Effect of Educational Guidelines on Diabetic Patients' Knowledge, Attitude, and Self-Efficacy Regarding Use of Artificial Pancreas

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ABSTRACT

Context: Artificial pancreas has a beneficial effect on controlling blood glucose levels. Nurses play a crucial role in helping diabetic patients through educational guidelines that increase their knowledge and improve their attitude and self-efficacy regarding the use of artificial pancreas as a new technology to help continuously control blood glucose levels.

Aim: to evaluate the effect of educational guidelines on diabetic patients' knowledge, attitude, and self-efficacy regarding using artificial pancreas.

Methods: A quasi-experimental study design (pre/post-test) was used to achieve the aim of this study. The study was conducted in the medical department and outpatient medical clinic at Benha University Hospital. A purposive sample of 100 adult patients with type 1 diabetes mellitus were admitted to the mentioned setting during the study period. Three tools were used. Patients' Assessment Questionnaire comprises two parts: Patients' personal data and health history of the disease and patients' knowledge assessment. Patients' attitude Rating Scale regarding the use of the artificial pancreas, and Self-Efficacy Scale.

Results: The result reported a significant difference in the satisfactory knowledge level of patients from 15% pre-educational guidelines to 57% post-educational guidelines. Significant differences in the total level of positive attitude increased from 22.0% pre-educational guidelines to 63.0% post-guidelines, and significant differences between the mean self-efficacy scores of the studied patients regarding their perception and confidence in the ability to use the artificial pancreas as it increased from 1.8±0.7 pre to 3.1±0.4 post the educational guidelines implementation.

Conclusion: Educational guidelines have a positive effect on improving diabetic patients' knowledge, attitude, and self-efficacy regarding the use of artificial pancreas. The study recommends implementing ongoing educational programs and workshops for diabetic patients on artificial pancreas.

Keywords: Educational guidelines, diabetes mellitus, knowledge, attitude, self-efficacy, artificial pancreas

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1. Introduction

Diabetes mellitus is a multi-causal metabolic disorder defined as persistent hyperglycemia and disruption of carbohydrate, lipid, and protein metabolism due to abnormalities in insulin production, insulin action, or both. This abnormality eventually causes serious problems to the heart, blood vessels, eyes, kidneys, and nerves. When the pancreas produces too little or no insulin to control blood sugar type 1 diabetes develops. Access to affordable treatment, such as insulin, is critical to the survival of people with diabetes. An international goal has been set to halt the rise in diabetes and obesity by 2025 *(WHO, 2018).*

Type 2 diabetes occurs due to insufficient insulin production by the pancreas or the body's developing resistance to insulin. Injecting insulin and, on occasion, glucagon helps individuals with type 1 diabetes and other patients with type 2 diabetes control their blood sugar. It is essential for reducing the risk of long-term consequences like blindness, renal failure, and cardiovascular disease *(Singh et al., 2022).*

According to the World Health Organization (WHO), diabetes affects over 422 million people globally, most of whom reside in low and middle-income nations, and the disease is directly responsible for 1.5 million fatalities annually. Over the past decades, there has been a steady rise in the number of cases and incidences of diabetes *(WHO, 2024).*

Patients with type 1 diabetes now have much better circumstances because of continuous glucose monitoring, made possible by advancements in clinical care and new tools *(Ramirez-Rincon et al., 2016).* An artificial pancreas was recently created to help these patients' glucose management even more. Insulin production is insufficient in those with type 1 diabetes to preserve appropriate glucose levels and energy

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balance. They need exogenous insulin to be administered via a pump, a needle injection, or, more recently, an automated insulin delivery system, sometimes known as an artificial pancreas *(Voelker, 2016).*

An artificial pancreas is a three-part device designed to replicate how a functioning pancreas regulates blood sugar. Patients with type 1 diabetes benefit most from using an artificial pancreas, which automatically checks blood glucose levels, determines how much insulin is required at different times, and provides the necessary quantity. Most artificial pancreas systems need the user to count and record the quantity of carbs the body consumes during meals. Because some insulin is administered automatically and some is administered depending on the information input, these artificial pancreas systems are referred to as "hybrid" systems. Patients with type 1 diabetes may more easily maintain their blood glucose levels, which assists in managing blood glucose levels during the day and at night *(Haidar et al., 2020).*

