: 0000-0002-0137-7120¹

ORCID: 0000-0001-7988-9196²

ORCID: 0000-0001-7153-9757³

ORCID: 0000-0003-0668-0417⁴

^aFaculty of Nursing, Universitas Airlangga, Surabaya, Indonesia

^bFaculty of Nursing, University of Central Florida, Florida

Correspondence: Ferry Efendi

E-mail: ferry-e@fkip.unair.ac.id

Recibido: 25 de enero 2023

Aceptado: 29 de marzo 2023

cuestionario de gestión del autocuidado. El análisis de datos utilizó una prueba estadística para evaluar efecto de la intervención en el paciente. Resultados: Con base en la prueba de Wilcoxon, ambos grupos mostraron una diferencia significativa ($p < 0,05$), lo que indica que ambos se influyen mutuamente. La prueba de Mann-Whitney indicó un valor de significancia de 0.0001 para ambos grupos, lo que demuestra que existe una diferencia en el valor de la ganancia de 45,62 para el grupo de intervención, lo que muestra que el grupo de intervención fue mayor que el grupo control. Conclusión: Las aplicaciones educativas estructuradas pueden ser utilizadas como medios de educación en salud para personas con DM e impactar en la mejora de la gestión del autocuidado. Además, el uso de la aplicación la hace más accesible y eficiente y ahorra suficientes costos operativos en comparación con las intervenciones convencionales/estándar.

Palabras clave: *Enfermedades no transmisibles, educación, mHealth, gestión del autocuidado, telemedicina, aplicación.*

INTRODUCTION

Self-care management is the care and encouragement provided to people with long term health conditions and their families to help them understand their role in managing independently their condition better on a day to day basis, allowing the patients to develop skills in solving problems, increasing self-confidence, and supporting the application of knowledge in real life (1). The vast majority of day-to-day care of patients with Diabetes Mellitus (DM) is handled by patients and/or their families (2). DM is associated with complications such as cardiovascular diseases, nephropathy, retinopathy and neuropathy, which can lead to chronic morbidities and mortality, which tends to increase and worsen due to the inability of patients to manage their disease independently (3). Based on data from The International Diabetes Federation (IDF), the number of people with DM was around 463 million people aged 20-79 years in the world who have diabetes in 2019, and it was estimated that by 2 045 this would increase to 700 million (4). The prevalence of DM sufferers in Indonesia in 2018 increased by 8.5 % of Indonesia's population (5), and based on data from the Gondang Public Health Center

in Tulungagung Regency, the number of DM individuals for the last three years recorded 432 patients in 2019, 457 patients in 2018, 2020 and 2021.

The knowledge of self-care management in patients with DM allows them to manage their care effectively, because patients have an essential role in managing their disease (6). Self-care is a form of behavior in maintaining life, health, development, and life around it (7). In the concept of self-care, a person should be able to take responsibility for self-care and be involved in making decisions for his health (8). Diabetes self-care activities are behaviors undertaken by people with or at risk of diabetes in order to successfully manage the disease on their own, and will be successful, or not, depending on the motivation for care and self-awareness, specifically designed to control symptoms and avoid complications (9). There are essential self-care behaviors in people with diabetes which predict good outcomes. These are healthy eating, being physically active, monitoring of blood sugar, compliant with medications, good problem-solving skills, healthy coping skills and risk-reduction behaviors. Education is one of the critical pillars that must be given to people with DM to promote healthy living and holistically improve DM management and management (10). Providing structured education to patients and families is very important for the successful, safe management of hyperglycemia and diabetes in the hospital. Structured diabetes education is an evidence-based intervention that promotes diabetes self-management in people with DM and meets nationally agreed-upon criteria such as an evidence-based curriculum, quality assurance of teaching standards, and regular audits (11,12). It gives people with diabetes the knowledge, skills, and confidence they need to manage their condition on their own successfully. It has also improved essential health outcomes like glycaemic control, quality of life, and self-management skills (13). As a result, it became a critical intervention that promotes diabetes self-management (14,15).

