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Health Education Interventions on Technology-Based Diabetes Management during the Covid-19 Pandemic

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ABSTRACT
Introduction: The management of diabetes mellitus (DM) is essential to take into account, especially during the Covid-19 pandemic. During the COVID-19 pandemic, diabetic patients have their worries and anxieties related to the transmission of Covid-19, so that diabetes self-management, including diet regulation, physical activity, controlling blood sugar levels to health care facilities, is not optimal. Therefore, it is necessary to design various distance education technologies that can support effective diabetes management. The purpose of writing: to identify various technology-based educational methods in diabetes management used during the covid-19 pandemic. Results: Various educational technologies designed include: Texas Strength Through Resilience in Diabetes Education (TX STRIDE), telemonitoring, telehealth, training, and counseling using video and mobile phones, telemedicine, virtual or online training, use of social media, diabetes education tools with devices touch screen and remote Continuous Glucose Monitoring. Through the use of this educational media, the benefits felt by diabetic patients include: diabetes self-management becomes effective, glycemic control becomes more optimal, prevents hyperglycemia as the cause of diabetic ketoacidosis, improves health status, and increases self-empowerment of diabetic patients. Conclusion: This technology-based educational intervention needs to be developed more widely and socialized for diabetics during the Covid-19 pandemic to support diabetes management so that patients can choose according to their abilities and conditions. Nurses in every health care setting need to educate about the use of technology in maximizing self-management for patients with diabetes mellitus.

I. INTRODUCTION.

Diabetes Mellitus (DM) is one of the most common non-communicable diseases and is a health threat for all ages. Individuals with diabetes need to continue to perform self-management or self-care activities to maintain glucose levels within normal limits. During the COVID-19 pandemic, the self-care activities of DM patients have many changes: diet, exercise, or physical activity to monitor blood glucose levels, further explained by (Monaghan and Marks, 2020) that the impact of COVID-19 for DM patients includes: anxiety about contracting COVID-19, difficulty accessing food/diet supplies for diabetes, barriers to maintaining self-care behavior during the COVID-19 pandemic, which considered as one of the factors of stress. Further explained by (Steinhardt et al., 2021), the COVID-19 pandemic causes feelings of fear, stress, and anxiety, especially in diabetic patients, because diabetes is a significant risk factor for faster development of COVID-19.

Diabetes management during the COVID-19 pandemic for DM patients is a challenge in itself. DM patients must manage their self-care activities, including diet, activities, medications, monitoring blood sugar levels, and foot care. On the other hand, DM is a risk factor for developing complications when experiencing COVID-19, causing worry and anxiety for DM patients. This condition will have an impact on the success of diabetes management. In response to this condition, it is essential for health care providers to carry out technology-based health education to increase patient compliance with diabetes management and facilitate access to services during Covid without being haunted by fear or anxiety.

Technology-based health education for diabetes management has been applied widely by health care providers and varies widely. Health

