



Effect of insulin adherence educational application on adherence and glycemic control in diabetes mellitus patients

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ARTICLE INFO

Article history:

Received Feb 13, 2025
Revised Feb 20, 2025
Accepted Feb 28, 2025

Keywords:

Diabetes Mellitus;
Educational Application;
Glycemic Control;
Insulin Adherence.

ABSTRACT

Diabetes mellitus is a chronic disease that requires lifelong management. Patient adherence to insulin use and glycemic control are crucial factors in diabetes mellitus management. However, low adherence and limited knowledge about insulin usage remain common issues. This study aims to evaluate the effect of the Insulin Adherence Educational Application on insulin adherence and glycemic control in patients with type 2 diabetes mellitus. This study employed a pre-experimental design with a pre-test and post-test without a control group. A total of 18 patients with type 2 diabetes mellitus at Prof. Dr. Margono Soekarjo Hospital were selected using purposive sampling. Data collection was conducted through questionnaires and glycemic level examinations. Paired t-test and Wilcoxon test were used for data analysis. The results showed a significant increase in family support, insulin adherence, and glycemic control after the intervention using the educational application ($p < 0.05$). The Insulin Adherence Educational Application effectively enhances family support, insulin adherence, and glycemic control in patients with type 2 diabetes mellitus. This research provides education, an Android application (aksi patas) to patients suffering from diabetes mellitus, which includes interesting features, especially about diabetes mellitus.

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1. Introduction

Diabetes mellitus (DM) is a condition characterized by hyperglycemia and metabolic disorders of carbohydrates, fats, and proteins due to an absolute or relative deficiency in insulin action and/or secretion. Common symptoms of DM include polydipsia, polyuria, polyphagia, weight loss, and tingling sensations. Indonesia ranks fourth in the world in the number of DM cases (Irianto, 2024). The prevalence of DM in Indonesia increased from 1.1% in 2020 to 2.4% in 2023. Risk factors include non-modifiable factors such as gender, age, and genetics, as well as modifiable factors such as smoking, body mass index, waist circumference, knowledge level, physical activity, and alcohol consumption (Simanjuntak et al., 2020). DM is known as a "silent killer" because it can damage organs such as the eyes, heart, kidneys, and lungs, and cause serious complications like gangrene, stroke, and vascular

abnormalities (Parangin-angin & S., 2023). One of the common complications is diabetic ulcers, which can lead to amputation if blood glucose control is not optimal (Raufa et al., 2023).

The management of DM requires a holistic approach involving lifestyle changes, the use of oral hypoglycemic agents, and insulin therapy. Insulin is generally administered subcutaneously in the abdomen, arms, thighs, and buttocks, with the abdomen being the fastest absorption site (Apriliana, 2022). To prevent irritation and lipohypertrophy, injection sites should be rotated every two days with a minimum distance of 2 cm from the previous site (Suwanti et al., 2021). The success of insulin therapy largely depends on patient adherence, which is influenced by their understanding of injection techniques. Non-adherence to treatment is a major cause of failure in blood glucose control (Sembiring, 2021; Ulfa Aulia, 2020). Contributing factors include lack of knowledge, forgetting to inject insulin, and improper injection techniques (Apriliana, 2022; Nugroho et al., 2023). Research indicates that proper diabetes management can reduce the risk of chronic complications by 20–30%, while every 1% reduction in HbA1c can decrease the risk of microvascular complications by 37% (Raufa et al., 2023). However, patient understanding of insulin use remains low (Aryani et al., 2022; Indra Hizkia et al., 2024).

A survey at the East Surabaya Public Health Center showed that 54.35% of type 2 diabetes patients did not adhere to prescribed medication regimens (Widiyoga et al., 2020). Interviews with ten patients at the diabetes endocrinology clinic revealed that seven patients had uncontrolled blood glucose levels due to non-adherence to injection schedules, while three adherent patients successfully controlled their blood sugar levels (Indra Hizkia et al., 2024). Patient and family rejection of insulin therapy often stems from a lack of understanding (Aryani et al., 2022). To address this issue, various educational strategies such as drug information services (PIO), counseling, brief reminders, and the use of audiovisual media have been implemented (Apriliana, 2022; Widiyoga et al., 2020). Audiovisual media can enhance patient comprehension by combining visual and auditory elements (Widiyoga et al., 2020).

