Effect of Diabetes Mellitus Technology Program on Elderly Competency Level and Glycemic control

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Abstract

Background: Diabetes mellitus technology program is a mobile application that emerged as an essential tool in managing diabetes potentially aiding elderly patients in achieving better glycemic control and enhancing their competency level. However, the effectiveness of such programs on elderly competency in diabetes management remains under explored.
Aim: This study evaluates the effect of a diabetes mellitus technology program (DMTP) on competency level and glycemic control among diabetic elderly patients. **Method:** A quasi-experimental design was used, with 60 elderly diabetic patients who were randomly assigned to either an intervention group (n=30) or a control group (n=30). The intervention group participated in the seven-session educational program using a mobile application designed for diabetes management. Pre, post, and follow-up assessments were conducted. S**tudy tools:** 1- Diabetes Knowledge Questionnaire. 2-Skills regarding practice of elderly toward diabetes mellitus that involves two observational checklists (self-insulin injection and diabetic foot self-care). **Results:** The intervention group showed significant improvements in both competency level and glycemic control as compared to the control group. Blood test of HbA1c for diabetic elderly patients reached the normal levels at (p=0.033). A significantly higher competency scores' level for knowledge and practice were also observed in the intervention group (P=0.001& p=0.000 respectively) compared to the control group after three months of the program intervention. **Conclusion:** The diabetes mellitus technology program significantly improved competency level and glycemic control among diabetic elderly patients. **Recommendations:** Future research should consider larger-scale studies to integrate competency-based diabetes technology programs for elderly diabetic patients.

Keywords: Diabetes mellitus technology program, Elderly competency, Glycemic control, Mobile application.

Introduction

Advances in digital technology and especially smartphone technology have led to a excess of innovative strategies aiming to improve the self-management skills of elderly patients with diabetes mellitus. Smartphone also enables diabetic elderly patients and related parties in the healthcare sector, such as

doctors and nurses, to access, collect, and manage medical data and information quickly and accurately, and to assist in recommending or supporting decisions for them (Aziz, Sultan, Ramadan & Abdm, 2023) .

Diabetes mellitus (DM) is a common chronic debilitating disease affecting older people, and it is becoming a global health concern. The International Diabetes Federation (IDF) determined the incidence of diabetes as over 422 million people globally and that will rise to 252 million by 2035, making the disease the 6th leading cause of death in 2030. The number of diabetic elderlies is expected to increase to 252.8 million by 2040 (ELabasy, Fouda, Mohamed & EL-Gamal, 2024)

The prevalence of diabetes is expected to increase exponentially in the next 20 years for developing countries. In the last few decades, it is documented that there is increase in the absolute and relative number of elderlies in Egypt. Egypt has 10.9 million people living with diabetes (aged from 20-79 years) in 2021 which expected to be duplicated in 2045 by reaching about 20 million patients with DM (Ghazi, 2022).

The incidence and prevalence of DM is increasing and is expected to continue on an upward trajectory as the adult population with DM ages. Older adults with DM are at high risk of DM-related complications. Complications of DM are divided into micro-vascular and macro-vascular complications. One of the most prominent micro-vascular complications is neuropathy which leading to impotence and diabetic foot disorders. Other complications include cognitive, visual and hearing impairment, as well as hypoglycemia and polypharmacy (Ali & Ghonem, 2019). The burden imposed by diabetes extends beyond financial implications and encompasses long-term complications which significantly impact individuals' quality of life and life expectancy. . (Peng etal., 2024) .

Competency can be defined as having the knowledge and practice, to perform specific activities and make decisions in the face of certain facts or events. Knowledge and practice regarding diabetes have been demonstrated to have an essential role to ensure better management of the disease. Improving diabetic elderly patient's knowledge can help in glycemic control and embraces healthy lifestyles practices. This may include practices such as calorie control, adequate sleep, and consistent physical activity. (Pakpour, Molayi & Nemati, 2024). Nursing role is essential for managing the elderly patients' care with DM; by identifying problems, giving guidance on the disease, and providing health education to make them take responsibility for their self-care. Whereas, the educational resources offered by digital-based nursing interventions can cover a wide range of diabetes-related topics, including proper blood glucose monitoring, insulin administration techniques, foot care, and healthy meal planning. To equip diabetic elderly patients with a holistic understanding of their condition, empowering them to make informed decisions about their health. Moreover, digital-based nursing interventions also provide continuous support and follow-up for diabetic elderly patients, promoting long-term engagement and accountability in self-care practices. (Shaban, Sharaa, Amer & Shaban, 2024).