The application of nursing to patients with diabetes is recommended to investigate the impact of technological innovations in improving care management and medical outcomes and

prevention of diabetes complications with reasonable glycemic control. Telenursing also involves a process of health education for patients, as well as the existence of a referral system. Efforts to carry out education in order that health information could be conveyed more clearly, thus receiving clear and precisely information, using different media such as the form of print media, billboard media, and electronic media (16). On the other hand, telenursing is mandatory for a therapeutic relationship between a nurse or medical staff and a patient, which can be done through communication media such as the telephone or media that supports telenursing (17). The study results of Kumar et al. (2020) show that a technology-based approach can be used as a media benchmark for public health to improve the quality of life for patients with type 2 DM (18).

Howland et al. (2020) in their study to evaluate the differences in the types of nursing activities and communication processes reported in a primary care clinic between patients who used a home-based monitoring system to electronically communicate self-monitored blood glucose and blood pressure values and those who assumed usual care, demonstrated that a greater nursing activity was reported in a primary care clinic in patients who utilized a home-based monitoring system (20). Similarly, Wang et al. demonstrated that mobile health smartphone application was effective to support self-management programmes on quality of life, self-management behaviour and exercise and smoking cessation behaviour in patients with chronic obstructive pulmonary disease (19). Although these studies (19,20) show that mobile health apps and home-based monitoring systems can promote self-care management, they do not compare to other interventions such as traditional diabetes education programs and structured diabetes education. To understand the potential impact of mobile structured educational applications, comparing them to other interventions to assess the effectiveness in improving self-care management in DM patients, this study aimed to examine the impact of mobile structured educational apps on self-care management in people with diabetes mellitus.

METHODS

This research was initiated by exploring strategic issues, expert consultation, Focus Group Discussion (FGD), due diligence, and outreach, followed by large-scale trials. This research used a Quasy Experiment study, with the "pre and post-test with control group design". This design uses an experimental group and a control group.

The subjects in this study were patients with DM in the Gondang Public Health Center, Tulungagung Regency, East Java Province, Indonesia. The inclusion criteria for this study were 1) Patients who have had DM for more than six months, 2) Can read and write, can speak Indonesian well, have a level of compos mentis awareness, 4) Patients or their families have and can operate a smartphone android-based, and 5) Patients who are willing to be respondents in the study. The study exclusion criteria were 1) Patients with DM with physical limitations such as blind, deaf, and mute, 2) Patients with an educational background in the health sector, and 3) Patients working in the health sector. The subjects of this study were divided into two groups: 1) the group that received intervention using a mobile structured educational application using Android, and 2) the non-intervention group was given standard health promotion at the Gondang Public Health Center. The sample calculation was carried out using the G Power sample calculation formula version 3.1 and was then divided into two groups: the intervention group and the control group.

It was obtained permission from the Health Research Ethics Committee of the Faculty of Nursing, Airlangga University, Surabaya, with number 2584-KEPK. The researcher requested a research permit from the Tulungagung District Health Office and, requested for data on DM patients. Research location was based on the highest prevalence of DM in the work area of the Tulungagung District Health Center. Several health workers from public health center team, such as nurses, nutritionists, and health promotion teams, each with one person participated in the study.

The measuring tool in the form of a questionnaire was tested for the validity and reliability of the questionnaire on respondents with type 2 DM patients who were not research subjects and had the same characteristics. The System Usability Scale (SUS) Questionnaire in Indonesia was developed in Indonesian by Sharfina & Santoso (2016) with a Cronbach's Alpha value of 0.841, which concluded that this version was reliable for use (21). All question items are valid with $r_{count} > r_{Table}$ value $0.528 - 0.916 > 0.3961$ and reliable with Cronbach's alpha results of 0.947. The Diabetes Self-Management Questionnaire (DSMQ) was used to observe and measure self-care behaviour before and after being given an intervention. DSMQ consisted of 16 questions and four domains: glucose management, diet control, physical activity, and health care, detail questions in Figure 1 (22,23). The self-care level was divided into two groups: lousy self-care level ≤ 6 and 6-10 good self-care level (24).

