ORIGINAL ARTICLE

Education model based on SMS gateway on blood sugar levels of diabetes mellitus patients

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ABSTRACT

Introduction: *Diabetes has become a global epidemic over the last two decades. The prevalence has doubled, from 4.6% to 9.3% in the population aged 20-79 years. Based on data from the International Diabetes Federation (IDF) 2019, it is estimated that 463 million people in the above age group live with diabetes, of which 90% of diabetes Indonesia faces the same diabetes threat as the world within five years. West Sumatra is number 21 out of 34 provinces with diabetes cases. Based on data from the Padang City Health Office in 2020, from 23 health centers in Padang City, Andalas Health Center is the highest coverage of type 2 diabetes mellitus, which is 1017 people. Of the ten sub-districts in the Andalas Community Health Center working area, the Jati sub-district is the highest case of diabetes mellitus. Reasonable blood sugar control is one of the essential factors and has been shown to reduce the risk of complications in people with diabetes. Therefore, holistic management, including education, is needed to achieve reasonable blood glucose control. Education with an SMS gateway approach can provide continuous and continuous information.* ***Objectives:*** *see the effect of the SMS gateway-based education model on the blood sugar levels of people with diabetes.* ***Methods:*** *Pre-experiment using the One Group Pretest-Posttest design approach. Data analysis using Paired T-test sample.* ***Results:*** *The results showed an effect of the education model based on sms gateway-based education model on the blood sugar levels of people with diabetes with p-value = 0.002.* ***Conclusion:*** *The SMS gateway-based education model affects the blood sugar levels of diabetics*

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1. Introduction

Diabetes Mellitus (DM) is a "long-life" disease that requires comprehensive and consistent disease control and management for the long term. Diabetes control is essential so that the quality of life for people with diabetes is good. Poor control of blood glucose levels and HbA1c levels can increase the risk of complications from diabetes. (American Diabetes Association, 2016). The global prevalence of diabetes will continue to triple by 2030; this increase has been predicted by the World Health Organization (WHO) that in 2030 there will be 21.3 million cases, and according to the International Diabetes Federation (IDF), in 2045, will reach 16.7 million cases.

Indonesia's condition is also not much different. High costs follow the high volume of events, so early diagnosis and comprehensive management of diabetics can reduce morbidity and morbidity. According to the 2019 International Diabetes Federation (IDF), Indonesia is included in the ten countries with the most diabetes in the world, where Indonesia is ranked seventh after Brazil (16.8%) and Mexico (12.8%). In 2020, Indonesia will still occupy the seventh position with the most diabetes, namely more than 10.8 million people, and is expected to increase to 16.7

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million per year in 2045. This result shows an increase in the proportion of individuals diagnosed with diabetes mellitus yearly.

In 2021, IDF recorded 537 million adults (aged 20-79 years), or 1 in 10 people living with diabetes worldwide. Diabetes also causes 6.7 million deaths, or one every 5 seconds. China has the most significant number of people with diabetes in the world. 140.87 million Chinese people will live with diabetes in 2021. Furthermore, India is recorded to have 74.19 million people with diabetes, Pakistan 32.96 million, and the United States 32.22 million. Indonesia is in fifth position, with 19 people with diabetes, 47 million. With a population of 179.72 million, the prevalence of diabetes in Indonesia is 10.6%. Furthermore, the IDF notes that 4 out of 5 people with diabetes (81%) live in low and middle-income countries. This is also what makes the IDF estimate that there are still 44% of adults with diabetes have not been diagnosed (International Diabetes Federation, 2021).

Indonesia is facing the same threat of diabetes mellitus as the world. Within five years (2013-2018), the number of people with diabetes has increased by more than twenty percent. Around 70% have not been diagnosed, and diabetes ranks third as Indonesia's highest cause of death. The number of diabetes patients whom a doctor has diagnosed is estimated to be 2% of the total population aged over 15 years, and there are many of them in productive age and urban areas (Ministry of Health, RI, 2013 & Indonesian Ministry of Health Research and Development Agency, 2018).

