REVIEW : THE EFFECT OF MEDICATION REMINDER APPLICATIONS ON MEDICATION COMPLIANCE IN TYPE 2 DIABETES MELLITUS PATIENTS

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ABSTRACT

Diabetes Mellitus (DM) is a medical disorder that is characterized by elevated blood glucose levels. Its prevalence is increasing globally, with Indonesia projected to have 21.3 million type 2 DM patients by 2030. Medication compliance is crucial in managing diabetes, and medication reminder applications can effectively enhance patient adherence. We conducted a systematic review of 10 national and international journals from to 2013-2023 using PubMed, Google Scholar, and Science Direct, focusing on the following keywords: Diabetes, Medication Compliance, Medication Reminder Application. Our findings suggest that patient knowledge and compliance play a pivotal role in the success of therapy management and that medication reminder applications have a positive impact on enhancing medication adherence. Ensuring that patients with diabetes have access to these tools may improve treatment outcomes.

Keywords: Diabetes Mellitus Type 2; Medication Compliance; Medication Reminder Application, Medication Adherence; Medication Reminder App

INTRODUCTION

Diabetes mellitus (DM) is a medical condition characterized by elevated blood glucose levels beyond normal levels or hyperglycemia. Diabetes mellitus (DM) is currently one of a global health concern. Epidemiological studies have shown an increasing trend in the incidence and prevalence of type 2 DM in various parts of the world. The WHO Organization predicts an increase in the number of patients with type 2 DM in Indonesia from 8.4 million in 2000 to approximately 21.3 million in 2030. The International Diabetes Federation (IDF) prediction also shows that in 2019–2030, the number of DM patients from 10.7 million to 13.7 million in 2030. (PERKENI, 2021)

Based on data from the Indonesian Central Bureau of Statistics in 2003, it is estimated that the Indonesian population over the age of 20 years was 133 million, with a DM prevalence of 14.7% in urban areas and 7.2% in rural areas, and it is estimated that in 2003 there were 8.2 million DM patients in rural areas. Based on population growth patterns, it is estimated that by 2030, there will be 194 million people over the age of 20, and assuming the prevalence of DM in urban (14.7%) and rural (7.2%) areas, there will be 28 million diabetes patients in urban areas and 13.9 million in rural areas. The 2018 Basic Health Research (RISKESDAS) Report by the Ministry of Health showed an increase in the prevalence of DM to 8.5%. (PERKENI, 2021)

Compliance is the level of accuracy of an individual's behavior through the provision of advice through media or health services, and describes the use of drugs according to the instructions on the prescription. Compliance in taking daily medication is the behavior to obey the doctor's suggestions or procedures regarding the use of drugs, which was previously preceded by a consultation process between the patient and the doctor as a health service provider (Pratiwi and Widayati, 2021).

Non-adherence to medication in patients with DM is associated with an increased risk of complications, increased mortality, increased use of services, increased health care costs, decreased quality of life, and even an increased economic burden on the country. The reasons why patients did not take medication were late to redeem the medicine (86.4%), forgetting (77.3%), feeling healthy (27.3%), feeling the medicine has no effect (18.2%), feeling side effects (13.6%), not understanding how to use the medicine (4.6%), and feeling that there are many drugs to take (4.6%). The patient had a busy activity so that the did not have time to check with the hospital, which resulted in the patient being late in redeeming the medicine. Patients admitted that they did not feel worried that the delay in redeeming medicine and a few days without medicine would have an impact on their health. Busyness also resulted in patients forgetting to take their medication. In addition, patients are admitted to forgetting because of traveling and forgetting to bring medicine (Srikartika, 2016).Click or tap here to enter text.

Health worker intervention is an action taken by health workers to assess, maintain, improve, and change health behaviors. Interventions can be in the form of follow-up (home care, teleconference), reminder media (short message service/SMS, WhatsApp/WA, telephone), pillbox/calendar packs (medication aids), training, booklet media, and special drug packaging. Interventions were conducted using a single model or a combination of several intervention models. Interventions can lead to improved medication knowledge, medication confidence, improved patient quality of life, as well as ways to prevent and reduce adverse events due to medication mismanagement. The role and ability of health workers to provide interventions to patients will have an impact on behavioral change. One behavior that is important in ensuring the success of patient therapy goals is patient compliance in carrying out therapy (Pratiwi and Widayati, 2021).