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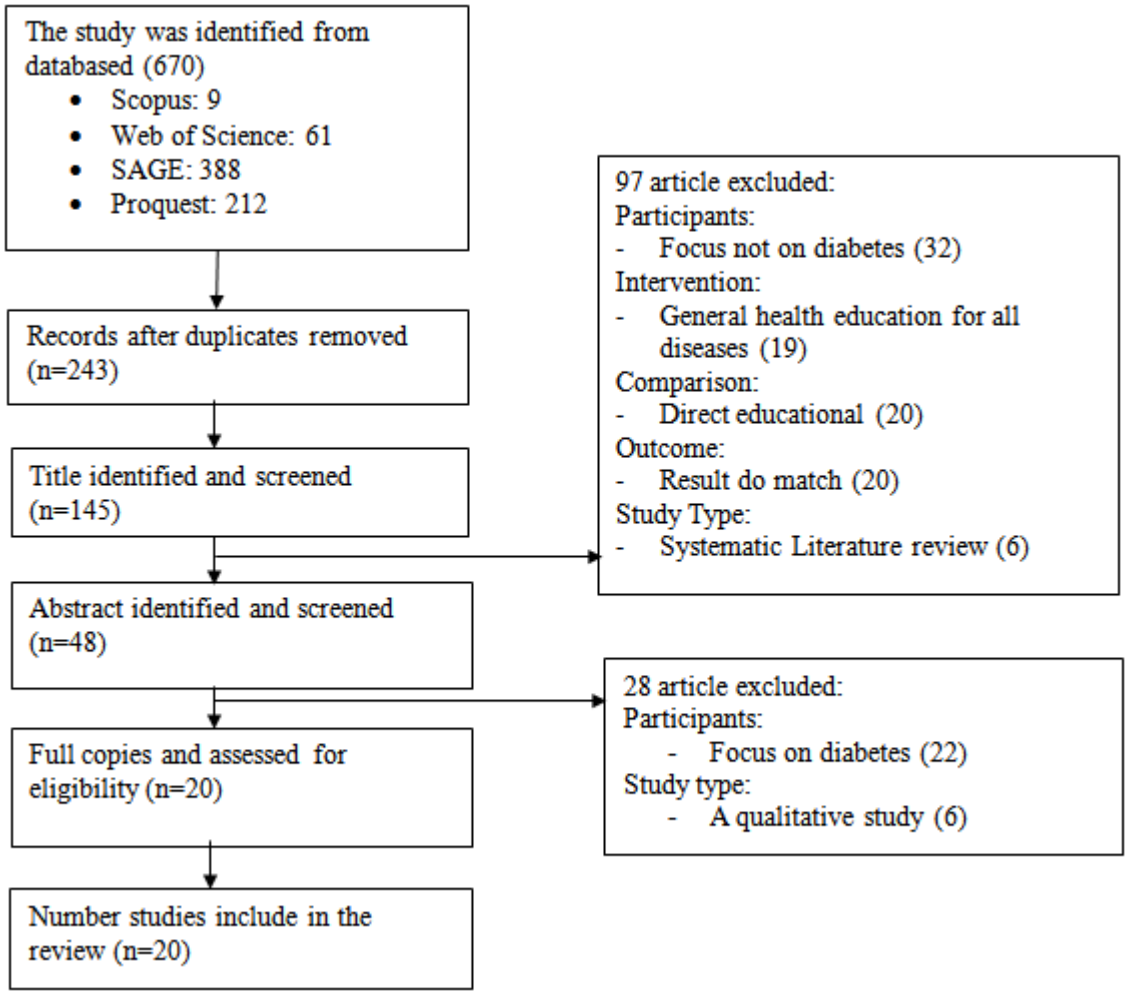
education used by diabetic patients is a form of innovation from health workers to make it easier for diabetic patients to manage diabetes. These various forms of innovation are expected to increase patient awareness and improve self-care behavior to achieve adequate glycemic control.

II. METHOD

The design of this research is a systematic literature review. The literature used in this study is a research article that discusses health education interventions about technology-based diabetes mellitus management during the COVID-19 pandemic. These articles were published in several reputable international journals. The literature search was carried out on data based on Scopus, Web of Science (WOS), SAGE, Proquest with the keywords "health education" and "technology and "diabetes" and "covid-19". The literature used met the inclusion criteria, including population: diabetic patients, Intervention: technology-based health education, Comparison: conventional or direct educational intervention, Outcome: impact of using technology for diabetes management, Time: 2020-2021.



III. RESULT

Table 1.1.
Types of technology-based health education interventions

No	Author, years	Intervention	Impact
1	(Galindo et al., 2020)	Use of CGM (Continuous Glucose Monitors) to monitor glucose	The use of this device offers good accuracy in monitoring blood glucose levels and calculating

No	Author, years	Intervention	Impact
		concentration and automatic determination of insulin dosing system (Automatic Insulin Dose)	insulin doses automatically. This tool is entirely accurate in determining blood glucose levels and insulin doses needed to reduce the incidence of hyperglycemia and hypoglycemia in patients.
2	(Steinhardt et al., 2021)	Texas Strength Through Resilience in Diabetes Education (TX STRIDE) study safely using remote technologies.	TX STRIDE is a method of health education for people with type 2 DM using remote technology that can be used during the COVID-19 pandemic. This system can improve diabetes self-management.
3	(Choudhary et al., 2021)	Telemonitoring Tools for People with Diabetes in Europe	Glucose control is becoming more practical for adults and children with type 1 diabetes mellitus, whose effectiveness is approaching the standard of care before COVID-19. In addition, with the use of this application, the quality of life and patient autonomy in managing diabetes increases.
4	(Sin et al., 2020)	Telemonitoring based on The Health Information Technology Acceptance Model (HITAM) using cellphones and smartphones	The advantages of this technology are that it is more effective, easy to use, saves costs, protects privacy, and provides treatment satisfaction using TM compared to face-to-face doctor consultations.
5	(Kerr and Warshaw, 2020)	Telehealth use	Optimal glucose management by using telehealth. Data integration connected with updated patient data will create a digital diabetes ecosystem.
		Training and counseling using video and mobile demonstrations regarding insulin injection and HbA1c. sampling	
6	(Fuchs and Hovorka, 2020)	Telehealth use	It empowers clients and reduces the burden of visits during the covid-19 pandemic.
7	(Haynes et al., 2021)	Telemedicine in the form of virtual visits	It can be accessed easier through the patient's smartphone and computer. Another advantage is that parents can monitor the health condition of their children through the use of telemedicine.
8	(Baek et al., 2021)	Diabetes education tool with touch screen device	Patients feel their health status is excellent/better by adopting technology educational methods. A DSMEs program using technology-based tools will benefit the diabetic population in this community in response to a pandemic or other event that causes isolation.