West Sumatra had a total prevalence of diabetes of 1.6% of the population in 2018, where West Sumatra ranks 21 out of 34 provinces in Indonesia (Ministry of Health, 2018, 2019). According to data from the West Sumatra Provincial Health Office, the number of diabetes cases in West Sumatra in 2018 totaled 44,280 cases, while in 2019, diabetes cases increased to 59,024 cases, with the highest number of cases being in the Padang City area (W Sumatra Health Office, 2018, W Sumatra Health Office 2019). Based on data from the Padang City Health Office in 2018, the number of diabetes mellitus patients aged over 15 years was 40,269 cases, while in 2019 there were 17,017 new cases discovered, and in 2020 there were 9,471 additional cases (Padang City Health Office, 2018, 2019, 2020).

Based on data from the Padang City Health Office in 2020, out of 23 Puskesmas in Padang City, the Andalas Health Center has the highest coverage of type 2 diabetes mellitus, with 1017 people. The working area of the Andalas Health Center has 10 Sub-Districts, and the Jati Sub-District has the highest coverage of type 2 diabetes mellitus, totaling 199 people. According to Yosmart, et al. (2019), 57.7% of the people of Padang City have a high risk of diabetes mellitus. They were related to indicators including gender, age, excess BMI, waist circumference, and a history of high blood sugar. Also, there is a positive family history of diabetes beforehand, which is also in line with the uncontrolled high glucose levels for people with diabetes. Reasonable blood sugar control is an essential factor and has been shown to reduce the risk of complications in people with diabetes. In order to achieve reasonable blood glucose control, holistic management is needed, including education, medical nutrition therapy, physical activity, administration of drugs, and monitoring of blood sugar for prevention and early complications (Perkini, 2019).

Education in the management of diabetes is needed by people with diabetes, starting with implementing a healthy lifestyle (medical nutrition therapy and physical activity) together with pharmacological interventions or drug administration. Knowledge of self-monitoring, hypoglycemia signs and symptoms, and how to treat it should be imparted to the patient. Education for diabetes patients is essential, intending to promote healthy living; it should always be done as part of prevention efforts and is crucial to managing diabetes holistically. Educational materials consist of initial and advanced (Perkeni, 2015).

According to research by Deharja et al. (2016), the SMS gateway increased the number of respondents' attendance at Posyandu activities, so it can be concluded that the SMS gateway technology has been created and can increase the number of Posyandu visits. Ellina et al. also found that before and after the SMS gateway intervention regarding disease danger signs, there were differences in respondents' perceptions of health promotion media through SMS gateways.

Technically, SMS gateways could be used as media education and health promotion, where respondents respond to messages as an interactive form that shows interest in consulting health services.

According to the results of research by Timothy Middleton et al. in 2021, in Australia and New Zealand with the title An Enhanced SMS Text Message-Based Support and Reminder Program for Young Adults With Type 2 Diabetes with the results of SMS text message-based support and reminder programs that increase attendance levels clients to scheduled clinics for patients with type 2 diabetes at a young age. Dan said this program was very acceptable and provided initial support for patient empowerment but had no significant effect on metabolic control or self-management in these clients. Therefore, researchers feel it is vital that this research is carried out, and the results of this study will be able to contribute and be of direct benefit to health workers in providing education and health promotion in an effective and efficient, and appropriate manner to address advanced problems in diabetes patients due to advanced complications of diabetes. Furthermore, this study aimed to see the effect of the SMS gateway-based educational model on the blood sugar levels of people with diabetes in Jati Village, Padang Timur Padang District.

2. Methods

This type of research is quantitative using a pre-experimental research design using the One Group Pretest-Posttest design approach, with a population of all people with diabetes mellitus and a sample of 25 people with inclusion criteria willing to be respondents, owning a mobile phone and being able to read and write using random sampling techniques. Paired T-test was used to analyze the data. This research sought ethics from the Faculty of Medicine, University of Andalas Padang on September 8, 2022, with the number of passing the ethical review 946/UN.16.2/KEP-FK/2022.