Significance of the Study

Diabetes Mellitus (DM) is considered as rapidly growing global health problem, the

prevalence of diabetes mellitus in the elderly by continent is as follows: In Middle East and North Africa (MENA) 24.2%, in Africa 8.4% and in Southeast Asia: 13.6% . In North Africa; two prevalence studies were carried out, one in Tunisia which found a prevalence of 27.4% and the other in Algeria which found 26.7% among diabetic elderly patients aged 65 and over (Chami & Khaled, 2022)

Egypt is listed as one of the top ten countries having people living with DM; according to the International Diabetes Federation (IDF), it is documented that there is increase in the absolute and relative number of elderlies in the last few decades in Egypt. The prevalence of DM is increased with age. Surprisingly, prevalence of DM is 24.0% in 2021 among older adults aged between 75–79 years and expected to reach 24.7% by the year 2045 (Ghazi, 2022).

Diabetes mellitus technology, is advancing at a fast pace and offers promises for care enhancement in older adults with DM. Evidence is supporting the use of DM technology in older adults with DM to improved self- management, in-dependency, increase satisfaction and decrease complications of the disease. So, nursing education and training of diabetic elderly patient, needs to be implemented, and patients may require the support from their families to successfully use DM technology (DeCarlo & Aleppo, 2021). Insufficient practice regarding diabetes mellitus leads to poor self-management, skills and poor level of glycemic control which could be linked to the declining health status and low compliance with disease prevention programs. (Sakeus, 2022).

In past decades, the smartphone has been increasingly used for health promotion. Recent studies have demonstrated the impact of using smartphone applications such as using the

Diabetes Under Control (DBEES) to improve the quality of life among diabetic elderly patients and found to be effective in improving health outcomes (Zhao et al. ,2020). So, integrating technology in diabetes management has the potential to provide a higher quality of diabetes care, lower costs and administrative burdens, and greater empowerment for people with diabetes and their caregivers. However, this integration of technology remains at an early stage, and the clinical experience with these technologies among older adults is modest. (Diabetes care, 2023).

Finally, the literature on the use of DM technology in older adults has been limited and many research work published have shown that the diabetic populace do not have enough awareness of diabetes, the proper use of medications, life style modifications, dietary plans, myths associated with insulin and other education programs on health matter (Believe &Alabere, 2022). Hence, this study seeks to identify the effectiveness of patient education by using DM technology in enhancing diabetic elderly competency and glycemic control

Operational definition

In the present study, competency is defined as having functional adequacy and capacity to integrate the knowledge and skills to perform specific activities for diabetic elderly self-care.

Aim of the Study

The aim of the study is to evaluate the effect of diabetes mellitus technology program on elderly competency level and glycemic control.

Research hypotheses

To fulfill the aim of this study the following research hypotheses were formulated:

H.1: Elderly patients with diabetes who will receive the proposed diabetes mellitus technology program (study group) will exhibit higher knowledge mean scores in the post test scores than in the pretest and higher mean score than the control group in the post test.
H.2: Elderly patients with diabetes who will receive the proposed diabetes mellitus technology program (study group) will exhibit higher practice mean score in the post test scores than in the pretest and higher mean score than the control group in the post test.
H.3: Elderly patients with diabetes who will receive the proposed diabetes mellitus technology program (study group) will exhibit higher glycemic control mean score in the post test scores than in the pretest and higher mean score than the control group in the post test.

Methodology

Study Design

This study used a quasi-experimental design with a pre-test/post-test structure involving control and intervention groups. The quasi-experimental approach allowed for comparison between an intervention group that received a diabetes mellitus technology program and a control group receiving standard care through pre- and post-intervention assessments, enabling the researcher to observe any changes in diabetes self-management practices and blood glucose levels (HbA1c) attributable to the program.

Setting

The study was conducted in the inpatient and outpatient clinics at the National Institute of Diabetes and Endocrinology, affiliated with Cairo University, Egypt. This institution was chosen due to its access to a large population of elderly patients receiving care for diabetes mellitus, which enabled the recruitment of participants within the target demographic. The Institute has a therapeutic role for patients with diabetes, thyroid and other endocrine diseases. It has also a preventive role, an educational role as well as a research role. It is composed of 3 buildings; outpatient clinics for diabetic elderly patients, pediatrics' outpatient clinics and nutrition clinics.

Study Sample

A purposive sampling technique was used to select 60 elderly diabetic patients who met specific inclusion and exclusion criteria. **Inclusion Criteria (**aged 60 years and older, elderly with type1 DM or type2 on insulin injection at any stage and elderly or caregiver who owns a smartphone).
Exclusion Criteria (elderly who received a technology program about diabetes and elderly with major disabling learning problems (psychiatric, cognitive or severe visual impairment) that would interfere with completion of study). After screening for eligibility, the 60 participants were randomly assigned into two equal groups: the intervention group (n=30) and the control group (n=30). Random assignment was achieved by allocating odd-numbered participants to the control group and even-numbered participants to the intervention group.

Study tools:

- **Tool I: Structured Interviewing Questionnaire for elderly to including three parts:**

Part (1) Elderly personal data consisted of 10 items such as age, gender, occupation, marital status, level of education, smoking

habits etc... .