No	Author, years	Intervention	Impact
9	(Monaghan and Marks, 2020)	Telehealth by using video conferencing	Many youth and families experience increased opportunities and motivation to establish or maintain healthy habits—routines for diabetes self-management to be more optimal.
10	(Al-Sofiani et al., 2020)	Telemedicine during a pandemic	Telemedicine is critical in maintaining reasonable glucose control during a pandemic (97%). Patients are delighted with the virtual educational session.
11	(Peters and Garg, 2020)	Telehealth to prevent being treated for diabetic ketoacidosis	This virtual system can effectively manage blood glucose levels to prevent patients from being hospitalized even though the risk of developing diabetic ketoacidosis is high.
12	(Vigersky et al., 2021)	Pelatihan virtual MiniMedTM 670G System	Pasien yang mengikuti pelatihan dengan metode ini melalui zoom merasa puas dan kontrol glukosa menunjukan hasil yang lebih baik jika dibandingkan dengan pelatihan/Pendidikan kesehatan perorangan.
13	(Ushigome et al., 2021)	Continuous Glucose	Remote glucose management using this system is relatively safe and effective (reasonable glycemic control is achieved).
14	(Jiwani et al., 2021)	Remote monitoring (CGM) in patients with severe Covid-19 infection and diabetes	Personal fitness technology (Fitbit) can improve type 2 diabetes management. There is increased knowledge about health behaviors, improved diabetes management, and improved quality of life after lifestyle behavioral interventions, even in stressful life situations due to COVID-19.
15	(Sarteau et al., 2021)	Changes to care delivery at nine international pediatric diabetes clinics in response to the COVID-19 global pandemic	The benefits of adaptation that they consider to have the potential for the future, namely: time savings on clinical processes, telemedicine, lifestyle changes driven by COVID-19, and increased literacy of families and health workers around data sharing.
16	(Zhang et al., 2020)	Effectiveness of Lilly Connected Care Program (LCCP) App-Based Diabetes Education for Patients With Type 2 Diabetes Treated With	The main results were changes in blood glucose levels at week 12 compared to baseline blood glucose. There were differences in blood glucose levels at week 12 between the three groups who took

No	Author, years	Intervention	Impact
		Insulin: Retrospective Real-World Study.	different courses.
17	(Thomas et al., 2021)	Use of social media (Twitter accounts, virtual conferences via zoom, and presentations using videos uploaded via YouTube) during the COVID-19 pandemic	Effective in increasing knowledge, glycemic management, eating habits or patterns, and increasing attendance at every outpatient clinic visit.
18	(Tourkmani. et al. 2021)	Telemedicine during the covid 19 pandemic	HbA1c levels decreased significantly, and most direct care visits were successful. Most patients (64%) required only one or two in-person visits over four months, compared to one visit every 1-2 weeks during integrated care.
19	(Fatyga et al., 2020)	Telemedicine during the covid 19 pandemic	Factors influencing glycemic control in elderly patients with type 2 diabetes can be identified. In addition, telemedicine can improve glycemic control and reduce anxiety in patients with type 2 diabetes during the COVID-19 pandemic.
20	(Faleh AlMutairi et al., 2021)	Telemedicine	The use of telemedicine can save costs, especially in the management of controlled type 2 DM patients. Telemedicine can also be socialized and incorporated into routine diabetes care.

IV. DISCUSSION

Continuous Glucose Monitors (GCM).