3. Results and Discussion

Based on the table above, it can be seen that from the sex characteristics, the majority (80.0%) of the respondents were female. Based on the table above, it can be seen that from the age characteristics of the respondents, the youngest was 50 years and the oldest was 88 years, and 12% were aged between 64 and 67 years. Based on the table above, it can be seen that from the educational characteristics of the respondents, almost half (36.%) of the respondents had a high school education. Based on the table above, it can be seen that from the long history of diabetes, 24.% have had diabetes for seven years and one respondent, or 4.0% for 12 years.

Based on Table 3, it was found that the average blood sugar before the educational intervention was carried out was 282.84 mg/dl, with a standard deviation of 76,500. The results of this study are supported by research conducted by Nicholas W. et al. in 2018, entitled Prevention of Diabetes Mellitus in Prediabetes Patients, with results. Eighty-four million patients in the United States have prediabetes, and at least 70% will become diabetic unless they receive intervention before that. , most of these patients have or are at risk for cardiovascular disease. When social and economic factors are the leading contributing causes, social and economic factors are the main causes that contribute to the expansion of diabetes mellitus with an average blood sugar level of > 250 mg/dl.

Diabetes is a chronic disease that, in its early stages, may be asymptomatic, but if it is not managed correctly, it continues to develop into an uncontrolled state which can cause severe damage to the heart, blood vessels, eyes, kidneys, and nerves. The burden due to diabetes can be reduced by controlling risk factors, early detection of people at risk, and monitoring and managing diabetes optimally so that diabetes can be controlled to delay complications or reduce the incidence of worsening during complications.

Table 1 Characteristics of the respondents

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Characteristics		N	Percentage
Gender	Male	5	20
	Female	20	80
Age	50 years old		
	52 years old		
	53 years old		
	54 years old		
	55 years old		
Education level	Elementary school	5	20.0
	Junior high school	7	28.0
	Senior high school	9	36.0
	College	4	16.0
Duration of disease	1-5 years	6	
	6-10 years	18	
	>10 years	1	

Table 2 The average blood glucose of respondents before education

Blood glucose levels	n	Mean	SD	Min	Max
Before	25	282.84	76.500	193	521
After	25	263.08	73.381	180	480

Table 3 Characteristics of respondents based on age

Age	Prekuensi	Persen	Valid present
	1	4.0	4.0
58	2	8.0	8.0
59	2	8.0	8.0
60	1	4.0	4.0
62	2	8.0	8.0
64	1	4.0	4.0
65	1	4.0	4.0
66	2	8.0	8.0
	2	8.0	8.0
	3	12.0	12.0
	2	8.0	8.0
	2	8.0	8.0
67	3	12.0	12.0
88	1	4.0	4.0

According to the research results of Moon et al. (2016), whose research results obtained lifestyles such as diet, exercise, breastfeeding, and weight control can reduce the risk of developing diabetes mellitus. Several intervention trials aimed at improving lifestyle-modifiable risk factors, including diet, exercise, and breastfeeding, have successfully reduced the incidence of postpartum diabetes, weight retention, and other obesity-related morbidities in blood sugar control.

Based on the table above, it was found that the average blood glucose of the respondents after the sms gateway-based educational intervention was carried out was 263.08 mg/dl with a standard deviation of 73.38. This result shows that the respondent's blood glucose decreased after being given an SMS gateway-based educational intervention, even though the results of his blood glucose level were still above 200 or even 265 mg/dl. This study is the same as the results of a study conducted by Rosario Alonso-Domínguez, et al (2016) results of their research that interventions with smartphone applications, easy to use for adults, allow a quick personal

assessment according to the recommended healthy lifestyle both nutritionally and physically active with the result of controlled and controlled blood glucose.