Some of the factors that cause patient noncompliance are the complexity of the therapy that patients receive, causing patients to forget to take medication or not comply with the prescribed medication schedule. This has encouraged efforts to improve patient compliance. This literature review is expected to illustrate the role of a health worker, in this case, a pharmacist, who can provide interventions that can be carried out through complete, accurate, and structured education or counseling. Counseling must be done correctly, easily understandable, accurate, and unbiased so that patients can comply with drug use regulations in accordance with the provisions, control disease conditions, and improve their quality of life. Providing education and counseling about the Reminder to Take Medication application is one of the interventions carried out to solve the problem of non-adherence to taking medication related to patients forgetting to take medication so that it can improve patient compliance.

RESEARCH METHODS

The method used in this research is the Literature Review method, which is a study conducted by analyzing and reviewing selected literature from various official sources that can be a conclusion. The journals selected in this study discussed topics with 3 keyword categories: Diabetes Mellitus Type 2, Medication Adherence; Medication Reminder App. This academic journal search was conducted through online databases, namely PubMed, Google Scholar, and Science Direct, and the majority of articles used were the latest articles written within the last 10 years, namely from to 2013-2023. The initial number of studies was 30 articles. The articles then resulted in 10 articles (published from 2015 to 2023) that provided information on the prevalence of type 2 diabetes mellitus, the effect of the Medication Reminder App, and pharmacist interventions to improve medication adherence in Type 2 Diabetes Mellitus patients. These articles were selected based on internationally published and Scopus-indexed journals. A comparative approach is used in this review. The contrastive approach is a technique for evaluating journals and articles, which involves identifying contrasts across multiple research journals before drawing conclusions. Prospective intervention studies, which aim to evaluate the impact of using a Medication Reminder App offered by pharmacists or other health professionals on improving medication

adherence in patients with type-2 diabetes mellitus, are a frequently used approach in the papers to be examined. To reduce bias, inclusion and exclusion criteria were established. Articles were included in this review if they met the following inclusion criteria: 1) patients were on T2DM treatment, 2) discussed the effect of medication reminders, 3) there were measurements of adherence parameters of hypoglycemic medication use and/or blood sugar levels before and after the intervention, and 4) were primary articles. The exclusion criteria were as follows: 1) articles in the form of theses, theses, and dissertations.

RESULTS AND DISCUSSION

The results of research at both the national and international levels show that medication reminder applications can increase adherence. Considering the influence of intervention tools, more appropriate and effective education can be chosen to improve individual self-care and independence, and as a result, the cost and duration of hospitalization can be reduced. reduce. The results of research on 10 journals using various methods showed that changes and increases in medication adherence scores increased in the medication application group (**Table I**). Results a literature review by Wanto Juli Silalahi (2021) regarding the Effect of Short Message Reminders (SMS) in Medication Compliance in T2DM Patients: The literature shows that the SMS reminder method can increase medication adherence in T2DM patients.(Silalahi, 2021reviewed the literatureew using the systematic review method by Tifanny Gita Cesaria eal.al (2021) regarding the Effectiveness of Smartphone and Non-Smartphone Application Managemenon t onhyperglycemiciregulationon in T2Dpatients and showedws that the provision of counseling and information books (booklets) can increase adherence to therapy in T2DM patients (Gita Cesaria, 2021). Furthermore, the results of research using the analytical modeling method conducted by Varshney and Singh on analytical models for evaluating reminders for adherence to therapy show that environment-appropriate reminders are more effective than simple reminders for consenting patients, even when they are entirely dependent on a reminder to take dose (Varshney and Singh, 2020). Research conducted by Zhilian Huang, MPH, et al. using a research method, namely a case control study that examined smartphone applications to increase medication compliance in T2DM patients in Asia, showed that the average level of medication compliance for participants throughout a 12-week period between 38.3% and 100% of the intervention group was monitored by the app. Most participants (>80%) concurred that the app was simple to use and increased their adherence to therapy. Therefore, it may be concluded that smartphone applications among non-adherent type 2 diabetes patients are acceptable, raise medication adherence knowledge, and lower self-reported obstacles to medication adherence (Huang et al., 2019). Furthermore, According to the analysis conducted by Posadzki et al. using a randomized control trial research method, they examined automatic telephone communications for health promotion care and long-term condition management, and found that automated telephone communication system (ATCS) interventions have a positive impact on a number of crucial areas, including immunizations, screening, appointment attendance, and adherence to medications or tests. They can also change patients' health behavior, improve clinical outcomes, and increase the use of health services (Posadzki et al., 2016). Furthermore, the explanation was also explained by Türkan Akyol Güner and Gülhan Cos¸ ansu, who explained that there were statistically significant variations in HbA1c, fasting blood sugar, lipids (apart from triglycerides), blood pressure, body mass index, and weighing findings between the intervention and control groups ($p < 0.001$). With the conclusion that there were statistically significant differences between the intervention group and the control group, there were significant differences in HbA1c, fasting blood sugar, lipids (other than triglycerides), blood pressure, body mass index, and weight (p 0.001). For better metabolic control and illness management, patients with type 2 diabetes mellitus benefit from diabetes education and SMS reminders sent every six months (Güner and Coşansu, 2020). A similar thing was done by Urip Harahap et al with the title the impact of diabetes education and SMS (short messaging service) reminders on disease management and metabolic control in