Using technology to maximize diabetes management for DM patients is one of the most critical efforts during the COVID-19 pandemic. Various applications can make it easier for patients to access information about diabetes management. In table 1.1, there is one type of technology, namely Continuous Glucose Monitors (GCM), which is used to monitor blood glucose levels and determine insulin dosage automatically. This application makes it easier for Diabetes patients during the covid-19 pandemic to control their blood glucose levels and determine the correct insulin dose to reduce hyperglycemia and prevent hypoglycemia (Galindo et al., 2020). Furthermore, the results of a study conducted by (Ushigome et al., 2021) on remote Continuous Glucose Monitoring (GCM) in patients with severe COVID-19 infection and diabetes showed that this system was relatively safe and effective for remote glucose management. It was further explained that patients using this system had reasonable glycemic control, reduced the number of days of hospitalization while in the isolation room, and reduced the number of invasive procedures.

Texas Strength Through Resilience in Diabetes Education (TX STRIDE).

Research conducted by (Steinhardt et al., 2021) shows that Texas Strength Through Resilience in Diabetes Education (TX STRIDE) is a method of health education for people with type 2 DM using remote technology that is useful during the COVID-19 pandemic. The use of this system can improve self-management for DM patients. The results of this study illustrate that the use of this technology includes 5 (five) categories, namely: Category 1: Individual experiences with covid-19. Using this application, participants can describe daily strategies that they can use to reduce the risk of being exposed to COVID-19, such as using masks, washing hands, and showering after work. In addition, the application also contains

sources of information about COVID-19 obtained by individuals through television, social media, churches, friends, or family members. The application also contains information related to individual perspectives on covid-19; Category 2: the impact of covid-19 on diabetes self-management: a. Dietary behavior: set a schedule for shopping for food needs in the morning to avoid long queues; b) physical activity: some participants reported that the use of wristwatches to detect fitness they received as part of the TX STRIDE program helped them stay motivated to achieve their daily step targets; c). medication adherence and blood glucose monitoring: TX STRIDE participants were given a glucometer. Using this application, it is easier for patients regarding drug prescriptions, therapeutic regimens, and monitoring of blood sugar levels; d). normal controls: many participants reported meeting with their health care provider by telephone during the pandemic; Category 3: psychosocial effects of covid-19; 4). Category 4: financial impact of covid-19 and category 5: Recommendations for restarting the TX STRIDE program. This study yielded strong evidence that participants successfully managed their diabetes effectively despite the challenges and disruptions caused by COVID-19.

There are also some shortcomings in the use of TX STRIDE, including patients complaining about the lack of interaction with other patients. The health education provided is incomplete without sharing experiences with fellow sufferers. However, the most beneficial impact is that through the use of this technology, participants can design culturally tailored interventions and build motivation and adherence to diabetes self-management during the COVID-19 pandemic. He further explained that TX STRIDE is one of the health care services that provide significant benefits, especially diabetes self-management education at a reasonably low cost. In addition, TX STRIDE provides health services that can reach many individuals, especially individuals who may experience barriers to direct visits to the clinic.

Telemonitoring tools, telemedicine, and telehealth

Table 1.1 also describes telemonitoring tools, telemedicine, and telehealth for patients with diabetes. Telemonitoring tools are a technology for remotely checking blood glucose levels that allow effective glucose control for adult and pediatric patients with type 1 DM, whose effectiveness is close to the standard of care before COVID-19. The results of this study show that adults and children with diabetes can engage with health professionals through telemonitoring and receive great benefits to support their quality of life. Furthermore, the research results conducted by (Sin et al., 2020) show that telemonitoring based on the Health Information Technology Acceptance Model (HITAM) using cellphones and smartphones is felt to be effective, easy to use, and saves costs, protects privacy, and has treatment satisfaction.

The use of telemedicine combined with telemonitoring can also increase patient autonomy to manage diabetes. This system supports continuous and widespread access to regular and continuous monitoring of blood glucose levels with remote monitoring (Choudhary et al., 2021). Regarding the use of telemedicine, there are also telemedicine applications to make virtual visits. The advantage is that it is easier to access via smartphones and patient computers (Haynes et al., 2021). It was further explained that parents who have children with diabetes could control their children's health with telemedicine. However, telemedicine for elderly diabetic patients (> 65 years) is less effective because they prefer in-person visits to get direct care.