Previous studies have demonstrated the effectiveness of application-based education in improving patient adherence. Apriliana (2022) found that the use of an educational application increased insulin adherence by up to 80%. Nugroho et al. (2023) reported that educational videos improved injection techniques in 75% of patients. Meanwhile, Aryani et al. (2022) noted that using an application with image and video-based education reduced patients' average HbA1c by 0.8% within three months. However, these studies did not specifically assess the impact of an audiovisual-based educational application designed to meet the local needs of patients at RSUD Prof. Dr. Margono Soekarjo, indicating a research gap that this study aims to fill.

This study focuses on the development and evaluation of the Insulin Compliance Education Application (AKSI PATAS) application, which aims to improve insulin adherence and glycemic control in DM patients. The primary difference between this study and previous research lies in the use of an application with locally tailored features that align with the patients' cultural and linguistic contexts in the research area. This research is important as it can contribute to reducing non-adherence rates and DM-related complications through an innovative educational approach. The objectives of this study are to: (1) measure the effect of the AKSI PATAS application on insulin adherence, (2) assess its impact on glycemic control, and (3) provide recommendations for effective educational strategies for use in similar healthcare facilities.

The AKSI PATAS application menu contains diabetes screening, daily diabetes monitoring, insulin injection videos, quizzes, and diabetes diet. Because it has a research object that can provide the data and information needed, patients from mild complications to severe complications are at the Prof. Margono Soekarjo Hospital. The limitation in previous research was that it only discussed insulin injection educational videos, and in this research I added a variety of research education and more complete features about insulin injection compliance and glycemic control in DM patients.

2. Methods

This study employed a pre-experimental design using a pretest-posttest model without a control group (Sugiyono, 2015). The respondents consisted of a single intervention group that was observed before (pretest) and after the intervention (posttest). The sample was selected using purposive sampling,

considering specific criteria and predetermined factors such as time, cost, and labor limitations (Saryono, 2011).

The operational definitions of the variables in this study include various factors such as gender, age, education, occupation, family support, insulin use compliance, glycemic control, and insulin education application (Nursalam, 2017). The instruments used included questionnaires, the HDFSS family support scale, the MMAS-8 compliance measurement tool, and laboratory tests to assess glycemic control in type 2 DM patients.

The research began in November 2023 at the Endocrine Metabolic Diabetes Polyclinic of RSUD Prof. Dr. Margono Soekarjo Purwokerto, which is part of the internal medicine department handling diabetes mellitus (DM) cases. The sample consisted of 18 respondents. Univariate analysis was conducted to describe the characteristics of each variable.

From the results of the sample calculations that I have calculated, 18 respondents have met the requirements for conducting research. The research I have carried out here is to educate those who were previously non-compliant to become compliant in using insulin and glycemic control by providing an Android-based educational application, ensuring that they are compliant in this research by having a separate data base icon in the application to see indicators or monitor blood sugar input data every day, so that patients can be more compliant in insulin injections. This research was carried out at the endocrine polyclinic at Prof. Dr. Margono Hospital, patients were given a pre-test questionnaire and downloaded the application on Playstore, after education and downloading of the application (patas action) the following month the patient was met again at the endocrine polyclinic at Prof. Dr. Margono Hospital for evaluation and given the post-test questionnaire again.

3. Results and Discussion

Results

a. Demographic Characteristics of Respondents

Table 1.
Distribution of Respondent Demographic Characteristics

Demographic Characteristics	n (%)
Gender	
Malei	6 (33.3)
Female	12 (66.7)
Age	
Early Adulthood (23-35 years)	3 (16.7)
Late Adulthood (36- 45 years)	4 (22.2)
Early Elderly (46-55 years)	3 (16.7)
Late Elderly (56-80 years)	8 (44.4)
Education Level	
Elementary High School	1 (5.6)
Junior High School	1 (5.6)
Senior High School	9 (50.0)
Higher Education	7 (38.9)
Occupation	
Retired Civil Servant	5 (27.8)
Teacher	1 (5.6)
Secretary	1 (5.6)
Entrepreneur	5 (27.8)
Student	1 (5.6)
Doctor	1 (5.6)
Midwife	1 (5.6)
Housewife	3 (16.7)
Total	18 (100)

Table 1 indicates that most respondents were female (12 respondents, 66.7%), aged 56-80 years (8 respondents, 44.4%), had completed senior high school (9 respondents, 50.0%), and were retired civil servants and entrepreneurs (5 respondents, 27.8%).

b. Family Support

Table 2.
Distribution of Family Support Frequency

Family Support	Total (n)		Percentage (%)	
	Pre-test	Post-test	Pre-test	Post-test
High	3	18	16.7	100
Low	15	0	83.3	0
Total	18	18	100	100