T2DM patients with a conclusion. Research shows that more patients had knowledge of 12 (40%) and 14 (46.67%), respectively. It can be conclution that more intensive outreach is needed regarding the use of medication reminder applications in order to increase patient compliance (Urip Harahap et al., 2020). Furthermore, Rosie Dobson, et al in the article entitled The purpose of this study was to investigate the efficacy of a text message-based, diabetic self management assistance program (SMS4BG) in a two arm, parallel randomized controlled trial and to modify the findings conceptually. Individualized, text message-based diabetes self-management support intervention (SMS4BG) was found to reduce HbA1c significantly more in the intervention group (mean -8.85 mmol/mol, standard deviation 14.84) than in the control group (-3.96 mmol/mol, 17.02) in adults with poorly controlled diabetes; P = 0.007 for the adjusted mean difference of -4.23 (95% CI -7.30 to -1.15). At nine months, only four of the 21 secondary outcomes provided statistically significant support for the intervention group. Health status on the EQ-5D visual analog scale (4.38 (0.44 to 8.33), P= 0.03), perception of disease identity (-0.54 (-1.04 to -0, 03), P=0.04), and foot care behavior all showed significant improvements (adjusted mean difference 0.85 (95% confidence interval 0.40 to 1.29), P0.001). A high degree of satisfaction with SMS4BG was discovered, with 161 (95%) of 169 participants expressing that the program was helpful and 164 (97%) saying they would suggest it to other people with diabetes.(Dobson et al., 2018) The conclusion drawn from this research is that mobile phones are utilized as a tool to monitor medication adherence and submit blood pressure values for lifestyle monitoring. MHealth also assists patients in managing their hypertension. mHealth also aids in controlling hypertension (Setyorini, Sudiana and Bakar, 2022). Furthermore, the last article that was reviewed was an article written by Ainul Mufidah et al. with the article titled Smartphones as an Educational Media for T2DM with method A Systematic Review with the aim of understanding the development of smartphones as an educational media for T2DM patients. The results of this research show that increased use of technology in the management of diabetes boosts patient-nurse interactions by facilitating it (Mufidah, Dian Kurniawati and Yuni Widyawati, 2021).

Literature Search Results
The following journals were selected for the literature review:

Table I. Details of Selected Literature Review Results

No	Writer's name	Journal Name (Year and Page)	Research Title	Research purposes	MethodStudy	Research result
1	Wanto July Silalahi	Indonesian Journal of Health Sciences (JIKSI) E-ISSN: 2745-8555 Vol. 2, no. 2, August 2021	Review of the Literature on Type 2 Diabetes Mellitus Patients' Medication Compliance and the Impact of Short Message Reminders	to assess how well Type 2 Diabetes Mellitus patients adhere to their prescription regimens as a result of SMS reminder services.	The method used is the electronic data base method, by searching 10 national and international journals using: Proquest, Clinicalkey and Google Scolar, from 2016 - 2021, with the keywords Diabetes; Medication Compliance; SMS reminder.	The impact of SMS (short messaging service) reminders services on compliance with medication consumption in patients of Type 2 Diabetes Mellitus, namely 90% said that there was an influence of SMS on compliance with taking medication and 10% there was no influence of SMS on compliance with taking medication.
2.	Tifanny Gita Sesaria, Kusnanto, and Abu Bakar	Forikes Voice Health Research Journal Volume 12 Number 1, January 2021	Effectiveness of Management of Smartphone and Non-Smartphone Applications on Glycemic Regulation in Diabetes MellitusPatients: A Systematic Review	To find out various types of non-smartphone and smartphone management of diabetes mellitus to glycemic regulate levels.	The Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) were used to compile this systematic review. The databases Scopus, Proquest, and Pubmed were utilized in this study to publications from the last 5 years from 2015 to 2020 and full text articles. a keywords are "diabetes mellitus" and "glycaemic	Management of nonsmartphones in diabetes patients can be decrerased of the regulate glycemic (blood sugar levels and HbA1c) is family support booklets, mobile apps and short message services are available to smartphone usersservices.