According to Perkeni (2015), the management of diabetes mellitus must be individual, where the drug needs, abilities, and desires of the patient are essential and primary components in determining choices to achieve therapeutic targets by adjusting the conditions and needs of patients, including patient's age and life expectancy, duration suffering from diabetes, history of hypoglycemia, co-morbidities, presence of cardiovascular complications, as well as other supporting components (availability of drugs and purchasing power). Management of diabetes begins with adopting a healthy lifestyle (medical nutrition therapy and physical activity) and pharmacological interventions with anti-hyperglycemic drugs orally and in injections. Knowledge of self-monitoring, hypoglycemia signs and symptoms, and how to treat it should be imparted to the patient. Education for diabetes patients is crucial and also intends to promote healthy living, and it should always be done as part of prevention efforts and is a crucial part of managing diabetes holistically. Educational materials consist of initial educational materials and advanced educational materials. (Perkeni, 2015).

Education or health education is to help people take a wise attitude toward their health and quality of life (Suiraoka & Supariasa, 2012). Health education aims to change people's or society's behavior from unhealthy behavior to healthy behavior.

According to Triwibowo and Pusphandani (2015) education is a process of achieving goals, meaning that education is in the form of a series of activities that start from the actual conditions of the individual who is learning, focused on the expected individual achievement. According to Nyswander (1947) in Machfoedz & Suryani (2008) health education is a process of human change that has something to do with achieving individual and community health goals.

According to the research results of Xuemei Wang et al. 2019, regarding the Management of diabetes mellitus with mobile health, the results showed a statistically significant decrease in the average HbA1c in the intervention group: 0.25 95% confidence interval: 0.41, 0.09; P = 0.003, I 2 = 12%). Subgroup analysis showed that the patient's age, type of intervention, and duration of intervention influenced blood glucose control. Judging from the results of this study, the average age of the respondents was in the elderly category, where all respondents were over 50 years old and 14% were 67 years old. There are even 4% who are 88 years old.

Theoretically, the factors that influence the acceptance of education, according to Machfoedz & Suryani, 2008 include The human factor concerning both the giver and the recipient. The things that play a role here are maturity, which includes physical, psychological and social maturity. Then the knowledge previously obtained by the recipient is very influential in the teaching and learning process. This will be better if the recipient has obtained much of the knowledge conveyed. Then motivation, if the educators or recipient respondents both have high motivation for the material presented, of course, the results will be better than vice versa. The task load factor and health education materials, which include changing behavior that requires muscle skills, will undoubtedly be different from changing behavior in the form of using words, such as singing or reading. In addition, the workload can also be in the form of language that is difficult to understand during learning activities, the amount of workload material. If the workload is large and complex, it will be heavier than learning only a few and simple. Apart from that, the other influencing factors are apparent if the material is transparent. The process of conveying information will go well, and finally, environmental factors, if the community environment opposes the workload of education, it will undoubtedly be challenging to succeed well.

Bivariate analysis was used to see whether or not there was a difference in blood glucose before and after the sms gateway education intervention.

Table 4 Differences in average blood glucose levels before and after education in diabetics

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Blood Glucose Levels	N	Mean	SD	Std Error	Mean Difference	P value
Before	25	282.84	76.500	15.300	19.76	0,002
After		263.08	73.381	14.676		

Based on Table 4, the average blood glucose before the sms gateway-based education model intervention was 282.84 mg/dl, and the average blood glucose after the sms gateway-based educational model intervention was 263.08 mg/dl with a mean difference of 19.76 mg/dl. The t-dependent statistical test found that p-value = 0.002 (p-value <0.05), meaning that the sms gateway-based education model was influenced by the decrease in respondents' blood glucose levels in Jati Padang Village.

The results of this study are the same as the results of Deharja's research (2016) concerning the Implementation of SMS Gateways to Increase the Number of Visits at Posyandu Catleya 14 Jember, where the qualitative approach results in a significant increase in the number of toddlers attending Posyandu activities. The results of this study are also in line with the results of Yongwen Zhang's research (2017) entitled Effectiveness of the Systematic Health Education Model for Type 2 Diabetes Mellitus patients with results. The systematic health education model causes favorable variations in HbA1c, LDL, cholesterol, and systolic blood pressure with results (P < 0 05). After the analysis, HbA1c decreased by 0.67% (P <0.01), concluding that the health education model affected the reducing HbA1c for people with diabetes mellitus.