The artificial pancreas may lessen the strain of daily self-management while enhancing glucose regulation *(Bally et al., 2017).* Its two major advantages are a shorter duration of hypoglycemia and an enhanced glucose time in the desired range. Both advantages are more noticeable at night than during the day *(Trevitt et al., 2016).*

Self-efficacy is the capacity for an individual to act effectively or their belief and assurance that they can manage their health *(Van der ven et al., 2003).* It influences adherence to therapy, which influences therapeutic results *(Mishalia et al., 2011).* Patients with higher levels of self-efficacy are more likely to adhere to treatment recommendations for chronic illnesses and are better able to modify their behavior to improve their capacity for self-care *(Zeng et al., 2014),* so nurses play a crucial role in helping diabetic patients through educational guidelines to increase their knowledge, improve their attitude and self-efficacy toward the use of artificial pancreas as a new technology to help control blood glucose levels and prevent developing other health problems, particularly in type one diabetic patients.

2. Significance of the study

Egypt ranked ninth in the world in 2019, according to the International Diabetes Federation (IDF), with over 8,850,400 cases of diabetes and a prevalence of 16.2% among adults (14.2% for men and 18.2% for women). It is expected to reach sixth place with 13.1 million cases by 2035. *(Abouzid et al., 2022)*. Furthermore, according to the IDF, 451 million individuals globally had diabetes mellitus (DM) in 2017, and if appropriate preventive measures are not taken, that number is predicted to increase to 693 million by 2045. In Egypt, diabetes is growing in severity as a clinical and public health concern, with expensive treatment for a range of consequences *(Arabic Association for the Study of Diabetes and Metabolism, 2022).*

This study will contribute to the body of knowledge by providing evidence on the effectiveness of educational guidelines in enhancing diabetic patients' understanding, attitudes, and self-efficacy concerning using artificial pancreas technology. By assessing the impact of structured education on these key factors, the research aims to inform healthcare professionals and policymakers about the importance of patient education in improving the management and outcomes of diabetes through advanced technological interventions.

3. Aim of the study

The study aimed to evaluate the effect of educational guidelines on diabetic patients' knowledge, attitude, and self-efficacy regarding using artificial pancreas.

3.1 Research hypotheses

H1- Diabetic patients' knowledge score regarding the use of artificial pancreas could be improved in a significant way after the implementation of the educational guidelines than before.
H2- Diabetic patients' positive attitude toward the use of artificial pancreas could be significantly improved after the implementation of the educational guidelines than before.
H3- The self-efficacy of diabetic patients could be positively improved after the implementation of the educational guidelines than before.

4. Subjects & Methods

4.1. Research Design

The study's aim was achieved using a quasi-experimental research design (pre/post-test). A quasi-experimental design is a tool for establishing a cause-and-effect relation between independent and dependent variables *(Maciejewski, 2020).*

4.2. Study setting

Under the auspices of Benha University, Qalubia Governorate, Egypt, the study was carried out in the hospital's inpatient medical department and outpatient medical clinic. The department, located on the sixth floor, included four rooms with 22 beds and was equipped to care for diabetic patients and meet their treatment needs.

4.3. Subjects

Over four months of data collection, a purposive sample of 100 adult patients with type 1 diabetes mellitus met the following inclusion criteria: Patients with uncontrolled blood glucose levels, no psychological disorders, and were admitted to the previously indicated setting during the study.

4.4. Tools of data collection

Three instruments were employed to gather data.

4.4.1. Patients' Assessment Questionnaire

The researchers created it after carefully examining all relevant references, including *Tauschmann and Hovorka (2017), Breton et al. (2020), and Haidar et al. (2020).* It is divided into two sections and was written in Arabic for the patients' ease of understanding:
Part one: Patients' personal data and health history of the disease, including their gender, age, educational level, residence, duration since diagnosing type 1 diabetes, and last Glycated Hemoglobin (HbA1c) levels.
Part two: The patients' knowledge assessment (pre/post implementing the educational guidelines) was designed to

assess patients' knowledge regarding the artificial pancreas and included 20 multiple-choice questions that covered general knowledge about the artificial pancreas, including the mechanism of action, parts of the artificial pancreas, types, using instructions, and maintenance.