The pre-test was conducted to determine and measure the respondents' self-care management level. The next stage is the determination of the non-intervention group and the intervention group so that the total number of respondents who have

been obtained will be divided into two groups. The structured educational intervention group used Android (Figure 2), while the non-intervention group only received standard treatment provided by the health promotion team at the public health center. Structured education was carried out for six weeks, which was divided into four sessions of providing visual educational notifications in the form of digital text and images and two face-to-face online education sessions with a duration of ± 60 minutes by presenters from researchers in the first week and the Gondang Public Health Center team in the second week, the Gondang Public Health Center team consists of health promotion and nurses. Previously, the research team and the Gondang Public Health Center team attended Android application training three times a week to control the quality of education for all educators. At the end of the meeting session, self-care management was re-measured using the same instrument. All the analyses were carried out using SPSS version 2.6 with the Wilcoxon Signed Rank Test to assess the distribution of respondents in each dependent variable before and after the intervention and to evaluate differences in the control and treatment groups using the Mann-Whitney test. A P-value of < 0.05 was considered significant.

Diabetes Self-Management Questionnaire (DSMQ)				
The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the last 8 weeks, please specify the extent to which each statement applies to you.	Applies to me very much	Applies to me to a considerable degree	Applies to me to some degree	Does not apply to me
1. I check my blood sugar levels with care and attention. <input type="checkbox"/> Blood sugar measurement is not required as a part of my treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
2. The food I choose to eat makes it easy to achieve optimal blood sugar levels.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
3. I keep all doctors' appointments recommended for my diabetes treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
4. I take my diabetes medication (e. g. insulin, tablets) as prescribed. <input type="checkbox"/> Diabetes medication / insulin is not required as a part of my treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
5. Occasionally I eat lots of sweets or other foods rich in carbohydrates.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
6. I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). <input type="checkbox"/> Blood sugar measurement is not required as a part of my treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
7. I tend to avoid diabetes-related doctors' appointments.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
8. I do regular physical activity to achieve optimal blood sugar levels.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
9. I strictly follow the dietary recommendations given by my doctor or diabetes specialist.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
10. I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control. <input type="checkbox"/> Blood sugar measurement is not required as a part of my treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
11. I avoid physical activity, although it would improve my diabetes.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
12. I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets). <input type="checkbox"/> Diabetes medication / insulin is not required as a part of my treatment.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
13. Sometimes I have real 'food binges' (not triggered by hypoglycaemia).	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
14. Regarding my diabetes care, I should see my medical practitioner(s) more often.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
15. I tend to skip planned physical activity.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
16. My diabetes self-care is poor.	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0

Figure 1. List Questions of The Diabetes Self-Management Questionnaire (DSMQ).

(Source: The Diabetes Self-Management Questionnaire (DSMQ): development and evaluation of an Instrument to assess diabetes self-care activities associated with glycaemic control)

EFFECT OF MOBILE STRUCTURED EDUCATIONAL APPLICATIONS

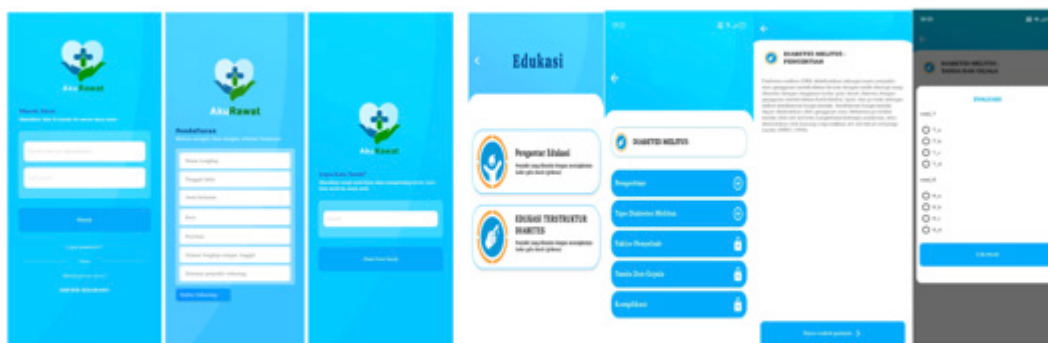


Figure 2. Structured Education Application Main Menu (Registration and Education).