Part (2) Past and current medical history formed of 7 items such type of diabetes mellitus, duration of the disease, & comorbidities such as hypertension, cardiac disease etc...

Part (3) Glycated hemoglobin (HbA1C) consisted of 2 items about time for last lab investigation of HbA1C and its result.

- **Tool II: Elderly competency of diabetes mellitus management tool** was assessed through:-

1- Diabetes Knowledge Questionnaire to assess the knowledge of diabetic elderly patients about diabetes mellitus.
2- Observational checklists covering essential diabetes management skills,
A- Insulin-self administration included 15-steps about preparation of insulin injection and technique of insulin injection. B-Diabetic foot routine self-care, which included 12-steps about how elderly could care of their foot through assessment and implementation of foot care. These checklists enabled the researchers to evaluate participants' proficiency and identify areas requiring targeted education and support.

Scoring system. The total score calculated by adding up all the points for tool II. Regarding Diabetes Knowledge Questionnaire, it was ranged from (0-32). While Oobservational checklists were ranged from (0-27). The high score indicated high level of knowledge and practice.

Content Validity

The study tools (Structured interviewing questionnaire for elderly tool & Elderly competency of diabetes mellitus management tool) were tested for content validity and were revised by jury of 3 experts in the field of Community Health Nursing to test its content validity. The resulting alpha coefficient was quantified to the extent to which there is agreement between the experts' ratings of the items. Content validity index (CVI) was 90%.

Tools Reliability

The reliability and internal consistency of the Diabetes Knowledge questionnaire tool with Cronbach's alpha coefficients of 0.70 and 0.87 for the Observational checklist of elderly skills about diabetes mellitus tool, respectively.

Ethical Considerations

The study was approved by the Faculty of Nursing Research Ethics Committee at Cairo University, with permissions also obtained from the administration of the National Institute of Diabetes and Endocrinology (Ethical code:2023-03-04). Diabetic elderly patients were fully informed about the purpose, nature, and procedures of the study, and potential risks and benefits were explained. They were assured of their rights to confidentiality, privacy, and voluntary participation, with the option to withdraw from the study at any stage without repercussions. Written informed consent was obtained from each diabetic elderly patient, following an in-depth explanation of the study in accessible language to ensure comprehension.

Procedure

The study followed a structured four-phase process: assessment, planning, implementation, and evaluation. Each phase was designed to systematically implement and measure the effects of the diabetes technology

program on the participants.

1. **Assessment Phase**

During the assessment phase, baseline data were collected for each diabetic elderly patient during an intervention schedule, including demographic data and medical history. A Blood sample was withdrawn by researchers from diabetic elderly patients after obtaining a written consent and sent to the laboratory to measure Glycated HbA1c levels. Competency in diabetes self-management was also assessed through:- 1-Diabetes Knowledge Questionnaire to assess the knowledge of diabetic elderly patients about diabetes mellitus. 2- Observational checklists covering essential diabetes management skills, such as insulin-self administration and diabetic foot care. These checklists enabled the researchers to evaluate diabetic elderly patients' proficiency and identify areas requiring targeted education and support. Each assessment session took place in the clinic/inpatient and lasted approximately 20–30 minutes.

2.

3. **Planning Phase and DMTP feature.**

Based on the assessment findings, the researchers developed an educational program tailored to the specific needs of elderly diabetic patients. Lewin's Change Model was used as the theoretical foundation for the program to support behavior modification in the elderly population. The theoretical and practical content of the mobile application were created by researchers. While the technical program was designed by an expert in the Communications and Information Technology at SCADA-UK LTD Company.

○ **Application Features:** The "Diabetes & Elderly" mobile application was designed by researchers with elderly usability in mind, including:

1-Educational Content: Information on diabetes basics, symptom recognition (hypoglycemia and hyperglycemia), and lifestyle modifications.
2-Video Demonstrations: Visual guides for insulin injection techniques and diabetic foot care to improve skill acquisition.
3-Reminders and Alerts: Scheduled reminders for blood glucose monitoring, mealtimes, and medication.
4-Tracking and Graphical Data: A feature for logging blood glucose levels, which could display trends in a visual graph, allowing users and their caregivers to track progress over time.

Implementation Phase

The intervention was implemented over seven sessions within a seven-week period, with a mix of theoretical instruction and practical skills.Each session lasted between 20-30 minutes to accommodate diabetic elderly patients' attention spans and avoid cognitive overload. The study were held individually, or with group discussions, in the inpatient or outpatient clinic one day/week from 9am-1pm over 3 months peroid, providing a supportive learning environment. Follow-up support was available remotely through WhatsApp or Zoom if diabetic elderly patients required assistance outside the clinic and for sending results of glycated HA1C test.