Scoring system

One score was given for the correct answer, and zero scores for the do not know/incorrect answer. Total scores were ranged from 0-20. The patients' total scores were summed, converted into percent, and classified as satisfactory knowledge level if the score was ≥75%, average knowledge level from 50% to 74%, and unsatisfactory knowledge level if the score <50%.

4.4.2. Patients' Attitude Rating Scale

It was designed to assess patients 'attitudes regarding the use of the artificial pancreas (pre/post-implementing the educational guidelines). It included six statements adapted from *Rasbach et al. (2015)* and *Morrison and Weston (2013).*

Scoring system

Each statement was scored one if the answer was not sure, two if may be, and three if sure. The total scores were ranged from 1-18. Total patients' scores were summed and then categorized into negative attitude toward using artificial pancreas if the scores were (6-10), average if the scores were (11-14), and positive attitude if the scores were (15-18).

4.4.3. Patient Self-Efficacy Scale

This part assessed patients' perception and confidence in using the artificial pancreas. It was adopted from *Schwarzer and Jerusalem (1995)* and includes five statements.

Scoring system

It is a five-response Likert scale with responses ranging from not confident at all (1) to somewhat confident (2), moderately confident (3), very confident (4), and extremely confident (5). The total scores were summed, and the mean was used to measure the effect of the guidelines.

4.4.4. Developed Educational Guidelines

The researchers designed it after reviewing the relevant literature *Russell et al. (2014); Breton et al. (2020); Haidar et al. (2020); Tauschmann and Hovorka, (2017).* It contains information related to the artificial pancreas, its mechanism of action, its parts and types, using instructions, and maintenance for type 1 diabetic patients. It was written in simple Arabic and supplemented by illustrative pictures to help the patients understand the content.

4.5. Procedures

Tools validity: Five nursing professionals from Benha University's medical-surgical department reviewed the data-collecting tools to assess the contents' appropriateness, organization, comprehensiveness, clarity, and relevancy.

Tool reliability: The consistency of the tools was assessed using Cronbach's Alpha coefficient test which yielded results of 0.78 for the knowledge part, 0.83 for the attitude section, and 0.86 for the self-efficacy scale.

Ethical considerations: The Benha Faculty of Nursing Scientific Research Ethics Committee granted study approval before beginning the study. Legal letters from the dean of Benha University's Faculty of Nursing were submitted, and the hospital directors and head managers of medical departments and outpatient medical clinics were granted official approvals for collecting data. Additionally, patients were asked for their verbal and written consent after being told about the study's purpose; participation is optional, and they can withdraw without repercussions. They received guarantees that the data would be kept private and anonymous and only be utilized for the benefit of the patients and the research.

Pilot study: Ten patients with type 1 diabetes participated in a pilot study to evaluate the validity of the educational guidelines, the applicability and clarity of the study tool, the feasibility of the research process, and the time needed for data collection. Based on the findings of the pilot study, no changes were made. Therefore, the study included the patients who had participated in the pilot trial before the commencement of data collection.

Fieldwork: Data was collected in the following sequence:

Data was gathered from the beginning of December 2023 to the end of March 2024, and the instructional guidelines were implemented. Data were gathered twice: Once prior to the implementation of educational guidelines to establish baseline assessments of patients' knowledge, attitudes, and self-efficacy regarding the use of artificial pancreas and once following the implementation of the guidelines to determine the impact on patients' knowledge, attitudes, and self-efficacy.

Assessment phase (baseline data): Once the researchers explained the study aim to all participants in simple Arabic words. Each patient was interviewed individually using a patient assessment questionnaire concerning personal data, medical history, and the patient's knowledge to evaluate their actual knowledge about the artificial pancreas. Before implementing the guidelines, they were asked about their attitude and self-efficacy regarding using an artificial pancreas as a baseline data assessment.

Planning phase (educational guidelines development): The researchers created instructional guidelines based on assessment phase data to help patients become more knowledgeable, self-assured, and positive about using an artificial pancreas.