RESULTS

At the intervention stage, structured educational applications were conducted after socialization using 134 DM patients. Table 1 shows that most respondents were aged 46-50 years in both groups (56.7 % and 62.7 %). The sex of DM patients in the intervention and control group was mainly female (55.2 % and 59.7 %). The most recent education in the intervention

group was in elementary school (49.3 %), while in the control group, most were junior high school (38.8 %). Most respondents in both groups were married, with 97 % of the intervention group and 98.5 % of the control group. In both groups, most respondents were farmers (52.2 % and 59.7 %, intervention, and control, respectively). And most of the respondents had DM for more than five years in the intervention (62.7 %) and control groups (94.0 %).

Table 1. Respondent's Characteristics

Characteristics		Intervention group (n-67)		Control group (n-67)	
		n	%	n	%
Age	41-45 years	24	35.8	22	32.7
	46-50 years	38	56.7	42	62.7
	51-55 years	5	7.5	3	4.5
Sex	Male	30	44.8	27	40.3
	Female	37	55.2	40	59.7
Education	Elementary school	33	49.3	24	35.8
	Junior high school	21	31.3	26	38.8
	Senior high school	13	19.4	17	25.4
Marital status	Marriage	65	97.0	66	98.5
	Not Marriage	2	3.0	1	1.5
Job	Self-employed	20	29.9	21	31.3
	Private sector employee	12	17.9	6	9.0
	Farmer	35	52.2	40	59.7
Length of illness with DM	≤ 5 years	25	37.3	4	6.0
	> 5 years	42	62.7	63	94.0

Based on the evaluation of self-care management in DM patients at the Gondang Health Center, it was found that most self-care management before using the structured education application was in a bad category, both in the intervention group (86.6 %) and the control group (91 %). After being given intervention for six weeks, it was seen that self-care management in DM patients after using structured educational

applications in the intervention group, most respondents (82.1 %) had self-care management in the excellent category. Whereas in the control group, as a comparison, it was found that most respondents had self-care management in the bad category (77.6 %). These data indicate that many intervention groups experienced increased self-care management from bad to good (Table 2).

Table 2. Self-care Management Pre-Test and Post-Test Results

Variable		Category Intervention (n-67)		Control (n-67)	
		Frequency	Percentage	Frequency	Percentage
Self-care Management	PRE-TEST				
	Bad	58	86.6	61	91.0
	Good	9	13.4	6	9.0
	POST-TEST				
	Bad	12	17.9	52	77.6
	Good	55	82.1	15	22.4

Wilcoxon test was carried out on the self-care management intervention group showing a significant yield value of 0.0001. It can be stated that structured educational applications have an effect. The result of the mean difference between the pre-test and post-test (Δ) of the variable self-care management in the intervention group was 0.6866. It was positive that providing structured educational applications improved self-care management in people with DM. While the control group produced a significance value of 0.0001, it can be stated that there is a significant difference between the pre-test and post-test. The results of the average difference between the pre-test and post-test (Δ) of the self-care

management variable in the control group were 0.1343 and were positive. However, the average difference was far below the difference between the intervention group's pre-test and post-test (Δ). While the difference in the average gain between the intervention group and the control group is positive, namely 45.62, meaning that the provision of structured educational applications can improve self-care management in patients with DM in the intervention group (Table 3). Based on the results of the Mann-Whitney test showing that the p-value is 0.0001, it can be stated that structured educational applications have a significant effect on self-care management in people with DM.