○ **Session schedule:**

Session 1: Introduction to the program and the mobile application. Pre-test assessments were conducted, and participants were guided through the app installation and basic navigation. **Session 2:** Knowledge about DM (nutrition, exercise, compliance to

medications). **Session 3:** Knowledge about signs and symptoms of hypoglycemia /hyperglycemia and their management and about DM complications.**Session 4:** Hands-on training on self-insulin administration, covering preparation, injection sites, and technique. Diabetic elderly patients practiced under supervision. **Session 5:** Education on foot care using instructional videos and images in the app. Participants practiced and received feedback on diabetic foot self-care routines. **Session 6:** Guided navigation through the app's main features, with personalized instruction on entering medical data, accessing educational content, and tracking glucose levels. **Session 7:** Summary and final demonstration of the skills covered, including insulin administration and foot care. Post-test assessments were conducted immediately after this session.

4. **Evaluation Phase**

The evaluation phase assessed changes in glycemic control and self-management competency after the intervention. Assessments were conducted using the same study tools immediately post implementation of DMTP and repeated three months later to evaluate the program's sustained effect.

- **Tool I:** Structured interviewing questionnaire for elderly.
- **Tool II:** Elderly competency of diabetes mellitus management tool was assessed through:1-Diabetes Knowledge Questionnaire .2-Observational checklists (self-insulin administration and diabetic foot care).
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Data Analysis

Data analysed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics, including mean, standard deviation, frequencies, and percentages, were used to summarize demographic characteristics, medical data, and baseline competency levels. Inferential statistics were applied to test study hypotheses and examine changes between pre- and post-test results. Specific statistical tests included: iindependent t-tests, paired t-tests and rrepeated measures ANOVA to determine significant differences in competency level and glycemic control over time, accounting for within-group and between-group variability.

Limitations of the study

Some limitations must be acknowledged. The sample size was relatively small and limited to a single setting, potentially limiting the generalizability of the findings. High costs of implementation of the DMTP and performing blood test of HA1C.

Results of The Study:

Table1: Chi square Test Distribution of Elderly Diabetic Patients' Personal Data in The Study and Control Group (n=60).

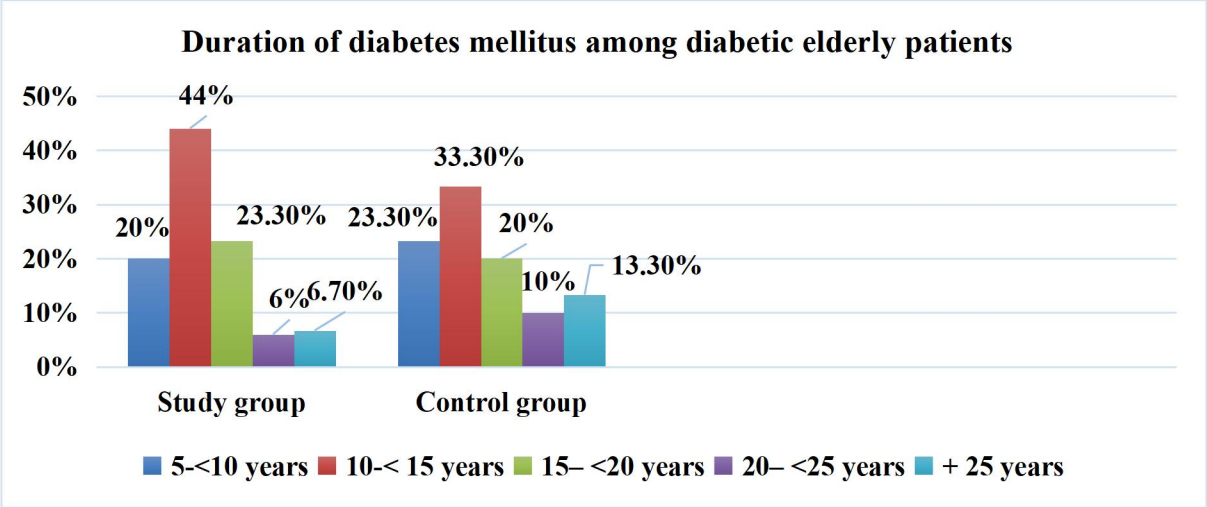
Variables	Study group (n=30)		Control group (n=30)		Chi square test	
	No.	%	No.	%	X^2	P
Age						
60 -	14	46.7	18	60.0	5.5	0.13
65 -	5	16.7	8	26.7		
70-	8	26.7	4	13.3		

75-80	3	10.0	0	0.0		
X±SD	66.13±7.16					
Gender						
Male	14	46.7	14	46.7	0.00	1.00
Female	16	53.3	16	53.3		
Residence						
Rural	11	36.7	12	40	0.071	0.791
Urban	19	63.3	18	60		
Educational level					5.3	0.37
Can read and write	21	70.0	19	63.3		
Primary	2	6.7	5	16.7		
Preparatory	3	10	1	3.3		
Secondary	3	10	1	3.3		
University	1	3.3	3	10.0		
Others	0	0	1	3.3		

Table (1) indicates that, 46.7% of diabetic elderly patients in the study group aged 60 to less than 65 years old while 16.7% aged 65 to less than 70% years old & 26.7% aged 70 to less than 75 years old as compared to 60%, 26.7% &13.3% respectively in the control group with mean age X±SD=66.13±7.16 years old . Regarding gender, 46.7% of diabetic elderly patients were males and 53.5% females in the study group whereas in the control group 46.7% were males and 53.5% females. 70% of the diabetic elderly patients in the study group can read and write, 6.7% primary education and 3.3% university education as compared to 63.3%, 16.7% & 3.3% respectively in the control group.