Implementation phase: The two sessions comprising the instructional guidelines lasted between thirty and forty-five minutes each, with time allotted for discussion based on the patient's requirements and health status. During the study period, the researcher worked three times a week in the morning and afternoon shifts in the clinical environment, which included the medical department and outpatient clinics. Prior to and during the adoption of the educational guidelines, patients underwent assessments.

Adding informative visuals to the Arabic text enhanced the patient's comprehension of the recommended instructions. Various pedagogical approaches were employed in the sessions, such as videos, images, and PowerPoint presentations, to improve patient education on the usage of artificial pancreas.

To obtain the relevant data, three to five patients were in each group of twenty groups. The researchers provided comments, addressed queries, and reiterated the acquired knowledge.

At the start of the first session, patients received orientation on the educational guidelines, their purpose, and how these guidelines would affect their understanding of using an artificial pancreas. After the first session, patients were told of the time of the following one. The second session began with a recap of the previous session's topics and goals. It also concluded with reviewing the session's contents and requesting input to ensure the patients received the most possible benefit.

Session one included orientation and explanation of the reason, the importance of the guidelines, and general knowledge of the artificial pancreas comprising various aspects such as general information about the artificial pancreas, mechanism of action, its parts and types, using instructions, and maintenance for diabetic patients. Session two included a quick summary of all the material provided to patients to address their inquiries regarding the artificial pancreas and its use.

Evaluation phase: Tools I, Tool II, and Tool III were used to evaluate the patient's knowledge, attitude, and self-efficacy as soon as the guidelines were implemented.

4.6. Data analysis

The acquired data were tabulated and statistically evaluated using an IBM computer and the statistical software for social science (SPSS Inc., Chicago, IL) (version 25). The mean and standard deviation were used to represent numerical data. Frequency and percentage were used to convey qualitative data. The difference and relationship between the qualitative variables were investigated using the chi-square test. A statistically significant p-value was defined as ≤0.05, and a highly significant p-value as ≤0.001.

5. Results

Table 1 shows that male patients constitute 65%; the age distribution indicated that 41% were from 20 to less than 30 years old, and 33% were between 30 and 40. The patients' educational backgrounds were diverse, with 40% having secondary education and 33% holding a bachelor's degree. 72% of patients resided in rural areas.

Table 2 shows that 38% of the studied patients were diagnosed with diabetes in less than three years and 35% in more than five years. 63.0% of the patients' average levels of accumulated Glycated Hemoglobin (HbA1c) levels for the last three months ranged from 7.5-<8, 27% of them had average levels from 7-<7.5, and a minimal percentage of the sample their average levels exceeded 8 (10%).

Table 3 shows statistically significant differences between pre-and post-educational guidelines mean scores for all knowledge items, with p-values of 0.0001. Patients had relatively low mean scores in knowledge items before the educational guidelines, with mean and standard deviation 1.8±0.8 for their knowledge about artificial pancreas types and the indication of each one and 2.7±0.5 for their knowledge about using and maintaining instruction. While posting the educational guidelines, there was a substantial increase in mean scores to 3.9±0.6 and 4.3±0.4, respectively.

Table 4 shows a statistically significant difference between the total knowledge levels of the studied patients regarding the artificial pancreas pre- and post-educational guidelines. The result reported a significant improvement in the satisfactory level of knowledge from 15% to 57% pre- and post-educational guidelines implementation. 54% of the patients had unsatisfactory levels of knowledge of pre-educational guidelines, which decreased to 18% after implementing the guidelines.

Table 5 shows a significant difference between the pre- and post-guideline mean scores for all attitude statements, with p-values of 0.0001. Patients exhibited relatively low mean scores for each attitude statement at pre-educational guidelines, ranging from 1.2 to 1.6. In contrast, post-educational guidelines showed a significant increase in mean scores across all attitude statements, with post-guidelines scores ranging from 2.1 to 2.5.

Table 6 shows that studied patients exhibited a significant positive shift in their attitudes toward the artificial pancreas post the educational guidelines (p=0.00001). The total level of positive attitude increased from 22.0% pre-the educational guidelines to 63.0% post-intervention.

Table 7 shows significant differences between the mean self-efficacy scores of the studied patients regarding their perception and confidence in their ability to use the artificial pancreas pre- and post-educational guidelines, with a p-value of 0.00001.