Table 3. Statistical test pre-test and post-test in each group

Variable	Group	Test	\bar{x}	SD	Δ	Z score	Sig.
Self-care Management	Intervention	Pre-test	1.1343	0.34358	0.6866	-7.177	0.0001
		Post-test	1.8209	0.38633			
	Control	Pre-test	1.0896	0.28769	0.1343	-7.175	0.0001
		Post-test	1.2239	0.41999			

DISCUSSION

Self-care management can enable patients to develop problem-solving skills, support the implementation of their knowledge into real life, and increase self-confidence (1). Patients and their families handle most of the problems in treating patients with DM (2). The complication rate of DM patients tends to increase and gets worse due to the patient's inability to manage the disease independently (3), that's way there is a need for reliable and valid self-care management in patients with DM (25). Knowledge of diabetes self-management is necessary for patients because patients have an essential role in managing their disease (6). Self-care is a behaviour in maintaining life, health, development, and life around it (7). In the concept of self-care, a person should be able to take responsibility for self-care and be involved in making decisions for his health (8). Self-care management of DM is successful or not depending on the motivation for care and self-awareness, specifically designed to control symptoms and avoid complications (9).

Primary health care nurses should introduce DM patients about the prevention and treatment of DM through health education and by equipping with the necessary screening and medication. Diabetes education is important, but it must be transferred to action or self-care activities to fully benefit the patient. Patient education is essential to raise awareness about DM due to ignorance and misunderstanding that is still widespread today (26). Most patients with diabetes can significantly reduce the chances of developing long-term complications by improving self-care activities. Despite this fact, compliance or adherence to these activities has been found to be low, especially when looking at long-term changes. That is why efforts are required for education in order to succeed in the transmission of all health information clearly and precisely. Thus for this purpose, media or tools are needed in the form of print media, billboard media, and electronic media (16). Implementation through structured health education is carried out in a programmed and systematic manner and is supported by specific methods needed by DM patients (27). It involves telenursing, which carries out the process of providing health

education and patient referrals. On the other hand, the therapeutic relationship between a nurse and her patient is still needed in the implementation of telenursing by using infrastructure such as internet and telephone networks and or using other media (17). This technology approach can be used as a benchmark for public health management to improve patient's quality of life with DM. This research was conducted to ensure the targets and goals for using the applications required for current needs of DM patients.

The results of self-care management in this study for the intervention group were better than the control group, which was given standard intervention from the public health center, even though both had the same effect on improving self-care management. Our results also reveal that the use of applications is more accessible, more efficient, and quite economical compared to conventional/standard interventions. In line with our results, Li et al. (28) stated that compared with the usual care mode, the mobile Health management model for patients with Type 2 DM improved the control rate of Haemoglobin A1c, and the mobile Health management mode had better cost effectiveness. Similarly, Boels et al. evaluated the effectiveness of diabetes self-management education via a smartphone app in DM patients on insulin therapy and showed that education that sends automated application messages that act as behavioral triggers require less effort from healthcare providers and patients and can be a low-cost solution compared to other strategies. The authors stated that innovative solutions are needed to improve the cost- effectiveness of self-management for the increasing number of T2DM patients, and indicating that this trial will provide evidence on the effectiveness of a newly developed smartphone app, designed to trigger diabetes self-management (29). It was also consistent with the findings of Wang et al. who demonstrated that mobile health apps effectively improved self-management behaviors and quality of life in patients with chronic diseases (19). The mobile phone-based reminder and monitoring system encouraged patients to take steps toward better diabetes management (30). So that from the many possibilities, this structured educational application can be one of the interventions that are pretty effectively implemented and answer

the research hypothesis as a medium that can be implemented as an intervention in improving self-care management, especially in people with DM.

Structured education application and standard health promotion are two distinct approaches to improving self-care behavior in people with DM, and they influence behavior change in different ways. Structured educational apps deliver personalized, interactive educational content that users can access at any time, and they frequently include behavior-change-supporting features like goal setting and tracking. Individuals can take a more active role in their care and receive real-time feedback, which can help reinforce positive behaviour (31,32). On the other hand, standard health promotion relies on face-to-face interactions between patients and healthcare providers to help build rapport and trust. Providers can personalize their approach to individual patient needs and address behaviour change barriers. This approach may be especially beneficial for patients who require more intensive care or have complex healthcare requirements (30,33). In some cases, combining the two approaches may most effectively encourage people with diabetes to change their self-care behaviours (30). Overall, the two approaches have their own strengths and limitations, and the chosen approach may be determined by each patient's needs, preferences, and resources.