Telemedicine is an information technology-based health service that is very important in controlling the blood glucose levels of diabetics during the COVID-19 pandemic (Al-Sofiani et al., 2020). Furthermore, it was explained that through telemedicine, patients felt satisfied with the virtual educational sessions that were displayed, especially during the COVID-19 pandemic. Through telemedicine, patients can access online by filling out forms at any time and submitting their requests remotely. Every morning, all types of patient requests are categorized and responded to within 24 hours. There is a diabetes protocol flowchart in this telemedicine, which includes: 1). patient triage and scheduling of clinic visits; 2). Preparation for virtual clinic visits; 3). Conduct virtual visits, and 4). Order and deliver diabetes medication. With the use of telemedicine, reducing the risk of acquired infection (74.4%), reducing waiting time to meet health care providers (72.4%), no need to visit the clinic (64.8%), the quality of care received is the same as traditional methods or direct visits (64.8%) and save costs (16.5%). Another benefit obtained is the increased empowerment and independence of the patient. The results of this study are in line with research conducted by (Faleh AlMutairi et al., 2021) that telemedicine treatment can save costs, especially in the management of controlled DM patients. In addition, the use of telemedicine needs to be

disseminated to the public and can be used as an alternative in routine diabetes care.

The results of a study conducted by (M Tourkmani et al., 2021) regarding the use of telemedicine during the COVID-19 pandemic had the impact that HbA1c levels in diabetic patients decreased significantly, and diabetic patients with high-risk groups could replace in-person visits, which were usually carried out every 1-2 weeks. To 1 or 2 times every four months. It was further explained that telemedicine reduces the risk of exposure to infection by minimizing visits to the clinic. Telemedicine plays a critical role in the care of diabetic patients, especially during the covid-19 pandemic with an increase in clinical outcomes (attainment of normal blood glucose levels). Research conducted by (Fatyga et al., 2020) also shows that factors that affect glycemic control, especially in elderly patients with type 2 diabetes, can be identified with telemedicine. In telemedicine, the advice provided is in the form of telemedicine consultation. In this case, structured telephone interviews were conducted for all patients. The topics discussed cover five areas: 1). Current glycemic control; 2). Comorbidities; 3). Supply of medicines and food products; 4). Compliance to protect oneself against Severe Acute Respiratory Syndrome Corona Virus 2 (SARS Cov-2); 5). Anxiety associated with the COVID-19 pandemic. With the use of telemedicine, most patients feel significant benefits, and it is further explained that telemedicine can reduce the anxiety of diabetic patients during the covid-19 pandemic.

In other studies related to the use of telehealth, there are several perceived advantages, such as more optimal glucose management. However, there are also limitations in telehealth use, including obstacles in using telehealth during the COVID-19 pandemic due to varying access capabilities (Kerr and Warshaw, 2020). The research conducted by (Monaghan and Marks, 2020) on telehealth with video conferencing shows several benefits: adolescents and families with diabetes have more significant opportunities and motivation to build and maintain healthy and regular habits in diabetes self-management. Furthermore, research conducted by (Peters and Garg, 2020) on telehealth to prevent the occurrence of diabetic ketoacidosis showed that this virtual system managed the patient's blood glucose levels effectively and prevented patients from being hospitalized. However, the risk of experiencing diabetic ketoacidosis was very high. In addition, this system can facilitate insulin dose adjustment, increased fluid requirements, and carbohydrate intake. It was further explained that in the case of newly diagnosed type 1 DM patients, most patients received distance health education conducted by nursing specialists and certified diabetes educators.

Video, handphone, and social media.

Research conducted by (Fuchs and Hovorka, 2020) on training and counseling using video demonstrations and mobile phones related to insulin injection and HbA1c sampling has had a positive impact, namely empowering patients and reducing visits to clinics during the covid-19 pandemic. Furthermore, the results of research conducted by (Vigersky et al., 2021) regarding the MinimedTM 670G System virtual training showed that most patients were satisfied with this method. In addition, better glucose control is achieved compared to individual health training or education. This virtual training uses zoom. There are also limitations in this virtual training, including patients needing assistance when logging in and installing software used during the training.