Table 8 shows no statistical relation between patients' knowledge level about artificial pancreas and their personal data in pre-educational guidelines implementation. At the same time, there is a statistically significant difference related to educational level and residence post-educational guidelines implementation p-value is ≤0.05. Bachelor's degree holders had the highest percentage of satisfactory ratings, followed by secondary and primary education levels. The result reveals no significant relation between gender and knowledge levels as p=0.7 pre- and p=0.9 post the educational guidelines implementation; males have a higher percentage of satisfactory and average ratings than females pre-implementation of educational guidelines. Rural areas had a higher percentage of unsatisfactory ratings level of knowledge than urban areas, where p≤ 0.05.

Table 9 finds that the correlation coefficient (r) of 0.71 indicates a highly statistically significant positive relationship between total knowledge and self-efficacy, with a p-value of 0.001. Similarly, the correlation coefficient of 0.68 indicates a highly significant positive relationship between self-efficacy and total attitude (p= 0.001).

Table (1): Frequency and percentage distribution of studied patients' data (n=100).

Patient data	N	%
Gender		
Male	65	65.0
Female	35	35.0
Age		
20-<30	41	41.0
30-<40	33	33.0
40-50	26	26.0
Mean±SD	38.97±9.02	
Education		
Primary	27	27.0
Secondary	40	40.0
Bachelor	33	33.0
Residence		
Rural	72	72.0
Urban	28	28.0

Table (2): Frequency and percentage distribution of the studied patients' health history (n=100).

Patient's health history	N	%
Duration since diagnosed		
<3 years	38	38.0
3-5 Y	27	27.0
More than five years	35	35.0
Last Glycated Hemoglobin (HbA1c) levels		
7-<7.5 %	27	27.0
7.5-<8 %	63	63.0
>8 %	10	10.0

Table (3): Comparison between the mean score of the studied patients' knowledge regarding the artificial pancreas before and after the educational guidelines (n=100).

Level of knowledge about artificial pancreas	Pre	Post	T	p
	Mean±SD	Mean±SD		
General knowledge about artificial pancreas	2.5±0.6	4.1±0.3	11.7	0.0001
Mechanism of action	1.9±0.8	4.3±0.3	13.1	0.0001
Parts of artificial pancreas	2.1±0.4	3.7±0.4	11.3	0.0001
The function of its parts	2.1±0.4	3.7±0.4	11.3	0.0001
Types of artificial pancreas	1.8±0.8	3.9±0.6	11.9	0.0001
The indication of each type	1.8±0.8	3.9±0.6	11.9	0.0001
Using & Maintenance instruction	2.7±0.5	4.3±0.4	10.7	0.0001

Table (4): Comparison of the studied patients' total knowledge before and after the educational guidelines (n=100).

Total Levels of knowledge	Pre		Post		X^2	p
	No.	%	No.	%		
Satisfactory	15	15.0	57	57.0		
Average	31	31.0	25	25.0	43.1	0.00001
Unsatisfactory	54	54.0	18	18.0		

Table (5): Comparison between the mean score of the studied patients' attitudes regarding using the artificial pancreas pre-and post-educational guidelines (n = 100).

Variables	Pre	Post	T	p
	Mean±SD	Mean±SD		
I am open to incorporating the artificial pancreas into my diabetes management regimen.	1.5±0.4	2.3±0.3	5.4	0.0001
I have confidence in the safety and dependability of artificial pancreas technology.	1.3±0.5	2.1±0.6	5.3	0.0001
I am convinced that utilizing the artificial pancreas would enhance my overall quality of life.	1.2±0.3	2.2±0.4	6.3	0.0001
I feel assured that I can efficiently adjust to and utilize the artificial pancreas.	1.4±0.3	2.4±0.4	6.1	0.0001
The prospective advantages of the artificial pancreas surpass any reservations I may harbor.	1.6±0.4	2.3±0.5	5.2	0.0001
I hold a positive outlook on the potential beneficial effects of the artificial pancreas on managing diabetes.	1.4±0.5	2.5±0.3	5.8	0.0001

Table (6): Comparison between the total levels of the studied patients' attitudes regarding using the artificial pancreas pre- and post-educational guidelines (n = 100).