Table 2: Chi square test distribution of diabetic elderly patient's medical data in the study and control group (n=60).

Medical data	Study group (n=30)		Control group (n=30)		Chi square test	
	No.	%	No.	%	X^2	P
Type of diabetes					0.28	0.59
Type 1	10	33.0	12	40.0		
Type2	20	66.0	18	60.0		
Family history for diabetes mellitus					2.4	0.11
Yes	10	33.3	16	53.3		
No	20	66.7	14	46.7		
Chronic disease					14.4	0.07
Hypertension	14	46.2	10	33		
Heart diseases	17	56.1	11	36.3		
Kidney disease	2	6.6	3	9.9		

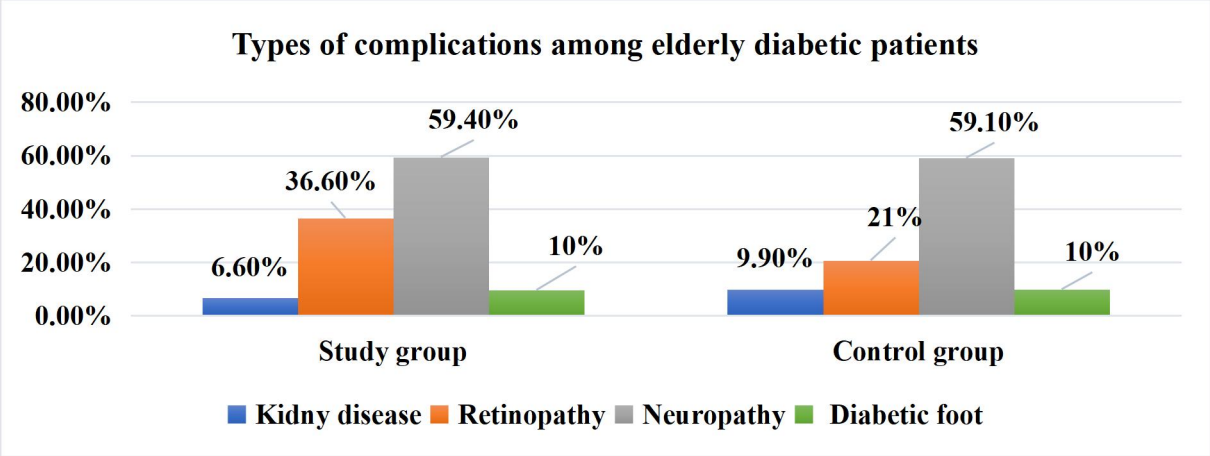


Ophthalmic disease	3	9.9	3	9.9		
Treatment regimen					8.5	0.009
Tablet and insulin	6	20.0	8	26.6		
Insulin	24	80.0	22	73.4		

Table (2) indicates that, 66% of diabetic elderly patients in the study group had type 2 diabetes mellitus and only 33% had type1 while 60% in the control group had type 2 and 40% of them were type 1 . Concerning their family history for DM, 66.7% has no family history and 33.3% had family history in the study group while 46.7% & 53.3% respectively in the control group . 80% of the diabetic elderly patients take insulin injection in the study group while 73.4% of them were in the control group . Moreover, 56.1% of the diabetic elderly patients in the study group had heart disease and 46.2% had hypertension. Otherwise, in the control group 36.3% had heart disease and 33 % had hypertension .

Figure 1. Percentage distribution of diabetic elderly patients regarding duration of disease (n=60).

Figure (1) indicates that, 44% of diabetic elderly patients in the study group were diagnosed with diabetes mellitus for 10 less than 15 years while 23.3% of them were diagnosed with diabetes mellitus for 15 less than 20 years while 33.3% and 20% of them respectively in the control group .



*Responses are not mutually exclusive

Figure 2. Percentage distribution of diabetic elderly patients regarding types of complications (n=60).

Figure (2) shows that, 59.40% of the diabetic elderly patients had neuropathy disease from diabetes mellitus while only 6.60% of them complained of kidney disease in the study group but in the control group 59.10% suffered neuropathy and 9.90% of them had kidney disease.

Table 3: Chi-square test distribution between Duration of Diabetes and Complication Occurrence among study and control groups in pre, post, and follow up (n=60).