CONCLUSION

It was determined that structured educational applications increased self-care management, carried out for six weeks in people with DM. The use of the application was more influential when compared to the control group using conventional/standard interventions. On the other hand, the findings indicate that the application is more accessible, more efficient, and saves enough operational costs compared to conventional/standard interventions. Thus, we can state that the use of this application is deemed worthy of being an intervention, and it can be developed according to the needs or conditions in improving self-care management in people with DM and other conditions.

REFERENCES

1. Grady PA, Gough LL. Self-management: A comprehensive approach to the management of chronic conditions. *Am J Public Health*. 2014;104(8):e25-31.
2. Bayem M V, Oriaran MB, Olugbade AC, Ogbu DO. Self-Care Challenges among Diabetic Patients in a South-Southern Teaching Hospital, Nigeria. *Int J Caring Sci*. 2019;12(2):906-915.
3. American Diabetes Association. Standards of Medical Care in Diabetes-2018 Abridged for Primary Care Providers. *Clin Diabetes*. 2018;36(1):14-37.
4. The International Diabetes Federation. Diabetes facts & figures. About Diabetes. 2021. Available from: [https://idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html#:~:text=Almost 1 in 2 \(240,living with type 1 diabetes](https://idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html#:~:text=Almost 1 in 2 (240,living with type 1 diabetes)
5. Ministry of Health. Infodatin Diabetes Mellitus. Jakarta, Indonesia; 2020.
6. Harris AN. Diabetes Self-management Education Provision by an Interprofessional Collaborative Practice Team: A Quality Improvement Project. *Nurs Clin North Am*. 2019;54(1):149-158.
7. Wang Z, Yin G, Jia R. Impacts of self-care education on adverse events and mental health-related quality of life in breast cancer patients under chemotherapy. *Complement Ther Med*. 2019;43:165-169.
8. Alligood MR. *Nursing Theorists and Their Work*. 9th edition. Elsevier; 2018.
9. Agustiningrum R, Kusbaryanto K. The Effectiveness of Diabetes Self Management Education on Self Care for Patients with Diabetes Mellitus: A Literature Review. *J Keperawatan Respati Yogyakarta*. 2019;6:558.
10. PERKENI. Pedoman Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 Dewasa di Indonesia [Guidelines for the Management and Prevention of Type 2 Diabetes Mellitus in Adults in Indonesia]. PB PERKENI; 2021.
11. Diabetes UK. Diabetes self-management education. 2022. Available from: <https://www.diabetes.org.uk/professionals/resources/resources-to-improve-your-clinical-practice/diabetes-self-management-education>
12. Findlay-White F, Slevin M, Carey ME, Coates V. "What's the point?": Understanding why people with type 2 diabetes decline structured education. *Clin Diabetes*. 2020;38(2):166-75.
13. Diabetes UK. Getting more of your patients on diabetes education courses. 2018:1-4.
14. National Institute for Health and Care Excellence (NICE). Type 2 diabetes in adults: management. Type 2 diabetes adults Manag. 2022 (March). Available from: <https://www.ncbi.nlm.nih.gov/books/NBK553486/>