Levels of attitude	Pre		Post		X^2	p
	No.	%	No.	%		
Positive	22	22	63	63		
Average	31	31	18	18	35.1	0.0001
Negative	47	47	19	19		

Table (7): Comparison between the mean score of the studied patients' self-efficacy regarding their ability to use the artificial pancreas pre- and post-educational guidelines (n=100).

Variables	Pre	Post	T	P
	Mean±SD	Mean±SD		
Adjusting basal insulin rates on the artificial pancreas	1.6±0.4	2.9±0.9	10.6	0.0001
Understanding and interpreting glucose data displayed on the artificial pancreas screen	1.9±0.2	3.3±0.8	9.01	0.0001
Understanding troubleshooting technical issues (e.g., connectivity problems) with the artificial pancreas	1.7±0.4	2.8±1.1	7.6	0.0001
Responding appropriately to alerts or alarms from the artificial pancreas device	1.4±0.8	2.9±0.9	8.3	0.0001
Adapting to changes in insulin requirements or device settings based on personal health status or activity level	1.5±0.6	3.2±0.7	11.2	0.0001
Total self-efficacy	1.8±0.7	3.1±0.4	12.2	0.0001

Table (8): Correlation between the studied patients' personal data and their knowledge levels pre- and post-educational guidelines (n=100).

Variables		Satisfactory 15		Average 31		Unsatisfactory 54		X^2	P	Satisfactory 57		Average 25		Unsatisfactory 18		X^2	p
		N	%	N	%	N	%			N	%	N	%	N	%		
Gender																	
Male	65	11	16.9	20	30.8	34	52.3	0.5	0.7	37	56.9	16	24.6	12	18.4	0.3	0.9
Female	35	4	11.4	11	31.4	20	57.2			20	57.1	9	25.7	6	17.1		
Education																	
Primary	27	4	14.8	6	22.3	17	62.9			10	37.0	11	40.7	6	22.2	14.6	0.005
Secondary	40	4	10	15	37.5	21	52.5	3.3	0.5	20	50.0	10	25.0	10	25.0		
Bachelor	33	7	21.2	10	30.3	16	48.4			27	81.8	4	12.1	2	6.0		
Residence																	
Rural	72	9	12.5	23	31.9	40	55.6	1.2	0.5	34	47.2	22	30.5	16	22.2	10.0	0.006
Urban	28	6	21.4	8	28.6	14	50			23	82.1	3	10.7	2	7.1	3	

Table (9): Correlations between the total level of studied patients' knowledge with their attitude and self-efficacy.

Items	Self-efficacy	
	r	P
Total knowledge	0.71	0.001
Total attitude	0.68	0.001

6. Discussion

The current era of intensive insulin therapy places substantial demands on patients with type 1 diabetes. Therefore, the current study aimed to evaluate the effect of educational guidelines on the knowledge, attitude, and self-efficacy of diabetic patients regarding the use of artificial pancreas. The study revealed that around two-thirds of the studied patients were males and the most resided in rural areas. It shows that about two-thirds of the studied patients' average last-glycated hemoglobin (HbA1c) ranged from 7.5 to <8 %. The fact that most of the studied patients fall within this specific range indicates relatively poor glycemic control among these patients over the last three months. The current study was supported by *Yahiya et al. (2023)*, who reported that about two-thirds of diabetic patients suffered from poor glycemic control. Along the same line, *Atallah et al. (2020)* evaluated the management of DM in Jordan and Lebanon and noticed poor blood sugar control. They suggested the need for more comprehensive DM management. However, according to *Ragheb et al. (2016)*, over two-thirds of the patients in the study expressed satisfaction with the management plan and good blood sugar control. The current study's patients' poor glycemic control suggested the need for educational guidelines to enhance their understanding, perspective, and sense of self-efficacy about using an artificial pancreas to control their condition and avoid complications.

The current study shows that less than one-fifth of the patients had a suitable level of understanding regarding the artificial pancreas prior to the educational guidelines. This low awareness level negatively impacts their attitude and perception of the device. In the same line, *Bolks (2014)* Indicated that diabetic patients had poor awareness of the artificial pancreas, and this affected the acceptance level. These findings were consistent with *Pauley et al.'s (2021)*

findings that diabetes-related technology has advanced significantly in recent years and that, irrespective of socio-demographic data, all patients perceive impediments to technology use due to low understanding.