Duration of Disease (years)	Complication occurrence					
	Study Group (n=30)		Control Group (n=30)		Chi-square	
					χ^2	p-value
	No.	%	No.	%	14.6	0.005*
5-<10	0	0%	7	23.3%		
10-<15	21	70%	10	33.3%		
15–<20	7	23.3%	6	20%		
20–<25	0	0%	3	10%		
+25	2	6.7%	4	13.3%		

*Significant at p-value < 0.05.

Table (3) illustrates that, there was a significant relationship between the duration of diabetes mellitus and the occurrence of complications among diabetic elderly patients in study and control groups. Moreover, the highest complication rates were observed in diabetic elderly patients with diabetes duration of 10-<15 years, with 70% in the study group and 33.3% in the control group ($\chi 2 = 14.6$, p= 0.005).

Table 4: **F-test distribution; comparing of mean total knowledge scores of the diabetic elderly patients among study and control groups in pre,post, and follow up test (n=60).**

Total mean score of knowledge subscales	Study group (n=30)			ANOVA		Control group (n=30)			ANOVA	
	Pretest	Post test	Follow - up			Pretest	Post test	Follow-up		
	Mean ±SD	Mean± SD	Mean± SD	F	P	Mean ±SD	Mean± SD	Mean±SD	F	P
General knowledge about diabetes mellitus	3.20±1.31	4.07±1.20	3.87±1.14	6.673	.004*	2.67± 1.24	2.37±1.52	2.17±1.29	2.123	0.162
Diagnosis of diabetes mellitus	1.40±1.13	2.93±1.09	2.90±1.01	7.772	.001*	1.00± 1.02	1.47±0.94	1.20±0.82	1.399	0.252
Treatment of diabetes mellitus	1.93±0.91	2.60±0.89	2.43±0.86	4.591	.013*	1.93± 0.91	1.53±0.71	1.93±0.91	2.435	0.094
Diet and exercise	2.73±1.44	3.97±1.22	2.83±1.37	7.801	.001*	2.73± 1.44	2.03±1.34	2.23±1.22	1.263	0.288
Foot care of diabetic elderly patients	2.53±1.01	3.47±1.17	3.37±1.25	6.017	.004*	2.53± 1.01	2.43±1.01	2.13±0.97	0.90	0.41
Complications of diabetes mellitus	2.97±1.10	4.43±1.57	4.40±1.54	6.974	.000*	2.97± 1.10	2.77±0.98	2.88±1.09	1.44	0.24
Total Knowledge	10.30± 2.85	20.13±4.07	18.90± 4.01	3.198	.001*	10.30 ±2.85	10.30±2.85	9.99±2.35	.0127	.793

*Significant at p-value<0.05.

Table (4) shows that, there were significant improvements in the total mean scores of knowledge across all subscales in the study group as compared to the control group at posttest and follow-up tests. For example, the total mean score for general knowledge increased from Mean±SD=3.50±1.31 at pretest to Mean±SD=4.07±1.20 at posttest and Mean±SD=3.87±1.14 at follow-up in the study group (F=.6.673, P= .004).While, in the control group, the mean score was Mean±SD=2.67±1.24 at pretest, Mean±SD=2.37±1.52 at posttest and Mean±SD =2.17±1.29 at follow-up test(F=2.123,P=0.162). The F-values and p-values indicate that, the differences between groups were statistically significant.

Table 5: F-test distribution; comparing of mean total practice scores of the diabetic elderly patients in study and control groups in pre, post and follow-up test (n=60).

Total mean score of practice subscales	**Study group (n=30)**			**ANOVA**		**Control group (n=30)**			**ANOVA**	
	Pretest	**Posttest**	**Follow-up**			**Pretest**	**Posttest**	**Follow-up**		
	Mean± SD	**Mean± SD**	**Mean± SD**	**F**	**P**	**Mean± SD**	**Mean± SD**	**Mean± SD**	**F**	**P**
Diabetic foot self-assessment	0.60±0.86	2.37±1.67	2.37±1.67	14.827	.000*	0.60±0.86	0.90±0.99	0.70±0.80	1.50	0.24
Implementation of foot care	4.20±2.23	7.67±1.94	7.67±1.94	28.872	.000*	3.79±2.10	4.00±2.21	4.00±2.21	2.10	0.15
Preparation of insulin injection	1.13±1.25	3.33±1.77	3.33±1.77	18.566	.000*	1.13±1.25	1.03±1.05	1.13±1.25	1.80	0.18
Technique of insulin administration	4.17±1.32	7.27±1.64	7.27±1.64	40.606	.000*	4.17±1.32	4.17±1.32	4.15±1.30	1.90	0.16
Total practice	10.10±3.45	20.63±4.67	20.63±4.67	9.931	.000*	10.10±3.45	10.10±3.45	10.10±3.45	.036	.665

*Significant at p-value<0.05

Table (5) reports that, the results showed significant improvements of diabetic practice across all subscales among the study group as compared to the control group at posttest and follow-up tests. For example, the study group mean score for diabetic foot self-assessment

increased from Mean±SD=0.60±0.86 at pretest to be Mean±SD =2.37±1.67 at posttest and follow-up test respectively (F=14.827, P=.000), whereas, the control group showed minimal changes Mean±SD=0.60±0.86 at pretest to Mean±SD =0.90±0.99 at posttest and Mean±SD=0.70±0.80 at follow-up test(F=1.50, P=0.24). The F-values and p-values indicate that the differences between groups are highly statistically significant.