No	Writer's name	Journal Name (Year and Page)	Research Title	Research purposes	MethodStudy	Research result
					control" and "health education" and "m-health". This 15 articles of systematic review that met the inclusion criteria.	
3	Upkar Varshney, Neetu Singh	Journal of Medical Informatics InternationalVolume 136, April 2020, 104091	a model for analysis to assess medication adherence reminders	interventions used to increase medication compliance, including those using reminder. Taking into account the type of reminder, when it is used	Analytical models are an effective and inexpensive method to obtain from further studies of interventions regarding medication compliance.	appropriate performed relied entirely on reminders to take.
4	Zhilian Huang, et al	Jmir Mhealth And Uhealth, 2019	A Smartphone App to Improve Medication Adherence in Patients With Type 2 Diabetes in Asia: Feasibility Randomized Controlled Trial	A multiethnic Asian population with type 2 diabetes will be studied to see if employing smartphone applications to enhance medication adherence is feasible, acceptable, and effective from a clinical trial perspective.	RCT	Average 12-week medication adherence rates of participants tracked by the app between 38.3% and 100% in the intervention group. The majority (>80%) of participants agreed that this application it is easy to use and makes them more compliant with their treatment. It can be concluded that among non-adherent patients with type 2 diabetes, smartphone applications are acceptable, increase awareness of medication adherence, and reduce self-reported barriers to medication adherence, but do not improve clinical outcomes in developing countries in Asia
5	Pawel Posadzki, Nikolaos Mastellos,	The Cochrane Collaboration. Published by John Wiley &	Automated telephone communication systems for	to evaluate the effects of automated telephone communication systems (ATCS) on patient-	RCT	ATCS treatments have a favorable impact on a number of crucial areas, including vaccines, screening, appointment attendance, and adherence to drugs or tests. They can also

No	Writer's name	Journal Name (Year and Page)	Research Title	Research purposes	MethodStudy	Research result
	Rebecca Ryan,	Sons, Ltd. 2016	preventive healthcare and management of long-term conditions	centeredness, behavioral, clinical, process, and cognitive outcomes when used in the treatment of chronic diseases and the prevention of disease.		influence patient health habits, enhance clinical outcomes, and boost healthcare consumption.
6	Türkan Akyol Güner , Gülhan Cos¸ ansu	TA Güner, G. Cos¸ ansu / (2020)	The effect of diabetes education and short message service reminders on metabolic control and disease management in patients with type 2 diabetes mellitus	This study's objective was to assess the effectiveness of diabetes education and short message services. Patients with type 2 diabetes mellitus who were enrolled at a family health center and using oral antidiabetics were reminded about metabolic control and illness management.	pre-test, post-test control group interventional study	HbA1c, fasting blood sugar, lipids (excluding triglycerides), blood pressure, body mass index, and weighing findings were all statistically different between the intervention group and the control group (p 0.001). Conclusion: Patients with type 2 diabetes mellitus who received diabetes education and SMS reminders for six months saw an improvement in their ability to manage their condition's metabolic side effects.
7	Urip Harahap, dkk	ANR Conference Series 03 (2020)	Utilization of the Medication Reminder Application (Pmo) to Improve Compliance with Type 2 Diabetes Mellitus Patients	For evaluating the use of medication reminder applications to increase patient compliance with diabetes mellitus type 2. Sample activities Outpatients were included in this research suffering from type 2	The investigation was conducted over the course of education about diabetes mellitus, distribution of leaflets, and socialization of its use PMO application, training on the use of the PMO application to patients and	This research shows that more than 90% of patients have a knowledge level of 12 (40%) and compliance was 14 (46.67%). The findings above lead to the conclusion that more intensive outreach regarding use of medication reminder applications to increase patient compliance.