The current study shows that the educational guidelines effectively improved the diabetic patients' levels of knowledge regarding artificial pancreas. This improvement may be referred to the comprehensive contents and various pedagogical approaches employed in the sessions. These findings were supported by *Okafor et al. (2023)*, who examined the impact of an educational intervention on the self-efficacy of people with diabetes mellitus in Southeast Nigeria. Their study found that the program significantly improved participants' knowledge scores. The current findings also aligned with the findings of *Gildersleeve et al. (2017),* who found that providing patients and caregivers with instructions was a useful way to raise knowledge of the artificial pancreas and assure its safe usage. These findings support the first research hypothesis.

In the current study, most patients' attitudes toward the artificial pancreas were unfavorable. As the data showed, about one-fifth of the respondents had only an optimistic outlook. This outcome could be explained by the patient's lack of understanding regarding the artificial pancreas. *Pauley et al. (2021)* corroborated this finding by claiming that a barrier to the use of the artificial pancreas was the patients' and their families' negative attitudes. However, according to *Marigliano et al. (2023),* around half of the patients in the study scored higher when it came to accepting the usage of an artificial pancreas. The difference between their research and the current study may be due to the patient's awareness level.

The current study shows that following the implementation of the educational guidelines, there was a considerable improvement in attitudes toward using artificial pancreas. About one-fifth of patients had a positive attitude before the instructions, whereas two-thirds did so after that. This improvement could be attributed to the patients' basic and intelligible education during the guidelines' delivery. *Alghadeer et al. (2019)* discovered that most healthcare professionals and diabetic patients had a negative attitude toward using insulin pumps and lacked basic knowledge about the therapy, supported the current study by pointing out that professional meetings and educational programs about the fundamentals of insulin pump therapy could help increase acceptance of the artificial pancreas. Similarly, *Hafez et al. (2024)* investigated the attitudes, awareness, and obstacles of diabetic patients about using artificial pancreas; they revealed satisfactory attitudes among the participants. These results support the second research hypothesis.

According to the current study, there was a statistically significant change in the mean self-efficacy of the patients concerning their perception and confidence in the ability to use the artificial pancreas pre and post- guidelines implementation. The observed outcome may be explained by the beneficial impact of the educational guidelines provided to the patients that improved their self-efficacy. These results aligned with the findings of *Rasbach et al. (2015)*, who examined the self-efficacy of parents and youth about continuous glucose monitoring and found that workshops and training programs can effectively raise self-efficacy. The current study is also consistent with *Hettiarachchi et al.'s (2022)* findings that patients with diabetes had higher levels of self-efficacy when they utilized simulators based on various physiological models. These findings provide credence to the third research hypothesis.

Additionally, there is a significant relationship between the patients' knowledge levels and their educational level and residence post-educational guidelines implementation. As noted, bachelor's degree holders had the highest percentage of satisfactory ratings knowledge, to prove that increasing the level of education positively affects perception and gaining of knowledge. Patients residing in rural areas had a higher percentage of satisfactory rating level of knowledge than urban areas in this study explains the fact that most of the patients in the study were from rural places.

The current study shows a statistically significant positive correlation between self-efficacy and overall knowledge. Similarly, the correlation coefficient shows a robustly positive association between overall attitude and self-efficacy. These findings show that patients' level of knowledge significantly influences their attitude and perception, directly affecting their self-efficacy toward using artificial pancreas. These findings were consistent with those of *Hafez et al. (2024),* who found that a diabetic patient's attitude and acceptance of an artificial pancreas were greatly influenced by their degree of knowledge.

7. Conclusion

Following the implementation of the educational guidelines, diabetic patients' knowledge about the use of artificial pancreas increased statistically, improving their attitude and self-efficacy regarding its use.

8. Recommendations

- Implement ongoing educational programs and workshops for diabetic patients focusing on using artificial pancreas.
- Presence of printed posters for diabetic patients about using artificial pancreas to increase awareness.
- Propose further research to include a larger sample and diverse settings such as different healthcare facilities and geographical regions to enhance representativeness

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