Table 6 :McNemar's Test Distribution of Diabetic Elderly Patient's Results of Glycated Hemoglobin (HbA1c) Pretest and Follow up in The Study and Control Group (n=60)

Levels	Study group (n=30)						Control Group (n=30)					
	Pretest		Follow-up		McNemar's Test	P	Pretest		Follow-up		McNemar's Test	P
	No	%	No	%			No	%	No	.%		
Normal	8	26.7	14	46.7	4.5	0.033	5	16.7	4	13.3	5.2	0.022
Intermediate	8	26.7	9	30.0			9	30.0	10	33.3		
High	9	30.0	4	13.3			8	26.7	7	23.3		
Very high-	5	16.7	3	10.0			8	26.7	9	10.0		

Table (6) presents the distribution of glycated hemoglobin (HbA1c) levels among diabetic elderly patients in both the study and control groups, measured at pretest and follow-up. The McNemar test was used to analyze changes in the proportions of HbA1c levels. In the study group, there was a significant increase in the proportion of patients with normal HbA1c levels from 26.7% at pretest to 46.7% at follow-up (McNemar's test, p = 0.033). Similarly, in the control group, there was a significant decrease in the proportion of patients with normal HbA1c levels from 16.7% at pretest to 13.3% at follow-up (McNemar's test, p = 0.02).

Discussion

Concerning diabetic elderly patients' personal data the current study showed that there were insignificant statistical differences (p>0.05) in all personal data (Age group, gender, place of residence, educational level and marital status) between study and control groups which means that the two groups are homogenous and comparable groups due to random assignment of the two group (study and control group). Concerning the mean age of the diabetic elderly patients the current study showed that it was sixty-six years, which aligned with the study done by Gazi, (2022) to estimate the gap between recommendations of guidelines and real-world data regarding control of glycemic state and its associated risk factors at Geriatric and Diabetes Outpatient Clinics of Specialized Medical Hospital, Mansoura University, Egypt and the study reported that the mean age was sixty-six years.

Current study findings revealed that, majority of the study and almost all of the control group reported that, their income is not enough and dependant on pensions or social benefits. These findings goes with Egede et al. (2024), who entitled a study as "Randomized controlled trial of technology assisted case

management in low-income adults with type 2 diabetes: Effect on quality of life and blood pressure". The study reported that, low-income elderly patients with diabetes often experience greater barriers to effective management, including limited access to healthcare resources, restricted medication options, and a higher reliance on family or social support. From the researcher's point of view, such financial limitations may limit access to healthcare services such as testing equipment, there by hindering self-management efforts. Additionally, diabetic elderly patients who live alone may experience isolation or lack of social support, further aggravating challenges in managing diabetes effectively. These findings emphasize the need for diabetes management programs that consider patients' socioeconomic contexts to ensure accessibility and effectiveness.

In relation to diabetic elderly patient's medical data, current study indicated that, almost two third of the diabetic elderly patients had type 2 DM. These findings matched with the result of the study done by Grammes et al, (2023) to analyze predictors for continuous glucose monitoring (CGM) in 6849 diabetes elderly patients aged sixty years and older using insulin therapy during recent years (2019–2021), about more than three quarters of them (5320) were type 2 diabetes mellitus in Germany, Austria, Luxembourg, and Switzerland.

Regarding family history, the current study reported that about more than half of the diabetic elderly patients didn't have family history of diabetes mellitus. This result contradicted with the study done in Sudan by (Elnour et al 2024) on 244 elderly diabetic patients to assess the impact of diabetes self-management education (DSME) on medication adherence and glycemic control in Sudanese adults with type 2 DM before and 3 months after the DSME intervention. The study reported that, majority of the diabetic elderly patients had family history of diabetes mellitus. From the researchers' point of view, the current study finding contradicted with Elnour et al., (2024) whose participants age was ranged from thirty to older than eighty years old. Whereas, the current study participants were sixty years and older with type 1 and almost all of them were type 2 DM which might be caused by unhealthy lifestyle.

Concerning the duration of diabetes mellitus disease, the current study reported that, more than two third of diabetic elderly patients were diagnosed with diabetes mellitus for 10 less than 15 years. This research in the same line with a study done by Egede et al, (2024), who reported that, the mean duration of diabetes for elderly patients was 12.2 years.