15. National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: Diagnosis and management [B] Evidence reviews for continuous glucose monitoring in adults with type 1 diabetes. Type 1 Diabetes in Adults: Diagnosis and Management. National Institute for Health and Care Excellence (NICE); 2022:1-89.
16. Budhirianto S, Sumiaty N. SAPAWARGA Application as a Media for Communication and Information to the Community Regarding the COVID-19 Pandemic. *J Ekon Sos Hum*. 2022;3(05):35-53.
17. Scotia N. Practice Guidelines Telenursing. 2017:1-14.
18. Sunil Kumar D, Prakash B, Subhash Chandra BJ, Kadkol PS, Arun V, Thomas JJ. An android smartphone-based randomized intervention improves the quality of life in patients with type 2 diabetes in Mysore, Karnataka, India. *Diabetes Metab Syndr*. 2020;14(5):1327-1332.
19. Wang L, Guo Y, Wang M, Zhao Y. A mobile health application to support self-management in patients with chronic obstructive pulmonary disease: a randomised controlled trial. *Clin Rehabil*. 2021;35(1):90-101.
20. Howland C, Despina L, Sindt J, Wakefield B, Mehr DR. Primary Care Clinic Nurse Activities with a Telehealth Monitoring System. *West J Nurs Res*. 2020;43(1):5-12.
21. Sharfina Z, Santoso H. An Indonesian Adaptation of the System Usability Scale (SUS). In: *The 8th International Conference on Advanced Computer Science and Information Systems (ICACSIS) 2016*. 2016.
22. Schmitt A, Gahr A, Hermanns N, Kulzer B, Huber J, Haak T. The Diabetes Self-Management Questionnaire (DSMQ): Development and evaluation of an instrument to assess diabetes self-care activities associated with glycaemic control. *Health Qual Life Outcomes*. 2013;11(1):1-14.
23. Ramadhani S, Fidiawan A, Andayani T, Endarti D. The Effect of Self-Care on Fasting Blood Glucose Levels in Type-2 Diabetes Mellitus Patients. *J Manaj DAN PELAYANAN Farm (Journal Manag Pharm Pract*. 2019;9(2).
24. Ang Ju Ying, Leo J-S, George D, Chan H-K. Inadequate Self-Care Behaviors among Malaysian Diabetic Patients: The Need for Action by Hospital Pharmacists. *J Pharm Pract Community Med*. 2018;4(2):51-54.
25. Larsen PD. *Lubkin's Chronic Illness: Impact and Intervention*. 10th edition. Jones & Bartlett Learning; 2017. Available from: <https://books.google.co.id/books?id=V5hIDwAAQBAJ>
26. International Diabetes Federation. Recommendations for managing Type 2 diabetes in primary care. *Diabetes Research and Clinical Practice*. 2017:5-20.
27. Wayunah W, Saefulloh M, Nuraeni W. Implementation of Structured Education Increases Self Efficacy and Reduces IDWG of Hemodialysis Patients at Indramayu Hospital. *J Pendidik Keperawatan Indones*. 2016;2:22.
28. Li J, Sun L, Hou Y, Chen L. Cost-Effectiveness Analysis of a Mobile-Based Intervention for Patients with Type 2 Diabetes Mellitus. *Int J Endocrinol*. 2021;(28):2021.
29. Boels AM, Rutten G, Zuithoff N, De Wit A, Vos R. Effectiveness of diabetes self-management education via a smartphone application in insulin-treated type 2 diabetes patients - Design of a randomised controlled trial ('TRIGGER study'). *BMC Endocr Disord*. 2018;18(1):1-10.
30. Banu B, Ko KC, Khan MMH, Ali L, Barnighausen T, Sauerborn R, et al. Effects of traditional versus m-Health educational interventions for diabetic patients: A randomised controlled trial in peripheral district of Bangladesh. *Diabetes Epidemiol Manag*. 2023;9:100106.
31. Liu K, Xie Z, Or CK. Effectiveness of mobile app-assisted self-care interventions for improving patient outcomes in type 2 diabetes and/or hypertension: Systematic review and meta-analysis of randomized controlled trials. *JMIR mHealth and uHealth*. JMIR Publications Inc. 2020;8.
32. Esferjani SV, Naghizadeh E, Albokordi M, Zakerkish M, Araban M. Effectiveness of a mobile-based educational intervention on self-care activities and glycemic control among the elderly with type 2 diabetes in southwest of Iran in 2020. *Arch Public Heal*. 2022;80(1):1-9.
33. Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National Standards for Diabetes Self-Management Education and Support. *Diabetes Educ*. 2017;43(5):449-464.