No	Writer's name	Journal Name (Year and Page)	Research Title	Research purposes	MethodStudy	Research result
				diabetes mellitus at the North Sumatra University Hospital.	evaluation of activities through distributing questionnaires to find out level of patient compliance	
8	Rinki Murphy et al	BMJ 2018;361:k1959 | doi: 10.1136/bmj.k1959	Effectiveness of text message based, diabetes self management support program (SMS4BG): two arms, parallel randomised controlled trials	Aims to test effectiveness theoretically in individuals with poorly managed diabetes, and individually designed, text message based diabetes self-management support intervention (SMS4BG).	RCT	When compared to the control group, the intervention group's HbA1c level was considerably lower (av-8.85 mmol/mol, SD 14.84; adjusted mean difference -4.23 (95% confidence range) -7.30 to -1.15; P = 0.007). Only four of the secondary outcomes' 21 exhibited statistically significant differences in favor of the intervention group at nine months. Health status on the EQ-5D visual analog scale (4.38 (0.44 to 8.33), P= 0.03), perception of disease identity (-0.54 (-1.04 to -0, 03), P=0.04), and foot care behavior all showed significant improvements (adjusted mean difference 0.85 (95% confidence interval 0.40 to 1.29), P0.001). A high level of satisfaction with SMS4BG was seen, with 161 (95%) of 169 participants stating that the program was useful and 164 (97%) saying they would suggest it to other people with diabetes.
9	Dwi Yoga Setyorini , I Ketut Sudiana , Abu Bakr	Journal of Nursing Research and Scientific Thought, 2021	Effectiveness of mobile health for monitoring medication adherence on hypertensive patients: A	seeks to evaluate the effectiveness of a reminder system for people with hypertension using mobile devices.	Following the criteria for inclusion (patients with hypertension, employing SMS reminders, phone reminders, and mHealth reminders, research type: RCT), this review found	Mobile phones are used as a tool to monitor medication compliance and report hypertensionmonitoring.

No	Writer's name	Journal Name (Year and Page)	Research Title	Research purposes	MethodStudy	Research result
			systematic review		fifteen pertinent papers.	
10	Ainul Mufidah, et al	Forikes Voice Health Research Journal Volume 12 Number 1, January 2021	Smartphones as an Educational Media for Diabetes Mellitus Patients: A Systematic Review	To learn more about the development of smartphones as an instructional medium for type 2 diabetes patients.	Systematic Reviews	Increased use of technology in the treatment of diabetesIncrease communication between nurses and patients.

Studies have shown that many treatments use medication reminder applications to help regulate glycemic levels (blood sugar levels and Hba1c) in patients with diabetes mellitus, with various benefits and intervention mechanisms. The therapeutic intervention of the medication reminder application is also good because it is cheap, can be applied independently, and can be accessed anywhere by adjusting the patient's condition so that the management of diabetic patients without using the medication reminder application and using the medication reminder application has significant benefits in improving the results of blood sugar and HbA1c levels in diabetic patients by increasing health information, increasing adherence to treatment, helping to improve access to health services, and monitoring physical activity for patients with diabetes mellitus. Various interventions such as medication reminder apps, booklets, and peer support need to be adapted and implemented in Indonesia.

CONCLUSION

Compliance with Dpabetes Mellitus Type 2 patients in carrying out therapeutic management is a determining factor for the success of therapy. The medication reminder application (PMO) increases patient knowledge and compliance with medication.

The study invariably had a positive impact on adherence to disease management and health outcomes in almost all the reviewed articles. However, the variability in the type of intervention (tools and tool use) and the lack of information in most articles on the details of the intervention process and the concept of behavior change make conclusions challenging. In addition, the methods used to measure the impact and the designs, samples, and outcomes measured (measured adherence and clinical outcomes) also differed. However, the cost-effectiveness and sustainability of medication reminder apps remain questionable. There is potential for the implementation of medication reminder apps with advances in technology and the diverse reach of mobile networks, thus offering the potential to reduce the population requiring long-term care for chronic diseases, making medication reminder apps an important part of the healthcare sector. In addition, the small amount of published literature on the topic also reduces the strength of the conclusions.

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