The model for managing chronic disease in primary care was started by Wagner et al. in the late 90s in the United States, and called the Chronic Care Model (CCM). CCM consists of six elements developed as a hypothesis to impact clinical and non-clinical outcomes related to disease management. These elements are made in order to create a more effective healthcare system through the development of healthcare organizations (Health Care Organization/HCO), reforms in service system design (Delivery System Design/DSD), support for decision-making mechanisms (Decision Support/DS), connecting primary health services to private and government partnerships (Community Resources and Policy/CR) in terms of disease management, providing self-management support services (Self Management Support/SMS) to patients and managing clinical information systems (Clinical Information System/CSO) centrally (Wagner, 2000).

Various institutions in the United States have adopted CCM and demonstrated improved control of patients' metabolic outcomes such as HbA1c, cholesterol, and blood pressure by implementing CCM elements. However, a meta-analysis study conducted by Tsai AC et al. found that applying one CCM element alone does not provide optimal outcomes for both patients and healthcare providers. Therefore a combination of several CCM elements is needed simultaneously at the same intervention time to get better outcomes. The implementation of CCM model for diabetes management has been implemented in other countries, such as Mexico, and shows the significant achievement of the HbA1c target (Stelefson, Dipnarine, & Stopka, 2013).

Models for chronic disease management continue to evolve, although CCM is the most widely used model. Several other models found in the literature include Innovative Care for Chronic Conditions (ICCC) which WHO developed, the Improving Chronic Care Illness Care (ICIC), developed by Wielawski, Standford Model developed by Stanford University, and Transitional Care Model developed by Naylor et al.. Each model will have different elements. The elements found from the various models above, apart from the six elements in the CCM, are focusing on patients and families (Patient Centered), health care coordination (Care Coordination), integration of health care systems (Build Integrated Health Care), Cultural Competence and remote patient monitoring remotely (Remote Patient Monitoring).

In this study, education was provided on the theory or concept of diabetes, control, and monitoring of diabetes, complications of diabetes, and its risks. Non-pharmacological and pharmacological interventions and treatment target Interactions between food intake, physical

activity, and oral anti-hyperglycemic drugs or insulin and other drugs how to monitor blood glucose and understand blood glucose or urine results independently Recognize symptoms and early treatment of hypoglycemia, the importance of regular physical exercise, the importance of foot care, and when to use the health care facilities provided or sent to respondents to predetermined numbers according to inclusion criteria, with text messages that are sequential and systematic according to the stages of initial and advanced education.

Judging from the difference in the results of decreasing blood glucose levels before and after being given the sms gateway-based educational model intervention, the respondents' blood glucose levels were still above 200 mg/dl or to be precise the average after the educational intervention was 263.08 mg/dl, which means that respondents still had high blood glucose levels, where usually fasting blood glucose levels are <125 mg/dl and glucose levels are below 200 mg/dl, this indicates that several factors influence it, including too high blood glucose levels in the previous respondent, where it is known, glucose levels The highest respondent's blood before the intervention was 521 mg/dl and the highest blood glucose after the intervention was 480 mg/dl, if you look at the mean difference it was only 19.76 mg/dl. In addition to the respondent's blood glucose level being too high, judging by the length of time he has had diabetes, some respondents have had diabetes for 12 years, and 24% of respondents have had diabetes for 7 years. This is a trigger factor for glucose levels to remain high.

4. Conclusion

The results of this study can be concluded as follows: the average blood glucose level of respondents before the SMS gateway education model intervention was 282.84 mg/dl with a standard deviation of 76.5, and the respondent's average blood glucose level after the sms gateway educational model intervention was 263.08 mg/dl with a standard deviation 73.3. The statistical test results showed a significant difference between blood glucose levels before and after the SMS gateway-based education model intervention with a value of $p = 0.002$ ($p < 0.05$).

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