Table 2 indicates that most respondents reported low family support during the pre-test (before) when the Insulin Compliance Education Application (AKSI PATAS) was not yet introduced, with 15 respondents (83.3%). However, after the post-test (after) the application was introduced, family support was reported as high by all 18 respondents (100%).

c. Insulin Use Compliance

Table 3.
Distribution of Insulin Use Compliance Frequency

Insulin Use Compliance	Total (n)		Percentage (%)	
	Pre-test	Post-test	Pre-test	Post-test
High	1	2	5.6	11.1
Medium	2	15	11.1	83.3
Low	15	1	83.3	5.6
Total	18	18	100	100

Table 3 indicates that most respondents reported low insulin use compliance during the pre-test (before) when the Insulin Compliance Education Application (AKSI PATAS) was not yet introduced, with 15 respondents (83.3%). However, after the post-test (after) the application was introduced, insulin use compliance was reported as moderate by 15 respondents (83.3%).

d. Glycemic Control

Table 4.
Distribution of Glycemic Control Frequency

Glycemic Control in Type 2 DM Patients	Total (n)		Percentage (%)	
	Pre-test	Post-test	Pre-test	Post-test
Controlled	0	5	0	27.8
Not Controlled	18	13	100	72.2
Total	18	18	100	100

Table 4 indicates that most respondents had uncontrolled glycemic control during the pre-test (before) when given the Insulin Adherence Educational Application (AKSI PATAS), with 18 respondents (100%). After the post-test (after) the application, 13 respondents (72.2%) still had uncontrolled glycemic control.

- e. Analysis of the Effect of Insulin Education Application on Family Support in Type 2 DM Patients, the normality test for family support was conducted using the Shapiro-Wilk test because the number of respondents was ≤ 50 . The data was found to be normally distributed with a significance value of $0.446 > \alpha = 0.05$, so the statistical test used was the paired t-test.

Table 5.
Effect of Insulin Education Application on Family Support

Variable	Mean \pm SD	Difference \pm SD	P. Value
Pre-test Family Support (n=18)	26.00 \pm 18.620	-40.722 \pm 19.712	0.000
Post-test Family Support (n=18)	66.72 \pm 7.858		

Table 5 shows that the average family support during the pre-test (before) the application of the Insulin Adherence Educational Application (AKSI PATAS) was 26.00 with a standard deviation of 18.620, while during the post-test (after) the application of AKSI PATAS, it was 66.72 with a standard deviation of 7.858. The mean difference in family support before and after was -40.722 with a standard deviation of 19.712. The paired t-test results showed a p-value of $0.000 < \alpha = 0.05$, indicating a significant difference in family support before and after implementing the Insulin Adherence Educational Application (AKSI PATAS).

- f. Analysis of the Effect of Insulin Education Application on Insulin Use Compliance in Type 2 DM Patients, the normality test for insulin adherence was performed using the Shapiro-Wilk test since the number of respondents was ≤ 50 . The results indicated that the data were not normally distributed, with a significance value of $0.001 < \alpha = 0.05$. Therefore, the Wilcoxon test was used for statistical analysis.

Table 6.
Effect of Insulin Education Application on Insulin Use Compliance

Variable	Median (Min-Max)	P. Value
Pre-test Insulin Compliance (n=18)	1 (0-8)	0.000
Post-test Insulin Compliance (n=18)	7 (5-8)	

Table 6 shows that the median of insulin use compliance during the pre-test (before) the application of the Insulin Adherence Educational Application (AKSI PATAS) was 1, with a minimum-maximum range of 0-8, while during the post-test (after) the application of AKSI PATAS, the median was 7, with a minimum-maximum range of 5-8. The Wilcoxon statistical test results showed a p-value of $0.000 < \alpha = 0.05$, indicating a significant difference in insulin adherence before and after the implementation of the Insulin Adherence Educational Application (AKSI PATAS). There were 0 respondents with lower compliance after the application, 3 respondents with no change, and 15 respondents with improved compliance.

- g. Analysis of the Effect of Insulin Education Application on Glycemic Control in Type 2 DM Patients, the normality test for glycemic control was conducted using Shapiro-Wilk because the number of respondents ≤ 50 . The data followed a normal distribution with a significance value of $0.446 > \alpha = 0.05$, leading to the use of a paired t-test for statistical analysis.