In terms of treatment, current study showed that, more than three quarters of the diabetic elderly patients take insulin injection, these results not matched with the results of study done by Yildirim et al., (2023), to examine the relationship between diabetes burden and health-related quality of life at hospital in Istanbul. The study found that, almost two-third of diabetic elderly patients take oral hypoglycemic drugs and only one-third of them take insulin. From the researchers' point of view, the difference in the findings was because of the current study that included only diabetic elderly patients who take insulin only as a line of treatment. Whereas, the other study included diabetic elderly patients who take oral hypoglycemic drugs and insulin injection.

As regard comorbidities, current study's findings revealed that, more than one - third of the study group and almost half of the control group had hypertension and regarding complications from DM , the results found that, more than three quarters of the studied sample had retinopathy and neuropathy , theses findings are congruent with the study done by Yen et al., (2023), to investigate whether the presence of complications and comorbidities was associated with poor health outcomes among older adults with type 2 DM among five-hundred and seventy seven diabetic elderly patients at a hospital in Taipei City. The study found that, almost half of diabetic elderly patients had retinopathy and hypertension .

The study's findings regarding the relationship between diabetes duration and complication rates among elderly patients align with a well-established body of research. Alshahrani et al. (2023) demonstrated that a longer duration of diabetes is associated with an increased likelihood of complications, which can significantly impact the quality of life. In this study, the highest complication rates were observed in elderly patients with diabetes duration of 10–15 years, emphasizing the progressive nature of diabetes complications over time. This trend underscores the importance of early and consistent self-management practices to mitigate the risks associated with long-term diabetes. The diabetes technology program's emphasis on self-monitoring and proactive management can play a critical role in helping elderly patients delay the onset or reduce the severity of complications, potentially preserving their quality of life.

As regard knowledge of diabetic elderly patients, current study revealed an observed improvement in elderly knowledge (at P=0,001). This result aligns with Pakpour, Molayi, and Nemati (2024), who demonstrated that, increasing diabetes-related knowledge directly healthier lifestyle practices. From the researchers' point of view, the mobile application provided not only educational materials on diabetes management but also guides for insulin administration, foot care, and lifestyle adjustments, which likely contributed to the significant increases in the competency scores of the study group. This result highlights the need for practical, interactive, and tailored educational resources in diabetes care, which can help diabetic elderly patients better understand and implement necessary self-care behaviours.

Furthermore, this study found that, diabetic elderly patients in the study group significantly improved specific skills, including self-insulin injection and diabetic foot care, which are essential to diabetes self-management. These results are consistent with those of Chen and Wu (2023), who observed that, digital self-management programs significantly enhanced foot care practices in diabetic elderly patients. Proper insulin administration and diligent foot care are critical to preventing complications, such as diabetic neuropathy and foot ulcers, which are prevalent in elderly diabetic populations and often lead to more severe health outcomes. From the researchers' point of view, the mobile application used in this study included visual aids and demonstrations, which likely facilitated better learning and retention of these essential self-care skills. As diabetic foot care is complex and requires consistent practice, digital tools that provide guidance may be particularly valuable for diabetic elderly patients who may otherwise find it

challenging to execute such care routines effectively.

Regarding glycemic control, diabetic elderly patients in the study group showed notable improvement in HbA1c levels, with a significant increase in the number of patients achieving normal HbA1c levels (at P=0.033). These fiindings matched with study done by Zhao et al., (2020) found that, mobile applications targeting health behaviors significantly improved health outcomes, including blood glucose levels, among elderly patients in a randomized controlled trial. From the researchers' point of view, the mobile app facilitated timely reminders for glucose monitoring, recorded blood glucose data, and offered real-time feedback. These functionalities can help diabetic elderly patients consistently monitor and regulate their blood glucose levels, there by promoting better glycemic control. The findings suggest that, such applications may reduce the challenges of manual record-keeping and memory recall, common barriers to diabetes management among older adults.

The current study has many strengths:-1-A new innovative technology based intervention to enhance diabetic elderly patients self-management .2-Incorporation of the practical part in the program.3-Reduce healthcare costs and alleviate the burden on healthcare systems is a crucial area for future investigation that, can reduce hospitalization rates and emergency visits, which are often costly for both patients and healthcare systems.4-Smartphone applications may reduce the challenges of manual record-keeping and memory recall, common barriers to diabetes management among older adults.

Conclusion

This study demonstrates that, a diabetes mellitus technology program significantly improved self-management competency and glycemic control among diabetic elderly patients. The program's success suggests that, digital tools, specifically mobile applications designed for diabetes management, hold promise as an effective and accessible intervention for older adults struggling with diabetes self-care. By integrating technology-based programs into routine diabetes care, healthcare providers may better support diabetic elderly patients in managing their condition and enhancing their quality of life.

Recommendations

Based on the study findings, it is recommended the following:

1- Replicate larger-scale studies are recommended to include diabetic elderly patients on oral hypoglycemic drugs or complicated cases across diverse Egyptian regions.

2- Conduct future biopsychosocial DMTP researches for diabetic elderly patients.

3-Raising diabetic elderly patients' awareness about diabetes technology programs.

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