Other information technology services during the COVID-19 pandemic in the care of diabetic patients can also be carried out in the form of using social media, for example, through Twitter accounts, virtual conferences via zoom, and presentations using videos uploaded via YouTube (Thomas et al., 2021). All information about diabetes management is shared using PowerPoint accompanied by pictures and explanations on each slide through a Twitter account. In this educational session, patients can ask questions, and the team will answer them. Educational sessions with discussion processes can increase interaction between patients and health care providers because patients can share their experiences. Other uses of social media include virtual conferencing via Zoom in person. Through this media, patients can ask questions through the chat column and answer the speaker directly. In addition, information about diabetes management during the COVID-19 pandemic can also be obtained by patients through videos uploaded on the YouTube channel. The mechanism is that all questions asked will be sent to the speaker's email, and separately, the questions and answers will be uploaded again to youtube, and the patient will be informed. Some of the uses of social media during the COVID-19 pandemic provide practical benefits for diabetic patients. This is shown by increased communication and involvement between patients and educators and peer support and involvement (Thomas et al., 2021).

Fitbit technology

Several previous studies have described technologies that diabetic patients can use during the COVID-19 pandemic for diabetes management. Furthermore, a study conducted by (Jiwani et al., 2021) on patient experiences related to lifestyle behavior using Fitbit technology in older adults to manage type 2 DM during the COVID-19 pandemic showed the Fitbit results technology could improve Type-2 DM management. Fitbit technology was carried out in 10 sessions, which focused on adherence to behavior using motivational strategies that included: self-monitoring, goal setting, feedback, reducing negative thoughts, managing diet, social support, rewards, problem-solving, relapse prevention, and recreation or vacation. Fitbit is given to all participants, and the application can be downloaded on all participants' smartphones. In this case, the participants received training on regulating their diet and recording their diet patterns and physical activities carried out using the Fitbit application on their smartphone. The benefit or positive impact of applying this Fitbit technology for diabetic patients is that it helps them through the process during the COVID-19 pandemic, especially in managing their lifestyle. It was further explained that the application of this Fitbit technology is a helpful program, has an impact, and can be socialized.

In a study conducted by (Sarteau et al., 2021) on changes in the way of care at nine pediatric diabetes clinics in response to COVID-19, the results showed that health workers reported concerns about the potential negative impact on COVID-19 patients. In addition, clinical adaptations required include fear of the effectiveness of telemedicine, blood glucose, and data sharing on insulin pen use and delay in seeking care. It was further explained that health workers showed adaptation in various care delivery domains, including staff roles and workloads, clinical and team meetings formats, care delivery platforms, self-management education technologies, and data sharing between staff and patients. The benefits of adaptation that are considered to have the potential for the future include time savings in clinical processes, telemedicine, lifestyle changes driven by Covid-19, and increased literacy of families and health workers around data sharing.

Diabetes education tool with touch screen device

The results of research conducted by (Baek et al., 2021) on diabetes education tools with touch screen devices show that patients feel their health status is very good or better by adopting educational methods using technology. A DSMEs program using technology-based tools will benefit the diabetic population in this community in response to a pandemic or other event that causes isolation. While using this diabetes education tool with a touch screen device, most of the patients reported that their glycemic control was increased, their quality of life improved, and they showed a positive attitude towards using this technology. In addition, the more perceived benefit is the decrease in HbA1c levels, especially in adults with diabetes. The use of educational tools as information media can also be applied in the community when there are obstacles in direct health education (Baek et al., 2021).

Lilly Connected Care Program (LCCP) Application.

The use of Lilly Connected Care Program (LCCP) technology based on educational applications aims to achieve adequate glycemic control in diabetic patients (Zhang et al., 2020). In this study, diabetic patients followed the program for 12 weeks. Patients were divided into 3 (three) groups, namely: group A (0-4 courses), group B (5-29 courses), and group C (≥ 30 courses). The results achieved from implementing the Lilly Connected Care Program (LCCP) based on educational applications were fasting blood glucose levels and 2 hours postprandial significantly lower at week 12 compared to the beginning of the examination. The group that completed more diabetes education courses had lower fasting blood sugar levels. When compared with the findings in the age group and associated with patient involvement in diabetes education courses, it can be seen that middle-aged patients (35-59 years) and elderly patients (≥60 years) completed more diabetes education courses than younger patients. (18-34 years).

V. CONCLUSION

During the COVID-19 pandemic, diabetes mellitus patients desperately need support in diabetes management. One of the supports needed by diabetes patients is information support to continue implementing self-care behaviors during the COVID-19 pandemic. Various technologies in applications are designed to make it easier for diabetic patients to access the information they need regarding their care. Through the use of technology, diabetic patients can still control their blood glucose levels independently, adjust the insulin dose needed, make adjustments to their diet and physical activity. The variety of technologies

designed allows diabetic patients to choose the technology that suits their condition and improve adherence in diabetes management so that adequate glycemic control is achieved.

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