Table 7.
Effect of Insulin Education Application on Glycemic Control

Variable	Median (Min-Max)	P. Value
Pre-test Glycemic Control (n=18)	1 (0-8)	0.000
Post-test Glycemic Control (n=18)	7 (5-8)	

Table 7 shows that the mean glycemic control during the pre-test (before) the application of the

Insulin Adherence Educational Application (AKSI PATAS) was 249.67 with a standard deviation of 50.278, while during the post-test (after) the application of AKSI PATAS, The average value was 147.39, with a standard deviation of 36.434. The mean difference in glycemetic control before and after was 102.278, with a standard deviation of 63.147. The paired t-test statistical analysis resulted in a p-value of $0.000 < \alpha = 0.05$, confirming a significant difference in glycemetic control before and after the implementation of the Insulin Adherence Educational Application (AKSI PATAS).

Respondent characteristics were dominated by women, aged 56-80 years, high school graduates or equivalent, and retired civil servants and entrepreneurs. Analysis of demographic characteristics was carried out on 18 diabetes mellitus sufferers. The results of the study showed that the average age of respondents was 53.9 years with a minimum age of 23 years and a maximum age of 78 years and the most common age group was 56-80 years, as much as 44.4%. The research results showed that the majority of respondents had a high school education of 50.0%. The research results show that the majority of respondents are retired civil servants and entrepreneurs, 27.8%.

The research results showed that the majority of family support was at the pre-test with an average score of 26 with a standard deviation of 18,620 and at the post-test with an average score of 66.72 with a standard deviation of 7,858. The results of the study showed that most of the insulin use compliance in type 2 DM patients was at the pre-test with an average score of 2.67 with a standard deviation of 2.635 and at the post-test with an average score of 6.83 with a standard deviation of 0.707.

The research results showed that the majority of respondents regarding glycemetic control at the pre-test were Uncontrolled, 18 respondents (100%) and at the post-test, 13 respondents (72.2%) were Uncontrolled, meaning there was an increase of 5 respondents in the Controlled group. The results of the paired t test show that there is an influence of the application of insulin adherence education (patas action) on family support for type 2 DM patients in the endocrine metabolic diabetes polyclinic at Prof. Hospital. Dr. Margono Soekarjo Purwokerto with a p value of $0.000 < \alpha = 0.05$. The results of the Wilcoxon test show that there is an influence of the application of insulin adherence education (patas action) on insulin adherence in type 2 DM patients at the endocrine metabolic diabetes polyclinic at Prof. Hospital. Dr. Margono Soekarjo Purwokerto with a p value of $0.000 < \alpha = 0.05$.

The results of the paired t test show that there is an influence of the application of insulin adherence education (patas action) on glycemetic control in type 2 DM patients at the endocrine metabolic diabetes polyclinic at Prof. Hospital. Dr. Margono Soekarjo Purwokerto with a p value of $0.000 < \alpha = 0.05$. After providing an educational application for compliance with insulin use (patas action), glycemetic control in type 2 DM patients became better. There is an influence of the application of insulin adherence education (patas action) on family support for type 2 DM patients at the endocrine metabolic diabetes polyclinic at Prof. Hospital. Dr. Margono Soekarjo Purwokerto with a p value of $0.000 < \alpha = 0.05$.

Discussion

This section discusses the impact of the Insulin Adherence Educational Application (AKSI PATAS) on insulin adherence and glycemetic control in diabetes mellitus patients at RSUD Prof. Dr. Margono Soekarjo.

a. Univariate Analysis

1. Respondents' Demographic Characteristics, the respondents' characteristics were predominantly female, aged 56–80 years, high school graduates or equivalent, and retired civil servants and entrepreneurs. The analysis of demographic characteristics was performed on 18 patients with type 2 diabetes mellitus. The findings indicated that the majority of respondents were female, accounting for 12 individuals (66.7%). The average age of the respondents was 53.9 years, ranging from 23 to 78 years. The most prevalent age group was 56–80 years, comprising 8 respondents (44.4%). Additionally, most respondents had completed high school education, with 9 individuals (50.0%), while the predominant occupations were retired civil servants and entrepreneurs, totaling 5 respondents (27.8%).
2. Family Support, the study results showed that family support during the pre-test (before using the AKSI PATAS insulin adherence educational application) was mostly low, with 15 respondents

(83.3%). However, during the post-test (after using the AKSI PATAS application), family support was high among all 18 respondents (100%). This demonstrates a notable improvement in family support from the pre-test to the post-test. This finding aligns with Hensarling (2009), who stated that family support is the strongest indicator of positive self-care outcomes in diabetes patients. Family support includes support from parents to children, children to parents, siblings to siblings, spouses, and grandchildren to grandparents. Family support for diabetes patients is demonstrated by their adherence to treatment regimens, including physical exercise.

3. Insulin Adherence, the study results showed that the majority of insulin adherence among type 2 diabetes patients was low during the pre-test (before using the AKSI PATAS insulin adherence educational application), with 15 respondents (83.3%). During the post-test (after using the AKSI PATAS application), adherence improved to a moderate level in 15 respondents (83.3%).
 4. Glycemic Control, the study results showed that most respondents had uncontrolled glycemic levels during the pre-test (before using the AKSI PATAS insulin adherence educational application), with all 18 respondents (100%) classified as "Uncontrolled." During the post-test (after using the AKSI PATAS application), 13 respondents (72.2%) remained "Uncontrolled," meaning that there was an improvement in glycemic control for 5 respondents who transitioned to the "Controlled" group.
- b. Bivariate Analysis
1. The Effect of the Insulin Educational Application on Family Support in Type 2 Diabetes Patients, a paired t-test showed that the AKSI PATAS insulin adherence educational application had a significant effect on family support for type 2 diabetes patients at the metabolic-endocrine diabetes clinic of RSUD Prof. Dr. Margono Soekarjo Purwokerto, with a p-value of $0.000 < \alpha=0.05$. After using the AKSI PATAS application, family support for type 2 diabetes patients improved. This is because the purpose of family support is mutual care, meaning the family serves as a source of warmth and support. These theories align with the findings of this study, which indicate that families who act as caregivers can provide effective support for family members with chronic illnesses.
 2. The Effect of the Insulin Educational Application on Insulin Adherence in Type 2 Diabetes Patients, a Wilcoxon test showed that the AKSI PATAS insulin adherence educational application significantly affected insulin adherence in type 2 diabetes patients at the metabolic-endocrine diabetes clinic of RSUD Prof. Dr. Margono Soekarjo Purwokerto, with a p-value of $0.000 < \alpha=0.05$. After using the AKSI PATAS application, no respondents had lower adherence than before, 3 respondents remained the same, and 15 respondents showed improved adherence. The researcher concluded that health education through the AKSI PATAS insulin adherence educational application was highly effective in increasing patients' knowledge, leading to a significant improvement in insulin adherence among 15 respondents.
 3. The Effect of the Insulin Educational Application on Glycemic Control in Type 2 Diabetes Patients, a paired t-test showed that the AKSI PATAS insulin adherence educational application had a significant effect on glycemic control in type 2 diabetes patients at the metabolic-endocrine diabetes clinic of RSUD Prof. Dr. Margono Soekarjo Purwokerto, with a p-value of $0.000 < \alpha=0.05$. After using the AKSI PATAS application, glycemic control in type 2 diabetes patients improved. This aligns with the purpose of health education, which is to enhance knowledge, change attitudes, and guide behavior toward desired health outcomes. According to Efendi & Larasati (2017), the goal of health education is to equip individuals with knowledge about health sciences, develop positive values and attitudes toward a healthy life, acquire skills in health-related activities, and establish healthy habits in daily life.

4. Conclusion

The respondents had an average age of 53.9 years, ranging from 23 to 78 years, with a majority being female (66.7%), mostly high school graduates (50%), and employed as retired civil servants or entrepreneurs (27.8%). Before the implementation of the Insulin Adherence Educational Application (AKSI PATAS), family support was low for most respondents (83.3%). However, post-intervention, family

support increased significantly to a high level for all participants (100%). Insulin adherence also improved after the intervention, with 83.3% of respondents showing moderate adherence. Glycemic control, initially uncontrolled in all respondents, showed improvement, with 5 participants moving to the controlled category after using AKSI PATAS. Statistical analysis revealed significant effects of AKSI PATAS on family support (p-value = 0.000), insulin adherence (p-value = 0.000), and glycemic control (p-value = 0.000), indicating the effectiveness of the intervention. This study contributes to understanding how educational interventions can enhance patient care in diabetes management. However, the study's limitations, such as the small sample size and lack of a control group, should be considered. Future research could explore additional factors influencing insulin adherence and glycemic control, and develop further educational tools, such as videos, to improve patient education and counseling in managing type 2 diabetes. The development of this educational application to be realized well requires funds and support from various parties. Previously, this application had been included in the Playstore but due to limited funds it was temporarily taken down. This application can be a reference for diabetes mellitus sufferers.

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